DISCUSSION PAPER SERIES

DP16253
(v. 2)

The Falling Price of Cement in Africa

Fabrizio Leone, Rocco Macchiavello and Tristan Reed

DEVELOPMENT ECONOMICS

INDUSTRIAL ORGANIZATION

MACROECONOMICS AND GROWTH

CEPR

ISSN 0265-8003

The Falling Price of Cement in Africa

Fabrizio Leone, Rocco Macchiavello and Tristan Reed

Discussion Paper DP16253
First Published 14 June 2021
This Revision 14 June 2021

Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

The Falling Price of Cement in Africa

Abstract

The average price of cement in Africa was the highest of any continent in 2011, but by 2017 had fallen by 34.6 percent, the largest decline in the world, according to data from the International Comparison Program. An empirical industry equilibrium model distinguishes between the fundamental drivers of differences in prices across countries: demand elasticity, costs, conduct, and entry. The model reveals that in 2011 average prices in Africa included the highest mark-ups and marginal costs in the world. The price decline in 2017 is accounted for by a rapid increase in the number of firms producing cement, which lowered mark-ups, and a declining marginal cost of production. Improvements in the quality of infrastructure or institutions could explain declining marginal costs, as could new technology installed by new entrants. Estimated fixed costs of entry are positive, though not systematically higher in Africa compared to other continents, suggesting equally free entry in the presence of a minimum efficient scale that does not vary across continents. These results suggest that the small size of national markets rather than regulation of entry explains why the price of cement was so high in Africa. As the market has grown, prices have fallen.

JEL Classification: L13, L41, L61, O11

Keywords: Africa, cement, Entry, intermediate goods price, market power, oligopoly

Fabrizio Leone - faleone@ulb.be
ECARES - Université Libre de Bruxelles

Rocco Macchiavello - r.macchiavello@lse.ac.uk
London School of Economics and Political Sciences and CEPR

Tristan Reed - treed@worldbank.org
World Bank

The Falling Price of Cement in Africa*

Fabrizio Leone†, Rocco Macchiavello‡, and Tristan Reed§

†Université Libre de Bruxelles, ECARES
‡London School of Economics, BREAD, CEPR
§World Bank Development Economics, Research Group

May 2021

Abstract: The average price of cement in Africa was the highest of any continent in 2011, but by 2017 had fallen by 35 percent, the largest decline in the world, according to data from the International Comparison Program. An empirical industry equilibrium model distinguishes between the fundamental drivers of differences in prices across countries: demand elasticity, costs, conduct, and entry. The model reveals that in 2011 average prices in Africa included the highest mark-ups and marginal costs in the world. The price decline in 2017 is accounted for by a rapid increase in the number of firms producing cement, which lowered mark-ups, and a declining marginal cost of production. Improvements in the quality of infrastructure or institutions could explain declining marginal costs, as could new technology installed by new entrants. Estimated fixed costs of entry are positive, though not systematically higher in Africa compared to other continents, suggesting equally free entry in the presence of a minimum efficient scale that does not vary across continents. These results suggest that the small size of national markets rather than regulation of entry explains why the price of cement was so high in Africa. As the market has grown, prices have fallen.

JEL Classification: L13, L41, L61, O11

Keywords: Africa, cement, entry, intermediate goods price, market power, oligopoly

*Thank you very much to Penny Goldberg, Aart Kraay, Phil Haile, Eduardo Morales, Tommaso Porzio, Bob Rjikers, Daria Taglioni, Catherine Thomas, and seminar participants at the World Bank Development Economics Research Group for helpful comments, and to Jan Gabriel Oledan for exceptional research assistance. Reed acknowledges a grant from the 2019 funding round of the Knowledge for Change III Program.
Email: faleone@ulb.be, r.macchiavello@lse.ac.uk, treed@worldbank.org.

1 Introduction

Figure 1 shows that the prices of several goods, including intermediate inputs such as cement, steel rebar, urea fertilizer and broadband internet, are highest on average in the world's poorest countries, many (though not all) of which are today in Africa. This fact is important for at least two reasons. First, higher prices for intermediate goods can slow economic growth (Jones 2011). Second, this evidence runs counter to the general tendency for prices to rise with national income (Kravis et al. 1982; Summers and Heston 1991)—a cornerstone of modern international macroeconomics.

The explanation for this unexpected pattern in price levels is not certain. One view is that higher prices reflect a higher cost of production (see, e.g., Hsieh and Klenow 2007). An alternative view suggests that higher prices might instead reflect higher mark-ups and less competition (see, e.g., Acemoglu 2008). The appropriate policy response, if any at all, critically hinges on quantifying the relative importance of these distinct views. Such a quantification exercise is complicated by lack of consistent data on prices, quantities, and market structure across countries.

This paper distinguishes between the two explanations in the case of Portland cement, a sector that is both of intrinsic relevance but also affords a number of distinct methodological advantages. Cement is a critical input in the construction sector and thus in aggregate investment with the average economy spending 1.3 percent of aggregate income on it in our data. We are able to combine a recent panel of internationally comparable prices from the 2011 and 2017 rounds of the International Comparison Program with a directory of cement plants in 96 countries on all continents. These data allow us to estimate an industry equilibrium model in the style of the empirical industrial organization literature (see Bresnahan 1989; Berry, Gaynor and Scott Morton 2019) and to separately quantify drivers of costs and mark-ups in the global cement industry.

Our analysis yields three main results. First, in an industry characterized by a relatively homogeneous product, differences in marginal costs and mark-ups across countries contribute roughly an equal share to the average difference in prices across countries. Despite substantial international trade, there is large dispersion in prices. Africa stands out because it had the highest US dollar cement price of any continent in 2011. Africa had higher prices in 2011 because it had the highest average marginal costs of any continent, and the highest average mark-up, at 58 percent.

Second, reductions in marginal costs explain three-fifths of the decline in the cement price in Africa, and roughly half of the price decline in the rest of the world. In 2017, the cement price in Africa had fallen more than in any other continent, by 34.6 percent. This decline is not explained by changes in tariffs and could be due in part to improvement in the quality of institutions or infrastructure. Counterfactual improvements in rule of law and road density show these could lead to lower prices by lowering marginal costs. Lower costs could also come from new entrants over the same time period, some of which are foreign owned firms, and may have brought with them lower cost technology as they installed new capacity.

Third, the African cement industry is characterized by relatively free entry in the presence of minimum efficient scale that does not vary across continents. Estimated fixed entry costs are positive, but not systematically higher in Africa compared to other continents, and have not changed between 2011 and 2017. Declines in mark-ups explain two-fifths of the decline in the price in Africa and are attributed to the number of firms on the continent almost doubling, increasing competition. Since changes in entry costs cannot explain this change, it must be attributed to a growing market size.

These results derive from a simple theoretical framework to explain differences in price levels across countries in a homogeneous good industry with market power, which we illustrate. We model each country as a distinct market, and consider a standard model of a cross-section of markets with symmetric firms in which identification of mark-ups and costs is well understood (e.g., Berry and Waldfogel 1999). The model includes the four building blocks that determine the level of prices: (i) a cement demand equation that pins down the demand elasticity, (ii) a marginal costs equation, (iii) a market conduct parameter that specifies the strategic behavior of firms, and (iv) an entry equation that identifies fixed costs.

The structural model is estimated in a transparent manner, as suggested by Andrews, Gentzkow and Shapiro (2017). The elasticity of the demand curve is identified from the exclusion of a cost variable (in our case, the price of diesel) from the demand equation. Under this assumption, we reject that the demand curve is weakly identified, and mark-up estimates are not sensitive to violation of the exclusion restriction. A 'conduct parameter' is identified from a 'demand rotator' (the share of construction in GDP) that alters the demand elasticity and is excluded from costs, following the argument of Bresnahan (1982).[1] Estimates of a conduct parameter that varies across space reveal that greater geographic concentration of urban centers within a national market lowers mark-ups, and that multimarket contact between firms increases mark-ups, as predicted by theory (Syverson 2004; Bernheim and Whinston 1990).

Though our evidence comes from a single industry, our findings have implications for our understanding of differences in market structures across countries (Mitton 2008; Bain 1966).[2] While the World Bank's Doing Business Indicators indicate that regulation of entry is prominent in Africa (Djankov, La Porta, Lopez-de Silanes and Shleifer 2002; World Bank 2020a), entry costs revealed by actual firm entry decisions are no different in Africa than in the rest of the world. In contrast to theories suggesting Africa's relatively low income per capita is explained by 'oligarchies' led by major producers that use political power to erect excessive entry barriers against new entrepreneurs (e.g., Acemoglu 2008), this result is consistent with an alternative theory in which minimum efficient scale is the same across

[1] A conduct parameter characterizes the competitive equilibrium concept, conditional on the number of firms and the demand elasticity. Specifically, different values of the parameter distinguish between perfect competition, non-cooperative Cournot competition between multiple firms, and a cartel of multiple firms that cooperate (collude) to price as a monopolist. See, e.g., Atkin and Donaldson (2015) and Genesove and Mullin (1998).

[2] Market structure may account for higher prices in lower income countries that have been documented in several critical sectors including generic pharmaceuticals (Silverman, Keller, Glassman and Chalkidou 2019) and mobile internet (Faccio and Zingales 2017). Africa has had higher than average prices of cement, fertilizer and telecommunications services (Begazo, Licetti, Nyman and Villaran 2016) and ready-mix concrete (Kirchberger and Beirne 2020). Hassan (2016) shows that among the poorest African countries the overall price level falls with national income.

continents and market size plays a comparatively more important role in accounting for differences in economic development (e.g., Murphy, Shleifer and Vishny 1989; Goldberg and Reed 2020). In this theory, it is primarily aggregate demand rather than rules and regulation that guide firm decision-making (for a similar argument see Hallward-Driemeier and Pritchett 2015). This theory of development can rationalize decelerating progress against extreme poverty in countries such as Rwanda, which have substantially improved their Doing Business indicators but nonetheless remain small markets.

In providing these facts, this paper contributes to several literatures, hopefully demonstrating the value of bringing methods from empirical industrial organization to answer questions in economic development. Recent empirical studies of competition in a developing country context focus on single regions or countries and primarily agricultural industries (e.g., Casaburi and Reed 2019; Bergquist and Dinerstein 2020; Rubens 2020; Zavala 2020; Macchiavello and Morjaria 2021; Bai 2021). We study a manufacturing industry in a large sample of countries, thus following a few industry case studies that also use international data (e.g., Goldberg and Verboven 2001; Kalouptsidi 2014; Atkin and Donaldson 2015; Asker, Collard-Wexler and De Loecker 2019).

Given its economic importance and methodological appeal, it is not surprising that the cement industry has been the focus of a large empirical industrial organization literature. Most studies have sought to describe the industry equilibrium in specific country, for instance as in Brazil (Salvo 2010), India (Bhayani 2010), Norway (Röller and Steen 2006) and the United States (Jans and Rosenbaum 1996; Newmark 1998; Ryan 2012; Miller and Osborne 2014; Fowlie, Reguant and Ryan 2016).[3] In contrast, our goal is to explain cross-country variation in prices, a focus of the macroeconomic literature on the price of investment (Easterly 1993; Jones 1994; Hsieh and Klenow 2007).

[3]From a methodological point of view, this paper is related to a literature on cartel conduct. Most empirical papers studying cartels have information on cartel operating rules and the exact times at which the cartel operated. This allows them to specify market conduct exactly when the cartel is active (e.g., Igami 2015; Röller and Steen 2006). In contrast, we test for collusion when conduct is not known ex-ante, though case study evidence suggests cartels have operated in several jurisdictions.

Three closely related papers also use the global cement directory we use in the this paper to study cross-country differences in the cement industry. Ghemawat and Thomas (2008) describe the strategic decision of multinational cement firms to enter national markets and the resulting firm concentration, though do not estimate costs or mark-ups. Begazo, Licetti, Nyman and Villaran (2016) highlight unusually high prices of cement in Africa using IPC data.

More recently, Kirchberger and Beirne (2020) also combine the global cement directory with IPC data like we do in this paper. They show that cement prices are higher in countries with fewer firms. The authors then embed an oligopoly model of the cement industry into a general equilibrium model and show that the steady-state capital stock in poorer countries is most sensitive to changes in markups in the cement industry. Despite using the same data, our paper differs from (and complements) theirs in three important ways. First, we structurally estimate an industry equilibrium model in the style of the empirical industrial organization literature (see Bresnahan 1989; Berry, Gaynor and Scott Morton 2019) rather than reduced-form relationships between market structure and prices in the spirit of the 'structure-conduct-performance'.[4] Second, differences in modeling approach (and thus in identification strategy), lead to rather different scope and focus: while we do not attempt to link market structure in the cement industry to macro aggregate capital stock, our model allows us to separately quantify drivers of costs and mark-ups in the global cement industry and perform a richer set of counterfactuals. Finally, we focus on the rapid *decline* of prices in some of the poorest countries, rather than exclusively on cross-sectional differences in price *levels*. This distinction, supported by the model's estimates, leads to rather different conclusions with respect to drivers of cross-country differences in market structure.

[4]See Berry, Gaynor and Scott Morton (2019) for a recent discussion of the difficulties in interpreting reduced-form relationships between market structure and mark-ups (and, a fortiori, prices).

2 Industry Background, Data, and Motivating Facts

We begin with background on the industry, focusing on technology and firms' competitive conduct, and then describe the data used in this study. The section closes by describing in detail our motivating fact, that the price of cement in Africa, which was once especially high relative to other continents, has fallen substantially between 2011 and 2017.

2.1 Industry Background

The cement industry is an important case study because of its importance in global expenditure and investment, and because of the salience of market power in the industry. We study the market for grey Portland cement (hereafter cement). For clarity, Portland cement is the most widely used type of hydraulic cement, which hardens when combined with water. Cement is a tradable input to ready-mix concrete, which is cement mixed with gravel, sand, and water. In contrast to cement, ready-mix concrete is truly non-tradable because it is a service (i.e., mixing and delivery). In our sample, countries import on average 41 percent of cement consumption, and produce the rest domestically. Several countries import all cement consumption in the absence of any domestic production capacity.

Figure 2 shows installed domestic production capacity plotted against cement consumption, where markers indicate values relative to China, the largest market. The markers for countries below the 45^o line do not have enough domestic production capacity to meet demand, and rely on imports for the remainder. Notably, at very low levels of consumption, most countries are below the 45^o line, including several with no domestic production capacity at all. This result suggests there is a potential threshold market size required for entry of at least one firm. As consumption increases, the number of countries with consumption less than installed capacity increases to become the more common. For countries where consumption is below capacity, exports do not make up for this shortfall, with average utilization rate (i.e., domestic production divided by capacity) being 0.49 across countries. Before looking further at the data, these facts provide conflicting evidence about the competitiveness of the industry. On the one hand, capacity under-utilization suggests potential for restrictions in quantity that exploit market power; on the other, competition from international imports may discipline the pricing of domestic producers.

Market power in this industry is potentially relevant for national welfare. In our estimation sample of countries (described below) cement expenditure itself accounts for 1.3 percent of GDP on average, or 13.5 percent of construction investment. In Africa, cement is used especially intensively in construction, where expenditure comprises on average 20.7 percent of construction investment, and 1.9 percent of GDP, compared to Europe where cement expenditure accounts for only 1.7 percent of construction investment, and 0.2 percent of GDP. Cement is germane to emissions regulators given the environmental externalities associated with production, which include approximately 7 percent of anthropogenic CO2 emissions (Fowlie, Reguant and Ryan 2016).

Anecdotal evidence suggests the industry is characterized by imperfect competition. For example, the Builder's Association of India recently initiated a case against 10 cement companies and the Cement Manufacturer's Association, which held a combined 57 percent of the market, alleging the group acted as a trade association, limiting capacity and production in order to raise prices. This case lead to the the largest fine in the history of the Competition Commission of India (Bhattacharjea and De 2012). In Africa until 2008, subsidiaries of Aveng and another South African engineering and mining services group called Murray and Roberts operated a cartel that lasted 35 years and covered the South Africa, Botswana, Namibia, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe markets (Lewis 2015).

In some cases, market power may be enabled by regulation or a lack thereof, suggesting a potential role for national institutions in sustaining less competitive market structures. In Norway, a legal cartel existed from 1923 to 1968, when it ended as cartel members found it more valuable to merge and become a monopoly (Röller and Steen 2006), which was permitted and still exists today under the ownership of the multinational HeidelbergCement.

In our data, Norwegian cement prices are among the highest in the world. In Nigeria, where import substitution by domestic production was achieved recently under import tariffs, the emergent domestic producer Dangote Cement, which holds 60 percent of domestic production capacity, holds the exclusive long-term right to exploit several vast reserves of limestone, a key input into cement production. Access to limestone, not available equally to other firms, has helped the firm expand internationally and establish new production and import facilities across Africa (Begazo, Licetti, Nyman and Villaran 2016).

Not all national markets are characterized by market power however. In a study of the Brazilian market, Salvo (2010) finds low market elasticities of demand inconsistent with the exercise of market power, and suggests the threat of imports, albeit at high cost, may play a role in disciplining the pricing of domestic firms.

Though there are a rich array of case studies in this important industry, no study yet has sought to characterize the extent of market power on average and how it varies across national cement markets.

2.2 Data

Prices. Cement prices and market exchange rates are measured by the International Comparison Program (ICP), which provides the first panel of internationally comparable prices, based on a survey of national statistical offices in 2011 and 2017 that recorded the average price of one metric ton of ordinary Portland cement for use in construction (World Bank 2020b). Average prices were recorded using either nationally-representative surveys underlying the local consumer and producer price indices, or a special survey fielded for purpose of the ICP. The ICP is the empirical basis for the measurement of global output by purchasing power parities and represents the statistical gold standard in terms of the care taken to ensure prices refer to the same quantity and quality of the good, such that they are comparable across countries.[5] No alternative database of cement prices that are comparable across

[5]Several minor adjustments are made to the price series to ensure comparability over time within countries. Between 2011 and 2017, in Belarus the currency was re-denominated at rate of 10,000:1, and in São Tomé

countries exists. Some industry sources (e.g., Armstrong et al. 2019) report prices in ranges for a smaller set of countries.

Quantities. Annual national cement consumption and domestic production in 2011 and 2017 is reported in megatons (millions of metric tons) by the Global Cement Report, a trade publication (Armstrong et al. 2013, 2019). These editions also record the number, identities and capacities of firms operating in each country in 2011 and 2017.

Market Structure. We measure market structure using the concentration-adjusted number of firms, given by $N^\star_{it} \equiv 1/H_{it}$, where H_{it} is the Herfindahl index of capacity concentration. $N^\star_{it}$ is the number of identical firms such that $H_{it} = \sum_i (1/N^\star_{it})^2 = N^\star_{it}(1/N^\star_{it})^2 = 1/N^\star_{it}$. This transformation allows us to capture information on market share in a way that is theoretically consistent with the symmetric model introduced in the following section.[6] Another practical advantage of this measure is that it reduces the correlation of our measure of market structure with market size, which may arise for instance in the few especially large markets in the data. For instance China had 27 large firms in 2017, but has a concentration-adjusted number of firms of 6.2. The United States, in comparison, had 17 firms and a concentration-adjusted number of firms equal to 12.7. For four countries, China, India, the United States and Vietnam Armstrong et al. (2013, 2019) do not report the capacities of all firms in the economy, just the largest. In these cases, we include in calculation of H_{it} an additional firm whose capacity is defined as the difference between total capacity and the sum of the capacities of the individual firms whose details are reported.

We measure multimarket contact as the average number of non-home market contacts,

and Principe and Zambia the currency was re-denominated at a rate of 1,000:1. To ensure comparability of price levels between years, this re-denomination is applied retroactively to the observed 2011 prices. There are also a few changes in reporting currency: Latvia and Lithuania report prices in Euros in 2017, and in local currency in 2011, while Liberia reports prices in local currency in 2017 and in US dollars in 2011. In these cases prices are matched in the analysis to the market exchange rate between the US dollar with the reporting currency at the time.

[6] See Berry and Reiss (2007). In practice, this choice of variable does not affect our parameter estimates in a statistically significant way, and allows for more precision in the estimate of the conduct parameter.

as suggested by Jans and Rosenbaum (1996). If this number is 2, for instance, the average pair of firms in the market meets twice in other markets. The number is zero if there is no contact between any pair of firms outside of the market. Bernheim and Whinston (1990) show theoretically that multimarket contact can make collusive agreements between firms easier to sustain, as deviations from the agreement in one market may be punished in others. Begazo, Licetti, Nyman and Villaran (2016) highlight multimarket contact between firms in Africa as a potential contributor to anti-competitive conduct. Like the number of firms, this variable could be potentially endogenous to market costs.

Market characteristics. The ICP makes available data on several other economic variables that are included in our empirical model: GDP per capita (at nominal prices), which may shift demand; the construction share of GDP, which rotates the demand curve, changing the elasticity; and the price of one litre of diesel, which shifts the marginal cost of cement production and transportation. Neither the price of diesel nor the construction share of GDP are available for such a broad sample of countries from any other source. The 2011 and 2017 rounds of the ICP innovate on construction expenditure data collection by estimating expenditure based on the cost of construction inputs, like cement, as opposed to based on the prices of output (e.g., housing rental services) as in previous generations of the survey.

In any industry, institutions and infrastructure may also affect the cost of operation. To account for institutions, our empirical model includes an index rule of law, used widely in the political economy literature, that aggregates views on the quality of governance from survey respondents and experts (Kraay et al. 2010). There is some time variation in this variable but it is relatively stable during the period we study. To account for infrastructure, the empirical model includes (the log of) road density, measured by the country's kilometers of road per kilometer-squared land area in 2015 (Meijer et al. 2018). As a potential source of variation in firm conduct, we use the concentration of urban centers, measured as the sum of the squared population share of each urban center within the country, where urban centers are identified using satellite images of built-up area (Florczyk et al. 2019). This variable proxies for the potential for the market to be segmented geographically for a given number of firms; greater concentration of urban centers should be associated with lower mark-ups (Syverson 2004).

Estimation sample. The estimation sample includes all 96 countries with non-missing values for prices, the number of firms, quantities, firm entry decisions and market characteristics. Over the two years 2011 and 2017 this yields a sample with 169 observations. Descriptive statistics for this sample are provided in Table A1.

2.3 Motivating Facts: The Fall of the Cement Price in Africa

A global map of the average price of one metric ton of cement in US dollars is provided in Figure 3. There is substantial variation in prices across countries, with prices in Asia being lower than \$100/t, while prices in Chad are above \$400/t. In Europe, there are cases of above median price, for instance in Finland. Asia appears to have the lowest prices. This large dispersion in prices across countries is perhaps surprising given that cement is tradable and frequently imported.

Table 1 reports the main facts motivating our analysis. Panel A of Table 1 reports the average prices by continent for both 2011 and 2017. The first motivating fact is that the average price of cement in Africa was the highest in the world in 2011, a pattern also observed by Begazo, Licetti, Nyman and Villaran (2016). This fact stands in stark contrast to the implications of classic theories of international price differences (Balassa 1964; Samuelson 1964; Bhagwati 1984). According to the theory, the price of a good like cement should be higher in richer countries, due to higher wages. As Africa hosts many countries with a low wage rate, the theory would predict lower price levels in Africa.

The second motivating fact is that, six years later, the price in Africa had fallen by 34.6%, the largest decline of any continent. It appears that in just six years, cement is no longer as expensive in Africa relative to other continents. Pricing in the industry is far less surprising today from perspective of the wage rate theory of international price differences. What could account for the initially high and the subsequent rapid decline in the price of cement in Africa? A potential explanation for the fall in prices is shown in Panel B of Table 1, which shows the number of firms in each market, their installed capacity, and changes over time. In Africa capacity increased by 66.3% as the number of firms increased from 34 to 60. In Panel A of Table A however, it is shown that total consumption however only increased by 23.8%.

An important question is the extent to which such a dramatic change in capacity explains a significant share of the drop in cement prices and, if so, through which channels. Descriptive evidence suggests potential roles for both reductions in marginal costs and also mark-ups through entry of new firms. Figure 4 shows a plot and linear best fit line of the change in price in a country between 2011 and 2017 and the change in the concentration-adjusted number of firms. Changes in prices in this figure are real, adjusted for general inflation by subtracting off the change in the local PPP price index. Several countries including Burkina Faso, Cote d'Iovire, Mali, Zambia, Cameroon had substantial declines in price and also increases in the number of (concentration-adjusted) firms by 2 to 4, amounting to economically meaningful declines in concentration. Other countries including Lesotho, Mauritius, and Sierra Leone have experienced substantial reductions in costs without changes in market structure. Figure 5 shows a negative correlation between the price of cement in US dollars and cement consumption, which is the basis for estimation of the demand curve. The countries in Africa are all in the upper left corner, with the highest prices and smallest consumption.

3 An Empirical Model of the Global Cement Industry

This section presents a simple model that illustrates the determinants of price differences across countries in homogeneous good industries in which firms may have market power. Given data availability, our setup is a standard model of a cross-section of markets with symmetric firms. Each country is a distinct market.

The model includes the four building blocks that determine the level of prices: (i) demand elasticity, (ii) marginal costs, (iii) market conduct, (iv) fixed costs. The elasticity of the demand curve is identified by the assumption that a certain cost variable does not shift demand (an exclusion restriction). Following the standard approach of the empirical industrial organization literature, we identify the marginal cost parameters combining estimates of the demand elasticity with the equilibrium pricing equation. We consider both cases in which the conduct parameter in the pricing equation may be fixed (e.g., as in a Cournot or monopoly model) or is identified empirically and potentially varies across markets. Identification of the conduct parameter relies on the assumption that a 'demand rotator', that is a variable that changes the demand elasticity, is excluded from the cost function (Bresnahan 1982). Since conditional on the number of firms mark-ups will respond differently to variation in the demand elasticity in a perfectly competitive industry, a Cournot industry, and a cartelized industry, variation in the demand elasticity can distinguish between these three models of conduct. Fixed costs are identified by combining the demand elasticity, marginal cost and the supply relation condition with the assumption of firm symmetry, which yields a unique equilibrium number of firms (Bresnahan and Reiss 1991; Berry and Waldfogel 1999). In this section, we describe the setup, the empirical model, and then describe in further detail these identification assumptions and the rationale behind them.

3.1 Setup

Consider a two-period entry game. In the first period, a set of symmetric firms decide whether to enter and operate in market i.[7] In the second period, conditional on the number of firms that have entered market i, firms chose the quantity they supply, q_i. The equilibrium of the game is solved by backward induction.

In the second period, firms choose quantity q_i to maximize profits given by

$$\Pi_i \equiv P(Q_i, \mathbf{D}_i)q_i - C(q_i, \mathbf{C}_i) - F(\mathbf{F}_i). \tag{1}$$

The inverse demand in each market in local currency is given by $P(Q_i, \mathbf{D}_i)$ where Q_i is total quantity consumed in market i and $\mathbf{D}_i$ is a vector of (exogenous) market characteristics that affect demand in country i. Costs in each market are given by a variable cost function $C(q_i, \mathbf{C}_i)$ and a fixed cost function $F(\mathbf{F}_i)$. $\mathbf{C}_i$ and $\mathbf{F}_i$ are vectors of (exogenous) variables affecting variable and fixed costs in country i respectively. Let $MC(q_i, \mathbf{C}_i) \equiv C'(q_i, \mathbf{C}_i)$ denote the marginal cost function in market i.

Firms interact strategically so that one firm's quantity choice q_i may affect other firms' profits through the aggregate quantity Q_i. To admit a variety of potential oligopoly equilibrium concepts, this relationship is summarized by a conduct parameter $\lambda_i \equiv \frac{\partial Q_i}{\partial q_i}$ (see, e.g., Genesove and Mullin 1998). Under perfect competition $\lambda_i = 0$, while under Cournot and monopoly pricing $\lambda_i = 1$. For a cartel that behaves as if it were a monopolists $\lambda_i = N_i$ the number of firms in the market.

The firms' first-order condition from Equation 1 describes the familiar equation for the equilibrium price, as marked up over marginal cost

$$P_i = \left(\frac{\eta_i(Q_i)N_i}{\eta_i(Q_i)N_i - \lambda_i} \right) MC(q_i, \mathbf{C}_i) \tag{2}$$

where $\eta_i(Q_i) = -\frac{\partial Q_i}{\partial P_i}\frac{P_i}{Q_i}$ denotes the market price elasticity of demand (expressed as a positive

[7] We do not index firms as they are assumed to be identical.

number, since the slope of the demand curve $\frac{\partial Q_i}{\partial P_i} < 0$). The dependence of this elasticity on aggregate quantity Q_i emphasizes that market size may be correlated with mark-ups independently of the number of firms in the market.

For a specific conduct parameter λ_i, the mark-up

$$M_i \equiv \left(\frac{\eta_i(Q_i)N_i}{\eta_i(Q_i)N_i - \lambda_i} \right) \tag{3}$$

can be computed directly from data on the demand elasticity and the number of firms. When P_i, N_i, and $\eta_i(Q_i)$ are observed, inverting Equation 2 allows one to recover marginal costs $MC_i = P_i/M_i$ in the market. This is the approach of the empirical industrial organization literature to measure marginal cost, which is otherwise unobserved, from data on prices and the components of the markup, $\eta_i(Q_i)$ and N_i, and an assumption about equilibrium conduct λ_i.[8]

Another advantage of the mark-up in Equation 3 is that it depends on conduct, λ_i. In antitrust law non-cooperative strategic behavior may be permitted while cartel behavior, for instance price-fixing, is illegal. In this case, an authority might be interested in testing whether $\lambda_i = \bar{N}$, the average number of firms in the market, as implied by a cartel that prices as a monopolist; or whether $\lambda_i = 1$, consistent with the non-cooperative equilibrium of the Cournot model. Evidence consistent with the former case could be used as *prima facie* evidence that firms are fixing prices, in the absence of direct evidence of an actual contract or conspiracy; whereas the latter case would suggest that though the firms do have market power, they do not appear to have monopolized the industry. Equation 3 shows that conditional on market structure, variation in the demand elasticity makes it possible to identify λ_i from the data. This insight of Bresnahan (1982) is used in this paper to estimate

[8] De Loecker and Warzynski (2012) develop an alternative approach to describe mark-ups in cases where information on the demand curve and market structure is not available, using an estimate of the production function. Though the conceptual assumptions of this approach are minimal, a drawback is that the resulting mark-ups do not depend explicitly on market structure. As a result, is not possible to evaluate counterfactual prices under a counterfactual market structure, as is possible using the mark-up described by Equation 3, and an estimate of marginal cost under the alternative market structure.

λ_i for the global cement industry.

Comparative statics of the equilibrium pricing condition in Equation 2 reveal that the price in market i will be higher due to either higher marginal costs MC_i, or higher mark-ups M_i. In turn, higher mark-ups could arise due to either less price sensitive consumers, who have a lower price elasticity of demand η_i; non-competitive conduct captured by a higher value of λ_i, or higher fixed costs of entry F_i, which reduce the equilibrium number of firms N_i in the market.

The second period of the game is a unique symmetric Nash equilibrium in which the number of firms is fixed and the price is set according to Equation 2. In the first period, a firm decides to enter if it will at least break even given all other firms' entry decisions and thus the equilibrium price in the second period. Denoting by $\Pi_V(N_i)$ variable profit in the second period as a function of the number of firms entering the market N_i, the break even condition is given by

$$\Pi_V(N_i) - F(\mathbf{F}_i) > 0 > \Pi_V(N_i + 1) - F(\mathbf{F}_i) \tag{4}$$

where $F(\mathbf{F}_i)$ are fixed costs. A market that is small relative to the size of the fixed costs will not be able to sustain a large number of firms and, all else equal, will be less competitive and have higher prices. Note that the fixed costs $F(\mathbf{F}_i)$ can capture both technological features of the industry (e.g., minimum efficient scale) as well as barriers to entry that might arise in weakly institutionalized economies.

The key advantage of this framework is that fixed costs are identified by the revealed preference of firms to operate in a particular market (sometimes referred to as revealed profitability). If the market has three firms for example, we know that fixed costs must be such that profits in the same market with four firms must be less than zero. This argument is elaborated in further detail below.

3.2 Empirical Model

We now take this model to the data. The purpose of the empirical model is two fold: (i) parameterize the mark-ups' two components, demand elasticity and the conduct parameter: (ii) project marginal and fixed costs on to covariates, which will allow us to test hypotheses for instance about the role of weak institutions and infrastructure in raising costs of operation and entry.

Demand. The demand curve for cement in each country i and year t is assumed to be a function of the US dollar price P_{it}, and exogenous market characteristics $\mathbf{D}_{it}$, which include a constant. We assume this curve takes the form

$$\begin{aligned}\ln(Q_{it}) = \alpha_{0t} &+ \alpha_1 \ln(P_{it}) + \alpha_2 \ln(P_{it}) \ln(CONST_{it}) \\ &+ \alpha_3 \ln(E_{it}) + \alpha_4 \ln(E_{it}) \ln(CONST_{it}) \\ &+ \alpha_5 \ln(CONST_{it}) + \alpha_6 \ln(GDPPC_{it}) \\ &+ \alpha_7 \ln(POP_{it}) + \xi_{it}\end{aligned} \tag{5}$$

where Q_{it} is total quantity consumed, $GDPPC_{it}$ is GDP per capita in local currency, POP_{it} is population, $CONST_{it}$ is construction investment as a share of GDP, and $\alpha_{0,t}$ is a fixed effect for each year t. Each market has a different local currency unit (LCU_i) and bilateral exchange rate with a common currency, which is set as the US dollar (USD). The market exchange rate is represented by $E_i = \text{USD}/\text{LCU}_i$ is included to control for effects of exchange rate volatility on pricing. ξ_{it} is an error term.[9]

The price elasticity of demand may vary with the quantity of cement consumed because it is equal to $\eta_{it} = -\alpha_1 - \alpha_2 \ln(CONST_{it})$. The construction investment share of GDP is

[9] An assumption required for identification of any demand elasticity is that shocks to demand for substitutes or complements (e.g., bricks, steel rebar) enter into the error term ξ_{it} as a scalar index (Berry and Haile 2016). While we do not observe consumption of such goods in each country and so cannot formally model their role in cement demand, we do include the log of the construction share of GDP (in addition to its interaction with the log of price) as a control that is correlated with demand for these goods.

a 'demand rotator' that changes the elasticity of demand. This term captures the cyclical component of demand. As a preview of results, we will find that consumers are less price sensitive when the construction sector is a larger share of the economy, leading to a lower price elasticity of demand in such settings, and higher mark-ups.

For a specific conduct parameter λ_i, we have the empirical mark-up

$$M_{it} = \left(\frac{-\alpha_1 - \alpha_2 \ln(CONST_{it})N_{it}}{-\alpha_1 - \alpha_2 \ln(CONST_{it})N_{it} - \lambda_i} \right). \tag{6}$$

Note that the mark-up depends on quantity consumed as in Equation 6 through the cement component of the construction share of GDP.

Marginal Cost. With data on the price and the mark-up, it is possible observe marginal costs directly as $MC_i = P_i/M_i$. In the results, we will present first averages by continent of these values.

In our estimation, we will also project these costs onto covariates $\mathbf{C}_i$, in order to describe the role of each factor in the sector, and, when we estimate the conduct parameter, control for observed determinants of cost. These variables might also be thought of as controls for other factors that might affect prices in the industry equilibrium condition in Equation (1). Here we assume constant returns to scale in these variables and thus a marginal cost independent of q_i, which takes the log-linear form:

$$\ln(MC_{it}) = \begin{cases} \beta_{0,t}^K + \beta_1^K \ln(E_{it}) + \beta_2^K \ln(PDIESEL_{it}) + \beta_3^K RLE_{it} & \text{if } N_{it} > 0 \\ \quad + \beta_4^K \ln(ROADDENS_i) + \omega_{it}^K & \\ \beta_{0,t}^O + \beta_1^O \ln(E_{it}) + \omega_{it}^O & \text{if } N_{it} = 0 \end{cases} \tag{7}$$

where N_{it} is the number of firms in country i at time t. We distinguish two cost functions depending on whether domestic production capacity exists at all. The superscript O indicates that $N_{it} = 0$, so the market has no domestic production capacity and therefore imports all of its cement. This identifies a benchmark for the open economy, in which pricing is (potentially) unconstrained by domestic factors. The superscript K indicates markets with $N_{it} > 0$, where there is some domestic production capacity. The purpose of separating the cost equation in this way is because cost variables may affect import-only markets differently, with for instance the exchange rate being more important, as well as the price of diesel, because of the greater importance of transportation in pricing.

The exchange rate E_{it} is included in marginal cost because of its direct effect on the cost of imported intermediate inputs. The price of diesel $PDIESEL_{it}$ affects the cost of transportation of both intermediate inputs and the final good, and potentially the cost of electricity, an essential input into cement production sometimes provided by diesel generators. We use the price of diesel instead of the price of electricity because (i) it affects the cost transport in addition to production; and (ii) it is available in more countries in the data from the ICP.

Marginal cost also includes measures of the quality of infrastructure and institutions. Given that cement is heavy and difficult to transport (it must be kept completely dry) we expect higher quality road infrastructure to be associated with lower costs. Kilometers of road per square kilometer of land, indicated by $ROADDENS_i$, summarize the quality of national road infrastructure. Rule of law, indicated by RLE_{it}, has an ambiguous role in marginal cost. On the one hand, it could lower cost, for instance by facilitating contracting with suppliers or reducing expropriation risk. On the other hand, it could be associated with higher income per capita and wages (Acemoglu, Johnson and Robinson 2005) and thus higher cost.

Market Conduct. Our baseline specification follows standard practice by assuming a specific industry equilibrium concept, namely $\lambda_i = 1$ which corresponds to a Cournot equilibrium (Berry and Reiss 2007). In an alternative specification of the model, which we call the Conduct Parameter model, we project conduct onto a constant and a geographic attribute of the market:

$$\lambda_{it} = \begin{cases} \lambda_0 + \lambda_1 Z(URBCON_i) + \lambda_2 Z(MMC_{it}) & \text{if } N > 0; \\ 0 & \text{if } N = 0. \end{cases} \tag{8}$$

where $Z(URBCON_i)$ is the Z-score of the Herfindahl index of the population of urban centers in a country, and $Z(MMC_{it})$ the Z-score of the average number of other markets in which a firm-pair observed in market i meets, a measure of multimarket contact suggested by Jans and Rosenbaum (1996). A priori, we expect that $\lambda_1 < 0$, since with greater concentration of urban centers a given number of firms are less able to segment the national market (Syverson 2004). Although we don't explicitly model plant's location choices, urban concentration tells us how spatially concentrated economic activity in a country is. A finding that less concentrated markets are less competitive would hint that firms may strategically locate to segment the market rather than competing among each other. We also expect that $\lambda_2 > 0$ since multimarket contact could make it easier for firms to sustain a collusive agreement that raises prices (Bernheim and Whinston 1990). Estimating Equation 8 allows us to test whether $\lambda_{it} = 1$ on average, which would indicate that Cournot competition is an appropriate assumption for the baseline specification.

With the form of conduct specified, the industry equilibrium condition in Equation 2 yields prices as a function of mark-up and marginal cost,

$$\ln(P_{it}) = \ln\left(\frac{-(\alpha_1 + \alpha_2 \ln(CONST_{it}))N_{it}}{-(\alpha_1 + \alpha_2 \ln(CONST_{it}))N_{it} - \lambda_i}\right) + \ln(MC_{it}(\beta)) + \omega_{it}. \tag{9}$$

where $\omega_{it} = [\omega_{it}^K, \omega_{it}^O]$.

Fixed Costs of Entry. Fixed cost variables $\mathbf{F}_i$ enter through the following function:

$$\ln(FC_{it}) = \gamma_{0,t} + \gamma_1 \ln(E_{it}) + \gamma_2 RLE_{it} + \sigma\epsilon_{it}. \tag{10}$$

where σ is a scale parameter and ϵ_{it} is distributed standard normal, hence fixed costs have a log-normal distribution. Empirical models of the cement industry have shown that firms face costs of entry and capacity installation (Ryan 2012). In our framework, the estimated fixed cost represents the annual amortization of such costs by the firm. The term $\gamma_{0,t}$ is a fixed effect for each year t.

The fixed cost parameters are identified by the break-even entry condition in Equation 4, which yields the likelihood of each observation,

$$\begin{aligned} L(\theta) = &\Phi\left(\frac{1}{\sigma}\left[\ln\left(\frac{Q_{it}^K}{N_{it}}\left[P_{it}\left(\frac{-(\alpha_1+\alpha_2\ln(CONST_{it}))N_{it}}{-(\alpha_1+\alpha_2\ln(CONST_{it}))N_{it}-\lambda_{it}}\right)-MC_{it}(\beta)\right]\right)-FC(\gamma)\right]\right)\\ &-\Phi\left(\frac{1}{\sigma}\left[\ln\left(\frac{Q_{it}^K}{N_{it}+1}\left[P_{it}\left(\frac{-(\alpha_1+\alpha_2\ln(CONST_{it}))(N_{it}+1)}{-(\alpha_1+\alpha_2\ln(CONST_{it}))(N_{it}+1)-\lambda_{it}}\right)-MC_{it}(\beta)\right]\right)-FC(\gamma)\right]\right) \end{aligned} \tag{11}$$

where Φ is the standard normal cumulative density function, and Q_{it}^K is the quantity of production using domestic capacity (i.e., domestic consumption minus imports). Note that this is a different value than the Q_{it} used in demand estimation, because we wish entry costs to reflect only those producers included in N_{it}.

Equation 11 demonstrates how fixed costs are identified by the revealed profitability of the market using a comparison between the observed market and a counterfactual market with one additional firm, conditional on estimates of the parameters related to demand and marginal cost (e.g., Berry and Waldfogel 1999). The fixed cost parameters γ and σ maximize the log-likelihood function of the data. For this reason, we hypothesize that $\gamma_1 = 0$.

3.3 Joint Estimation and Identification

The model has three equations: (i) the demand curve (Equation 5), (ii) the industry equilibrium condition relating prices and marginal costs (Equation 9), and (iii) the likelihood of the number of entrants (Equation 11); and three endogenous variables: (i) price, (ii) quantity and (iii) the number of firms. We estimate this model using the generalized method of moments (GMM). Estimating all three equations jointly ensures the standard error of each parameter accounts for estimation error in all three equations.

Identification of the parameters in the presence of endogenous variables relies on three distinct assumptions. First, the heterogeneous price elasticity of demand is identified by the assumption that a cost shifter, (the log of) the price of diesel and its interaction with (the log of) the construction share of GDP are uncorrelated with the unobserved component of demand ξ_{it}. The moment conditions associated with this assumption are $E[\ln(PDIESEL_{it})\xi_{it}] = 0$ and $E[\ln(PDIESEL_{it})\ln(CONST_{it})\xi_{it}] = 0$. Energy prices are used regularly as cost-shifter instruments in the estimation of cement demand (Salvo 2010; Ryan 2012). We experimented with including the price of electricity in addition to the price of diesel in the marginal cost function, and as an instrument for price in the demand function. Though this specification had fewer observations due to limitations of the ICP electricity price series, the price of diesel retained a large and statistically significant relationship with marginal cost, while the coefficient on electricity was close to zero and statistically insignificant, suggesting the variable provided little additional information.

Second, fixed cost parameters are identified using a revealed profitability argument. A number of symmetric firms equal to N_{it} is observed in equilibrium if and only if fixed costs are such that N_{it} firms make a profit but $N_{it}+1$ firms would not. The number of symmetric firms in the market is thus unique, leading to an ordered probit estimator for fixed costs (Bresnahan and Reiss 1991). In the GMM framework, the fixed cost parameters are identified by moment conditions given by $E\left[\frac{\partial \ln(L_{it}(\alpha,\beta,\lambda,\gamma,\sigma))}{\partial \gamma}\right] = 0$ and $E\left[\frac{\partial \ln(L_{it}(\alpha,\beta,\lambda,\gamma,\sigma))}{\partial \sigma}\right] = 0$.

With these identification assumptions, the Cournot model (where $\lambda_i = 1$) is just-identified with 26 moment conditions and 26 unknowns. The Conduct Parameter model has two additional unknowns, the intercept and slope of the conduct function λ_i in Equation (8). These parameters are identified by a third identification assumption, that the demand rotator (the log of) the construction share of GDP, and its interaction with (the Z-score of) the concentration of urban centers are excluded from the marginal cost function (Bresnahan 1982). The intuition for identification of conduct using these two moment conditions is as follows. If the demand rotator, which changes the demand elasticity, is not included in the cost function, any variation in prices correlated with the demand rotator must come from variation in the mark-up. Since, conditional on the number of firms, the mark-up responds differently to changes in the demand elasticity under different competitive regimes, variation in the demand rotator identifies equilibrium conduct. For instance, with multiple firms, a decrease in the demand elasticity will raise the mark-up more when firms are operating as a cartel that obtains the monopoly mark-up compared to when firms operate in Cournot equilibrium.

The formal moment conditions associated with this assumption are $E[\ln(CONST_{it})\omega_{it}] = 0$, $E[\ln(CONST_{it})Z(URBCON_{it})\omega_{it}] = 0$ and $E[\ln(CONST_{it})Z(MMC_{it})\omega_{it}] = 0$.[10] We do not assume that $E[Z(MMC_{it})\omega_{it}] = 0$, since multimarket contact is a strategic choice, like the decision of a firm to enter a market, and may be endogenous to unobserved components of marginal cost (Ghemawat and Thomas 2008). These assumptions are justified on the basis that the construction share of GDP is cyclical and driven by determinants of national growth unrelated to the cement industry. For instance, in Africa in 2011 a boom in construction investment was driven by elevated global commodity prices, which increased demand for infrastructure and real estate, the latter of which has been an important destination for private savings of commodity export profits. These exclusion restrictions would be violated if high costs in the cement industry in particular reduced demand for construction invest-

[10] An alternative approach to identifying the conduct parameter would be to assume that the number of firms in the market, which also shifts mark-ups, is uncorrelated with unobserved marginal cost, i.e., $E[N_{it}\omega_{it}] = 0$. Given that unobserved costs enter into a firm's entry decision, such an assumption would not be appropriate.

ment overall, for instance by lowering the return on investment, or by diverting investment expenditure from construction to machinery and equipment. Given that the construction share of GDP is high in some countries in Africa where the price of cement is also the highest (e.g., Republic of Congo) however this is perhaps not a first-order concern. With these additional moment conditions, the Conduct Parameter model is just-identified with 28 moment conditions and 28 unknowns.

To improve the precision of our estimates, in the Conduct Parameter model only we use four additional moment equations to identify conduct: $E[(\ln E_{it} \ln(CONST_{it}))^n \omega_{it}] = 0$ and $E[\ln(POP_{it})^n \omega_{it}] = 0$ where $n \in \{1, 2\}$. Goldberg and Hellerstein (2008) highlight the exchange rate as a useful source of exogenous variation in industry equilibrium models such as this. Population shifts demand conditional on the construction share of income, and is a standard instrument for costs, for instance as in Berry and Waldfogel (1999).

With these assumptions, the resulting moment conditions are given by

$$g(\theta) = \sum_{it} \begin{pmatrix} Z_{it}\xi_{it}(\alpha) \\ W_{it}\omega_{it}(\alpha, \beta, \lambda) \\ \partial \ln(L_{it}(\alpha, \beta, \lambda, \gamma, \sigma))/\partial\gamma \\ \partial \ln(L_{it}(\alpha, \beta, \lambda, \gamma, \sigma))/\partial\sigma \end{pmatrix},$$

where the vector Z_{it} contains all variables in the demand Equation 5, but replacing $\ln(P_{it})$ with $\ln(PDIESEL_{it})$ and $\ln(P_{it})\ln(CONST_{it})$ with $\ln(PDIESEL_{it})\ln(CONST_{it})$ to identify the demand elasticity. In the Cournot specification, W_{it} contains all exogenous variables of the marginal cost function in Equation 7. In the Conduct Parameter specification, W_{it} also includes columns $\ln(CONST_{it})$, $\ln(CONST_{it})Z(URBCON_{it})$, $(\ln E_{it} \ln(CONST_{it}))^n$, and $\ln(POP_{it})^n$ where $n \in \{1, 2\}$.

We estimate all parameters jointly using the continuously-updating GMM estimator, which has better small sample properties than the canonical two-step procedure (Hansen, Heaton and Yaron 1996). Each equation of the model is estimated separately and these parameters are used as starting values when minimizing the objective function of the estimator.

4 Results

This section reviews the estimates of the empirical model described in the previous section, and then uses the model to decompose prices into mark-ups and marginal costs on each continent. We then estimate marginal costs and fixed costs for the African continent, and compare them to the average of all other continents, to describe how Africa specifically is different (or not) from the rest of the world.

We then demonstrate the potential role of infrastructure (road density) and institutions (rule of law) in determining equilibrium outcomes by simulating entry and pricing under counterfactual improvements in these variables. We close by providing some additional descriptive results on the types of firms that have entered different in countries.

4.1 Estimated Empirical Model

Estimated coefficients of the empirical model described in the previous section are reported in Table 2. Two specifications are reported for comparison. The first model assumes firms compete in a Cournot or monopoly model ($\lambda_i = 1$) in every market. The estimation of this model does not assume that the demand rotator, $CONST_{it}$, is uncorrelated with the error in the marginal cost function ω_{it}. The second model rather treats λ_i as an object of estimation, which allows a test of whether the Cournot equilibrium accurately characterizes competition in this industry. As described above, the conduct parameter is identified using the assumption that the demand rotator is uncorrelated with the error in the marginal cost function. Both models use the assumption that a marginal cost shifter (the price of diesel) is uncorrelated with the error in the demand function to identify the demand elasticity.

In the Cournot model, the main concern is that the demand elasticity is weakly identified. Reassuringly, in two-stage least squares estimation of the demand curve, using as instruments for price and its interaction with the construction share of income the terms $\ln(PDIESEL)$ and $\ln(PDIESEL)\ln(CONST)$, yields a Kleibergen-Paap F-statistic of 23.871, greater than the heuristic minimum of 10. In the Conduct Parameter model, overidentification is an additional concern. Reassuringly, we cannot reject the hypothesis that the instruments are uncorrelated with the observed errors in this model. The p-value associated with this hypothesis test is 0.194, well above the heuristic minimum of 0.10.

A comparison of the two models provides support for the hypothesis that the Cournot equilibrium concept accurately characterizes competition in the industry, at least in the average market. The far right column of Table 2 reports the T-statistic from a Welch's test of the null hypothesis of equality of the demand and cost coefficients in both models. This hypothesis is not rejected for any coefficient, and moreover the coefficients of the demand and industry equilibrium equations in the two models are generally within a few decimal points of one another.

We now review the estimates of demand, marginal cost and fixed cost, focusing attention on the estimated parameters of of the Cournot model, which are statistically indistinguishable from those in the Conduct Parameter model. We then turn to the estimate of conduct in the Conduct Parameter model, before reviewing the sensitivity of mark-up estimates to the exclusion restrictions.

Estimated Demand Our estimates of demand are broadly in line with industry accounts and existing studies of the industry. Considering the price sensitivity of market demand, we estimate a coefficient on price $\alpha_1 = -1.010$ (s.e.=0.956). The coefficient α_1 equals (the negative of) the price elasticity of demand when $CONST_{it} = 1$ and therefore $\ln(P_{it})\ln(CONST_{it}) = 0$. This result suggests that for the maximum value of the construction share of GDP, firms appear to be operating on the inelastic part of the market demand curve. Jans and Rosenbaum (1996) and Salvo (2010) find inelastic market demand curves, which can be consistent with a Cournot equilibrium and multiple firms. Ryan (2012) finds an elastic market demand curve.[11] The coefficient on the interaction of log price and log construction share of GDP is positive, with $\alpha_2 = 0.314$ (s.e. $= 0.430$), indicating that the price elasticity of demand falls (moves closer to zero) as the construction share of GDP rises. This is as expected under our hypothesis that cement demand will be less price sensitive when construction is a larger share of the economy.[12] Turning to the other terms in the demand equation, national income and population have a statistically significant and positive effect on demand, as expected. The level of the log of the construction share of GDP has a negative and statistically insignificant coefficient, as expected since the log of the construction share is negative.

Estimated Marginal Costs Estimates of the equilibrium pricing condition reveal the main drivers of marginal cost in the industry. First consider marginal costs in countries with domestic production capacity. Here, there is no significant trend in costs over time, with an economically small and statistically insignificant change in costs in 2017 relative to 2011 of $\beta^K_{0,2017} = -0.040$ (s.e. $= 0.067$), reflecting a mature industry with relatively little technological change. In countries with domestic production capacity, the exchange rate has the coefficient $\beta^K_1 = 0.009$ (s.e. $= 0.014$) and the price of diesel has the coefficient $\beta^K_2 = 0.354$ (s.e. $= 0.071$). The exchange rate does not appear to effect the price, though energy prices are a significant contributor to costs. (The log of) road density has the negative and statistically not significant coefficient $\beta^K_4 = -0.052$ (s.e. $= 0.032$), suggesting that in addition to the cost of imported goods and the price of diesel, the quality of domestic infrastructure can lower end-consumer prices. This is as expected, given that cement is tradable, but heavy and so is sensitive to transportation costs. Rule of law, our measure of institutional quality, has a negative, though not significant, coefficient $\beta^K_3 = -0.072$ (s.e. $= 0.055$). This suggests that

[11] An inelastic market demand curve is inconsistent with the existence of a monopolist (i.e., either a single firm, or a cartel), which will always price on the elastic portion of the demand curve.

[12] While this coefficient is not statistically significant and standard levels, the construction share still introduces useful variation into the demand elasticity as required for identification of the conduct parameter. A test of whether this variation is sufficient will be in the significance of the conduct parameter itself, which we discussed above.

institutions protecting legal contracts may reduce the marginal cost of production and that this effect might out weight the increase in costs that would result from higher wages due to better institutions.[13]

Turning to countries without domestic production capacity, we find that they are, as expected, qualitatively different from countries with domestic production capacity.[14] The constant is substantially higher than in the cost function with domestic capacity ($\beta_0^O > \beta_{0,2017}^K$) indicating costs are are on average higher in markets that only import. Notably however, costs for markets with no domestic production capacity have fallen over time, with $\beta_{0,2017}^O = -0.364$ (s.e. = 0.166).

Estimated Fixed Costs Turning to the fixed costs, we find that (the log of) fixed entry costs in the average market are positive and precisely estimated, with mean $\gamma_0 = 18.541$ (s.e. = 0.144) and standard deviation term $\sigma = 1.403$ (s.e. = 0.192). These numbers imply a distribution of annualized entry costs with mean of approximately US$110 million, and US$7 million at the 5th percentile and $1.76 billion at the 95th percentile. These values appear consistent with capacity installation costs reported by industry sources. Installation costs are approximately US$150 million per megaton (million tons) of annual capacity (Cembureau 2021). The average market in our sample has 14 megatons of annual capacity per firm (measuring the number of firms, as in estimation, as the inverse of the Herfindahl index), which at this price will cost US$2,520 billion to install. At a discount rate of $\$139/\$2,520 = 0.055$, the annuity value of our estimated annualized entry cost equals the total cost of installing capacity for the average firm in the sample.

An important question is whether fixed costs vary systematically across countries. We do not find evidence of this, nor does there appear to have been a substantial change in

[13] In a specification not reported, we included income per capita in costs, and find that the negative coefficient on rule of law remained. We do not include income per capita in our main specification since we later use the model to examine prices and entry under counterfactual institutions, and wish this counterfactual to account for any general equilibrium effects of institutions on wages.

[14] The precision of the marginal cost coefficient estimates is lower as expected given that there are only 13 such countries.

fixed costs between periods. The exchange rate and the rule of law coefficients in fixed costs are statistically insignificant and quantitatively small relative to the average of fixed costs. Perhaps surprisingly, the coefficient on rule of law is positive. One might have expected that better legal institutions would lower entry costs, for instance through better anti-trust enforcement. The positive coefficient suggests legal institutions may have other countervailing effects that also raise entry costs, for instance higher costs of regulatory compliance or wages. The finding that this widely-used variable loads on marginal costs rather than fixed entry costs provides new evidence on how to interpret the variable: it may capture differences in production technology, but not barriers to entry.

Estimated Conduct In the Conduct Parameter model, conduct is the function of the concentration of urban centers in Equation 8. Before estimation, the concentration of urban centers variable is transformed into a Z-score by subtracting off its mean and dividing by its standard deviation; therefore the estimated value of the conduct parameter constant $\lambda_0 = 1.013$ (s.e. $= 0.222$) corresponds to the conduct parameter in a market with the average concentration of urban centers. The hypothesis that this coefficient is greater than one can be rejected, as this value is much less than the average number of firms in the sample, 5.053, as reported in Table A1. Recall that for a cartel, where all firms behave jointly as a monopolist and $\lambda = N_{it}$.

In the average market a firm can exert market power. The market looks most like the pure strategy Nash equilibrium of the Cournot model. Though firms in this model behave non-cooperatively, they nonetheless affect prices through their choices of quantities, and their ability to affect prices in this way is increasing in their market share. The industry does not appear to be characterized by a global cartel in which multiple firms achieve the monopoly price; however there is evidence that firms have market power, and that two factors specifically shape the extent of this power.

The first is the concentration of urban centers. The coefficient $\lambda_1 = -0.222$ (s.e. $= 0.063$)

is statistically significant and negative, suggesting that the market becomes more competitive when the concentration of urban centers increases. That is, when the country's population is spread across fewer cities, firms behave more as if the market is characterized by perfect competition than as if it is characterized by the Cournot equilibrium. The intuition is as follows. For a given number of firms, if the entire population of a country is concentrated in one city, the firms must compete in the same market; whereas if the population is spread across many cities, it is possible for firms to each focus on a distinct set of cities, and price as a monopolist in each set.[15]

Second, multimarket contact between firms has been shown theoretically and empirically to lead to higher mark-ups, through firms sustaining collusive equilibria. The parameter value $\lambda_2 = 0.252$ (s.e. $= 0.112$) indicates that more average contacts across firms in a market is also associated with larger mark-ups in this industry.

Sensitivity of Mark-ups to Violations of Exclusion Restrictions We investigate the estimated mark-ups' sensitivity to one-standard-deviation changes in each instrument, as suggested by Andrews et al. (2017). The sensitivity of average mark-up to such violations of the exclusion restrictions that identify α_1 and λ_0 in the model with conduct is -0.007, respectively 0.040. There are two inferences from this result. First, average mark-up is insensitive to some correlation between the price of diesel and cement demand via the error term in equation (5). Second, using the log of the construction share of GDP as demand rotator robustly identifies conduct in the average market (i.e., a market with average multi-market contact and concentration of urban centers) in our sample (following the arguments of Bresnahan (1982)).

However, we also find that mark-ups are very sensitive to the excluded moment conditions involving $(\ln E_{it} \ln(CONST_{it}))^n$ and $\ln(POP_{it})^n$ where $n \in \{1, 2\}$, which we used to in the Conduct Parameter model. The sensitivity of average mark-up to local violations

[15] Agreement to allocate markets between distinct competitors is illegal under antitrust law, for instance in the United States, the European Union and Mexico. Firms however can tacitly enter in different locations to be closer to specific markets and take advantage of internal transport costs to gain some market power.

concerning these moment conditions is 10.976, -8.872, 3488.123, and -2598.3606. This result highlights one interesting trade-off that emerges in our setup. On the one hand, the excluded instruments help us to achieve lower standard errors when estimating the model jointly. On the other, local violations of these instruments' validity produce large effects on conduct, and therefore mark-ups.

4.2 Testing for Different Costs and Conduct in Africa

The estimates above do not answer directly the question of whether costs are different in Africa in particular. In Table 3 we test this hypothesis by estimating an alternative version of the model, which instead of including continuous measures of institutions and infrastructure in costs includes rather a dummy for whether the market is in Africa and an interaction of this dummy with a dummy for 2017. This model has greater flexibility, and allows for unobserved components of fixed and marginal costs to be different in Africa.

Estimates in Table 3 show that marginal costs were systematically higher in Africa in 2011, but that this difference is no longer significant in 2017. In this period, technology in Africa appears to have converged with the rest of the world. This result holds in both the Cournot and Conduct Parameter models, though standard errors are larger in the Conduct Parameter Model.

These results also show that average fixed costs in Africa are not statistically different from other continents. The magnitude of the Africa fixed effect in the Cournot model in Table 3 for example is -0.519 (s.e. = 0.673), much smaller in magnitude than the average fixed cost reported in Table 2, which is 18.541 (s.e. = 0.144). The fixed effect on Africa interacted with the year 2017 is even smaller at -0.080 (s.e. = 0.535). Coefficients are similar in magnitude, with larger standard errors, in the Conduct Parameter model. These results are consistent with a model of an industry with minimum efficient scale of production that is common across continents, and a reject the hypothesis that Africa is characterized by unusually high barriers to entry.

Finally, we test whether conduct in Africa is different from the rest of the world. One hypothesis to explain higher prices in Africa is that firms there find it easier to sustain collusive equilibria. To test this hypothesis, we estimate an Africa fixed effect in the Conduct Parameter and remove the multi-market contact variable from the specification; while retaining the concentration of urban centers, a fixed geographic determinant of the competitive environment. Here we find that the Africa conduct parameter is negative at -2.79 (s.e. = 2.851). Since the standard error is large, we cannot reject that conduct in Africa (conditional on geography) is different from in other continents; if anything however the negative sign points to more rather than less competition in Africa. This can be explained by the fact that multi-market conduct is more prevalent in higher-income markets such as Europe.

Overall, these results suggest that high average prices in Africa were explained in part by higher marginal costs, which declined between 2011 and 2017, though that high average prices cannot be explained by excessive entry barriers or collusive conduct.

4.3 Decomposing Price Differences Across Continents, Income Levels, and Time

Having estimated the model, we can now divide the observed price by the mark-up to observe marginal costs. In this section, we report average prices, mark-ups and marginal cost for each continent. We then consider whether differences in marginal cost or mark-ups contribute to the observed negative relationship between national income and the price of cement, which motivated this paper.

In this subsection we use the estimated coefficients from the Conduct Parameter version of the model, to allow for maximal variation across countries in mark-ups. In the Conduct Parameter model, mark-ups are given by

$$M_{it} = \left(\frac{-(\alpha_1 + \alpha_2 \ln(CONST_{it}))N_{it}}{-(\alpha_1 + \alpha_2 \ln(CONST_{it}))N_{it} - \lambda_0 - \lambda_1 Z(URBCON_i) - \lambda_2 Z(MMC_{it})} \right). \quad (12)$$

As a first description of the results, Figure 6 reports mark-ups for each country in 2017, where mark-ups are calculated using Equation 12. The average mark-up in 2017 is 1.26, or a 26 percent premium over marginal cost. While substantial, this value is well below the aggregate mark-up of 61 percent for 2016 estimated by De Loecker, Eeckhout and Unger (2020). Rather, it appears roughly in line with the range of aggregate mark-ups estimated by these authors for the years 1960 to 1980. Relative to this benchmark, mark-ups in the global cement industry appear modest. The model however does identify several outlier countries; mark-ups higher than 100 percent are identified in Niger, Burundi, Botswana, Togo, Sierra Leone, Norway and Finland. These countries are all supplied by monopolists, and have concentration of urban centers that is below average. Though the effect of concentration in these markets cannot function through multiple producers dividing geographic markets, it is possible that geographic markets in the country are still segmented, for instance between those served primarily by the domestic producer, and those served by imports. Moreover, retail and wholesaler distributors of the cement, firms which are not observed but are distinct from producers, may segment the market. Chad and Rwanda are two countries supplied by duopolists, but with mark-ups greater than 50 percent, due in part to their relatively low concentration of urban centers.

Average prices, marginal costs and mark-ups by continent and year are reported in Table 4. The sample is restricted to the estimation sample (which have observed values of the price of diesel, rule of law, and road density, etc.) and includes only the balanced panel of countries with capacity in both years, ensuring we compare like with like between years.[16] The first two rows of the table report values for 2011 and 2017, and the changes between these years. In this sample, the price of cement has fallen on average by 20.1 percent between 2011 and 2017.[17] Decomposing this price decline into changes in mark-up and marginal cost,

[16] By assumption, there mark-ups are zero in countries with no capacity in 2011 and no capacity in 2017, where we assume $\lambda_i = 0$. For countries which had installed capacity for the first time in 2017, we see a large decline in costs and an increase in mark-ups mark-ups.

[17] This is similar to the decline of 23.7 percent observed in Table 1 in the slightly larger sample of countries, which had price, but not necessarily the other variables required for the empirical model

we find that almost exactly half of the decline was due to falling mark-ups (which fell 10.1 percent), while the other half of the decline was due to falling marginal costs (which fell 10 percent).

These changes in mark-ups could arise due to either changes in the number of firms, due to entry; or changes in demand elasticity, due to changes in the construction share. To distinguish between these two effects, we consider counterfactual changes between 2011 and 2017 that hold the number of firms or construction share of income constant in 2017 at their values in 2011. Holding the number of firms constant leads to a negligible increase in mark-ups of just 0.1 percent, indicating that the global decline in mark-ups can be attributed almost entirely to entry. Moreover, since the counterfactual led to an (albeit small) increase in mark-ups, we infer that that mark-ups fell despite a slight decrease in the average demand elasticity, which would have increased mark-ups had the number of firms not changed. Holding the construction share of income constant leads to a decline in mark-ups of 9.9 percent, almost identical to the observed decline in mark-ups. This result indicates that none of the observed decline in mark-ups can be attributed to change in the demand elasticity.

Subsequent rows in Table 4 report averages by continent. In some continents, we only have a small number of observations, with the majority of observations being in Africa and Asia. In certain regions, such as Europe, the Americas and Oceania, the ICP uses a smaller number of 'core' countries as a source of price data. The results show that prices in Africa, which were the highest in the world, were high on average due both to higher costs and higher mark-ups. In 2011, mark-ups in Africa were the highest of any continent, equal to approximately 47.2 percent on average. The next highest mark-ups were in Europe, at 35.3 percent on average, and the lowest were in Asia, at 21.9 percent on average. Looking at marginal cost in 2011, the average marginal cost in Africa was the second highest of any continent, with the first highest being South America. This suggests that greater market power and operating costs both play an important role in determining the high price of cement in Africa. Examining changes between 2011 and 2017, approximately half of the decline in prices in Africa was due to falling mark-ups, and the other half was due to falling costs. In 2017, the average mark-up in Africa, at 33.5 percent, is now just slightly lower than in Europe, though still higher than in other continents. From the counterfactuals holding firms and the construction share of income constant in 2011 in this subsample, we see that, as in the full sample, the vast majority of this decline in mark-ups was due to entry, rather than changes in the demand elasticity. Trends in Asia are striking in that a price decline of 12 percent can be explained primarily by a decline in mark-ups, with a much smaller (2.9 percent) decline in marginal cost than observed in Africa. The two continents with the highest concentration of low and lower-middle income countries have therefore both experienced substantial entry, leading to declines in mark-ups and prices.

We use regressions to test whether higher prices observed in Africa are due to marginal costs or mark-ups, and what drives differences in these variables. Columns 1 to 5 of Table 5 report regressions of (the log of) the US dollar cement price on a fixed effect for the African continent and for the year 2017, and the interaction of these two effects.[18] In Column 1, the estimated coefficient on the African continent statistically significant, equal to 0.464 (s.e. = 0.096). Column 2 includes the price of diesel. The coefficient on Africa falls to 0.0360 (s.e. = 0.088), indicating that about one quarter of the difference in the cement price between is explained higher fuel costs in Africa. Column 3 includes the exchange rate, which changes the coefficient on the Africa coefficient little. Column 4 includes the import tariff on cement (which is only available for a subset of countries) and this does not change the coefficient on Africa significantly, indicating tariffs cannot explain the high cost of cement in Africa. Finally, Column 5 in includes the marginal cost, calculated by dividing price by the mark-up in Equation 12. Here the coefficient on the Africa fixed effect falls to 0.152 (s.e. = 0.066). Comparing this coefficient to the one in Column 1 indicates that approximately two-thirds of the difference in prices between Africa and the rest of the world is explained by differences in marginal costs, with the remainder being explained by differences in mark-ups.

[18] Appendix Table A2 shows a similar analysis for the variable log PPP GDP per capita, in place of the Africa fixed effect. As shown in Figure 1, the two are correlated.

Columns 6-10 of Table 5 consider the relationship between the mark-up itself and various country characteristics, as well as the Africa fixed effect. Column 6 confirms that the relationship is positive, with the coefficient on the Africa fixed effect is equal to 0.154 (s.e. = 0.076), indicating that richer countries have lower average mark-ups. Column 7 includes two variables that could affect mark-ups, the construction share of income, which shapes the demand elasticity, and the concentration of urban centers, which could shape conduct. These variables affect mark-ups as expected, but increase the value of the Africa effect when included, indicating differences in these variables do not explain higher mark-ups in Africa. Column 8 includes rule of law and Column 9, an index of the effectiveness of anti-monopoly policy, which is available only for a subset of countries. There is no statistically significant association between these variables and mark-up, and the Africa fixed effect remains statistically significant and positive. This is intriguing, as it appears we have identified higher mark-ups in the African cement industry, are not explained by structural factors or (measured) institutions.

In Column 10, we add the (log) quantity consumed to the regression. Only in this specification, the Africa fixed effect has a coefficient near zero, at 0.016 (s.e. = 0.069). It appears that the small size's of Africa's markets were a key contributor to higher mark-ups.

Overall, these results paint a nuanced picture of variation in prices across countries in the cement industry. The majority of the puzzling fact that cement is more expensive in the poorest countries in Africa appears to be explained by higher marginal costs and mark-ups. Africa's higher mark-ups can be explained by its previously small market size, which has been growing.

4.4 Additional Results on the Nature of Entry

We provide additional evidence on what market and firm characteristics determined entry across markets. In Table 6, Column 1 reports a regression of the difference in the number of firms between 2017 and 2011 on annualized forecast and actual GDP growth, using data from the International Monetary Fund (2020), where forecast and actual are measured as the cumulative annualized growth rate between 2013 and 2015. The oil price (and the broader commodity cycle) peaked in 2014. Both variables have a positive effect on entry, though forecasts do not appear to be more predictive than actuals.

The remaining columns in Table 6 provide some additional insight as to which types of firms entered in which markets. The dependent variable in Column 2 is the share of capacity belonging to firms with operations in two or more countries, which measures the presence of multinational firms in the market. Here, the the Africa fixed effect is significant and positive, suggesting a greater presence by multinationals on the continent. The coefficients on the concentration of urban centers are negative and statistically significant, while rule of law is positive and statistically significant. The dependent variable in Column 3 is the share of capacity in firms that entered in the last year, either 2010 and 2016. This shows that capacity expansion by new entrant is similar in Africa to the rest of the world. If anything rule of law is associated with less capacity held by new entrants. These two pieces of evidence are contrary to the hypothesis of regulation of entry.

The dependent variable in Column 4 is a measure of multimarket contact, MMC. If anything this appears to be more common in countries with stronger rule of law.

4.5 Counterfactual Institutions and Infrastructure

Consider how the price and number of firms changes with shifts in two variables that could potentially be affected by public policy: road density (infrastructure) and rule of law (institutions).

Counterfactual scenarios are calculated as follows. First, the cost variables (road density or rule of law) are changed to their 90th percentile values holding all other variables fixed, implying a new marginal and fixed cost. The 90th percentile is the target for improvement. Next, the new marginal cost is multiplied by the observed mark-up to yield the equilibrium price under these new costs. At this price, a new equilibrium domestic consumption is calculated from the demand curve. Domestic production is inferred from this new consumption, assuming imports remain a constant share of domestic consumption. With these counterfactual domestic production quantities, prices and marginal costs, we calculate the new expected variable profit in each country. Next, we repeat this exercise using a counterfactual mark-up with $N_{it} + 1$ firms. If profits are positive for the equilibrium with $N_{it} + 1$ firms, we record that 1 firm has entered. We then continue with $N_{it} + 2$ and so forth until the break even condition no longer holds. The counterfactual price is the price that holds when the next firm cannot break in.

In Table 7, we report the average change in prices and number of firms relative to what is observed for two counterfactual scenarios: (i) infrastructure, or changing the road density in all countries to be equal to that of the United Kingdom; and (ii) institutions, or improving the rule of law to be that of Taiwan (China). The sample here is the same balanced panel of countries as in Table 4.

The infrastructure counterfactual leads to a 25.2 percent reduction in prices. It also leads the entry of 6 additional firms on average (recall firms are measured as $N^{\star}_{it} = 1/H_{it}$), an increase of almost 60%. The institutions counterfactual leads to similar, though smaller effects, a decline in prices by 18.6 percent and the entry of 5.9 additional firms. Comparing continents, the greatest entry appears to occur in Asia and North America in response to both interventions.

Overall, these results suggest that both institutions and infrastructure can have substantial effects on costs and therefore entry, subsequently lowering prices. However, as measured in our data (e.g., by average road density and percieved rule of law) both variables are roughly constant over time on the African continent, these variables specifically cannot explain the price drop that the continent experienced between 2011 and 2017. This does not preclude however that unobserved changes in infrastructure or institutions specific to the cement industry explain some of the observed decline in prices.

5 Conclusion

Why was cement so expensive in Africa? Though Africa did in 2011 have a higher than average marginal cost of production, prices there at that time reflected the highest mark-ups in the industry. One hypothesis is that these high mark-ups are symptomatic of 'oligarchic' societies, where major producers use political power to erect entry barriers against new entrepreneurs. Our empirical model of industry demand and costs rejects this view. Estimated entry costs vary little across continents and time, consistent with the idea that they derive from common technological features of the industry including capital investment requirements. There is no evidence that fixed costs are higher in Africa than in any other continent; if anything, it appears that rule of law (an expert-survey-based measure of institutional quality that Africa scores poorly on) is positively associated with higher mark-ups. We conclude from these results that the regulation of entry is not an important factor constraining growth in this industry. Cement was so expensive in Africa primarily because the market was not large enough to sustain many entrants given fixed costs of entry, due to minimum efficient scale.

Our results are consistent with a class of models in which a small market size leads to a stable low income equilibrium, e.g., Murphy, Shleifer and Vishny (1989). Unlike in this influential contribution, in which small market size inhibits the adoption of technology with higher fixed costs and lower variable costs, our evidence is consistent with an alternative mechanism in which a small market size reduces the number of entrants and leads to higher mark-ups and monopoly power. If such distortions influence sufficiently many sectors in the economy, then this can lead to lower aggregate income, demand and market size in each sector. Institutional constraints might thus keep prices high if they affect market size, not just through their detrimental impact on variable costs.

Why did prices in Africa fall? One candidate explanation is that institutions have improved, reducing marginal costs and facilitating entry by moving consumers down the demand curve. Indeed, counterfactual improvements in both institutions and infrastructure appear to have substantial effects on price and entry because they reduce costs. The average rule of law index is -0.58 in 2011 in Africa and -0.59 in 2017. National road density is only measured once in 2015. If institutions improved, the changes are unobserved, except in the marginal costs reported by this model.

Considering all of this evidence, our preferred explanation for the decline in the price of cement in Africa is expectations of future growth, in the context of limited barriers to entry. After years of slow growth in 1970s, 1980s, and 1990s, the continent was still a small market that could sustain only a few firms in the presence of entry costs, leading to high mark-ups over already high marginal costs. As growth accelerated in the 2000s, and external demand for commodities exports drove construction investment, cement demand increased. By 2011, the year of the Economist's 'Africa rising' cover, local and multinational firms had begun to take note and began installing capacity. By 2017, the number of firms on the continent had increased from 34 to 60. This fact alone, that entry was rampant during a period of rapid growth provides further evidence that barriers to entry do not appear to be a major problem in Africa.[19]

An additional question is whether more anti-trust enforcement globally would lead to lower cement prices. Our model suggests that on average conduct is consistent with non-cooperative conduct as in the Cournot model, rather than a multi-firm cartel able to price as a monopolist. Many antitrust statutes, for instance the United States' Sherman Act, require evidence of a contract or conspiracy between firms in order for market power to be prosecuted. Despite several salient examples of cartels in the industry, there is no prima facie evidence that such a conspiracy characterizes the global cement industry.

[19]Another example of free entry in Africa comes from the Sierra Leone ice manufacturing industry, where four new entrants challenged an internationally-owned incumbent monopolist leading to a dramatic reduction in consumer fish prices (Ghani and Reed forthcoming).

Figure 1: Intermediate Goods Prices and National Income. National income is measured using the 2017 results of the International Comparison Program (World Bank 2020b). Intermediate goods prices are measured in US dollars at market exchange rates. The dashed line shows the fit of a local linear regression of each price on national income. Units at which prices are measured are, for cement, one metric ton of grey Portland cement; for steel rebar, one metric ton of high-yield steel 16mm diameter reinforcement bars; for urea fertilizer, one metric ton in the month of March, and for internet, a month's subscription to wired broadband service. Plots show data from 2017, except for the urea fertilizer plot, which shows data from 2014, the last year the United States Department of Agriculture (2019) reports the farm price of urea in the United States. The slopes are similar, if slightly declining over time, in the other years of available data from the International Comparison Program, for cement and rebar; AfricaFertilizer.org (2019), for urea; and the International Telecommunications Union (2019), for broadband internet.

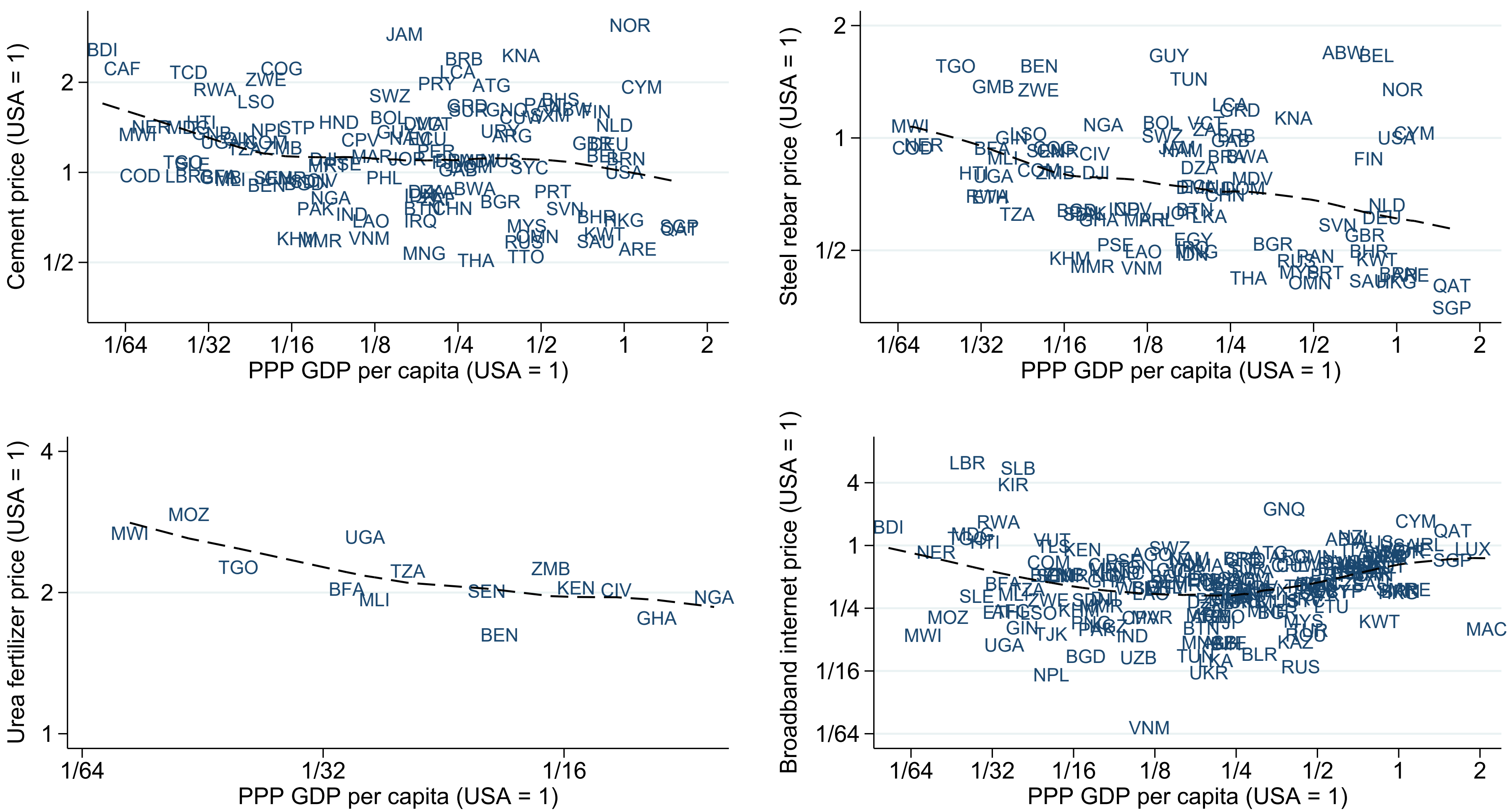


Figure 2: Cement Production Capacity and Consumption. Consumption is total consumption including imports and local production. Observations with zero installed production capacity and non-zero consumption are reported on the bottom line of the figure. Figure reports observations for 2017 only.

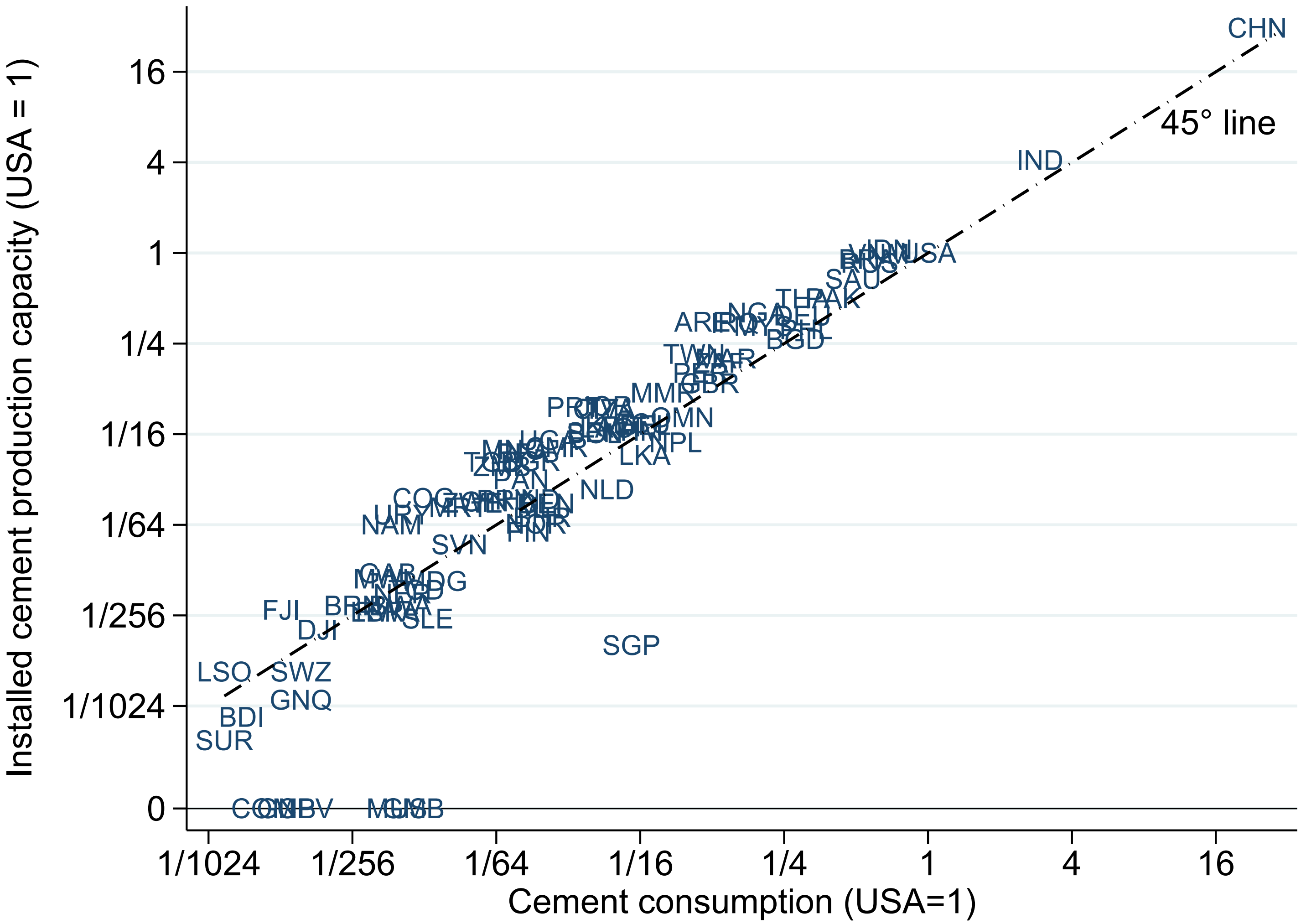
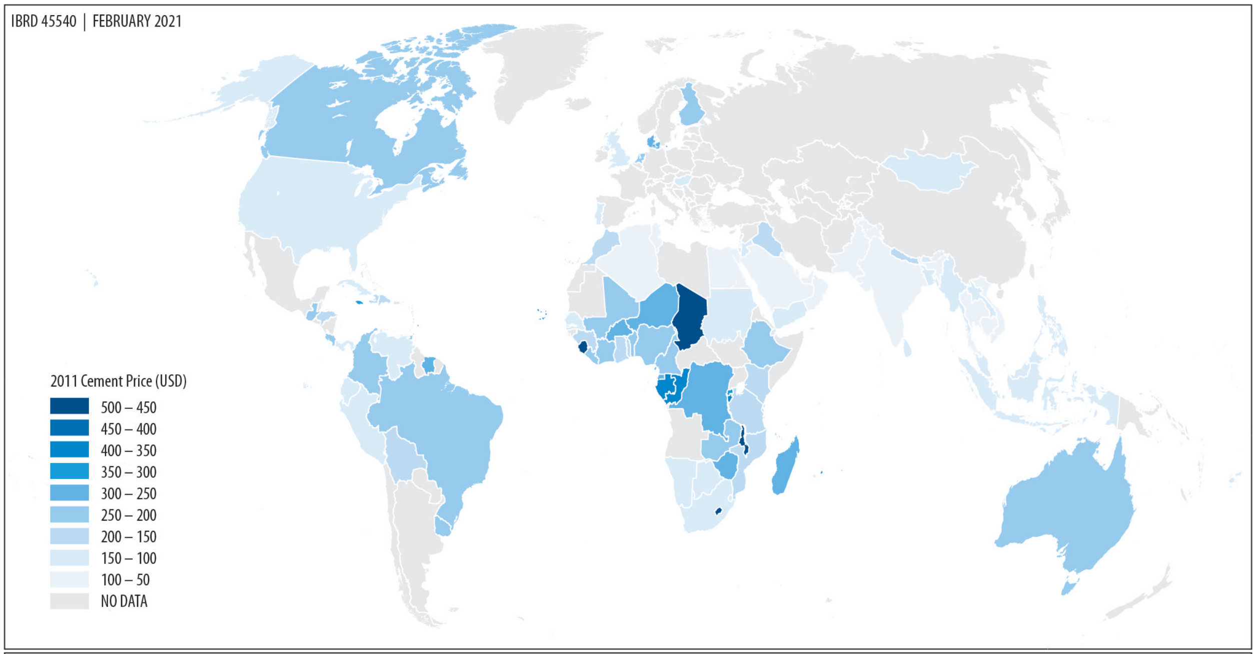


Figure 3: The Price of Cement Across Countries. The choropleth map shows the US dollar price of one metric ton of grey Portland cement at the market exchange rate, in 2011 and 2017, as reported by the International Comparison Program.



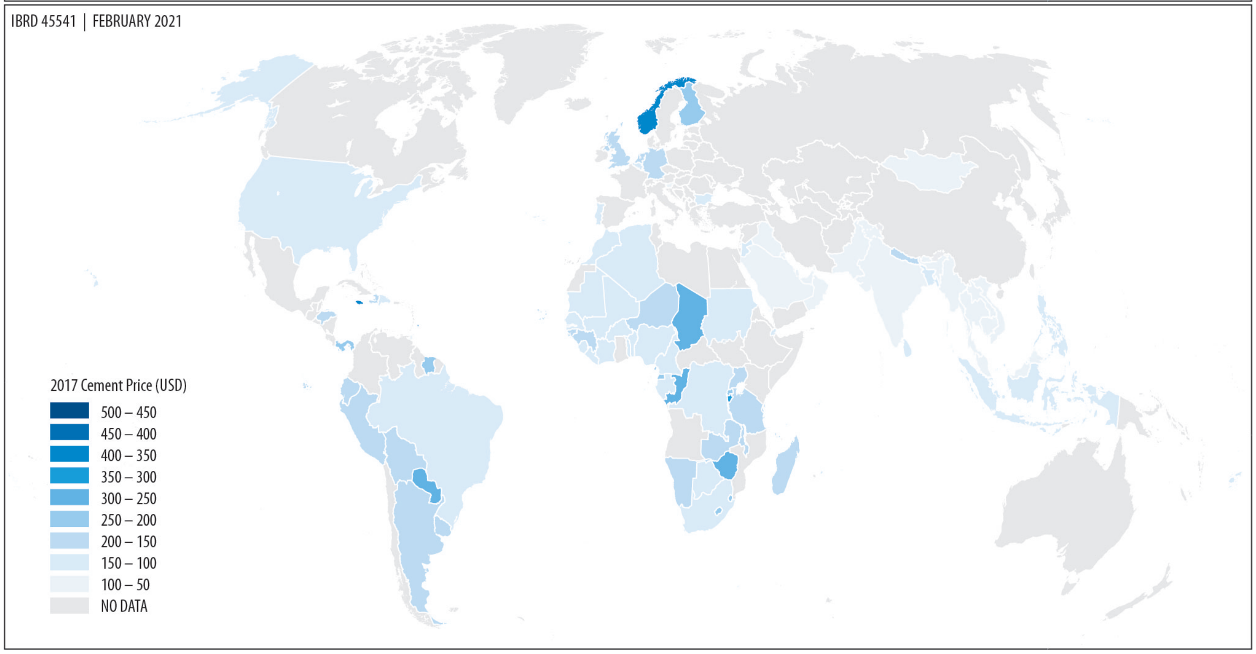


Figure 4: Prices and Entry Green markers indicate countries in Africa. Changes are between 2011 and 2017. The change in real local currency cement price is the difference in (the log of) the nominal price per ton in 2017 and 2011 minus the difference in (the log of) the PPP index between the two years. The concentration-adjusted number of firms is the inverse of the Herfindahl index, equal to the number of firms in the market under the assumption that firms are symmetric. Firms are cement groups in the country, where all subsidiaries with common group ownership are counted as a single firm. The sample includes all countries with price data in both years.

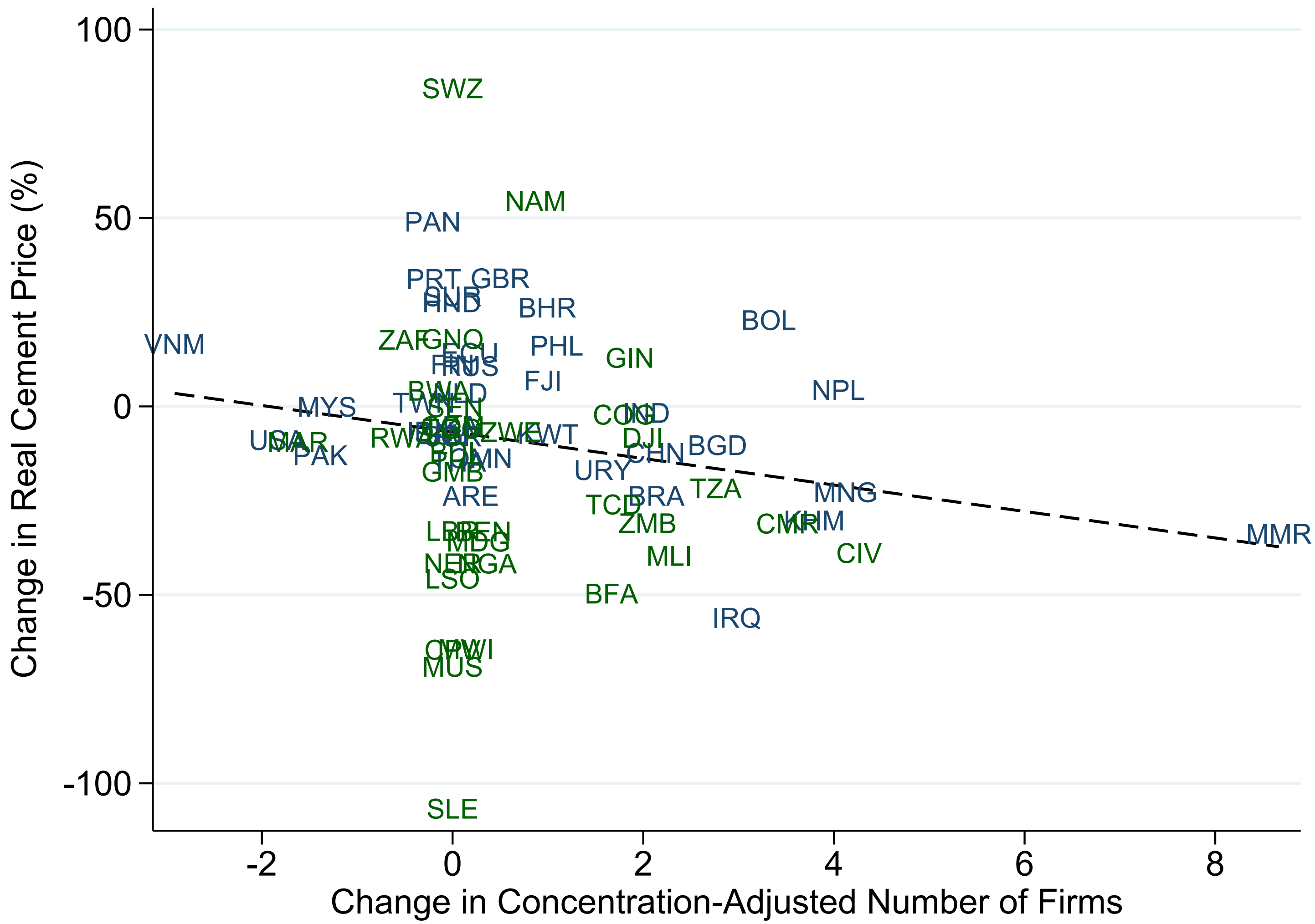


Figure 5: Market Size and the Cement Price. Prices in dollars are reported at market exchange rates. Real GDP is measured in US dollars at the market exchange rate. Green markers are countries in Africa. Figure reports observations for 2017 only. Figure reports observations for 2017 only.

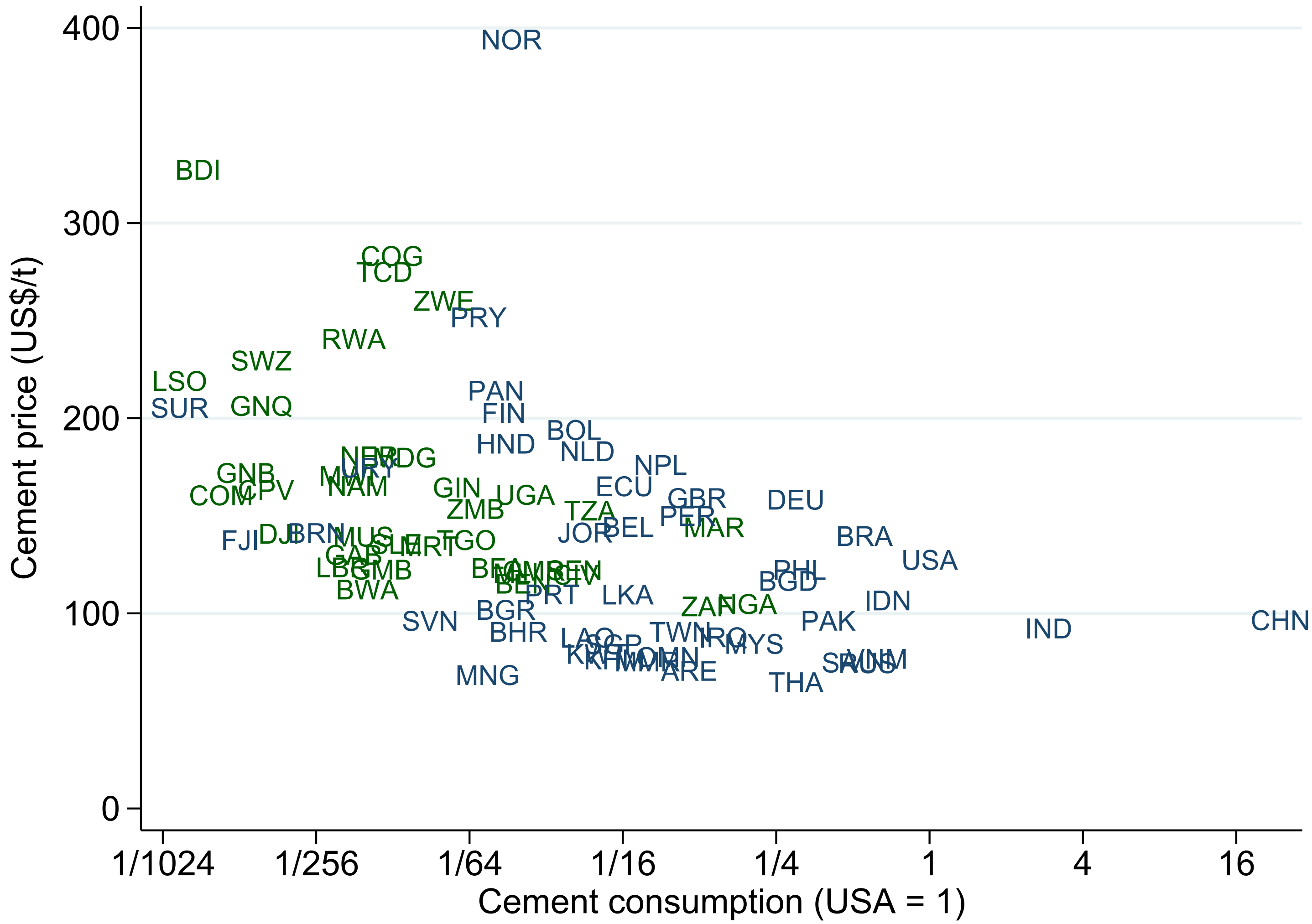


Figure 6: Estimated Mark-ups and the Concentration of Urban Centers. Mark-ups over marginal cost are calculated using as the number of firms the inverse of the Herfindahl index and parameters from the variable conduct parameter specification of the model. Concentration of urban centers is the sum of each urban center's share of total population squared, a proxy for the potential that the market could be segmented, conditional on the number of firms. Green markers are countries in Africa. Figure reports observations for 2017 only. The average mark-up in this sample is 1.26, and the median value is 1.17.

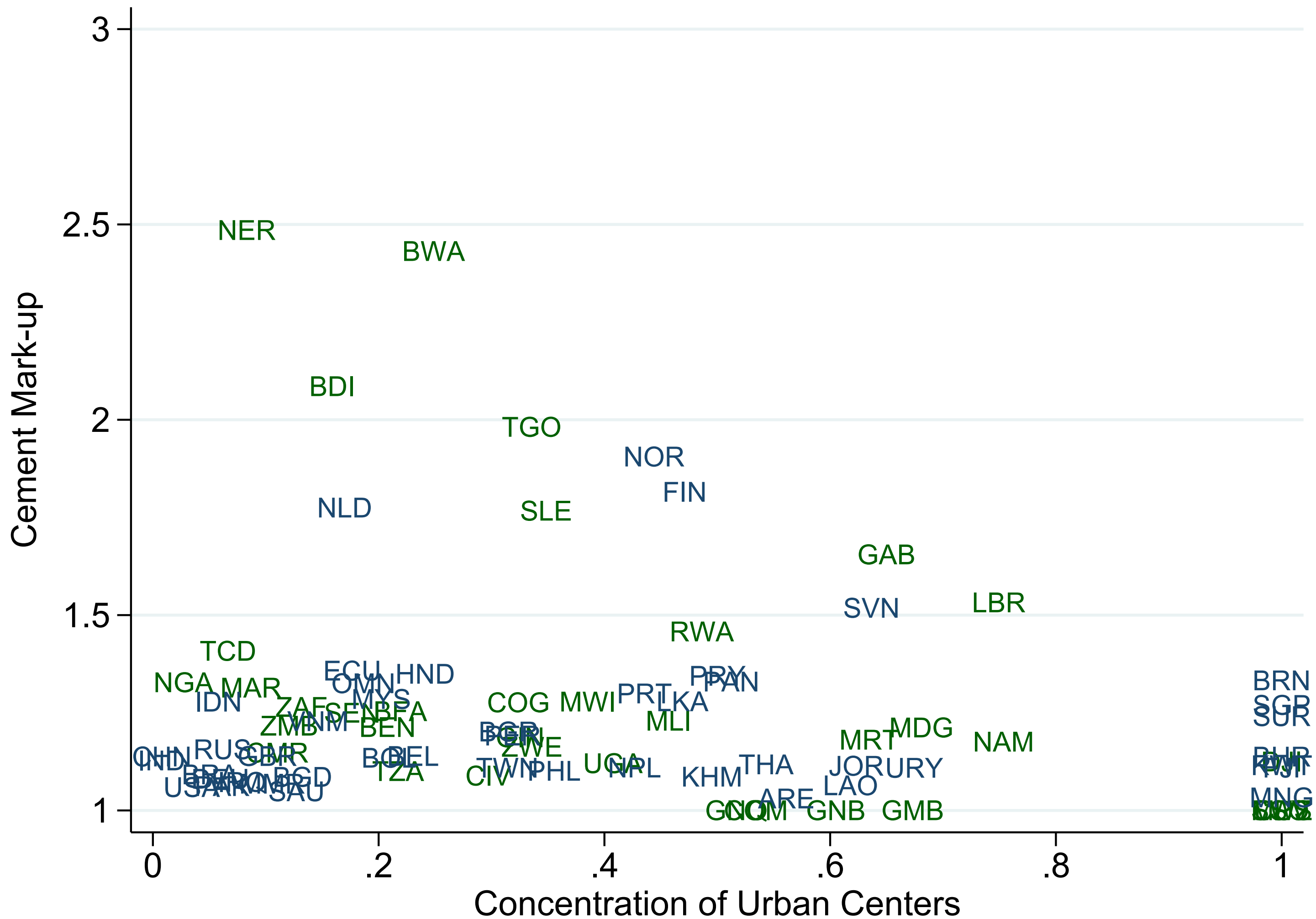


Table 1: Trends in the Global Cement Industry by Continent. The sample includes all countries in which prices and quantities are observed in 2011 and 2017, a total of 87 countries. Africa has 38 observations, North America, 8, South America, 6, Europe 5, Oceania, 1, Asia, 29.

Panel A: Prices and Quantities

	Average Price USD/t			Total Consumption Mt		
	2011	2017	Δ	2011	2017	Δ
Africa	246.53	161.26	-34.6%	92.7	114.7	23.8%
North America	209.78	198.48	-5.4%	75.6	100.8	33.3%
South America	187.04	171.30	-8.4%	82.9	75.3	-9.2%
Europe	163.67	145.69	-11.0%	80.6	76.5	-5.0%
Oceania	149.45	137.40	-8.1%	0.1	0.2	58.3%
Asia	107.49	96.07	-10.6%	2618.0	3022.4	15.4%
All continents	186.82	142.47	-23.7%	2949.8	3389.9	14.9%

Panel B: Entry and Capacity Expansion

	Unique Firms Count			Total Capacity Mt		
	2011	2017	Δ	2011	2017	Δ
Africa	34	60	76.5%	132.6	220.5	66.3%
North America	15	21	40.0%	17.8	19.6	10.2%
South America	20	38	90.0%	108.3	148.5	37.2%
Europe	14	11	-21.4%	108.1	137.1	26.8%
Oceania	1	2	100.0%	0.2	0.5	186.1%
Asia	185	209	13.0%	1486.7	2593.1	74.4%
All continents	269	341	26.8%	1853.6	3119.4	68.3%

Table 2: Industry Equilibrium Model. Two specifications are reported, one in which conduct is as in the Cournot model, and another where the conduct parameter is estimated. In each specification, all coefficients are estimated jointly using the generalized method of moments, so that asymptotic standard errors account for estimation error in every equation. The T-statistic corresponds to a test of the null hypothesis of equality between the estimated coefficients in the Cournot and Conduct Parameter models. The estimation sample includes 169 observations, including those countries with only one year observed. The Andrews et al. (2017)'s sensitivity of average mark-up to local violations of the exclusion restrictions that identify α_1 and λ_0 in the model with conduct is -0.007, respectively 0.040.

		Cournot		Conduct Parameter		T-Statistic
Variable	Parameter	Coefficient	S.e.	Coefficient	S.e.	H_0: Equality
Demand:						
Constant	α_0	4.700	4.900	4.700	2.766	0.000
Year = 2017	$\alpha_{0,2017}$	-0.195	0.092	-0.195	0.091	0.000
$\ln(\text{P}_{it})$	α_1	-1.010	0.956	-1.010	0.514	0.000
$\ln(\text{P}_{it})\ln(\text{CONST}_{it})$	α_2	0.314	0.430	0.314	0.229	0.000
$\ln(\text{E}_{it})$	α_3	0.112	0.074	0.112	0.069	0.000
$\ln(\text{E}_{it})\ln(\text{CONST}_{it})$	α_4	0.043	0.035	0.043	0.033	0.000
$\ln(\text{CONST}_{it})$	α_5	-1.043	2.103	-1.043	1.132	0.000
$\ln(\text{GDPPC}_{it})$	α_6	0.310	0.046	0.310	0.046	0.000
$\ln(\text{POP}_{it})$	α_7	0.855	0.038	0.855	0.037	0.000
Supply with domestic production capacity:						
Constant	β_0^K	4.578	0.106	4.606	0.121	-0.170
Year = 2017	$\beta_{0,2017}^K$	-0.040	0.067	-0.033	0.069	-0.070
$\ln(\text{E}_{it})$	β_1^K	0.009	0.014	0.009	0.013	0.000
$\ln(\text{PDIESEL}_{it})$	β_2^K	0.354	0.071	0.301	0.062	0.560
RLE_{it}	β_3^K	-0.072	0.055	-0.021	0.044	-0.720
$\ln(\text{ROADDENS}_i)$	β_4^K	-0.052	0.032	-0.056	0.024	0.100
Supply with no domestic production capacity:						
Constant	β_0^O	5.460	0.379	5.649	0.360	-0.360
Year = 2017	$\beta_{0,2017}^O$	-0.364	0.166	-0.397	0.166	0.140
$\ln(\text{E}_{it})$	β_1^O	-0.013	0.066	0.023	0.062	-0.400
Fixed costs:						
Constant	γ_0	18.541	0.144	18.532	0.324	0.030
Year = 2017	$\gamma_{0,2017}$	-0.545	0.269	-0.636	1.011	0.090
E_{it}	γ_1	1.061	0.060	1.050	0.187	0.060
$\ln(\text{RLE}_{it})$	γ_2	0.092	0.199	0.095	0.367	-0.010
Standard Deviation Term	σ	1.403	0.192	1.610	0.177	-0.790
Conduct:						
Constant	λ_0			1.013	0.222	
$Z(\text{URBCON}_i)$	λ_1			-0.222	0.063	
$Z(\text{MMC}_{it})$	λ_2			0.252	0.112	
Sargan-Hansen J-Statistic				6.071		
p-value				0.194		

Table 3: Industry Equilibrium Model with Continental Africa Fixed Effect. Two specifications of the model that are identical to the specification in Table 2, except rule of law and road density are removed from marginal and fixed costs and a dummy for the Africa continent and its interaction with a dummy for 2017 are included in fixed costs, and marginal costs for countries with production capacity. The number of non-home markets is replaced with a dummy for Africa in conduct. Only coefficients on these new terms are reported.

	Cournot		Conduct Parameter		T-Statistic
Variable	Coefficient	S.e.	Coefficient	S.e.	H_0: Equality
Supply with domestic production capacity:					
Africa_{it}	0.248	0.120	1.380	0.826	-1.356
$\text{Africa} \times 2017_{it}$	-0.117	0.150	-0.384	0.247	0.923
Fixed costs:					
Africa_{it}	-0.519	0.673	0.195	5.467	-0.129
$\text{Africa} \times 2017_{it}$	-0.080	0.535	0.197	7.599	-0.036
Conduct:					
Africa_{it}			-2.790	2.851	

Table 4: Accounting for Levels and Trends in Cement Prices Across Continents and Technologies. Average US dollar price, marginal cost and mark-ups are reported in natural logs. Marginal cost is inferred from price given the estimated conduct (λ_i) and mark-ups. Δ MC is the log difference in average marginal cost between 2017 and 2011. Mark-up is the log ratio of price over marginal cost, and Δ Mark-up is the log difference in mark-up between 2017 and 2011. Counterfactuals show the change in marginal cost and mark-up between 2017 and 2011, holding constant in 2017 a single variable at its value in 2011 (i.e., N_{it}, $CONST_{it}$) while allowing the rest of the variables to change as observed. The sample includes only countries with domestic cement capacity in which all data are available in two years.

Continent	Year	Obs	Price	Δ Price	Markup	Δ Markup	Δ Markup (2011 N firms)	Δ Markup (2011 Constr Share)	MC	Δ MC
Balanced Panel with Capacity	2011	60	5.039	-	0.428	-	-	-	4.612	-
Balanced Panel with Capacity	2017	60	4.839	-0.201	0.294	-0.134	0.011	-0.132	4.545	-0.067
Africa	2011	23	5.406	-	0.581	-	-	-	4.825	-
Africa	2017	23	5.037	-0.369	0.425	-0.156	0.050	-0.146	4.612	-0.214
Asia	2011	23	4.630	-	0.292	-	-	-	4.337	-
Asia	2017	23	4.510	-0.120	0.156	-0.136	-0.011	-0.138	4.354	0.016
Europe	2011	5	5.031	-	0.459	-	-	-	4.573	-
Europe	2017	5	4.919	-0.113	0.440	-0.019	-0.001	-0.018	4.479	-0.094
North America	2011	3	5.019	-	0.261	-	-	-	4.758	-
North America	2017	3	5.147	0.129	0.293	0.032	0.010	0.014	4.855	0.097
Oceania	2011	1	5.007	-	0.286	-	-	-	4.721	-
Oceania	2017	1	4.923	-0.084	0.136	-0.150	-0.002	-0.149	4.787	0.066
South America	2011	5	5.264	-	0.442	-	-	-	4.823	-
South America	2017	5	5.159	-0.105	0.209	-0.233	-0.048	-0.241	4.951	0.128

Table 5: Cement Prices and mark-ups in Africa. In Columns 1-5 the dependent variable is the log of the US dollar cement price at market exchange rates. In Columns 6-10, the dependent variable is the mark-up calculated using Equation 12 and the coefficient estimates from the Conduct Parameter model. Heteroskedasticity robust standard errors in parenthesis. * for $p < .05$, ** for $p < .01$, and *** for $p < .001$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	$\ln(P_i)$	$\ln(P_i)$	$\ln(P_i)$	$\ln(P_i)$	$\ln(P_i)$	$\ln(M_i)$	$\ln(M_i)$	$\ln(M_i)$	$\ln(M_i)$	$\ln(M_i)$
Africa	0.464***	0.360***	0.373***	0.339***	0.152**	0.154**	0.207***	0.229***	0.157**	0.016
	(0.096)	(0.088)	(0.092)	(0.103)	(0.066)	(0.076)	(0.069)	(0.074)	(0.071)	(0.069)
Africa × 2017	-0.177	-0.187*	-0.180	-0.224	-0.021	-0.027	-0.048	-0.046	0.010	-0.035
	(0.123)	(0.112)	(0.113)	(0.138)	(0.077)	(0.104)	(0.097)	(0.097)	(0.098)	(0.083)
Year = 2017	-0.098	-0.076	-0.075	-0.089	-0.104**	-0.077	-0.086	-0.088*	-0.068	-0.080*
	(0.084)	(0.077)	(0.076)	(0.102)	(0.046)	(0.060)	(0.052)	(0.051)	(0.052)	(0.048)
ln(PDIESEL)		0.329***	0.333***	0.318***						
		(0.051)	(0.051)	(0.068)						
ln(E)			0.008	-0.000						
			(0.011)	(0.015)						
ln(TARIFF)				0.476						
				(0.377)						
ln(MC)					0.745***					
					(0.049)					
ln(CONST)							0.084*	0.080*	0.031	0.136***
							(0.048)	(0.048)	(0.046)	(0.047)
Z(URBCON)							0.135***	0.130***	0.122***	-0.001
							(0.024)	(0.024)	(0.028)	(0.032)
RLE								0.034	0.063	0.045*
								(0.031)	(0.049)	(0.026)
Effectiveness of Anti-monopoly policy									-0.002	
									(0.052)	
ln(Q)										-0.113***
										(0.018)
Constant	4.873***	4.945***	4.966***	4.924***	1.499***	0.371***	0.560***	0.548***	0.424*	2.451***
	(0.058)	(0.055)	(0.060)	(0.082)	(0.226)	(0.043)	(0.111)	(0.111)	(0.243)	(0.325)
Observations	169	169	169	126	169	151	151	151	130	151
R-squared	0.225	0.363	0.366	0.393	0.710	0.070	0.236	0.244	0.230	0.424
Sample	Full	Full	Full	Full	Full	N>0	N>0	N>0	N>0	N>0

Table 6: Regressions of Firm Outcomes on Market Characteristics. Dependent variables are outcomes of firm decision-making. Column 1 regresses the difference in the number of firms between 2017 and 2011 on annualized forecast and actual GDP growth. Forecast growth is the International Monetary Fund's April 2013 forecast for growth between 2013 and 2015. The peak of the oil price was in June 2014. Actual GDP growth is the actual growth over that period. Columns 2-4 include observations from 2011 and 2017. MNC is multinational corporation. Entrant share of capacity refers to the share of capacity in firms that entered since 2010 and 2016. The average number of non-home market contacts is a measure of multimarket contact, calculated as in Jans and Rosenbaum (1996). Heteroskedasticity robust standard errors in parenthesis. * for $p < .05$, ** for $p < .01$, and *** for $p < .001$.

	(1)	(2)	(3)	(4)
VARIABLES	Δ N	MNC share of capacity	Entrant share of capacity	Multi-market contact
AFR		0.15*	-0.03	-0.42
		(0.08)	(0.04)	(0.34)
ln(CONST)		-0.03	-0.02	0.09
		(0.08)	(0.04)	(0.28)
Concentration of urban centers		-0.10***	0.01	-0.70***
		(0.04)	(0.02)	(0.18)
Rule of law		0.13***	-0.04***	0.63*
		(0.04)	(0.02)	(0.33)
Forecast GDP Growth	-0.01			
	(0.07)			
Actual GDP Growth	0.19**			
	(0.08)			
Constant	0.35	0.38**	0.07	1.51**
	(0.39)	(0.18)	(0.08)	(0.63)
Observations	59	169	169	169
R-squared	0.10	0.10	0.03	0.18

Table 7: Counterfactual Infrastructure and Institutions. This table reports counterfactual price changes and entry for two counterfactual scenarios. The first, infrastructure, reports the percentage decline in price and additional number of firms in 2017, if all countries over that period expanded their road network to reach the density of the United Kingdom, the observation at the 90th percentile of road density, all else equal. The second, institutions, reports the change in prices and additional firms in 2017, if all countries over that period improved their rule of law to be that of Taiwan (China), the observation at the 90th percentile of rule of law. The sample includes only countries in which all data are available in two years, and marginal cost is calculated using mark-ups implied by the Conduct Parameter model in Table 2.

	Year	USD P Cement	Mean N firms	CF Price − Obs Price (Q90 Roaddens)	CF N firms − Obs N firms (Q90 Roaddens)	CF Price − Obs Price (Q90 RLE)	CF N firms − Obs N firms (Q90 RLE)
Balanced panel with capacity	2017	4.839	3.872	-0.252	6.028	-0.186	5.866
Africa	2017	5.037	2.529	-0.345	2.531	-0.271	2.537
Asia	2017	4.510	5.513	-0.151	10.357	-0.102	9.846
Europe	2017	4.919	2.610	-0.316	4.665	-0.268	4.735
North America	2017	5.147	4.827	-0.251	6.392	-0.167	7.018
Oceania	2017	4.923	1.947	-0.209	1.011	-0.078	1.017
South America	2017	5.159	3.578	-0.231	4.355	-0.131	4.280

References

Acemoglu, Daron, "Oligarchic versus Democratic Societies," *Journal of the European Economic Association*, 2008, *6* (1), 1–44.

_ **, Simon Johnson, and James A Robinson**, "Institutions as a Fundamental Cause of Long-Run Growth," *Handbook of Economic Growth*, 2005, *1*, 385–472.

AfricaFertilizer.org, "Fertilizer Statistics," 2019.

Andrews, Isaiah, Matthew Gentzkow, and Jesse M Shapiro, "Measuring the Sensitivity of Parameter Estimates to Estimation Moments," *The Quarterly Journal of Economics*, 2017, *132* (4), 1553–1592.

Armstrong, Thomas, Muriel Bal, Peter Bell, Jolyne Fernandes, and Suzanne Starbuck, *Global Cement Report, 10th edition*, Tradeship Publications Ltd., 2013.

_ **,** _ **,** _ **,** _ **, and** _ , *Global Cement Report, 13th edition*, Tradeship Publications Ltd., 2019.

Asker, John, Allan Collard-Wexler, and Jan De Loecker, "(Mis) Allocation, Market Power, and Global Oil Extraction," *American Economic Review*, 2019, *109* (4), 1568–1615.

Atkin, David and Dave Donaldson, "Who's Getting Globalized? The Size and Implications of Intra-National Trade Costs," 2015.

Bai, Jie, "Melons as Lemons: Asymmetric Information, Consumer Learning and Quality Provision," 2021.

Bain, Joe Staten, *International differences in industrial structure: eight nations in the 1950s.*, Yale University Press, 1966.

Balassa, Bela, "The Purchasing-Power Parity Doctrine: a Reappraisal," *Journal of Political Economy*, 1964, *72* (6), 584–596.

Begazo, Tania, Martha Martinez Licetti, Sara Nyman, and Lucia Villaran, "Breaking Down Barriers: Unlocking Africa's Potential through Vigorous Competition Policy," Technical Report, World Bank 2016.

Bergquist, Lauren Falcao and Michael Dinerstein, "Competition and Entry in Agricultural Markets: Experimental Evidence from Kenya," *American Economic Review*, 2020, *110* (12), 3705–47.

Bernheim, B Douglas and Michael D Whinston, "Multimarket Contact and Collusive Behavior," *The RAND Journal of Economics*, 1990, pp. 1–26.

Berry, Steven and Joel Waldfogel, "Free Entry and Social Inefficiency in Radio Broadcasting," *RAND Journal of Economics*, 1999, *30* (3), 397–420.

_ **and Peter Reiss**, "Empirical Models of Entry and Market Structure," *Handbook of Industrial Organization*, 2007, *3*, 1845–1886.

_ **and Philip Haile**, "Identification in Differentiated Products Markets," *Annual Review of Economics*, 2016, *8*, 27–52.

_ **, Martin Gaynor, and Fiona Scott Morton**, "Do Increasing Markups Matter? Lessons from Empirical Industrial Organization," *Journal of Economic Perspectives*, 2019, *33* (3), 44–68.

Bhagwati, Jagdish N, "Why are Services Cheaper in the Poor Countries?," *The Economic Journal*, 1984, *94* (374), 279–286.

Bhattacharjea, Aditya and Oindrila De, "Cartels and the Competition Commission," *Economic and Political Weekly*, 2012, pp. 14–17.

Bhayani, Sanjay J, "Determinant of Profitability in Indian Cement Industry: An Economic Analysis.," *South Asian Journal of Management*, 2010, *17* (4).

Bresnahan, Timothy F, "The Oligopoly Solution Concept is Identified," *Economics Letters*, 1982, *10* (1-2), 87–92.

_ , "Empirical Studies of Industries with Market Power," *Handbook of Industrial Organization*, 1989, *2*, 1011–1057.

_ **and Peter C Reiss**, "Entry and Competition in Concentrated Markets," *Journal of Political Economy*, 1991, *99* (5), 977–1009.

Casaburi, Lorenzo and Tristan Reed, "Interlinked Transactions and Competition: Experimental Evidence from Cocoa Markets," 2019.

Cembureau, "Key Facts and Figures," 2021.

Djankov, Simeon, Rafael La Porta, Florencio Lopez de Silanes, and Andrei Shleifer, "The Regulation of Entry," *The Quarterly Journal of Economics*, 2002, *117* (1), 1–37.

Easterly, William, "How Much do Distortions Affect Growth?," *Journal of Monetary Economics*, 1993, *32* (2), 187–212.

Faccio, Mara and Luigi Zingales, "Political Determinants of Competition in the Mobile Telecommunication Industry," Technical Report, National Bureau of Economic Research 2017.

Florczyk, Aneta, Christina Corbane, Marcello Schiavina, Martino Pesaresi, Luca Maffenini, Michele Melchiorri, Panagiotis Politis, Filip Sabo, Sergio Freire, Daniele Ehrlich, Thomas Kemper, Pierpaolo Tommasi, Donato Airaghi, and Luigi Zanchetta, "GHS Urban Centre Database 2015, Multitemporal and Multidimensional Attributes, R2019A," 2019.

Fowlie, Meredith, Mar Reguant, and Stephen P Ryan, "Market-Based Emissions Regulation and Industry Dynamics," *Journal of Political Economy*, 2016, *124* (1), 249–302.

Genesove, David and Wallace P Mullin, "Testing static oligopoly models: conduct and cost in the sugar industry, 1890-1914," *The RAND Journal of Economics*, 1998, pp. 355–377.

Ghani, Tarek and Tristan Reed, "Relationships on the Rocks: Contract Evolution in a Market for Ice," *American Economic Journal: Microeconomics*, forthcoming.

Ghemawat, Pankaj and Catherine Thomas, "Strategic Interaction across Countries and Multinational Agglomeration: An Application to the Cement Industry," *Management Science*, 2008, *54* (12), 1980–1996.

Goldberg, Pinelopi Koujianou and Frank Verboven, "The evolution of price dispersion in the European car market," *The Review of Economic Studies*, 2001, *68* (4), 811–848.

_ **and Rebecca Hellerstein**, "A Structural Approach to Explaining Incomplete Exchange-Rate Pass-Through and Pricing-to-Market," *American Economic Review*, 2008, *98* (2), 423–29.

_ **and Tristan Reed**, "Income Distribution, International Integration and Sustained Poverty Reduction," 2020.

Hallward-Driemeier, Mary and Lant Pritchett, "How Business is Done in the Developing World: Deals Versus Rules," *Journal of Economic Perspectives*, 2015, *29* (3), 121–40.

Hansen, Lars Peter, John Heaton, and Amir Yaron, "Finite-Sample Properties of Some Alternative GMM Estimators," *Journal of Business & Economic Statistics*, 1996, *14* (3), 262–280.

Hassan, Fadi, "The Price of Development: The Penn–Balassa–Samuelson Effect Revisited," *Journal of International Economics*, 2016, *102*, 291–309.

Hsieh, Chang-Tai and Peter J Klenow, "Relative Prices and Relative Prosperity," *American Economic Review*, 2007, *97* (3), 562–585.

Igami, Mitsuru, "Market Power in International Commodity Trade: The Case of Coffee," *The Journal of Industrial Economics*, 2015, *63* (2), 225–248.

International Monetary Fund, "Historical World Economic Outlook Forecasts Database," 2020. visited on 2020-11-16.

International Telecommunications Union, "World Telecommunication/ICT Indicators Database online," 2019.

Jans, Ivette and David I Rosenbaum, "Multimarket Contact and Pricing: Evidence from the US Cement Industry," *International Journal of Industrial Organization*, 1996, *15* (3), 391–412.

Jones, Charles I, "Economic Growth and the Relative Price of Capital," *Journal of Monetary Economics*, 1994, *34* (3), 359–382.

_ , "Intermediate Goods and Weak Links in the Theory of Economic Development," *American Economic Journal: Macroeconomics*, 2011, *3* (2), 1–28.

Kalouptsidi, Myrto, "Time to Build and Fluctuations in Bulk Shipping," *American Economic Review*, 2014, *104* (2), 564–608.

Kirchberger, Martina and Keelan Beirne, "Concrete Thinking about Development," Centre for Economic Policy Research Structural Transformation and Economic Growth Virtual Workshop on Firms, Frictions and Spillovers and Industrial Policy 2020.

Kraay, Aart, Daniel Kaufmann, and Massimo Mastruzzi, *The Worldwide Governance Indicators: Methodology and Analytical Issues*, The World Bank, 2010.

Kravis, Irving B, Alan Heston, and Robert Summers, *World Product and Income: International Comparisons of Real Gross Product*, The World Bank, 1982.

Lewis, David, "Bid Rigging and its Interface with Corruption," in "The Economic Characteristics of Developing Jurisdictions," Edward Elgar Publishing, 2015.

Loecker, Jan De and Frederic Warzynski, "Markups and firm-level export status," *American economic review*, 2012, *102* (6), 2437–71.

_ , Jan Eeckhout, and Gabriel Unger, "The Rise of Market Power and the Macroeconomic Implications," *The Quarterly Journal of Economics*, 2020, *135* (2), 561–644.

Macchiavello, Rocco and Ameet Morjaria, "Competition and Relational Contracts in the Rwanda Coffee Chain," *Quarterly Journal of Economics*, 2021, *forthcoming.*

Meijer, Johan R, Mark AJ Huijbregts, Kees CGJ Schotten, and Aafke M Schipper, "Global Patterns of Current and Future Road Infrastructure," *Environmental Research Letters*, 2018, *13* (6), 064006.

Miller, Nathan H and Matthew Osborne, "Spatial Differentiation and Price Discrimination in the Cement Industry: Evidence from a Structural Model," *The RAND Journal of Economics*, 2014, *45* (2), 221–247.

Mitton, Todd, "Institutions and Concentration," *Journal of Development Economics*, 2008, *86* (2), 367–394.

Murphy, Kevin M, Andrei Shleifer, and Robert W Vishny, "Industrialization and the Big Push," *Journal of Political Economy*, 1989, *97* (5), 1003–1026.

Newmark, Craig M, "Price and Seller Concentration in Cement: Effective Oligopoly or Misspecified Transportation Cost?," *Economics Letters*, 1998, *60* (2), 243–250.

Röller, Lars-Hendrik and Frode Steen, "On the Workings of a Cartel: Evidence from the Norwegian Cement Industry," *American Economic Review*, 2006, *96* (1), 321–338.

Rubens, Michael, "Market Structure, Oligopsony Power and Productivity," 2020.

Ryan, Stephen P, "The Costs of Environmental Regulation in a Concentrated Industry," *Econometrica*, 2012, *80* (3), 1019–1061.

Salvo, Alberto, "Inferring Market Power under the Threat of Entry: The case of the Brazilian Cement Industry," *The RAND Journal of Economics*, 2010, *41* (2), 326–350.

Samuelson, Paul A, "Theoretical Notes on Trade Problems," *The Review of Economics and Statistics*, 1964, pp. 145–154.

Silverman, Rachel, Janeen Madan Keller, Amanda Glassman, and Kalipso Chalkidou, "Tackling the Triple Transition in Global Health Procurement," Technical Report, Center for Global Development 2019.

Summers, Robert and Alan Heston, "The Penn World Table (Mark 5): an Expanded Set of International Comparisons, 1950–1988," *The Quarterly Journal of Economics*, 1991, *106* (2), 327–368.

Syverson, Chad, "Market structure and productivity: A concrete example," *Journal of Political Economy*, 2004, *112* (6), 1181–1222.

United States Department of Agriculture, "Fertilizer Use and Price," 2019.

World Bank, *Doing business 2020*, The World Bank, 2020.

_ , "Purchasing Power Parities and the Size of World Economies: Results from the 2017 International Comparison Program.," 2020.

Zavala, Lucas, "Unfair Trade? Market Power in Agricultural Value Chains," 2020.

Appendix A: Additional Tables.

Table A1: Summary Statistics

	(1)	(2)	(3)	(4)	(5)
VARIABLES	N	mean	sd	min	max
Cement expenditure/GDP	169	0.0133	0.0125	0.000620	0.0738
Cement expenditure/construction investment	169	0.135	0.170	0.00750	1.417
Cement imports/cement consumption	169	0.410	0.377	0	1.016
Year = 2011	169	0.509	0.501	0	1
Year = 2017	169	0.491	0.501	0	1
ln(Cement consumption)	169	14.92	1.891	11.51	21.56
ln(Price of cement)	169	4.997	0.453	4.169	6.180
ln(E)	169	-3.732	2.956	-10.02	1.273
ln(CONST)	169	-2.198	0.489	-4.017	-1.124
ln(GDPPC)	169	8.273	1.490	5.526	11.48
ln(POP)	169	16.41	1.685	12.97	21.05
ln(PDIESEL)	169	-0.102	0.540	-2.708	1.074
Rule of law	169	-0.197	0.895	-1.780	2.027
Road density (km per km^2)	169	0.512	1.207	0.0123	9.574
Concentration of urban centers	169	0.398	0.315	0.00771	1
Production capacity (=1)	169	0.893	0.309	0	1
Number of firms	169	5.053	6.137	0	41
Herfindahl index of capacity	151	0.492	0.315	0.0715	1
Multinational share of capacity	169	0.496	0.412	0	1.591
Recent entrant share of capacity	169	0.101	0.206	0	1
Average number of non-home market contacts	169	0.985	2.175	0	13.17
Effectiveness of anti-monopoly policy (WEF)	142	3.957	0.768	2.350	5.779

Table A2: Cement Prices and mark-ups and PPP GDP per capita. In Columns 1-5 the dependent variable is the log of the US dollar cement price at market exchange rates. In Columns 6-10, the dependent variable is the mark-up calculated using Equation 12 and the coefficient estimates from the Conduct Parameter model. Heteroskedasticity robust standard errors in parenthesis. * for $p < .05$, ** for $p < .01$, and *** for $p < .001$.

VARIABLES	(1) $\ln(P_i)$	(2) $\ln(P_i)$	(3) $\ln(P_i)$	(4) $\ln(P_i)$	(5) $\ln(P_i)$	(6) $\ln(M_i)$	(7) $\ln(M_i)$	(8) $\ln(M_i)$	(9) $\ln(M_i)$	(10) $\ln(M_i)$
ln(PPP GDP per capita)	-0.135***	-0.080***	-0.124***	-0.138**	-0.061***	-0.024	-0.051**	-0.109***	-0.088***	0.008
	(0.029)	(0.027)	(0.038)	(0.054)	(0.020)	(0.024)	(0.021)	(0.028)	(0.029)	(0.031)
ln(PDIESEL)		0.363***	0.358***	0.349***						
		(0.054)	(0.054)	(0.077)						
ln(E)			0.027*	0.025						
			(0.015)	(0.019)						
ln(TARIFF)				0.033						
				(0.396)						
ln(MC)					0.770***					
					(0.045)					
ln(CONST)							0.080	0.074	0.009	0.134***
							(0.051)	(0.053)	(0.047)	(0.049)
Z(URBCON)							0.133***	0.133***	0.131***	-0.011
							(0.026)	(0.026)	(0.029)	(0.034)
RLE								0.106**	0.105**	0.042
								(0.042)	(0.052)	(0.037)
Effectiveness of Anti-monopoly policy									0.036	
									(0.050)	
ln(Q)										-0.117***
										(0.019)
Constant	6.222***	5.763***	6.252***	6.385***	1.946***	0.608***	1.043***	1.572***	1.064***	2.388***
	(0.260)	(0.244)	(0.379)	(0.529)	(0.344)	(0.217)	(0.243)	(0.283)	(0.349)	(0.289)
Observations	164	164	164	121	164	147	147	147	126	147
R-squared	0.132	0.291	0.309	0.347	0.700	0.009	0.163	0.201	0.219	0.402
Sample	Full	Full	Full	Full	Full	N>0	N>0	N>0	N>0	N>0

Table A3: Regressions of Firm Outcomes on Market Characteristics, with PPP GDP per capita. Heteroskedasticity robust standard errors in parenthesis. * for $p < .05$, ** for $p < .01$, and *** for $p < .001$.

VARIABLES	(1) MNC share of capacity	(2) Entrant share of capacity	(3) Multi-market contact
ln(PPP GDP per capita)	-0.07	-0.01	0.25*
	(0.04)	(0.02)	(0.13)
ln(CONST)	-0.05	-0.01	0.05
	(0.08)	(0.04)	(0.28)
Concentration of urban centers	-0.10**	0.01	-0.77***
	(0.04)	(0.02)	(0.19)
Rule of law	0.17***	-0.03	0.52
	(0.05)	(0.03)	(0.36)
Constant	1.08**	0.19	-1.07
	(0.42)	(0.21)	(1.45)
Observations	164	164	164
R-squared	0.11	0.03	0.19