Policy Research Working Paper 9706

The Falling Price of Cement in Africa

Fabrizio Leone
Rocco Macchiavello
Tristan Reed

WORLD BANK GROUP
Development Economics
Development Research Group
June 2021

Abstract

Prices for several intermediate inputs, including cement, are higher in developing economies—particularly in Africa. Combining data from the International Comparison Program with a global directory of cement plants we estimate an industry equilibrium model to distinguish between drivers of international price dispersion: demand, costs, conduct, and entry. Developing economies feature both higher marginal costs and higher markups. African markets are not characterized by higher barriers to entry and, if anything, feature relatively more competitive conduct. The small size of many national markets, however, limits entry and competition and explains most of the higher markups. Policy implications are discussed.

This paper is a product of the Development Research Group, Development Economics. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at treed@worldbank.org.

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

Originally published in the Policy Research Working Paper Series on *June 2021.* This version is updated on *June 2022.*
To obtain the originally published version, please email prwp@worldbank.org.

JEL Classification: E31, L13, L61, O12

Keywords: International price dispersion, market power, market size, markup, cement, Africa.

*Many thanks to David Atkin, Ana Paula Cusolito, Penny Goldberg, Phil Haile, Aart Kraay, Eduardo Morales, Tommaso Porzio, Bob Rjikers, Mike Sinkinson, Daria Taglioni, Catherine Thomas, seminar participants at the Africa and North America meetings of the Econometric Society, the International Industrial Organization Conference, the World Bank Development Research Group, and Yale University for helpful questions and comments, and to Jan Gabriel Oledan for exceptional research assistance. Reed acknowledges a grant from the Knowledge for Change III Program. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the World Bank or their affiliated organizations, or those of the Executive Directors of the the World Bank, their Managements, or the governments they represent. Address for correspondence: Tristan Reed, treed@worldbank.org.

1 Introduction

The prices of several goods, including intermediate inputs such as cement, broadband internet, steel reinforcement bars, and urea fertilizer, are highest on average in low-income economies, many (though not all) of which are in Africa (see Figure 1). 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 (Balassa, 1964; Samuelson, 1964; Summers and Heston, 1991)—a cornerstone of modern international macroeconomics.

The explanation for this unexpected cross-country pattern in price levels is not certain. One view is that higher prices reflect higher costs of production. An alternative view is that higher prices might instead reflect a higher markup. To the extent that prices do reflect a higher markup, a variety of economic forces could lie underneath. Regulatory requirements (e.g., environmental standards) or disadvantageous market institutions (e.g., borrowing constraints, expropriation risk) can increase entry costs and reduce entry and competition. Given entry, collusive conduct (e.g., cartels) also increases markups. Higher markups could reflect a small market size that is unable to sustain more than a few competitors. The appropriate policy response, if any at all, critically hinges on quantifying the relative importance of these forces. Such a quantification exercise is complicated by a lack of consistent data on prices, quantities, and market structure across economies.

This paper distinguishes between these hypotheses in the case of Portland cement, an industry that is both of intrinsic relevance but also affords a number of 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 GDP on it in our data. We combine a recent panel of internationally comparable prices from the 2011 and 2017 rounds of the International Comparison Program (ICP) with a directory of cement plants in 96 economies on all continents. These data allow us to tease apart and quantify drivers of markups and costs in the global cement industry. We do so by estimating a model of a cross-section of markets in which identification of markups and costs is well understood.

Analysis of the model yields four main insights. First, in an industry characterized by a relatively homogeneous product, differences in marginal costs and markups contribute roughly an equal share to the average difference in prices across economies. Africa stands out because it had the highest average US dollar cement price of any continent in 2011, the highest average marginal cost, and the highest average markup, at about 50 percent.

Second, by 2017 the average cement price in Africa had fallen by one-third, due three-fifths to a decline in marginal cost and two-fifths to a decline in the markup. These declines coincided with substantial entry and investment in new capacity. While markups and marginal costs in Africa remain somewhat higher than the global average, these differences are far less pronounced than at the beginning of the decade. This result casts doubts on views that emphasize deep rooted institutional differences as the direct cause of Africa's initially higher prices and markups.

Third, to the extent that markups in Africa remain high, our estimates suggest this is not due to higher barriers to entry or to widespread cartel conduct across the continent. We identify fixed costs from actual firm entry decisions and find them to be economically significant and in line with figures reported in industry publications. These costs however are not systematically higher in Africa compared to other continents, suggesting that Africa does not have extraordinarily high barriers to entry. We identify conduct following the argument in Bresnahan (1982) generalized by Berry and Haile (2014).[1] While Cournot competition provides an accurate characterization of conduct in the average market, we estimate differences in conduct across economies. Conditional on the number of firms, more geographic concentration of urban centers within a national market lowers markups, while contact between firms in other countries, which theoretically could facilitate collusion, increases markups, consistent with evidence from the United States (e.g., Syverson, 2004; Evans and Kessides, 1994). Yet, quantitatively these factors cannot account for the high price of cement in Africa. This is consistent with the fact, presented in Section 2, that there are fewer known private cement cartels in Africa compared to other continents.

Finally, our estimates suggest that higher prices and markups reflect the small economic size of many national markets on the continent. Fixed costs of establishing a cement plant imply increasing returns to scale and a minimum threshold market size below which a firm will not enter. Many African countries have small market sizes that can only support a limited number of firms.[2] Once market size is properly accounted for, cement markets in Africa do not appear to be characterized by especially high levels of distortions induced by poorly functioning institutions. Consistently with this view, rapid entry occurred in Africa at a time of rapid economic growth. Our evidence is thus in line with Hallward-Driemeier and Pritchett (2015) who observe that, across countries, it is likely the fundamentals of costs and demand, rather than rules and regulations, that guide firm decision-making. We discuss the policy implications of these findings in the conclusions.

Though our findings come from a single industry, they contribute to the understanding

[1] The conduct parameter characterizes the oligopoly solution concept, conditional on market concentration, costs, and demand elasticity. Different values of the parameter distinguish between perfect competition, Cournot competition, and a cartel that jointly maximizes firms' profits (e.g., Atkin and Donaldson, 2015). Joint profit maximization can be illegal whereas Cournot competition need not be (Whinston, 2008).

[2] Some are also landlocked, or with less road density. Importing cement is thus expensive.

of differences in market structures across countries, a topic pioneered by Bain (1966). Basic oligopoly theory predicts a positive relationship between the markup and market concentration. In low- and middle-income economies, the concentration of both sales and employment is substantially higher (Mitton, 2008). High markups in sufficiently many industries in the economy can lead to lower aggregate income in the economy as a whole (see Edmond, Midrigan and Xu, 2018; De Loecker, Eeckhout and Unger, 2020; Baqaee and Farhi, 2020).[3] However, little is known about the underlying causes of high concentration. One hypothesis is that it is enforced by oligarchies led by major producers that use political power to erect entry barriers against new entrepreneurs, e.g., Acemoglu (2008). In support of this hypothesis, empirical work has documented regulation of entry by governments (Djankov, La Porta, Lopez-de Silanes and Shleifer, 2002), damages from cartels (Ivaldi, Jenny and Khimich, 2016), and relatively lower profit margins in nontradable sectors in countries with greater legal scope for antitrust policies (Besley, Fontana and Limodio, 2020).

The case of the cement industry however points to an alternative hypothesis in which, due to increasing returns to scale, market size plays a comparatively more important role in accounting for higher concentration and markups. Unlike in the influential model of development formalized by Murphy, Shleifer and Vishny (1989), in which small market size inhibits the adoption of technology with a higher fixed cost and lower marginal cost, our evidence suggests an additional mechanism in which a small market size reduces the number of entrants and leads to higher markups and market power. Entry barriers and cartel conduct are not a binding constraint and income can only grow when firms get access to a larger market, for instance through exporting (Van Biesebroeck, 2005) or broadening the income distribution (Goldberg and Reed, 2021).

Several recent contributions have studied competition in developing countries focusing on the agriculture sector (e.g., Bergquist and Dinerstein, 2020; Zavala, 2020; Rubens, 2021; Macchiavello and Morjaria, 2021; Bai, 2021; Ghani and Reed, 2022; Casaburi and Reed, 2022). We complement these contributions with an analysis of differences in market structure in an important manufacturing industry across countries.[4] Besides the different context and scope of our analysis, we hope to demonstrate the value of using a transparently identified (Andrews, Gentzkow and Shapiro (2017)) structural industry equilibrium model in the vein of the Empirical Industrial Organization literature (see Bresnahan, 1989; Einav and Levin,

[3]Cherif, Dhungana, Fang, Gonzalez-Garcia, Mendes, Yang, Yenice and Eun Yoon (2020) estimate markups in Africa across many industries and finds levels comparable to our estimates. De Loecker and Eeckhout (2018) report a relatively lower markup among publicly traded firms in South Africa.

[4]Our approach is inspired by Goldberg and Verboven (2001); Kalouptsidi (2014); Atkin and Donaldson (2015); Asker, Collard-Wexler and De Loecker (2019), analyses of cross-country differences in the car, shipping, trade, and oil industries. Costinot, Donaldson, Kyle and Williams (2019) document the role of domestic market size in explaining cross-country differences in pharmaceutical industries.

2010; Berry, Gaynor and Scott Morton, 2019) to answer important questions in development economics.

Given its economic importance and methodological appeal, a large empirical literature has studied the cement industry. Many studies have sought to describe the industry equilibrium in a specific economy, 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; Miller, Osborne, Sheu and Sileo, 2022). In contrast, our goal is to explain sources of variation in prices across countries and contribute to macroeconomic debates on the price of investment (Easterly, 1993; Jones, 1994; Hsieh and Klenow, 2007).

Three closely related papers also study cross-country differences in the cement industry. None of these papers, however, estimates costs (and thus markups) and their underlying drivers. Ghemawat and Thomas (2008) use the global cement directory to describe the strategic decision of multinational cement firms to enter national markets. The World Bank (2016) highlights high prices of cement (and other products) in Africa, using the 2011 IPC data.[5] Beirne and Kirchberger (2021) combine the global cement directory with IPC data like we do and show that cement prices are higher in more concentrated markets. The authors embed an oligopoly model of the cement industry into a general equilibrium model and show that the steady-state capital stock in Africa 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 ways. First, we estimate a structural model rather than a reduced-form relationship between market concentration and prices.[6] Second, differences in modeling approach (and identification strategy), lead to a distinct focus: while we do not link concentration in the cement industry to the aggregate capital stock, our model allows us to disentangle drivers of costs and markups in the industry and perform rich counterfactuals. Finally, we highlight the rapid decline of prices in Africa, rather than exclusively cross-sectional differences in price levels. These distinctions, supported by the model's estimates, lead to rather different conclusions with respect to drivers of cross-economy price dispersion, and how it may (or may not) be addressed by public policy.

The rest of the paper unfolds as follows. Section 2 presents the data, motivating facts, and industry background. Section 3 introduces the model. Section 4 applies the model

[5] Hassan (2016) finds that the overall price level falls with national income among low-income economies in Africa. Higher prices in low-income economies have been documented for generic pharmaceuticals (Silverman, Keller, Glassman and Chalkidou, 2019) and mobile internet (Faccio and Zingales, 2017).

[6] See Berry et al. (2019) for a discussion of the difficulties in interpreting reduced-form relationships between market structure and markups (and, a fortiori, prices) in the spirit of the older 'structure-conduct-performance' paradigm.

to the global cement industry and presents our identification and estimation strategies. Section 5 reports the main empirical results and considers potential threats and sensitivity to identification assumptions. Section 6 discusses policy implications.

2 Data, Motivating Facts, and Industry Background

We begin by describing our data and three unique characteristics of cement markets in Africa that motivate this research. A variety of hypotheses could account for these facts, necessitating an economic model to distinguish them. This section closes by providing background on the technology, market structure, and demand of the cement industry as a prelude to the model.

2.1 Data

The sample of cement markets includes 96 economies with available data on cement and input prices, consumption and production quantities, the number of cement firms, and other market characteristics. Over the two years of the panel, 2011 and 2017, our sample has 169 observations.[7] Price data are from the ICP, which in 2020 released the first ever large-sample cross-economy panel of average prices of investment goods (World Bank, 2020b). The ICP data are the empirical basis for the measurement of global output by purchasing power parities and represent the statistical best practice 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 economies.

The cement price used is for one metric ton of ordinary Portland cement in bags or bulk delivery. Given this definition suggests transportation costs may factor into in prices, in our empirical model, we include variables related to transportation costs, including road density and the price of diesel, in the measure of marginal cost. Average prices are calculated from either regular surveys underlying the national consumer and producer price indices, or a special national survey fielded for purpose of the ICP. No alternative database of cement prices that are comparable across economies exists. Prior to 2011, the ICP only collected data from several 'core' economies in each continent.

2.2 Motivating Facts

The data reveal three facts about African cement markets that motivate our research.

[7]Appendix A includes a detailed description of the sources, and summary statistics for each variable in the sample are provided in Table A1.

1. *The average price of cement in Africa was the highest of any continent in 2011, and consumption was the lowest.* Panel A of Table 1 reports average prices in each continent and year in our sample, showing that the price in Africa is the highest in 2011, at \$252/t. This pattern is also visible on the global map of prices in Figure A2. High cement prices on the continent have been highlighted by others (e.g., World Bank, 2016; Beirne and Kirchberger, 2021), in part because they stand in stark contrast to the implications of the classic theory of international price differences (Balassa, 1964; Samuelson, 1964; Bhagwati, 1984). According to this theory, lower wages in Africa should lead to a lower price of cement. Even though cement production is not labor intensive, lower productivity in the non-tradable sector could reduce the price of other locally procured inputs (Hsieh and Klenow, 2007). While high prices could lead to lower consumption by moving down the demand curve, lower consumption could also reflect exogenously lower demand conditional on prices, due for instance to lower GDP per capita or population in African countries.

2. *African economies have on average fewer cement firms and less production capacity than other continents.* Panel B of Table 1 indicates that the average economy in Africa had just 1.2 firms in 2011, adjusted for market concentration. Throughout, we refer to the (concentration-adjusted) number of firms, or $N^\star_{it} \equiv 1/H_{it}$, where H_{it} is the Herfindahl index of capacity concentration.[8] Average installed capacity in each African economy is similarly low, at 3 megatons per annum in 2011.

3. *The average price of cement in Africa fell by more than any in other continent between 2011 and 2017, coinciding with entry and capacity installation.* Panel A of Table 1 shows the average price of cement in Africa had fallen by one-third to \$167/t, substantially less than the price in North America. In just six years, cement in Africa was less expensive than in several other continents (comparing the 2011 and 2017 maps in Figure A2 illustrates the pattern). A potential explanation for the fall in prices is shown in Panel B of Table 1. Between these years there was a substantial increase in the average number of firms (by 58.5%) and average installed capacity (by 70.3%).

An important question is the extent to which the observed increase in the number of firms and capacity explains the decline of cement prices and, if so, through which channels.

[8] $N^\star_{it}$ is the number of firms such that $H_{it} = N^\star_{it}(1/N^\star_{it})^2 = 1/N^\star_{it}$. A 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 firms in 2017, but it 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. Further, this transformation allows us to capture information on market share in a way that is theoretically consistent with the model in Section 3.

The evidence suggests potential roles for both reductions in marginal costs and in markups through entry of new firms. Figure 2 shows a plot and linear best fit line of the change in price in a economy between 2011 and 2017 and the change in the number of firms. Changes in prices in this figure are real, adjusted for inflation by subtracting off the change in the local PPP price index. Several economies including Burkina Faso, Cameroon, Cote d'Iovire, Mali, and Zambia experienced substantial declines in price and also increases in the number of firms by 2 to 4, amounting to economically meaningful declines in concentration. Other economies including Lesotho, Mauritius, and Sierra Leone experienced substantial reductions in prices without changes in market structure, suggesting a role for reductions in marginal cost.

To the extent that prices in Africa remain high, another important question is whether this is due to higher barriers to entry or to widespread cartel conduct across the continent. To summarize the candidate hypotheses, Figure 3 reports average values by continent of four proxies for market competitiveness. The first (upper left-hand) panel shows that the effectiveness of anti-monopoly policy, according to a survey of experts (Schwab, 2019), is highest on average in Europe and North America and the second lowest in Africa (though in South America it is lower). This fact is often used to suggest that insufficient antitrust could explain high prices in Africa (e.g., World Bank, 2016; Cherif et al., 2020). A different pattern emerges however in the second (clockwise, upper right-hand) panel, which shows the share of consumption sold under a known private cartel (Connor, 2020). Here, less than 10 percent of cement consumption is sold under a known cartel in the average African economy, while more than 90 percent of cement consumption is sold under a cartel in Europe.[9] Taken at face value, this result suggests Africa is less cartelized than other continents. Of course, cartels in Africa could be unknown because of less effective anti-monopoly policy leading to fewer investigations so these data are not conclusive.

The bottom two panels of Figure 3 show averages of two more variables suggesting alternative hypotheses. Africa is in the middle of other continents in terms of procedures to start a new business, as reported by the Doing Business Indicators (World Bank, 2020a). There are more procedures in Africa compared to Europe and North America, suggesting entry barriers might play a role in higher prices. However, this evidence is also not conclusive. Hallward-Driemeier and Pritchett (2015) show that there is zero correlation between this de-jure measure of the number of procedures required to start a business and the de-facto time business owners report to get an operating license in another survey. The last (lower

[9] Almost all variation in these data is cross-sectional, as most economies with cartels have them in 2011 and 2017. Two economies that change cartel status between years do have prices that move as expected. Between 2011 and 2017 Indonesia removes a cartel and prices fall ($\$129/t \rightarrow \$106/t$), while the Philippines gain a cartel and prices rise ($\$113/t \rightarrow \$122/t$).

right-hand) panel points to yet another potential hypothesis, showing the average cement consumption by continent. Here, African markets have the lowest average cement consumption, indicating small market size and potentially low demand. This evidence is also not conclusive, since consumption is endogenous to prices.

2.3 Industry Background

The model in the next section will be used to distinguish between alternative explanations for cement price levels and changes. The structure of the model is informed by the specific characteristics of the cement industry: technology, market structure, and demand.

Technology. Portland cement (hereafter cement) is the most widely used type of hydraulic cement, which hardens when combined with water. The main inputs to cement production are limestone, clay, and gypsum, which are heated in a kiln to form clinker. Clinker is ground into a fine powder, which finished cement. Cement is a tradable input to ready-mix concrete, which is cement mixed with gravel, sand, and water, and delivered to a construction site. Unlike cement, ready-mix concrete is non-tradable because it is a service (i.e., mixing and delivery).

The cement industry is characterized by increasing returns to scale at the firm level (Norman, 1979). An important source of increasing returns is the capacity installation cost equaling about US$150 million per megaton (million tons) of annual production capacity (Cembureau, 2021). This fixed cost must be paid back by earnings over time, implying a minimum threshold market size below which firms do not enter. As a result, installed capacity is closely related to consumption volume across economies, as shown in Figure 4. Economies below the 45^o line do not have enough domestic production capacity to satisfy consumption, and import some consumption. At very low levels of consumption, most economies are below the 45^o line, and several have no domestic production capacity at all. However, as consumption increases, it becomes more common for economies to have domestic production capacity in excess of consumption.

Market Structure. In the presence of increasing returns to scale, some markup of prices over marginal cost is required to cover fixed costs, and the market is therefore characterized by some degree of imperfect competition. Moreover, a cement market with at least one producer cannot be characterized by perfect competition, under which price equals marginal cost, since then no profit would be available to fund fixed costs, and no firm would enter. The industry includes domestic and multinational firms. Multinationals may strategically enter markets where they face familiar competitors, potentially facilitating collusion (Ghemawat and Thomas, 2008).

Demand. Population, income, and construction investment determine demand. In our sample cement expenditure itself accounts for 1.3 percent of GDP on average, or 13.5 percent of construction investment. We consider several alternative estimates of a demand curve, where Q_{it}, the total quantity of cement in each economy i and year t, is a function of the price P_{it} (measured in US dollars, for comparability across countries) and exogenous market characteristics $\mathbf{D}_{it}$:

$$\ln(Q_{it}) = \alpha_{0t} + \alpha_1 \ln(P_{it}) + \alpha_{\mathbf{D}}\mathbf{D_{it}} + \xi_{it}. \quad (1)$$

The market price elasticity of demand (expressed as a positive number) is $\eta \equiv -\frac{\partial Q_i}{\partial P_i}\frac{P_i}{Q_i} = -\alpha_1$. To account for potentially endogenous prices that could bias our estimate of $-\alpha_1$, we exploit the international data and use cement exports to the world of the nearest neighboring country as an instrument for the cement price in a country. These exports proxy for the availability of low-cost imports. Intuitively, if a firm in country i prices too high, competitors can import cement from country i's neighbor, especially if the neighbor exports large cement volumes. The threat of imports from the neighbor therefore shifts the price P_i, but is plausibly unrelated to unobserved local demand ξ_{it}.[10]

The neighboring country is identified using the minimum of the bilateral distances between country centroids reported by Head and Mayer (2014). The first stage relationship between prices and exports of the nearest neighbor is shown in Figure 5. Though there is substantial variation in prices within countries whose neighbor does not export, all countries with a neighbor who exports substantial quantities have lower prices, which is consistent with our argument about the relevance of the instrument.

The identifying assumption behind this instrument is that exports of the nearest neighbor are related primarily the size of the neighbor's domestic market and available factors, rather than unobserved local demand ξ_{it}. Genesove and Mullin (1998) use a similar approach to identify the elasticity of demand for sugar in the United States, instrumenting for the United States price with the volume of sugar imports to the United States from Cuba in a time series.

[10] We experimented with alternative cost shifter instruments, namely the prices of diesel and electricity. Using these prices as instruments for the cement price, the estimated elasticity was not statistically different. We prefer the neighbor's exports to these candidate instruments because the specification with the price of electricity had fewer observations due to limitations of the ICP electricity price series, leading to larger standard errors, and because of concerns that diesel is a complement to cement, and so enters directly into demand. In Section 5, we evaluate the sensitivity of markups to beliefs about violations of the exclusion restriction related to the neighbor's exports.

Most of our variation in contrast is cross sectional, across countries, so we use exports of different countries. Suppose a country in our sample were the United States as in the sugar example; then we are using the equivalent of Cuban exports to the world to instrument for price in that country. Compared to the approach of using the neighbor's imports, using the neighbor's exports to the world provides us with greater assurance that the instrument is unrelated to local demand, since exports to the world are determined by international demand.[11] A neighbor's exports of cement are generally either much more or much less than local consumption of cement: the standard deviation of the ratio of the nearest neighbor's exports to local consumption is 1.4.

Table 2 reports several estimates of Equation (1) using this instrument, with all market characteristics in natural logs. Estimates of the demand curve are broadly in line with industry accounts and existing studies of the industry. In all Columns 1-5 the demand elasticity is greater than 1, consistent with the exercise of market power. The model in Column 1, which includes no market characteristics, yields $\eta = 1.96$ (s.e. $= 0.80$). The Kleibergen-Paap F-statistic of the first stage relationship is 29.23, well above the heuristic threshold of 10. Column 2, which includes population, GDP per capita, and the construction share of GDP, all of which have positive and significant effects on demand, yields $\eta = 1.38$ (s.e. $= 0.26$), and has a slightly larger first stage F-statistic of 30.65. The lower standard error and higher F-statistic in this specification motivate retaining these demand shifters in the demand curve. All are plausibly exogenous, with population and GDP per capita determined over the long term. The share of cement in construction investment (13.5 percent in our sample), leads construction investment to be considered exogenous to unobserved cement demand or costs (e.g., Syverson, 2004).

An assumption required for identification of any demand elasticity is that shocks to demand for complements and substitutes enter into the error term ξ_{it} as a scalar index (Berry and Haile, 2014). While we do not observe consumption of such goods in each economy, Column 2 does include the log of the construction share of GDP as a control that is correlated with demand for these goods. In addition, in Column 3, we include the exchange rate, which may affect demand for imported construction goods, the price of diesel, and the price of aggregate. The latter two prices may affect the ready-mix concrete industry, which is a major consumer of cement. In this specification these variables do not have a significant effect on demand, and the elasticity changes little relative to Column 2, at $\eta = 1.41$ (s.e. $=$ 0.36), though it has a higher standard error. For these reasons, and because the ICP reports the price of aggregate for a smaller set of countries, we prefer the specification in Column 2

[11] Genesove and Mullin (1998) study the period 1890-1914, and it is plausible they did not have access to comprehensive data on Cuba's sugar exports to the world during that time period.

to that in Column 3.

Columns 4 and 5 provide additional robustness tests. In Column 4, the GDP per capita of the neighboring country is included as a control for the fact that demand in the neighboring country may be correlated with local demand. Reassuringly, this control is not statistically significant and the estimated elasticity does not change materially. This result provides suggestive evidence in support of our exclusion restriction. In Column 5, the same specification as in Column 2 is estimated using as an alternative instrument the exports of all countries weighted by their inverse distance. The elasticity does not change significantly, though the F-stat is lower. Of all these specifications we prefer Column 2.[12]

3 A Model of Equilibrium Prices, Markups, and Entry

Given data availability, we present a standard model of a cross-section of markets (e.g., Berry and Waldfogel, 1999). Each economy is a distinct market, and market concentration is determined endogenously as the result of a two-period entry game. In the first period, firms indexed by j decide whether to enter and operate in each market i. In this exposition we suppress the subscript t for observations of the same market i in different time periods. In the second period, conditional on N_i, the number of firms that entered market i in first period, each firm choses the quantity they supply in each market, q_{ij}. If no firms enter, the price will be set by imports.[13] Firms may be multinational, in that they operate in multiple economies.

Firms may interact strategically so that one firm's quantity choice q_{ij} in the second period affects other firms' profits through the aggregate quantity $Q_i = \sum_j q_{ij}$. This relationship is summarized by a conduct parameter $\lambda_i \equiv \frac{\partial Q_i}{\partial q_{ij}}$ (see e.g., Genesove and Mullin, 1998; Atkin and Donaldson, 2015). The case $\lambda_i = 0$ coincides with perfect competition, under which firms do not interact strategically. The case $\lambda_i = 1$ coincides with either a monopolist (when $N_i = 1$) or the Nash equilibrium of the Cournot oligopoly game (when $N_i > 1$) in which the firm perceives the choices of others to stay the same when choosing quantity. The case

[12] We experimented with estimating a heterogeneous demand elasticity, for instance one that varies with the construction share of GDP, which might affect price sensitivity. Here we found some evidence that demand becomes less elastic when construction is a greater share of GDP, but the interaction was not statistically significant. Further, allowing the elasticity to vary according to the insignificant heterogeneity in the construction share of GDP did not change our quantitative estimates of markups significantly.

[13] Imports can also shape pricing in an equilibrium where firms do enter, in two possible ways. One, cement producers may also import cement and distribute it locally, setting their marginal cost equal to the cost of imports. In a variation, firms may import clinker and grind it locally, effectively separating the production process across multiple countries. Two, the threat of imports can regulate firms' conduct, as in Salvo (2010). This model allows for marginal cost and conduct to vary across markets, potentially capturing both of these mechanisms.

$\lambda_i = N_i$ corresponds to a model of joint profit maximization, where a firm's output changes are matched by all other firms.

In principle, different equilibria may hold in different markets, in ways that vary with observable market characteristics. For instance, if firms in one country meet each other in other countries (i.e., they have "multimarket contact") this could make it easier to sustain joint profit maximization, since deviations from that agreement in one market can be punished in all other markets, raising the cost of deviation (Bernheim and Whinston, 1990; Evans and Kessides, 1994; Jans and Rosenbaum, 1996; Ghemawat and Thomas, 2008). For this reason, we allow λ_i to vary across markets.

The equilibrium of the game is solved by backward induction. In the second period, firms choose quantity q_{ij} to maximize profits in each market i or

$$\max_{q_{ij}} \Pi_j = \sum_i P(Q_i, \mathbf{D}_i) q_{ij} - C_j(q_{ij}, \mathbf{C}_i) - F_j(\mathbf{F}_i). \tag{2}$$

The continuously differentiable inverse demand in each market is given by $P(Q_i, \mathbf{D}_i) = Q^{-1}(P_i, \mathbf{D_i})$ 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 that market. Each firm j may have different costs in each market given by a variable cost function $C_j(q_{ij}, \mathbf{C}_i)$ and a fixed cost function $F_j(\mathbf{F}_i)$ where $\mathbf{C}_i$ and $\mathbf{F}_i$ are vectors of (exogenous) variables affecting marginal and fixed costs in economy i respectively. Fixed costs include both technological features of the industry (e.g., amortization of capacity installation or acquisition costs), regulatory barriers to entry (e.g., environmental licenses), and other market institutions that hinder entry (e.g., credit market imperfections, expropriation risk).

Consistent with our evidence in Column 4 of Table 2 that the income of a neighboring country does not affect the demand in a country, pricing decisions in each market are taken to be separable. Profit maximization in Equation (2) and aggregation of the first order conditions for all firms in each market yields the equilibrium price in the second period

$$P_i = \left(\frac{\eta N_i}{\eta N_i - \lambda_i} \right) \overline{MC}(\mathbf{C}_i). \tag{3}$$

where $\overline{MC}(\mathbf{C}_i) \equiv \frac{1}{N} \sum_{j=1}^{N} C'_j(q_{ij}, \mathbf{C}_i)$ denotes the average marginal cost in market i (the steps of this derivation are in Appendix B).

Definition 1 (Market power and the markup)**.** *Firms' market power is summarized by the* *markup of price over average marginal cost*

$$M_i(\eta, N_i, \lambda_i) \equiv \frac{P_i}{\overline{MC}(\mathbf{C_i})} = \left(\frac{\eta N_i}{\eta N_i - \lambda_i}\right). \tag{4}$$

When $N_i = 1$ and $\lambda_i = 1 = N_i$, there is a monopoly that obtains the monopoly markup. When $N_i > 1$, there is an oligopoly. If $\lambda_i = N_i$, an oligopoly jointly maximizes profits, which obtains the monopoly markup, whereas if $\lambda_i = 1$, an oligopoly obtains the Cournot markup, which is less than the monopoly markup.

To close the model, consider the first period in which a firm decides to enter if it will at least break even given the second period markup resulting from other firms' entry decisions. To select a unique equilibrium, we consider a sequential entry game. In each market, firms with lower marginal costs move first and decide whether to enter. With this equilibrium selection, the entry game has a unique cutoff equilibrium with $N_i^\star$ firms, in which only firms with marginal costs below some cutoff enter the market. Firms enter until the next firm would not break even. This equilibrium implies the following condition on firm profits:

$$\left(\frac{Q_i}{N_i^\star}\left(M_i(Q_i, N_i^\star) - 1\right)\overline{MC}(\mathbf{C_i})\right) - \overline{F}(\mathbf{F}_i) \geq 0 > \left(\frac{Q_i}{N_i^\star + 1}\left(M_i(Q_i, N_i^\star + 1) - 1\right)\overline{MC}(\mathbf{C_i})\right) - \overline{F}(\mathbf{F}_i). \tag{5}$$

$\overline{F}(\mathbf{F}_i)$ is average fixed cost in market i. The term $\left(\frac{Q_i}{N_i^\star}\left(M_i(Q_i, N_i^\star) - 1\right)\overline{MC}(\mathbf{C_i})\right)$ captures variable profit with the observed number of firms and $\left(\frac{Q_i}{N_i^\star+1}\left(M_i(Q_i, N_i^\star + 1) - 1\right)\overline{MC}(\mathbf{C_i})\right)$ captures variable profit with an additional entrant. Note this equation does not imply that all profits are used to cover fixed costs. Since the markup is a continuous function of the number of firms, if the number is discrete firms still make profit after funding fixed costs, except in the knife-edge case where they break even exactly. Further, the markup falls less and less with entry as the number of firms increases.

Proposition 1 (Equilibrium existence and uniqueness)**.** *Suppose firms j maximize profits given demand $\mathbf{D_i}$, conduct λ_i, marginal costs $C_j'(q_{ij}, \mathbf{C}_i)$, and fixed costs $F_j(\mathbf{F}_i)$. If firms enter each market sequentially in ascending order of marginal cost there exists a unique industry equilibrium $\langle P_i, Q_i, N_i^\star\rangle$ with market power defined by Equation* (4)*.*

Proof. A number of firms equal to $N_i^\star$ is observed in equilibrium if and only if fixed costs are such that $N_i^\star$ firms make a profit but $N_i^\star + 1$ firms would not. The number of entrant firms is thus unique. Since firms enter sequentially, the identity of the entrants is unique as long as the distribution of marginal and fixed costs is smooth. □

In this equilibrium, Definition 1 describes an empirical approach to measuring market power that we apply in this paper. When conduct λ_i is specified and data on endogenous market characteristics $\langle P_i, \eta, N_i^\star \rangle$ are available, markup M_i can be calculated directly and Equation (3) allows to decompose prices into markups and marginal costs. A standard approach is to estimate η from an instrumental variables regression of Q_i on P_i.[14] In the absence of direct evidence (e.g., records of communications between firms) of a cartel, it is also standard to assume $\lambda_i = 1$. Given cartels have been documented in the cement industry (see, e.g., Röller and Steen (2006) for an analysis of the (legal) cement cartel in Norway) we will also estimate differences in λ_i across countries.

Conditional on the number of firms and market size, a greater concentration of demand in a small number of urban centers will force firms to compete with each other (Syverson, 2004). For a given number of firms, 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. Miller and Osborne (2014) show that within the United States, spatial differentiation provides cement firms with market power. Although we don't explicitly model plant's location choices in the absence of available data on location-specific prices or costs, we will use the concentration of population in urban centers to proxy for how spatially concentrated cement demand in a economy is. A finding of lower competition in less concentrated economies would hint that firms may serve different locations to be closer to specific markets and take advantage of internal transport costs to gain some market power.

Equation (3) makes clear that prices are determined either by marginal cost or markups. For a policy maker concerned with a price level that is too high, lower marginal cost could be achieved by reducing input prices or increasing productivity, e.g., through the adoption of technology with lower marginal cost.[15] Yet how to address market power is less straightforward. One policy to reduce the price in market i would be to increase the number of firms in the market. After all, Equation (4) indicates that increasing $N_i^\star$ should reduce market power summarized by the markup M_i, and hence prices. However, once accounting for firms' endogenous decision to enter, a variety of different economic forces could generate a small number of firms. Comparative statics of the equilibrium established in Proposition 1 highlight these different scenario and other drivers of market power, each with a different policy implication. These comparative statics, which motivate our empirical analysis, are stated in Proposition 2.

[14] De Loecker and Warzynski (2012) develop an alternative approach that estimates markups from knowledge of the production function and material cost shares without making assumptions on the elasticity of demand nor market structure. Conditional on data availability, the minimal assumptions required makes it the approach of choice to estimate markups. Leaving aside data availability, however, the standard demand approach pursued here remains necessary to explore counterfactual scenarios, as we later do in Section 5.

[15] In the case of cement, policy makers might also be concerned that the price is too low, given carbon emissions associated with production (see Fowlie et al., 2016).

Proposition 2 (Drivers of market power). *Given the demand elasticity η, the following variables can increase market power summarized by the markup:*

1. *Market characteristics $\mathbf{D_i}$ (e.g., smaller population, lower income) implying a smaller market size Q_i at any price P_i, reducing the number of firms $N_i^\star$ that choose to enter.*
2. *Marginal cost shifters $\mathbf{C}_i$ (e.g., transportation costs) leading to higher marginal costs and therefore higher prices, which reduce demand and therefore reduce the number of firms $N_i^\star$ that choose to enter.*
3. *Higher fixed cost shifters $\mathbf{F}_i$ (e.g., regulatory barriers) implying higher fixed costs for all firms, reduceing the number of firms $N_i^\star$ that choose to enter.*
4. *Cartel conduct by firms, summarized by $\lambda_i = N_i^\star > 1$, rather than $\lambda_i = 1$.*

4 An Empirical Model of the Cement Industry

We now take the model to the data using specific estimating equations. We first present the empirical counterpart to the model's equations and then discuss identification and estimation.

4.1 Estimating Equations

Demand. We will use the demand curve specified in Equation 1 and estimated in Section 2.3. Recall the demand elasticity $\eta = -\alpha_1$. For specific conduct λ_i, Definition 1 yields the empirical markup

$$M_{it} = \left(\frac{-\alpha_1 N_{it}^\star}{-\alpha_1 N_{it}^\star - \lambda_i} \right) \tag{6}$$

where $N_{it}^\star$ is the number of firms observed in economy i at time t.

Marginal Cost. Marginal costs are projected onto covariates $\mathbf{C}_{it}$ in order to control for and describe the role of observables. We assume average marginal cost takes the log-linear form:

$$\ln(\overline{MC_{it}}) = \begin{cases} \beta_{0,t}^K + \beta_{\mathbf{C}}^{\mathbf{K}} \mathbf{C}_{\mathbf{it}}^{\mathbf{K}} + \omega_{it}^K & \text{if } N_{it}^\star > 0; \\ \beta_{0,t}^O + \beta_{\mathbf{C}}^{\mathbf{O}} \mathbf{C}_{\mathbf{it}}^{\mathbf{O}} + \omega_{it}^O & \text{if } N_{it}^\star = 0. \end{cases} \tag{7}$$

We distinguish two cost functions depending on whether domestic production capacity exists at all. The superscript K indicates markets with $N_{it}^\star > 0$. In this case, C_{it}^1 indicates that there is some domestic production capacity. The superscript O indicates that $N_{it}^\star = 0$, so the market has no domestic production capacity and therefore imports all of its cement. In this case, C_{it}^{O} corresponds to an open economy benchmark in which pricing is driven by the exchange rate.

Conduct. We consider two alternative specifications for conduct. A first version of the model follows standard practice and assumes a non-cooperative industry equilibrium, namely

$$\lambda_{it} = \lambda_{it}^{COURNOT} \equiv \begin{cases} 1 & \text{if } N_{it}^{\star} > 0; \\ 0 & \text{if } N_{it}^{\star} = 0, \end{cases} \tag{8}$$

We refer to this formulation as the Cournot model. In the small number of economies with no cement plants and $N_{it}^{\star} = 0$, we assume perfect competition in the absence of data on the market concentration of importers (rather than producers). As a result, the estimated marginal cost parameters $\beta_{0,t}^{O}$ include any market power importers have when $N_{it}^{\star} = 0$. In contrast, domestic producers' conduct is separately identified from marginal cost when $N_{it}^{\star} > 0$.

A second specification of the model projects conduct onto a constant and certain market attributes,

$$\lambda_{it} = \lambda_{it}^{CONDUCT} \equiv \begin{cases} \lambda_0 + \lambda_1 Z(URBCON_i) + \lambda_2 Z(MMC_{it}) & \text{if } N_{it}^{\star} > 0; \\ 0 & \text{if } N_{it}^{\star} = 0, \end{cases} \tag{9}$$

We refer to this formulation as the Conduct model. $URBCON_i$ is the sum of squared shares of the population in every urban center in national market i (a Herfindahl index), where urban centers are identified using satellite images of built-up area in 2015 (Florczyk, Corbane, Schiavina, Pesaresi, Maffenini, Melchiorri, Politis, Sabo, Freire, Ehrlich, Kemper, Tommasi, Airaghi and Zanchetta, 2019). The term MMC_{it} is the average number of other markets in which a firm-pair observed in market i meets, a standard measure of multimarket contact (Jans and Rosenbaum, 1996). If the multimarket contact statistic is 2, for instance, the average pair of firms in the market meets twice in other markets. The statistic is set to zero if there is no contact between any pair of firms outside of the market. As stated previously theoretical and empirical evidence from other settings suggests this could facilitate collusion. Both $URBCON_i$ and MMC_{it} are standardized, so that the estimated value of the constant λ_0 corresponds to the Conduct in a market with the average concentration of urban centers and average multimarket contact.[16]

[16] In principle, we could also include observed cartels in the Conduct λ_{it}. Data on observed cartels, however, are subject to selection as cartels are only observed when investigated. The two variables included in $\lambda_{it}^{CONDUCT}$ are not subject to such selection issues. As a sanity check, observed cartels do positively

Substituting Equations (6) and (7) into the profit-maximization condition in Equation (3) and taking logs yields the market price as a function of the empirical markup and marginal cost,

$$\ln(P_{it}) = \ln\left(\frac{-\alpha_1 N^{\star}_{it}}{-\alpha_1 N^{\star}_{it} - \lambda_{it}}\right) + \ln(\overline{MC_{it}}) + \omega_{it}. \tag{10}$$

When $N^{\star}_{it} > 0$ we set $\lambda_{it} = 1$ for the Cournot specification or $\lambda_{it} = \lambda_0 + \lambda_1 Z(URBCON_i) + \lambda_2 Z(MMC_{it})$ for the Conduct specification. When $N^{\star}_{it} = 0$ we set $\lambda_{it} = 0$.

Distribution of Fixed Costs. Fixed cost covariates $\mathbf{F}_{it}$ enter through the following function:

$$\ln(\overline{F_{it}}) = \gamma_{0,t} + \gamma_{\mathbf{F}}\mathbf{F_{it}} + \sigma\epsilon_{it}. \tag{11}$$

where σ is a scale parameter and ϵ_{it} is distributed standard normal, hence fixed costs have a log-normal distribution. Having specified a distribution for fixed costs, the break-even entry condition in Equation (5) yields the empirical likelihood of each observation,

$$\begin{aligned} L(\theta) = \Phi & \left(\frac{1}{\sigma}\left[\ln\left(\frac{Q^K_{it}}{N^{\star}_{it}}\left(\frac{-\alpha_1 N^{\star}_{it}}{-\alpha_1 N^{\star}_{it} - \lambda_{it}} - 1\right)\overline{MC_{it}(\beta)}\right) - \overline{F_{it}(\gamma)}\right]\right) \\ & - \Phi\left(\frac{1}{\sigma}\left[\ln\left(\frac{Q^K_{it}}{N^{\star}_{it}+1}\left(\frac{-\alpha_1 (N^{\star}_{it}+1)}{-\alpha_1 (N^{\star}_{it}+1) - \lambda_{it}} - 1\right)\overline{MC_{it}(\beta)}\right) - \overline{F_{it}(\gamma)}\right]\right) \end{aligned} \tag{12}$$

where Φ is the standard normal cumulative density function, and Q^K_{it} is the quantity of production using domestic capacity (i.e., domestic consumption minus imports).[17] Q^K_{it} is a different value than domestic consumption Q_{it} used in demand estimation, because we wish fixed costs to reflect only those of producers included in $N^{\star}_{it}$.

4.2 Identification and Joint Estimation

The Cournot and Conduct models are estimated separately in the presence of the three endogenous variables $\langle P_{it}, Q_{it}, N_{it}\rangle$ using the generalized method of moments (GMM). Within each specification there are three estimating equations: (i) the demand curve, Equation (1); (ii) the profit maximization condition relating prices and marginal costs conditional

correlate with estimated Conducts (p-value < 0.00).

[17] Since the firm's decision to enter depends on expectations about demand, greater variance in the unobserved component of demand could lead to a higher estimated variance in fixed costs in the cross section. We examine this hypothesis in Section 5.

on conduct, Equation (10); and (iii) the likelihood of the observed number of firms given fixed costs, Equation (12). All parameters are jointly estimated to ensure the asymptotic standard error of each parameter accounts for estimation error in all three equations (see Appendix C for the moment conditions). The model is estimated without restricting the covariance between endogenous variables and unobserved demand or costs. We discuss these assumptions here and postpone to Section 5 an analysis of the results' sensitivity to potential violations.

In both models, we allow for the possibility that the price is correlated with unobserved demand, i.e., $E[\ln(P_{it})\xi_{it}] \neq 0$. Without restrictions on this term, the price elasticity of demand is identified by the assumption that a cost instrument is excluded from the demand shifters $\mathbf{D_{it}}$. As described in Section 2.3, we use the cement exports to the world of a country's nearest neighbor as this cost instrument. The functional form assumes $E[\ln(Q_{it})\omega_{it}] = 0$ so increasing returns are measured by fixed costs rather than a variable marginal cost function, but this condition is not used as a moment in estimation.

The model allows for endogenous entry, i.e., for the possibility that $E[N_{it}\omega_{it}] \neq 0$ or $E[N_{it}\xi_{it}] \neq 0$. Fixed costs are identified without restrictions on these terms using a revealed profitability argument for the number of symmetric firms in a market. By Proposition 1, the number of firms in the market is unique, leading to an ordered probit estimator for fixed cost. In the GMM framework, this result implies the moment conditions $E\left[\frac{\partial \ln(L_{it}(\alpha,\beta,\lambda,\gamma,\sigma))}{\partial \gamma}\right] = 0$ and $E\left[\frac{\partial \ln(L_{it}(\alpha,\beta,\lambda,\gamma,\sigma))}{\partial \sigma}\right] = 0$. With these assumptions, the Cournot model is just identified.

The Conduct model is identified by the exclusion of certain instruments from the marginal cost function defined by cost shifters $\mathbf{C_{it}}$, following the argument of Bresnahan (1982) generalized by Berry and Haile (2014).[18] An advantage of this instrumental variable approach is that the model can be overidentified, which allows to test the joint validity of the over-identifying restrictions. One example of such instruments are demand instruments, which change the marginal revenue function, conditional on marginal costs. The resulting variation identifies conduct, for given prices and entry. Berry and Waldfogel (1999) for instance use population as a demand-side instrument excluded from the cost function, which in our model shifts demand conditional on the construction share of GDP. Formally, we incorporate this idea with additional moment conditions $E[\ln(POP_{it})^n\omega_{it}] = 0$ where $n \in \{1, 2\}$. To achieve parsimonious over-identification we also exclude the variables in the conduct function itself from the marginal cost function, by assuming $E[Z(URBCON_{it})\omega_{it}] = 0$ and $E[Z(MMC_{it})\omega_{it}] = 0$. The concentration of urban centers is plausibly exogenous to present

[18] An alternative approach to identifying conduct would be to assume that the number of firms in the market, which also shifts markups, is uncorrelated with unobserved marginal cost, i.e., $E[N_{it}\omega_{it}] = 0$. However, given that marginal cost could still enter into a firm's entry decision, such an assumption is not attractive.

unobserved costs because it is determined over the long run. Multimarket contact is a strategic choice determined by decisions to enter markets other than market i, and so is plausibly exogenous to costs in market i. In Section 5, we evaluate the sensitivity of markup estimates to potential violations of these exclusion restrictions. Further, since the exclusion restrictions including ω_{it} depend on the set of variables included in $\mathbf{C_{it}}$, to assess robustness we estimate conduct using the same identifying assumptions but alternative specifications of the marginal cost function.

5 Results

5.1 Estimated Empirical Equilibrium Model

Table 3 reports estimated coefficients of the two model specifications, Cournot and Conduct. The far right column of Table 3 reports the p-value from Welch's test of the null hypothesis of equality of the demand and cost coefficients across the two models. This hypothesis is not rejected for any coefficient, providing initial evidence that conduct approximates Cournot in the average market.

Demand. For the demand curve, we use the specification in Column 2 of Table 2, including (the log of) population, (the log of) GDP per capita, and (the log of) the construction share of GDP, and also included the exchange rate as a control because prices P_{it} are measured in US dollars for comparability across countries. Considering price sensitivity in the Cournot model, it is statistically significant with the price elasticity of demand $\eta_{it} = 1.268$ (s.e. $=$ 0.329), and in the Conduct model it is $\eta_{it} = 1.272$ (s.e. $= 0.327$), within the range of estimates considered in Table 2. Turning to shifters of the level of demand, population, GDP per capita, and the construction share of GDP all have a statistically significant and positive effect on demand. The effect of the exchange rate is quantitatively and statistically insignificant.

Marginal Costs. Estimates of the equilibrium pricing condition (Equation (10)) reveal drivers of marginal costs in the industry. In this baseline specification, we include many potential drivers of costs in $\mathbf{C_{it}}$ to illustrate the role of each. All are measured in natural logs unless otherwise specified. Consider first economies with domestic production capacity (i.e., $N_{it} > 0$). Consistent with limited technological progress in the six-year time period studied, we find no significant trend in costs over time, with an economically small and statistically insignificant change in costs in 2017 relative to 2011 in the Cournot and Conduct models.

The cement exports of the nearest neighbor are negatively related to costs in both models, as already explained in Section 2.3 and demonstrated indirectly in Figure 5.

In both models, the exchange rate, which may affect the price of imported inputs, does not appear to relate to the price, though the diesel price is a significant contributor to costs, pointing to an important role of transportation costs for cement, which is heavy and also has a low value per unit of weight compared to many other goods.[19] The model includes kilometers of road per square kilometer of land, which summarizes the quality of national road infrastructure (Meijer, Huijbregts, Schotten and Schipper, 2018). This variable has the negative coefficient that is statistically significant in the Conduct model, suggesting that in addition to the price of diesel, the quality of domestic infrastructure is associated with lower end-consumer prices. A dummy for the presence of gypsum deposits in the country (US Geological Survey, 2020) is not significant, suggesting that local supplies of this cement are not a major determinant of prices. The model also includes the Z-score of the rule of law a generic control for the quality of national institutions (Kraay, Kaufmann and Mastruzzi, 2010). This variable has an a priori ambiguous influence on marginal cost. On the one hand, greater rule of law 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. Either way, this variable has a negative coefficient, though it is not statistically significant. In the Conduct model, where overidentifying restrictions yields more precise estimates, the coefficients on the cement exports of the nearest neighbor, the price of diesel, and road density are statistically significant at 1 percent, whereas the coefficient on the exchange rate, gypsum deposits, and rule of law remains statistically insignificant and falls closer to zero.

Turning to economies without domestic production capacity, we find that they are, as expected, qualitatively different from economies with domestic production capacity.[20] When calculated at average values of the covariates in both samples, marginal costs are 8.9 percent higher on average in countries with no domestic production capacity. Excluding the exchange rate, costs in these markets have also fallen over time.

Fixed Costs. Estimates of the entry condition (Equation (12)), indicate that (the log of) fixed entry costs in the average market are positive and precisely estimated, with a constant

[19]When including price of electricity in addition to the price of diesel in the marginal cost function and estimating on the smaller sample of economies where both variables are available, the coefficient on the price of electricity is not statistically significant, though the coefficient on the price of diesel remains so.

[20]The precision of the marginal cost coefficient estimates in these economies is lower as expected given that there are only 13 such economies in our sample.

in the Cournot model equal to 17.556 (s.e. = 0.14) and standard deviation term $\sigma = 1.394$ (s.e. = 0.119). These numbers imply a distribution of annualized entry costs with mean of approximately US$42 million, and US$2.7 million at the 5th percentile and $647 million at the 95th percentile. These values appear consistent with capacity installation costs reported by industry sources. In 2011, installation costs were approximately US$150 million per megaton (million tons) of annual capacity (Cembureau, 2021).[21] The average market in our sample has 14.5 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$2,175 million to install. This implies that for a discount rate of $\$42/\$2,175 = 0.02$ the annuity value of fixed costs equals the expected total cost of installing capacity in the average market.

Given the substantial variation in fixed costs observed, an important question is whether average fixed costs vary systematically across economies, for instance those with different institutions. Rule of law does not have statistically significant effects on fixed costs. Perhaps surprisingly, the coefficient on rule of law is positive. One might have expected that better legal institutions would lower fixed costs, for instance through less expropriation risk. The positive coefficient suggests legal institutions may have other countervailing effects that also raise entry costs, for instance higher costs of environmental compliance (see Ryan, 2012). An alternative measure of institutions, the (Z-score of) the procedures required to start a business as reported by the Doing Business indicators (World Bank, 2020a), has a positive and statistically significant effect on fixed costs. This result validates this de-jure measure of entry costs by showing it is related to observed fixed costs in the cement industry. The exchange rate, which may affect fixed costs to the extent that capital is imported, does not have an economically or statistically significant effect on fixed costs.

Conduct. The Cournot equilibrium concept appears to accurately characterize competition in the average market in the industry.

The Conduct model also reports estimates for Equation (9). The estimated value of the Conduct model constant, which corresponds to the Conduct in a market with the average concentration of urban centers and average multimarket contact, is $\lambda_0 = 0.688$ (s.e. = 0.257). The hypothesis that this coefficient is equal to one cannot be rejected. Moreover, this value is one-fifth of the (concentration-adjusted) number of firms in the average market, 3.362, as reported in Table A1. Recall that for a cartel, all firms behave jointly as a monopolist and $\lambda = N_{it}$. The average market looks most like the Nash equilibrium of the Cournot model. Though firms have market power, and affect prices through their choices of quantities,

[21] Cembureau reports a euro value for 2021, which we convert to dollars in 2011 using the current exchange rate and the US GDP deflator.

they appear to behave non-cooperatively. The average market thus doesn't appear to be characterized by a cartel in which firms collude to jointly maximize profits.

Nonetheless, market attributes appear to shape the extent of market power, conditional on the number of firms. The first is the concentration of urban centers. The coefficient $\lambda_1 = -0.165$ (s.e. $= 0.061$) is statistically significant and negative, suggesting that the market becomes more competitive when the concentration of urban centers increases. Second, the parameter value $\lambda_2 = 0.166$ (s.e. $= 0.098$) indicates that more multimarket contact between firms is also associated with larger markups.

Threats and Sensitivity to Identification Assumptions. We now consider whether and how potential violations of the exclusion restrictions could affect our results. As a preliminary test, in the over-identified Conduct model, a Sargan-Hansen test cannot reject the hypothesis that the instruments are uncorrelated with the observed errors in this model (J-statistic is 2.032, p-value 0.362). For transparency, as suggested by Andrews et al. (2017), in Table 4 we also investigate the estimated markups' sensitivity to beliefs about the effect of a one-standard-deviation increase in each instrument on either unobserved demand or costs.

We consider separately each excluded instrument, that is, each instrument that does not enter the demand or marginal cost equations directly. One instrument, the cement exports to the world of the nearest neighbor, was excluded from the demand. The sensitivity reported in Table 4 indicates that if there is a one-standard-deviation change in the moment restricting the covariance of this variable with ξ_{it}, the markup would stay virtually unchanged. Therefore, even if the exclusion restriction summarized by this moment were violated, it would have little effect on our quantitative results. Four instruments were excluded from the marginal cost curve. Of these, the markup is most sensitive to changes in the moments associated with (the log of) population, its square, and the unobserved cost error. The markup is much less sensitive to changes in the moment associated with the concentration of urban centers, and even less sensitive to changes in the moment associated with multimarket contact. A one-standard-deviation change in the moment restricting the covariance of multimarket contact with ω_{it} would increase the markup by only 0.02.

There are two inferences from this sensitivity analysis. First, the identifying variation in the model comes primarily from the the exclusion of population and its square, and to a lesser extent the concentration of urban centers, from the cost function. As stated previously, the relative values of these variables between countries are determined by history, and so are plausibly exogenous to unobserved costs in the industry in 2011 and 2017. Other authors have also made this assumption about population. Second, if one is concerned about potential violations of the other exclusion restrictions (i.e., that cement exports of the nearest neighbor are correlated with unobserved local demand, or that multimarket contact is chosen endogenously given unobserved local costs), even if such violations were present, it would matter little for our quantitative results.

Another potential threat to identification relates to the fact that, through the moment conditions involving ω_{it}, estimates of the conduct parameter also depend on the variables $\mathbf{C_{it}}$ included in the marginal cost function (see, e.g., Backus, Conlon and Sinkinson, 2021). To assess this threat, Appendix Table D1 reports estimates of the conduct parameter for the same model as in Table 3, but with three alternative specifications of marginal cost for countries with production capacity. Alternative 1 is more parsimonious including only the exchange rate, cement exports of the neighbor, the price of diesel, and a constant. In this specification we again cannot reject a Cournot equilibrium in the average market, and the effects of concentration of urban centers and multimarket contact remain the same sign and statistically significant. Alternative 2 includes all variables in the specification in Table 3, and their squares, and Alternative 3 is the same as Alternative 2, but with all possible interactions. In these alternatives, the sign and magnitude of coefficients and failure to reject Cournot in the average market remains, though statistical significance is reduced, as expected in a model with fewer degrees of freedom.

Taken together, these sensitivity analyses give us confidence in the robustness of our results to potential violations of our identification assumptions and thus in our interpretation of the resulting estimates.

5.2 Drivers of International Price Dispersion and Changes.

With an estimate of the empirical model in hand, we can now describe the roles of marginal cost and markups in determining the price of cement in Africa and other continents, and distinguish between the drivers of market power described in Proposition 2.

Average Prices, Markups, and Marginal Costs by Continent. Table 5 reports a variance decomposition of prices, splitting the variation into the markup and marginal cost. Markups are calculated using coefficients from the Conduct model, in order to capture variation in conduct across economies. Prices are divided by these markups to yield marginal cost. Overall, the majority of the variance appears to come from marginal cost rather than the markup. Markups and marginal costs co-vary negatively, but only slightly.

Even though the markup explains a minority of the variation in prices, it could explain a disproportionate amount of the price in certain regions, such as Africa. As a preliminary investigation of this idea, Table 6 reports average prices, decomposed into marginal costs and markups, by continent and year. The sample is restricted relative to the estimation sample to include only the balanced panel of economies with capacity in both years, ensuring we compare like with like between years. In this restricted sample, the price of cement has fallen on average by 19.5 percent between 2011 and 2017 overall. This decline is smaller than in Table 1, indicating the overall average price decline was to a significant extent driven by countries moving from being importers to having at least one domestic producer.

First, consider markups. Globally, the average markup in the cement industry in 2011 is a 36.1 percent premium over marginal cost, while the average markup in 2017 has fallen to 26.0 percent. Non-zero markups are in line with expectations, given increasing returns to scale. Comparing markups across continents, we see that in 2011, markups in Africa were the highest of any continent, equal to 49.6 percent on average. The next highest markups were in Europe, at 41.2 percent on average, and the lowest were in Asia, at 22.1 percent on average. All continents experienced a decline in markups between 2011 and 2017, except for North America, which experienced a slight increase.

Second, consider marginal costs. In 2011, the average marginal cost in Africa was the highest of any continent, though it was similar to average cost in South America. Africa stands out as experiencing the largest decline in marginal cost between 2011 and 2017. Asia, North America, and South America experienced increasing marginal costs.

Together, these results suggest that both greater than average market power and higher operating costs played a role in determining the high average price of cement in Africa in 2011. However, the continent is no longer a clear outlier in 2017.

Is Africa Different? Regressions can shed further light on the differences between Africa and other continents, and the extent to which differences in demand, marginal costs, entry costs, or conduct explain the motivating facts in Section 2. Table 7 reports regressions of (the log of) the US dollar cement price on a fixed effect for the African continent.[22]

In Column 1, the estimated Africa coefficient is statistically significant, equal to 0.373 (s.e. = 0.065). Column 2 includes cement exports to the world of the nearest neighbor, the price of diesel, and road density, leading the Africa coefficient to fall to 0.160 (s.e. = 0.066), indicating that about three fifths of the difference in the cement price is explained by higher transportation costs and the absence of large cement exporters in Africa. Column 3 includes the import tariff on cement (which is only available for a subset of economies). Including this variable changes the Africa coefficient only slightly relative to Column 1, and the positive effect of tariffs on prices is not statistically significant, indicating tariffs cannot explain the

[22]Table D2 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 highly correlated when measured at the country level. This specification provides a direct test of the Balassa-Samuelson-Bhagwati hypothesis that price levels and national income should be positively correlated.

higher price in Africa. Column 4 includes the same variables as in Column 2 and population and GDP per capita, two determinants of demand, which lead the Africa coefficient to fall to 0.0529 (s.e. = 0.072) and be no longer statistically significant. This result implies that, after marginal costs, differences in exogenous demand shifters can account for the rest of the high price of cement in Africa. Subsequent columns test and reject other hypotheses for the high price of cement in Africa. Interestingly though both population and GDP per capita have negative effects on the price in this regression, only the effect of population is statistically significant. Column 5 includes the construction share of GDP, in addition to the other demand shifters. The coefficient on this variable is not significant and the Africa coefficient does not change at all, indicating that there is no clear relationship between the size of the construction sector and cement prices, conditional on GDP, even though the size of the construction sector was a significant determinant of demand in Table 2. Column 6 includes procedures to start a business, which we have shown these significantly affect fixed costs. The effect of procedures on prices is positive but statistically and economically insignificant, and the Africa coefficient changes little when including this variable, suggesting that procedural barriers to entry cannot account for the cement price in Africa. Column 7 includes the two conduct variables and these lower the Africa coefficient slightly, suggesting that they can account for some of the higher price in Africa, but overall this is not meaningful relative to the marginal cost and demand shifters.

An alternative way to test whether the African cement industry is different is to estimate a more flexible version of the empirical model that includes an Africa fixed effect in demand, the demand elasticity, and costs, rather than the continuous variables in Table 3. The results of this estimation are reported in Table D3. Overall, the Africa fixed effect coefficients are not statistically significant, indicating that the model with continuous covariates provides more insight in this setting. The point estimates however support our conclusion that demand and marginal costs, rather than collusive conduct or entry barriers, explain the high price of cement in Africa. In this alternative model, the conduct parameter for Africa though insignificant is also negative, implying, if anything, more competitive conduct. Africa fixed effects in the mean and standard deviation terms for the distribution of fixed costs are estimated to be negative, though statistically insignificant. One hypothesis to explain limited entry in Africa is that demand there is more volatile, in which case a greater dispersion in fixed costs could be estimated in the cross section. The lower estimated variance however implies, if anything, less volatility of demand.

As a final robustness check, Table D4 reports the mean and standard deviation of the demand and supply errors in the Conduct model reported in Table 3. We cannot reject the null hypothesis that the two groups have the same demand and supply errors, indicating that this model is not mis-specified differently in Africa.

Together, these results suggest that the puzzling fact that cement has been more expensive in Africa (Table 1; Figure A1) is explained primarily by higher marginal costs, though higher markups play some role. With respect to markups, one hypothesis, advanced for instance by the World Bank (2016), is that stricter regulation of entry and/or cartel conduct could be playing an important role.[23] If this hypothesis is correct, the regulation of entry and under-resourced competition authorities are a binding constraint on the African construction sector.

Our results cast some doubts on this view. First, to a great extent, elevated marginal costs and markups appear to have been temporary. This fact alone is inconsistent with the hypothesis that high cement prices reflect barriers to entry and expansion. A plausible explanation for the decline of the price of cement in Africa is the adjustment to accelerating growth in the context of free entry. After years of slow growth in the 1970s, 1980s, and 1990s, African economies were still small markets that could sustain only a few firms, leading to high markups over high marginal costs. As growth accelerated in the 2000s, cement demand increased. After 2011, the year of the Economist 'Africa rising' cover, local and multinational firms installed new capacity. To the extent that some African economies still have a small number of firms leading to higher markups, the cause is likely that these markets remain small in terms of population and GDP per capita (col 4 of Table 7). In this story, markups are endogenous to growth, rather than a fixed characteristic of an economy.

5.3 Counterfactual

The empirical model allows us to quantify the potential effects of supply and demand side changes on prices, costs and markups, and compare their magnitude. Specifically, we simulate two counterfactual scenarios that shift components of either cost or demand, and one counterfactual that shifts both at the same time. A cost scenario only changes marginal costs, through changes in road density, holding constant demand. A demand scenario changes income per capita, holding costs constant. The scenario that changes both allows us to explore whether changes in costs and demand are substitutes or complements. Given that the model estimates do not point to higher average fixed costs in Africa, these are held fixed in all scenarios.

In each economy we set either of the cost variable (road density) or the demand variable (income per capita) to the corresponding levels observed for Republic of South Africa. We choose the Republic of South Africa, an upper-middle income African economy, since we

[23] Barriers to entry and anti-competitive conduct could also lead to higher costs, e.g., by attenuating selection forces in the market.

are particularly interested in understanding the relative importance of costs and demand in driving prices and mark-ups in Africa.[24] This counterfactual allows us to observe how the market would change if low- and middle-income economies in Africa adopted the costs and demand of their regional peer, both in absolute terms as well as in comparison to the resulting changes in other (higher-income) economies.

The counterfactual cost scenario is calculated as follows. In each economy road density is changed to the value of South Africa holding all other variables fixed, implying through Equation (7) a new marginal cost. Next, the new marginal cost is multiplied by the observed markup to yield the new equilibrium price. At this price, a new equilibrium domestic consumption is calculated through Equation (1), the demand curve. New domestic production is taken to be a share of this new consumption, assuming imports remain a constant share of consumption. With these new counterfactual domestic production quantities, prices, and marginal costs, a new expected variable profit is calculated in each economy, as in Equation (12). This exercise is repeated using a counterfactual markup with $N_{it} + 1$ firms, holding the demand elasticity and conduct fixed. 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 even.

The counterfactual demand scenario is calculated similarly. Per capita income is changed to the value of South Africa, holding all other variables fixed, including population, the construction share of GDP, implying a new quantity demanded in Equation (1). Expected profit is calculated at this new demand and current costs, and firms are allowed to enter until they no longer break even.

Table 8 reports the results, showing the distribution across countries of changes in price, markup, marginal cost, and quantities for Africa and the rest of the world. There are three main conclusions from this. First, price changes in Africa are on average larger than in the rest of the world when changing either costs or demand. Changing the road density to the level of South Africa reduces prices in Africa by 17.3 percent on average, and a similar change in the rest of the world reduces costs by 9.8 percent. While some countries do see increases in price under this counterfactual, these are smaller in magnitude than the price reductions in Africa. This result suggests higher returns in Africa to investments that increase demand or reduce costs, with the mechanism being that these investments can induce entry, and relatively larger decreases in markups, since African markets start from a base with a smaller number of firms.

[24]South Africa has a highly rated competition commission that in 2008 broke up a cement run by local groups that covered the Southern African Development Community (Lewis, 2015).

Second, changing demand produces similar effects as the changes in costs. Changing GDP per capita to the level of South Africa, holding costs constant, reduces prices in Africa by 15.2 percent, and in the rest of the world by 9.5 percent. Further, changes in demand and costs appear to be substitutes rather than complements, with the changes in outcomes in the third scenario being very similar to the changes in the scenarios that vary demand or cost alone. This highlights the potential for both demand and supply side policies to achieve significant price reductions by increasing market access, while casting doubt on the proposition that they are highly complementary, and so need to be executed in concert.[25] Through its effect on entry, market access plays a quantitatively important role in driving cross-country cement price differences.

Third, the vast majority of the price reduction in Africa is driven by changes in markup. In many markets in Africa, the counterfactual reduction in costs triggers entry that would qualitatively change the competitive landscape. In 7 countries, the reduction in costs changes the number of firms from 0 to 1. There are also 3 African countries in which the reduction in costs would lead to the establishment of domestic capacity, passing from 0 to either 1 or 2 firms. This further highlights the role of endogenous entry, and thus market access, in determining prices and markups in the presence of increasing returns to scale.

6 Conclusions

Substantial attention has been paid to high price levels in Africa, in the cement as well as other industries. While these high price levels are unexpected under the Balassa-Samuelson-Bhagwati hypothesis that the continent's lower average income should lead to lower prices, they are expected in the presence of increasing returns to scale, which implies that lower income economies with smaller markets will have fewer firms and higher markups. An empirical industry equilibrium model is estimated to test whether factors other than market size (e.g., cartel conduct, excessive fixed costs) could explain high markups in the African cement industry. The data do not support these alternative hypotheses.

The (in)famous case of Nigeria, where the domestic producer Dangote Cement has amassed fortunes from the market power gained from controlling 60 percent of domestic production capacity, is thus not representative of the experience of developing economies in general, nor of their differences with high-income economies: cartels and anti-competitive conduct exist there as well, as illustrated by the role of HeidelbergCement's monopoly in Norway (see Röller and Steen (2006)), and emerging markets can have competitive cement

[25] In the trade literature, "market access" is a summary statistic that summarizes market size by dividing demand in each market by the cost of reaching that market (see, e.g., Reed and Trubetskoy, 2019).

industries when market size and conditions allow (see Salvo (2010) for the case of Brazil).[26]

These findings and considerations have important implications for public policy, specifically the long-standing program to reduce entry barriers and increase competition in low- and middle-income economies. Measured entry barriers are subject to selection issues. Hallward-Driemeier and Pritchett (2015) criticize the focus on reforming de jure entry barriers measured by the Doing Business indicators (Djankov et al., 2002; World Bank, 2020a) on the basis that such barriers need not bind when firms have the ability to side-step official procedures, i.e., by operating through "deals versus rules." Similarly, ineffective anti-monopoly policy in an economy need not imply that cartels are widespread. This paper demonstrates how a transparent industry equilibrium model and data on market prices, quantities, and market structure can be used to move beyond de jure indicators to measure de facto entry and operating costs and firm conduct.

While we would not necessarily advocate against further deregulation of entry or more resources for antitrust investigations, these results do challenge the hypothesis that such policies could have an impact on markups and prices in industries like cement that feature increasing returns to scale. To the extent that there are also increasing returns in other industries, this observation is consistent with decelerating progress against extreme poverty in economies such as Rwanda and Senegal that have deregulated entry (World Bank, 2020a) but nonetheless remain small markets by international standards (see Goldberg and Reed (2021)). Atkin and Donaldson (forthcoming) survey research showing how trade (i.e., market size) can increase competition in developing economies. In such contexts, policy makers may find that prices and markups are more responsive to policies that enlarge the national market, for instance regional integration or the reduction of trade costs through increasing road density.

[26] Even for Dangote, abnormal profits are likely not due only to the direct exercise of market power in cement but rather stem from the firm's exclusive long-term right to exploit several vast reserves of limestone (a key input into cement production) and the ability to foreclose potential rivals in vertically related markets (World Bank, 2016). Supported by this advantage at home, the firm established new production and import facilities across Africa, possibly contributing to price reductions on the continent.

Figure 1: Intermediate Goods Prices and National Income. Green markers indicate economies in continental Africa. 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. The units at which prices are measured and sources are, for cement, one metric ton of ordinary Portland cement (World Bank, 2020b); for steel reinforcement bar, one metric ton of high-yield steel 16mm diameter reinforcement bars (World Bank, 2020b); for urea fertilizer, one metric ton in the month of March AfricaFertilizer.org (2019), and for internet, a month's subscription to wired broadband service International Telecommunications Union (2019). Plots show data from 2017, except for the urea fertilizer plot, which shows data from 2014 and 2013, the last years the United States Department of Agriculture (2019) reports the farm price of urea in the United States for comparison.

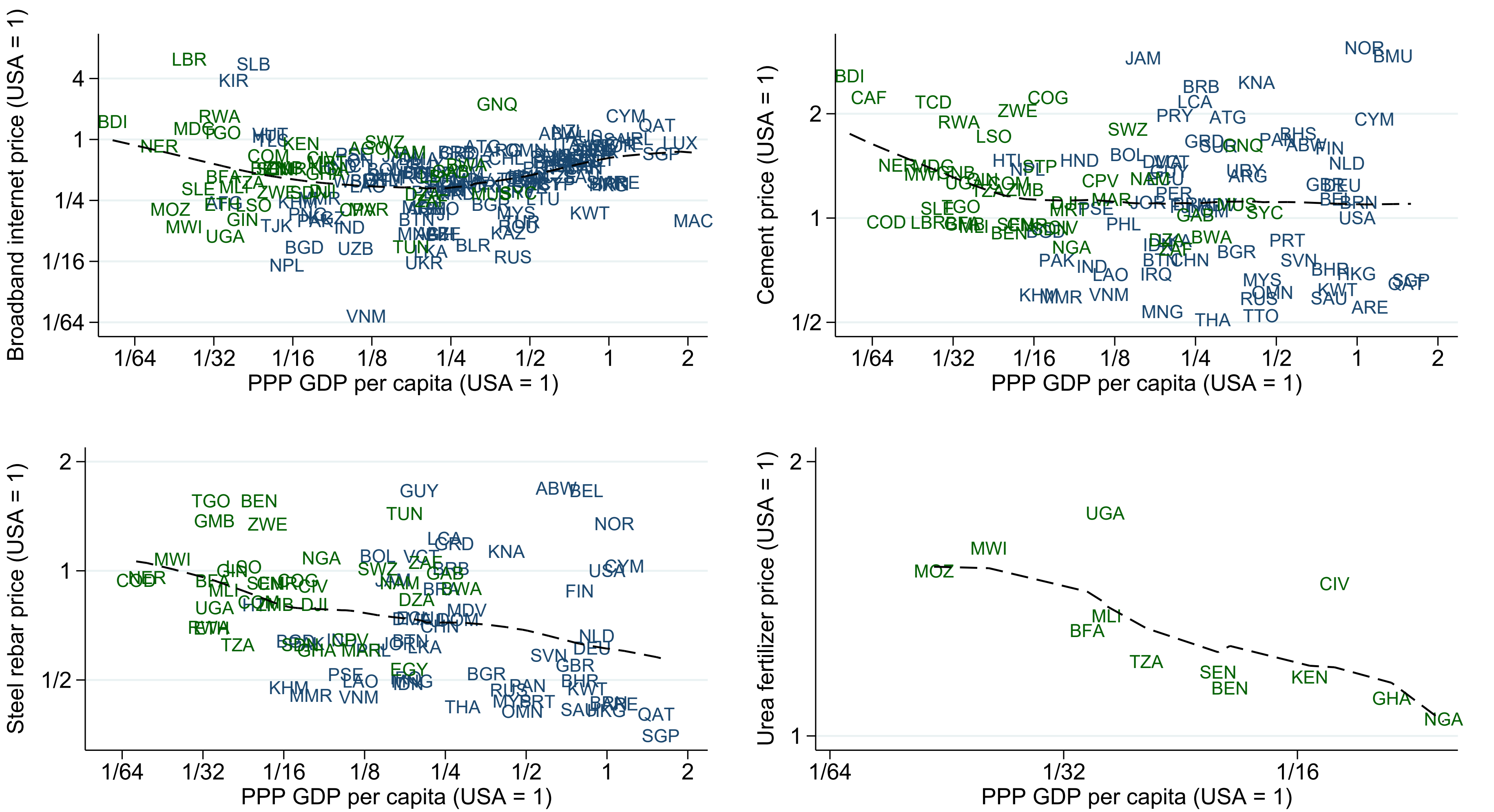


Figure 2: Prices and Entry in the Cement Industry. Green markers indicate economies in continental Africa. Changes are between 2011 and 2017. The change in real cement price is the difference in (the log of) the nominal price per ton in 2017 and 2011 minus the difference in (the log of) the PPP index between the two years. The change in the concentration-adjusted number of firms is the change in the inverse of the Herfindahl index of cement production capacity. All subsidiaries with common group ownership are counted as a single firm. The sample is the balanced panel of economies with price data in both years.

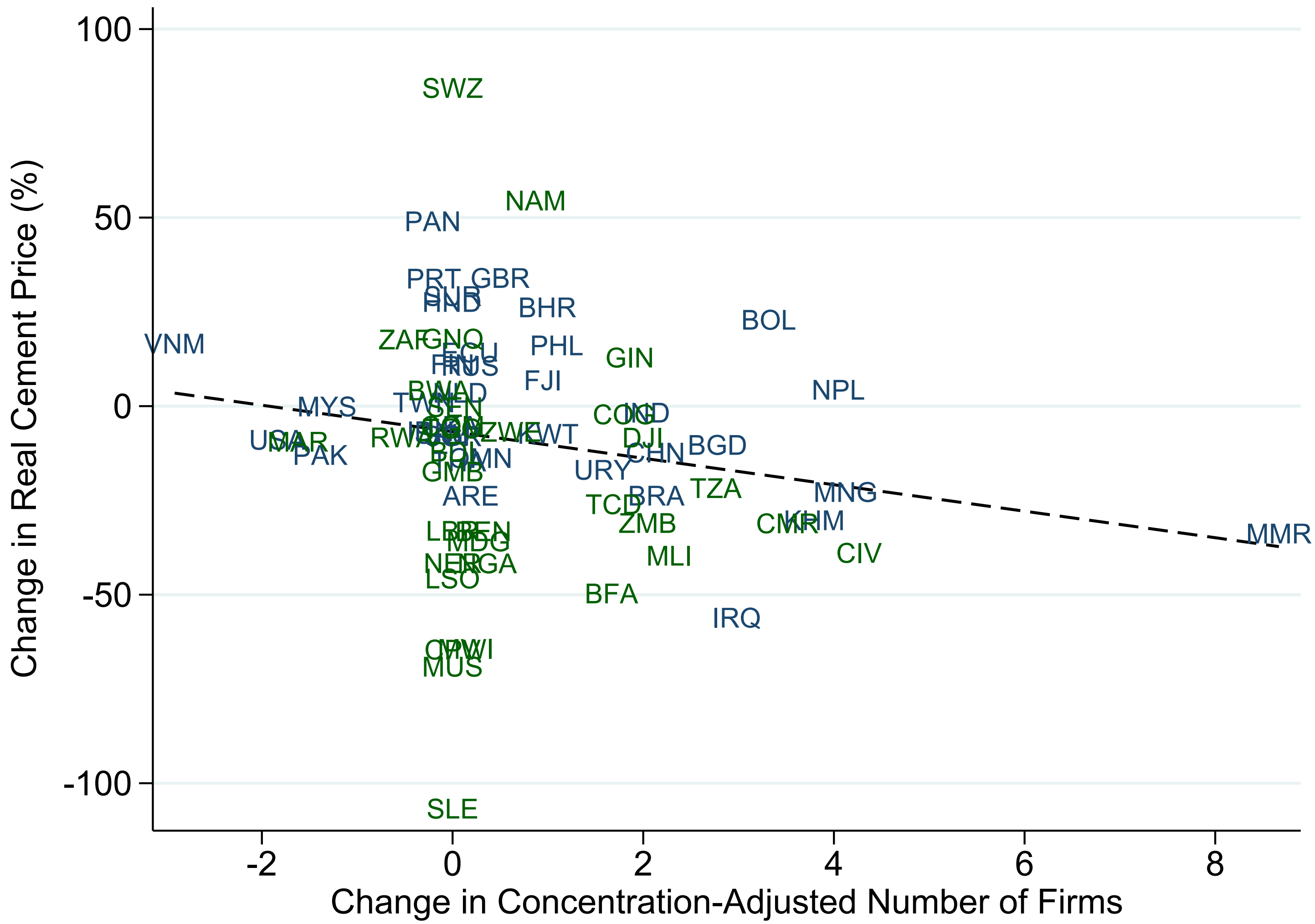


Figure 3: Potential Explanations for Market Power by Continent. Green bars highlight continental Africa. Effectiveness of anti-monopoly policy is measured in a survey of discipline experts by the World Economic Forum (Schwab, 2019). Known cement cartels are those reported in the Private International Cartel database (Connor, 2020). The number of procedures to start a business are from the Doing Business Indicators (World Bank, 2020a). Cement consumption is from the Global Cement Report (Armstrong et al., 2013, 2019). Data are the full analysis sample, pooling 2011 and 2017. Averages are unweighted by consumption.

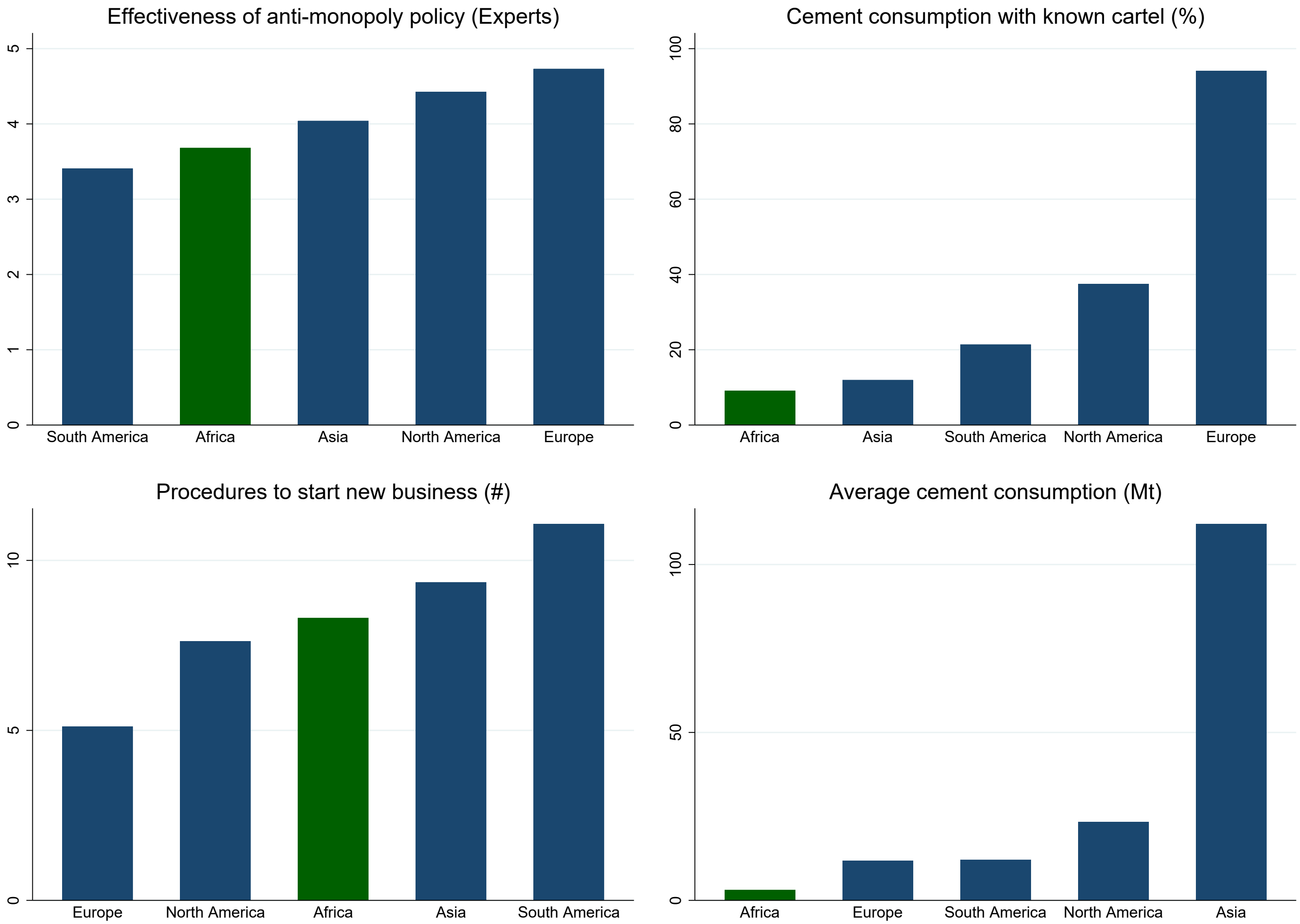


Figure 4: Cement Production Capacity and Consumption. Green markers indicate economies in continental Africa. Consumption is total consumption including imports and local production. Observations with zero installed production capacity and non-zero consumption are reported on the bottom line of the plot. Data from 2017 are shown.

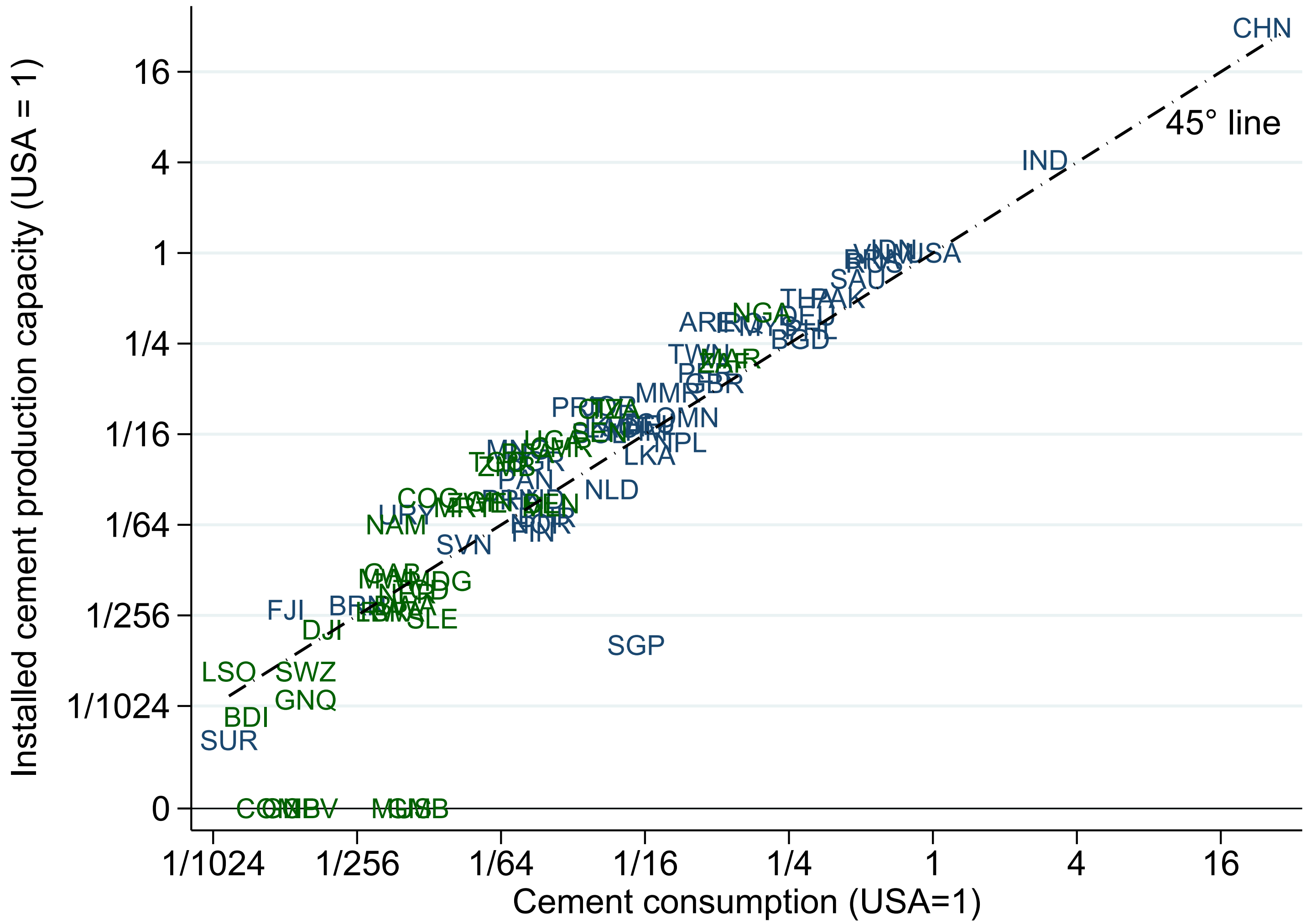


Figure 5: Prices and Exports of the Nearest Neighbor. Green markers indicate economies in continental Africa. The neighboring country is identified using the minimum of the bilateral distances between country centroids reported by Head and Mayer (2014). Data from 2011 and 2017 are shown.

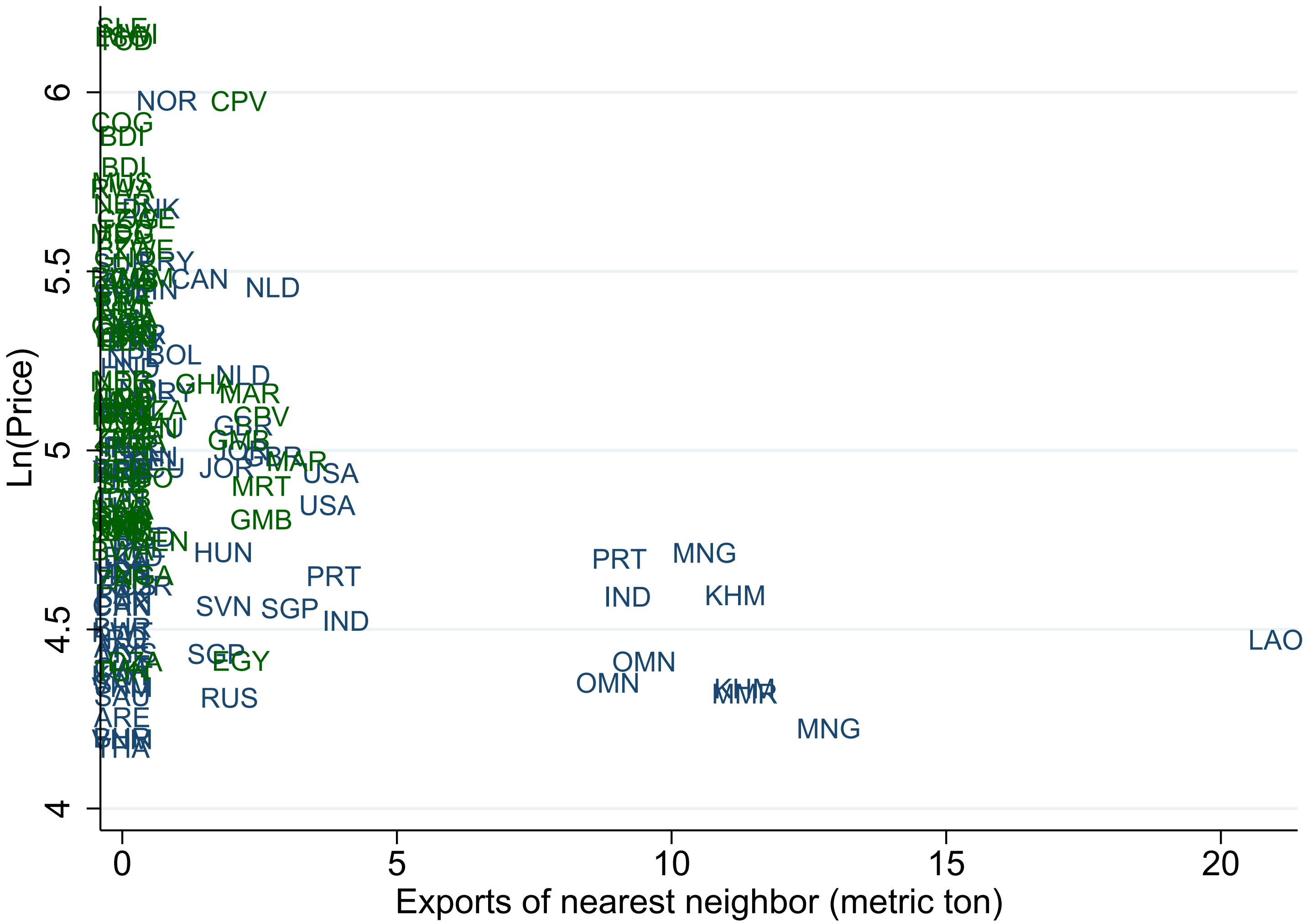


Table 1: Trends in the global cement industry by continent. The concentration-adjusted number of firms is $N_{it}^{\star} \equiv 1/H_{it}$, where H_{it} is the Herfindahl index of capacity concentration. The sample is the balanced panel of all economies in which prices and quantities are observed in 2011 and 2017, including economies without domestic production capacity. Continent groupings follow Nunn and Puga (2012), with Fiji, the only economy in our data set in Oceania, grouped with economies in Asia.

Panel A: Prices and Quantities

	Average price USD/t			Total consumption Mt		
	2011	2017	Δ	2011	2017	Δ
Africa	252.26	167.09	–33.8%	67.1	81.7	21.7%
South America	197.45	175.60	–11.1%	74.5	64.4	–13.5%
Europe	163.67	145.69	–11.0%	80.6	76.5	–5.0%
North America	151.83	176.03	15.9%	75.6	100.8	33.3%
Asia	107.78	95.54	–11.4%	2605.2	3001.8	15.2%
Total	188.18	142.02	–24.5%	2902.9	3325.2	14.6%

Panel B: Entry and Capacity Expansion

	Average number of firms (concentration-adjusted)			Average capacity Mt		
	2011	2017	Δ	2011	2017	Δ
Africa	1.2	1.9	58.5%	3.0	5.1	70.3%
South America	2.1	3.6	67.6%	18.8	25.8	37.6%
Europe	2.5	2.6	4.5%	21.6	27.4	26.8%
North America	5.5	4.8	–12.4%	35.3	42.7	21.0%
Asia	4.2	5.4	28.9%	168.0	210.2	25.1%
Total	2.6	3.4	32.4%	63.4	80.1	26.3%

Table 2: Demand for cement. The instrument for price is the cement exports of the neighboring country in columns 1-4, and is the cement exports of all countries weighted by their inverse distance in column 5. The neighboring country is the one with the nearest geographic distance. All variables are in natural logs except for the indicator for whether the neighboring country is an importer, the indicator for whether the year is 2017, and the constant. Robust standard errors in parenthesis. * for $p < .05$, ** for $p < .01$, and *** for $p < .001$

VARIABLES	(1) Quantity	(2) Quantity	(3) Quantity	(4) Quantity	(5) Quantity
Price of cement (USD)	-1.96**	-1.38***	-1.41***	-1.40***	-1.22***
	(0.80)	(0.26)	(0.36)	(0.27)	(0.31)
Population		0.87***	0.88***	0.84***	0.88***
		(0.04)	(0.04)	(0.03)	(0.04)
GDP per capita		0.37***	0.33***	0.32***	0.38***
		(0.03)	(0.05)	(0.04)	(0.04)
Construction share of GDP		0.38***	0.45***	0.30***	0.39***
		(0.10)	(0.11)	(0.09)	(0.09)
Exchange rate (USD/LCU)			0.02		
			(0.02)		
Price of diesel			-0.10		
			(0.11)		
Price of aggregate			-0.03		
			(0.12)		
GDP per capita of neighbor				0.04	
				(0.04)	
Year (=2017)	-0.34	-0.15	-0.17*	-0.15	-0.11
	(0.31)	(0.09)	(0.10)	(0.09)	(0.10)
Constant	24.86***	5.44***	6.05**	5.85***	4.27*
	(4.10)	(1.98)	(2.37)	(1.99)	(2.27)
Observations	166	166	158	155	166
R-squared	0.30	0.93	0.93	0.92	0.93
First Stage F-stat	29.23	30.65	21.10	30.24	11.63
Elasticity	1.957	1.384	1.415	1.395	1.219

Table 3: An Empirical Equilibrium Model of the Global Cement Industry. Continuous market characteristics are in natural logs unless otherwise specified.

	Cournot		Conduct Parameter		P-value
Variable	Coefficient	S.e.	Coefficient	S.e.	H_0: Equality
Demand:					
Constant	4.919	2.552	4.919	2.538	1
Year (=2017)	-0.117	0.099	-0.117	0.099	1
Price of cement USD	-1.268	0.329	-1.272	0.327	0.99
Exchange rate USD/LCU	0.016	0.017	0.015	0.017	0.97
Construction share of GDP	0.398	0.095	0.397	0.095	0.99
GDP per capita	0.35	0.047	0.353	0.047	0.96
Population	0.88	0.044	0.879	0.044	0.98
Supply with domestic production capacity:					
Constant	4.208	0.484	4.698	0.158	0.34
Year (=2017)	0.211	0.283	-0.053	0.09	0.37
Cement exports of neighbor	-0.007	0.027	-0.031	0.011	0.41
Exchange rate USD/LCU	0.009	0.02	0.007	0.013	0.94
Gypsum deposits (=1)	0.43	0.376	-0.009	0.094	0.26
Price of diesel	0.318	0.092	0.303	0.055	0.89
Road density	-0.016	0.051	-0.049	0.024	0.56
Rule of law (Z-score)	-0.097	0.091	-0.015	0.042	0.41
Supply without domestic production capacity:					
Constant	5.46	0.379	5.464	0.378	0.99
Year (=2017)	-0.364	0.166	-0.351	0.166	0.95
Exchange rate USD/LCU	-0.013	0.066	-0.007	0.066	0.95
Fixed cost:					
Constant	17.556	0.14	17.268	0.18	0.21
Year (=2017)	-0.287	0.264	-0.402	0.288	0.77
Exchange rate USD/LCU	0.059	0.061	0.046	0.089	0.9
Procedures to start business (Z-score)	0.309	0.151	0.338	0.168	0.9
Rule of law	0.221	0.163	0.249	0.233	0.92
Standard deviation term	1.394	0.119	1.608	0.141	0.25
Conduct:					
Constant			0.688	0.257	
Concentration of urban centers (Z-score)			-0.165	0.061	
Multimarket contact (Z-score)			0.166	0.098	
Sargan-Hansen J-Statistic			2.032		
Sargan-Hansen test p-value			0.362		

Table 4: Sensitivity of markup following Andrews, Gentzkow and Shapiro (2017). All excluded instruments are listed, i.e., those that do not enter the demand or marginal cost equations directly. For the instrument excluded from the demand, sensitivity can be interpreted as the sensitivity of the markup to beliefs about the effect of a one-standard-deviation increase in each instrument on unobserved demand in the average market. For the instruments excluded from supply, sensitivity be interpreted as the sensitivity of the markup to beliefs about the effect of a one-standard-deviation increase in each instrument on unobserved marginal cost in the average market.

	Sensitivity
Instrument excluded from demand	
Cement exports of neighbor	0.00000000002
Instruments excluded from supply	
Log of population	-10.52530405673
Log of population squared	-12149.24293074500
Concentration of urban centers	0.80201349306
Multimarket contact	0.02370531510

Table 5: Price Variance Decomposition. Using the full sample, we decompose $Var(P) = Var(M) + Var(MC) + 2Cov(M, MC)$ and report the single elements.

$Var(P)$	$Var(M)$	$Var(MC)$	$Cov(M, MC)$
.206	.052	.196	-.021

Table 6: Average Prices, Markups, and Marginal Costs by Continent. The average price (in US dollars at the market exchange rate), marginal cost, and markups are reported in natural logs. Δ P is the log difference in costs between 2017 and 2011. Marginal cost is inferred by dividing price by the empirical markup from the Conduct model. Δ MC is the log difference in marginal cost between 2017 and 2011. The markup is the ratio of price over marginal cost as defined in Equation (3), and Δ markup is the log difference in markup between 2017 and 2011. The sample includes only economies with domestic cement capacity in which all data are available in two years.

Continent	Year	Obs	Price	Δ Price	MC	Δ MC	Markup	Δ Markup
Capacity in both years	2011	59	5.043		4.682		0.361	
Capacity in both years	2017	59	4.848	-0.195	4.587	-0.095	0.26	-0.101
Africa	2011	23	5.406		4.91		0.496	
Africa	2017	23	5.037	-0.369	4.661	-0.249	0.376	-0.121
Asia	2011	23	4.637		4.417		0.221	
Asia	2017	23	4.536	-0.101	4.401	-0.016	0.135	-0.086
Europe	2011	5	5.031		4.619		0.412	
Europe	2017	5	4.919	-0.113	4.523	-0.097	0.396	-0.016
North America	2011	3	5.019		4.793		0.226	
North America	2017	3	5.147	0.129	4.912	0.119	0.235	0.009
South America	2011	5	5.264		4.85		0.414	
South America	2017	5	5.159	-0.105	4.972	0.122	0.187	-0.227

Table 7: Regressions of Prices and Markups on Market Attributes. Robust standard errors in parenthesis. * for $p < .05$, ** for $p < .01$, and *** for $p < .001$.

VARIABLES	(1) Price	(2) Price	(3) Price	(4) Price	(5) Price	(6) Price	(7) Price
Africa (=1)	0.373***	0.160**	0.381***	0.059	0.059	0.066	0.022
	(0.065)	(0.066)	(0.080)	(0.072)	(0.072)	(0.074)	(0.077)
Cement exports of neighbor (Level)		-0.040***		-0.043***	-0.044***	-0.043***	-0.042***
		(0.008)		(0.008)	(0.008)	(0.007)	(0.007)
Price of diesel		0.391***		0.398***	0.402***	0.413***	0.412***
		(0.049)		(0.049)	(0.050)	(0.052)	(0.051)
Road density		-0.048*		-0.050**	-0.051**	-0.047*	-0.033
		(0.025)		(0.025)	(0.025)	(0.025)	(0.024)
Cement tariff			0.503				
			(0.437)				
Population				-0.060***	-0.061***	-0.062***	-0.128***
				(0.015)	(0.015)	(0.016)	(0.028)
GDP per capita				-0.024	-0.025	-0.021	-0.028
				(0.026)	(0.026)	(0.027)	(0.027)
Construction share of GDP					0.045	0.049	0.053
					(0.056)	(0.057)	(0.056)
Procedures to start business (Z-score)						0.024	0.031
						(0.029)	(0.027)
Concentration of urban centers (Z-score)							-0.127***
							(0.048)
Multimarket contact (Z-score)							0.013
							(0.026)
Constant	4.831***	4.940***	4.777***	6.163***	6.288***	6.297***	7.471***
	(0.043)	(0.053)	(0.066)	(0.393)	(0.449)	(0.454)	(0.613)
Observations	166	166	123	166	166	166	166
R-squared	0.169	0.388	0.195	0.430	0.433	0.435	0.464

Table 8: Counterfactual Technology and Market Size. This table reports counterfactual price markups, marginal costs, and quantity changes for three counterfactual scenarios. To simulate technology transfer, we calculate the equilibrium if an economy was given the road density of South Africa. This exercise quantifies what would happen if technology was taken from South Africa, and installed in a country, holding all else equal. To simulate an exogenous shift in demand, we calculate the equilibrium if any economy was given the demand of a country with the GDP per capita of South Africa, holding the construction share of GDP, population, the exchange rate and costs constant. The sample includes only economies with domestic cement capacity in which all data are available in two years. Finally, we simulate both scenarios simultaneously. We report the average by continent in the top row of each cell and indicate the 5th and 95th percentile of the changes distribution within continent between brackets.

Continent	Outcome	Road density of South Africa	GDP per capita of South Africa	GDP per capita and road density of South Africa
Africa	Δ Price	-0.173 [-0.491, 0.000]	-0.152 [-0.526, 0.000	-0.174 [-0.499, 0.000]
Rest of World	Δ Price	-0.098 [-0.362, 0.045]	-0.095 [-0.452, 0.074]	-0.098 [-0.363, 0.048]
Africa	Δ Markup	-0.148 [-0.504, 0.000]	-0.152 [-0.526, 0.000]	-0.150 [-0.525, 0.000]
Rest of World	Δ Markup	-0.095 [-0.456, 0.084]	-0.095 [-0.452, 0.074]	-0.095 [-0.452, 0.076]
Africa	Δ Marginal Cost	-0.025 [-0.092, 0.045	0.000 [0.000, 0.000]	-0.025 [-0.092, 0.045]
Rest of World	Δ Marginal Cost	-0.003 [-0.105, 0.105	0.000 [0.000, 0.000]	-0.003 [-0.105, 0.105]
Africa	Δ Quantity	0.219 [0.000, 0.625]	0.193 [0.000, 0.669]	0.222 [0.000, 0.635]
Rest of World	Δ Quantity	0.125 [-0.058, 0.461]	0.121 [-0.094 , 0.575]	0.125 [-0.061, 0.462]

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.

_ **and** _ , "The Role of Trade in Economic Development," in "Handbook of International Economics," Vol. 5 forthcoming.

Backus, Matthew, Christopher Conlon, and Michael Sinkinson, "Common ownership and competition in the ready-to-eat cereal industry," Technical Report, National Bureau of Economic Research 2021.

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.

Baqaee, David Rezza and Emmanuel Farhi, "Productivity and Misallocation in General Equilibrium," *The Quarterly Journal of Economics*, 2020, *135* (1), 105–163.

Beirne, Keelan and Martina Kirchberger, "Concrete Thinking about Development," Centre for Economic Policy Research Structural Transformation and Economic Growth Virtual Workshop on Firms, Frictions and Spillovers and Industrial Policy 2021.

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 T 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 A Haile**, "Identification in Differentiated Products Markets Using Market Level Data," *Econometrica*, 2014, *82* (5), 1749–1797.

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

Besley, Timothy, Nicola Fontana, and Nicola Limodio, "Antitrust Policies and Profitability in Non-Tradable Sectors," *American Economic Review: Insights*, 2020.

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

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

Biesebroeck, Johannes Van, "Exporting Raises Productivity in Sub-Saharan African Manufacturing Firms," *Journal of International Economics*, 2005, *67* (2), 373–391.

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.

Casaburi, Lorenzo and Tristan Reed, "Using Individual-Level Randomized Treatment to Learn about Market Structure," 2022.

Cembureau, "Key Facts and Figures," 2021.

Cherif, Reda, Sandesh Dhungana, Xiangming Fang, Jesus Gonzalez-Garcia, Miguel Mendes, Yuanchen Yang, Mustafa Yenice, and Jung Eun Yoon, "Competition, Competitiveness and Growth in Sub-Saharan Africa," *IMF Working Paper No. 20/30*, 2020.

Connor, John M., "Private International Cartels Full Data 2019 edition," Aug 2020.

Costinot, Arnaud, Dave Donaldson, Margaret Kyle, and Heidi Williams, "The more we die, the more we sell? a simple test of the home-market effect," *The Quarterly Journal of Economics*, 2019, *134* (2), 843–894.

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.

Edmond, Chris, Virgiliu Midrigan, and Daniel Yi Xu, "How Costly are Markups?," Technical Report, National Bureau of Economic Research 2018.

Einav, Liran and Jonathan Levin, "Empirical Industrial Organization: A Progress Report," *Journal of Economic Perspectives*, 2010, *24* (2), 145–62.

Evans, William N and Ioannis N Kessides, "Living by the "Golden Rule": Multimarket Contact in the US airline Industry," *The Quarterly Journal of Economics*, 1994, *109* (2), 341–366.

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*, 2022, *14* (1), 330–365.

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 Tristan Reed**, "Demand-Side Constraints in Development: The Role of Market Size, Trade, and (In)Equality," 2021.

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.

Head, Keith and Thierry Mayer, "Gravity equations: Toolkit, cookbook, workhorse," *Handbook of International Economics*, 2014, *4*, 131–195.

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

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

Ivaldi, Marc, Frédéric Jenny, and Aleksandra Khimich, "Cartel Damages to the Economy: An Assessment for Developing Countries," in "Competition law enforcement in the BRICS and in developing countries," Springer, 2016, pp. 103–133.

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.

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

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.

_ **and Jan Eeckhout**, "Global Market Power," Technical Report, National Bureau of Economic Research 2018.

_ **,** _ **, 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.

_ , _ , Gloria Sheu, and Gretchen Sileo, "The Evolution of Concentration and Markups in the United States Cement Industry," 2022.

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.

Norman, George, "Economies of Scale in the Cement Industry," *The Journal of Industrial Economics*, 1979, pp. 317–337.

Nunn, Nathan and Diego Puga, "Ruggedness: The Blessing of Bad Geography in Africa," *Review of Economics and Statistics*, 2012, *94* (1), 20–36.

Reed, Tristan and Alexandr Trubetskoy, "Assessing the value of market access from belt and road projects," *World Bank Policy Research Working Paper*, 2019, (8815).

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," 2021.

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.

Schwab, Klaus, "The Global Competitiveness Report 2019," in "World Economic Forum" 2019.

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.

US Geological Survey, *Mineral Commodity Summaries, 2020*, Government Printing Office, 2020.

Whinston, Michael D, "Lectures on Antitrust Economics," *MIT Press Books*, 2008, *1.*

World Bank, "Breaking Down Barriers: Unlocking Africa's Potential through Vigorous Competition Policy," Technical Report, World Bank 2016.

_ , *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.

APPENDICES FOR ONLINE PUBLICATION

Appendix A: Data

Prices. Cement prices and market exchange rates are measured by the International Comparison Program (ICP) 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). Several minor adjustments are made to the price series to ensure comparability over time within economies. Between 2011 and 2017, in Belarus the currency was re-denominated at rate of 10,000:1, and in São Tomé and Princípe 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.

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 economy in 2011 and 2017.

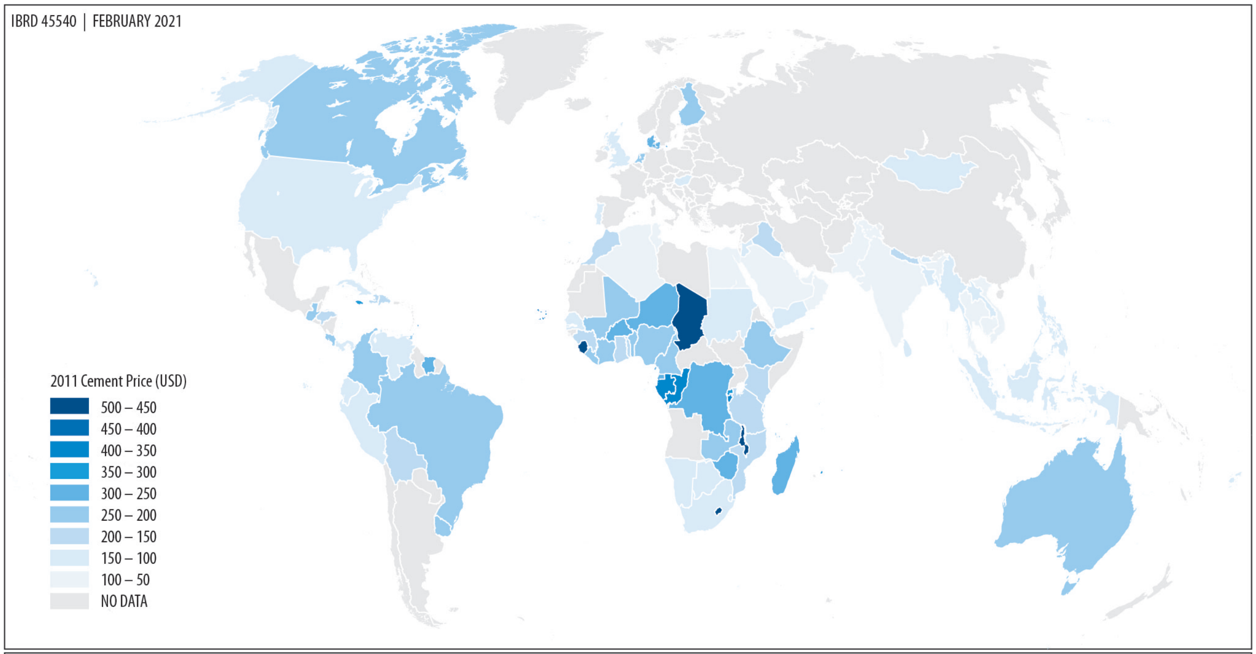
Market structure. Market structure is measured using the concentration-adjusted number of firms, given by $N_{it}^{\star} \equiv 1/H_{it}$, where H_{it} is the Herfindahl index of capacity concentration. For four economies, China, India, the United States and Vietnam Armstrong et al. (2013, 2019) do not report the capacities of all firms in the economy, just the largest. In these cases, we include in the calculation 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.

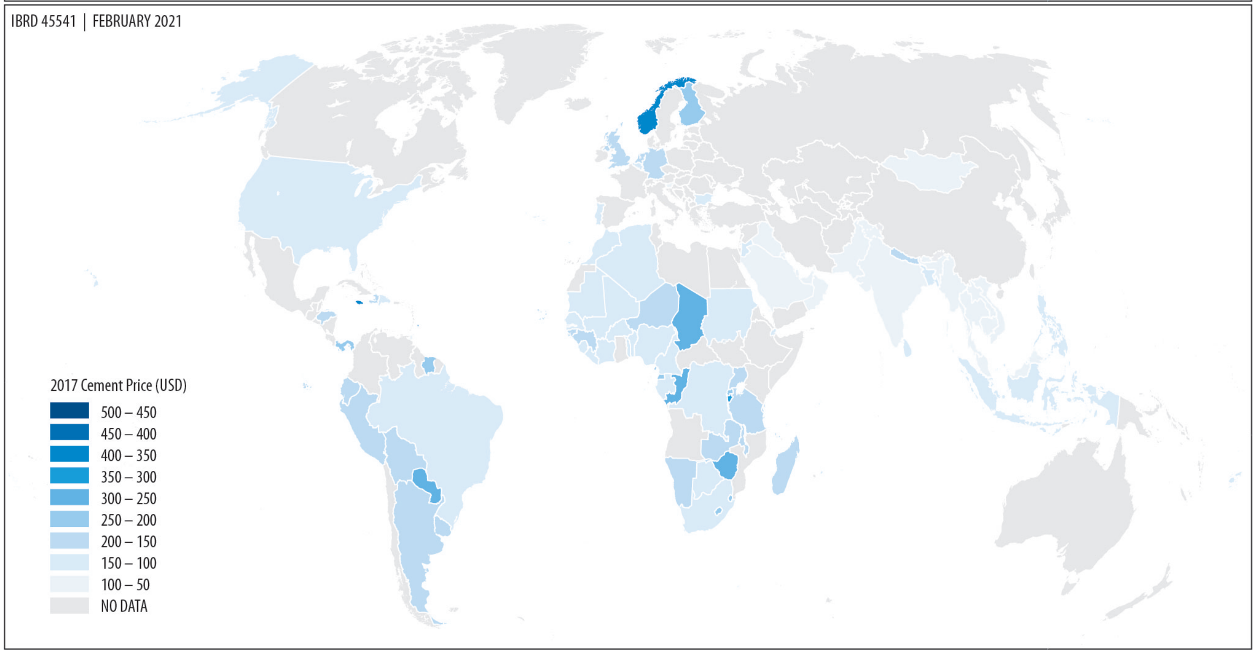
Market characteristics. The ICP makes available data on several other economic variables that are included in our empirical model: nominal GDP per capita in US dollars at market exchange rates, which may shift demand; the construction share of GDP, which rotates the demand curve; and the price of one liter 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 economies from any other source.

Table A1: Summary Statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Cement expenditure/GDP	166	0.0134	0.0125	0.000620	0.0738
Cement expenditure/construction investment	166	0.136	0.171	0.00750	1.417
Cement imports/cement consumption	166	0.412	0.379	0	1.016
Year = 2011	168	0.506	0.501	0	1
Year = 2017	166	0.494	0.501	0	1
ln(Q)	166	14.90	1.902	11.51	21.56
ln(P)	166	5.004	0.454	4.169	6.180
ln(E)	166	-3.718	2.974	-10.02	1.273
ln(CONST)	166	-2.195	0.492	-4.017	-1.124
ln(GDPPC)	166	8.260	1.488	5.526	11.48
ln(POP)	166	16.40	1.696	12.97	21.05
ln(PDIESEL)	166	-0.102	0.544	-2.708	1.074
GYPSUM	166	0.205	0.405	0	1
EXPORTNEAR	166	1.167	2.897	0	21
RLE	166	-0.205	0.887	-1.780	2.027
STARTUPPROCEDURES	166	8.500	3.409	2	19
ROADDENS (km per km^2)	166	0.493	1.202	0.0123	9.574
URBCON	166	0.401	0.317	0.00771	1
MMC	166	1.002	2.191	0	13.17
Production capacity (=1)	166	0.892	0.312	0	1
firms_hhi	148	3.358	2.785	1	13.98
cartel	166	0.211	0.409	0	1
Herfindahl index of capacity	148	0.493	0.314	0.0715	1
Multinational share of capacity	168	0.498	0.412	0	1.591
Recent entrant share of capacity	168	0.101	0.206	0	1
Effectiveness of anti-monopoly policy (WEF)	140	3.945	0.766	2.350	5.779

Figure A1: The Price of Cement Across Economies. The choropleth shows the US dollar price of one metric ton of Ordinary Portland cement at the market exchange rate, in 2011 and 2017. Geographic boundaries are as of February 2021.





Appendix B: Derivation of the Markup

Proof. Index each firm by j and suppress the index for each market. In each market, each firm's problem is

$$\max_{q_j} P(Q, \mathbf{D})q_j - C(q_j, \mathbf{C}_j) - F(\mathbf{F}_j).$$

By the product and chain rules, each firm's first order condition is

$$P + \frac{\partial P}{\partial Q}\frac{\partial Q}{\partial q_j} q_j = C'(q_j, \mathbf{C}_j). \tag{B1}$$

Define $\lambda \equiv \frac{\partial Q}{\partial q_j}$ as firm j's beliefs about the post entry game. Define marginal cost as $MC_j \equiv C'(q_j, \mathbf{C}_j)$ and market share $s_j = \frac{q_j}{Q}$. Substituting these identities into Equation (B1) yields

$$P + \frac{\partial P}{\partial Q} Q \lambda s_j = MC_j. \tag{B2}$$

Define $\eta \equiv -\frac{\partial Q}{\partial P}\frac{P}{Q}$ as the market price elasticity of demand. Assuming that the demand curve $Q(P)$ is continuously differentiable, by the inverse function theorem $\eta = -\frac{1}{\frac{\partial P}{\partial Q}\frac{P}{Q}} \iff \frac{\partial P}{\partial Q} Q = \frac{-P}{\eta}$. Substituting this identity into Equation (B2) yields

$$P - \frac{P \lambda s_j}{\eta} = MC_j \tag{B3}$$

To explore the effect of the number of firms N on prices, we aggregate Equation (B3) to yield an expression for average marginal cost or $\overline{MC} = \frac{1}{N}\sum_{j=1}^{N} MC_j$ or

$$P = \left(\frac{\eta N}{\eta N - \lambda}\right) \overline{MC}. \tag{B4}$$

Equation (B4) is Equation (3) in this paper, the Cournot case ($\lambda = 1$) of which is Equation (8) in Berry and Reiss (2007). There, the market price elasticity of demand is expressed as a negative number, whereas we express it as a positive number, the colloquial form. □

Appendix C: GMM Estimation

The estimator chooses $\theta = (\alpha, \beta, \lambda, \gamma, \sigma)$ to minimize the objective function

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

where the vector Z_{it} contains all variables in the demand Equation (1), but replacing $\ln(P_{it})$ with $EXPORTNEAREST_{it})$ to identify the demand elasticity. In the Cournot model, W_{it} contains all variables in the marginal cost function in Equation (7). In the Conduct model, W_{it} also includes columns $Z(URBCON_{it})$, $Z(MMC_{it})$, and $\ln(POP_{it})^n$ where $n \in \{1, 2\}$. We employ a 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.

Appendix D: Additional Tables and Figures

Table D1: Robustness of conduct to alternative specifications of marginal cost. The table reports the estimated conduct parameters for the same model as in Table 2, but with different specifications of marginal cost for countries with production capacity. Alternative 1 includes only the exchange rate, cement exports of the neighbor, the price of diesel, and a constant. Alternative 2 includes all variables in the specification in Table 2, and their squares. Alternative 3 is the same as Alternative 2, but with all possible interactions.

	Coefficient	S.e.
Alternative cost model 1		
Concentration of urban centers	-0.1767	0.0630
Multimarket contact	0.1889	0.0958
Constant	0.7646	0.2464
Alternative cost model 2		
Concentration of urban centers	-0.1149	0.0565
Multimarket contact	0.1533	0.1008
Constant	0.6017	0.2696
Alternative cost model 3		
Concentration of urban centers	-0.1364	0.0639
Multimarket contact	0.0900	0.1204
Constant	0.5238	0.2876

Table D2: Cement Prices and markups and PPP GDP per capita. Market characteristics are in natural logs unless stated otherwise. Robust standard errors in parenthesis. * for $p < .05$, ** for $p < .01$, and *** for $p < .001$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Price	Price	Price	Price	Price	Price	Price
GDP per capita (PPP)	-0.136***	-0.054*	-0.207***	-0.066**	-0.067**	-0.063**	-0.061**
	(0.029)	(0.028)	(0.039)	(0.028)	(0.028)	(0.028)	(0.030)
Cement exports of neighbor (Level)		-0.045***		-0.044***	-0.044***	-0.044***	-0.042***
		(0.008)		(0.007)	(0.007)	(0.007)	(0.007)
Price of diesel		0.406***		0.391***	0.396***	0.412***	0.402***
		(0.051)		(0.052)	(0.053)	(0.055)	(0.054)
Road density		-0.049*		-0.045*	-0.046*	-0.041*	-0.027
		(0.026)		(0.024)	(0.024)	(0.025)	(0.024)
Cement tariff			-0.482				
			(0.471)				
Population				-0.069***	-0.070***	-0.073***	-0.132***
				(0.015)	(0.016)	(0.016)	(0.026)
Construction share of GDP					0.054	0.060	0.061
					(0.056)	(0.057)	(0.056)
Procedures to start business (Z-score)						0.029	0.039
						(0.029)	(0.028)
Concentration of urban centers (Z-score)							-0.118**
							(0.047)
Multimarket contact (Z-score)							0.021
							(0.026)
Constant	6.232***	5.509***	6.912***	6.750***	6.905***	6.937***	7.902***
	(0.263)	(0.268)	(0.381)	(0.407)	(0.466)	(0.475)	(0.567)
Observations	163	163	120	163	163	163	163
R-squared	0.131	0.386	0.230	0.451	0.454	0.457	0.484

Table D3: Industry Equilibrium Model with an Africa Fixed Effect. The price of cement is in logs.

	Cournot		Conduct Parameter		P-value
Variable	Coefficient	S.e.	Coefficient	S.e.	H_0: Equality
Demand:					
Africa = 1	3.116	3.6	3.114	3.167	1
Price of cement × (Africa = 1)	-0.716	0.717	-0.652	0.634	0.94
Supply with domestic production capacity:					
Africa = 1	0.018	0.584	0.66	0.511	0.41
Fixed costs:					
Africa = 1	-0.635	1.032	-1.73	0.999	0.45
Standard Deviation Term × (Africa=1)	-0.302	0.362	-0.276	0.243	0.95
Conduct:					
Africa (= 1)			-0.749	0.93	
Sargan-Hansen J-Statistic			0.793		
Sargan-Hansen test p-value			0.673		

Table D4: Error Decomposition. We compute the mean and standard deviation of the demand and supply error empirical distribution functions by continent that we obtain using the Conduct model. We cannot reject the null hypothesis that the two groups have the same demand and supply errors.

Continent	Mean $\widehat{\omega}$	Std $\widehat{\omega}$	Mean $\widehat{\xi}$	Std $\widehat{\xi}$
Africa	-.010	.610	.0155	.412
Rest of World	.015	.517	-.002	.310