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The impact of pharmaceutical tendering on prices and market concentration in South Africa over a 14-year period

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ABSTRACT

Objective: We investigated the South African tendering system for medicines to (a) evaluate its impact on prices and market concentration over a 14-year period and (b) analyze the accuracy of government forecasts of drug demand.

Methods: We calculated Herfindahl-Hirschman indexes to measure market concentration levels based on all pharmaceutical tender contracts issued by the South African government between 2003 and 2016 (n = 8701). We estimated price indexes to track changes in medicine costs over this period. We compared prices set through tenders in the public health care system to the corresponding prices in the private system. We also analyzed government data on procurement in selected drug classes to assess the accuracy of demand forecasts.

Findings: Between 2003 and 2016, the prices of medicines in most tender categories in the public health care system dropped by an average of around 40% or more. The prices of medicines procured for the public system through tenders were almost always lower than those sold in the private system. Tenders generally remained moderately to highly competitive over time (i.e., Herfindahl-Hirschman indexes < 2500), although the number of different firms winning contracts decreased in many categories. There were large discrepancies between the drug need estimates by the government and the quantities it went on to procure, with estimates off by more than 50% in most drug classes (9/16 observations).

Conclusion: Tendering may be an effective measure to lower drug costs. Because most tenders remained competitive over time, price decreases may be durable. South African government officials should monitor the availability and prices of medicines to ensure continued access to affordable medicines for patients, as it may be undermined by the decreasing number of firms winning contracts over time. Given the large discrepancy between forecasts and procurements, the government would benefit from improving the accuracy of its demand forecasts.

1. Introduction

Pharmaceutical tendering refers to the bulk purchase of medicines by a central buyer at fixed prices over specific periods following a confidential bidding process (Wouters et al., 2017). In this way, the buyer exercises its monopsony power to purchase medicines on behalf of a wider patient population (Barber et al., 2013; Bergman et al., 2017). This is expected to reduce drug costs as a result of price competition, achieve economies of scale and scope for the buyer, and cut administrative inefficiencies that arise in fragmented distribution systems (Bulow and Roberts, 1989). Indeed, the World Health Organization considers tendering to be a form of strategic purchasing of health care inputs, i.e. "active, evidence-based engagement in defining the service-mix and volume, and selecting the provider-mix in order to maximize societal objectives" (World Health Organization, 2018).

The procurement of medicines through government tenders is increasingly common in the face of budgetary pressures (Callender and Matthews, 2000; Dylst et al., 2011; Lalitha, 2008; Matthews, 2005; Nguyen et al., 2015; Panteli et al., 2016; Vogler et al., 2017; Wirtz et al., 2017; Wouters and Kanavos, 2015, 2017; Wouters et al., 2017). Proponents of pharmaceutical tendering argue it stimulates competition between generic drug firms and drives down drug prices to more accurately reflect costs of production. The strategic purchasing of medicines from pharmaceutical firms may promote universal health coverage and help ensure timely access to affordable medicines for patients (Honda et al., 2016; Kutzin, 2013).

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Box 1
List of medicine tender categories in South Africa (2017).

1. Anti-tuberculosis medicines
2. Anti-infective medicines (ie, antibiotic, anti-fungal, antiprotozoal, and anti-viral agents)
3. Family planning agents
4. Oncology and immunological agents
5. Diagnostic agents and contrast media
6. Small-volume parenterals and insulin devices
7. Drops, aerosols, inhalers, and inhalants
8. Semi-solid-dose medicines (incl. powders)
9. Solid-dose medicines and transdermal patches
10. Biological preparations
11. Large-volume parenterals
12. Pharmaceutical liquids, alcohols, ethers, glycerin, and methylated spirits
13. Anti-retroviral medicines
14. Pharmaceutical packaging materials
15. Intravenous administration accessories

Note: The groupings have changed since 2003. For instance, between 2003 and 2008, the second group only included antibiotics. In 2009, the group was expanded to include other types of anti-infective medicines. The category for intravenous administration accessories was introduced in 2015.

The short-term cost savings from tendering must be weighed against potential long-term adverse effects on competition in generic drug markets. Critics claim tendering will drive losing firms out of business and lead to higher prices over time, as manufacturers exit the market (Hollis and Grootendorst, 2012; Sheppard, 2009). Moreover, tendering is contingent on accurate forecasts of drug demand, which are complicated to produce. Critics also argue that it increases the risk of product shortages, as the market is forced to rely on fewer firms for supply than under free-market conditions. If a contracted firm is unable to supply the required quantities of a medicine on time—due to a manufacturing failure, for instance—it may lead to supply disruptions. Indeed, there have been documented cases of medicine shortages in countries which use medicine tenders, including the Netherlands (Kanavos et al., 2009) and New Zealand (PHARMAC, 2016), often owing to problems with the manufacture or availability of ingredients. The New Zealand authorities, however, have noted that “despite the myth that sole supply contracts lead to stock supply issues, the reverse is true. New Zealand experiences comparatively fewer supply issues than most other countries due to [the government's] approach to managing supply” (PHARMAC, 2016).

Prior studies have looked at the impact of tendering on the costs of biosimilars (Curto et al., 2014), vaccines (Garattini et al., 2012), medicines sold in retail pharmacies (Bergman et al., 2017; Danzon et al., 2015; Kanavos et al., 2012; Kanavos et al., 2009; Petrou, 2016; Petrou and Talias, 2014), and medicines sold in hospital pharmacies (Baldi and Vannoni, 2015; Bartels, 2016; Kastanioti et al., 2013; Raventós and Zolezzi, 2015; Vogler et al., 2013). These studies have generally found that the introduction of pharmaceutical tenders was associated with large price decreases for generic medicines. In the Netherlands, the prices of some generic drugs in retail pharmacies dropped by as much as 90% overnight when insurers first started issuing tenders, suggesting that tenders can scoop substantial one-off savings from price competition (Kanavos et al., 2009). Another study found that originator and generic drugs procured through tenders for international non-governmental organizations in 37 low- and middle-income countries were priced, on average, 42% and 34% lower respectively than the same products sold in retail pharmacies in these countries (Danzon et al., 2015). In China, where tendering at provincial level was introduced in all regions by the end of 2010, the national government reported that prices of essential medicines dropped by an average of 17% between 2009 and 2011 (Barber et al., 2013).

The findings of previous studies cannot necessarily be generalized to other countries, given differences between countries in regulation, patent-litigation procedures, and political economies of health care systems (Barber et al., 2013; Wouters et al., 2017). Most existing analyses are from high-income countries, and the applicability of the results of those studies to lower-income settings is unclear. Also, results cannot necessarily be generalized across therapeutic areas or medicine forms (e.g., tablets versus creams), and it is not clear whether subsequent tenders would sustain price decreases—or if prices would rebound as manufacturers drop out of the market. The duration of follow-up in earlier analyses have been short: all studies have examined at most six years of data, except one study that examined medicines sold in hospital pharmacies over eight years (Bartels, 2016). Most studies have analyzed less than five years of data (Amaral and Blatt, 2011; Baldi and Vannoni, 2015; Blankart and Stargardt, 2017; Danzon et al., 2015; Ewen et al., 2014; Garattini et al., 2012; Gómez-Dantés et al., 2012; Kastanioti et al., 2013; Lunte et al., 2015; Messori, 2016; Petrou and Talias, 2014; Vogler et al., 2013). Data over longer periods and from more countries, especially low- and middle-income ones, are needed to assess the impact of pharmaceutical tendering on prices and market concentration.

In this study, we investigated the South African tendering system for medicines, which has been in operation since 1982. The country's national government issues tenders for essential medicines and related products sold in all pharmacies in the public health care system. The government divides these items into 15 categories (Box 1) and issues tenders for each category every two to three years. The government accepts confidential bids from national and international manufacturers and importers with the right to sell a given product in South Africa (i.e., a firm must have received marketing authorization from the national medicines agency). To date, all international firms have operated in the country through locally-registered subsidiaries, offices, or importers (Gray et al., 2016). Demand estimates for each line item are largely based on usage rates in previous years and epidemiological forecasts. The estimated quantities are not binding, and the South African government may procure smaller or larger amounts of drugs than those requested in the tender contracts.

In most cases, a two-stage scoring system is used to determine the winner for each item. First, the firm offering the lowest price gets 90 points, and other firms receive deductions proportional to their distance from the lowest bid, based on a published formula. Then, the remaining 10 points are allocated based on so-called broad-based black economic

empowerment scores. Each company is given an empowerment score by the government according to preset criteria, such as the proportions of equity owners and management teams that belong to racial groups previously disadvantaged under apartheid.

The South African national government considers other factors on an ad hoc basis when awarding tender contracts. For example, the government may be willing to pay a premium corresponding to up to 10 points to national drug makers to promote local economic growth, industry diversification, job creation, and a positive trade balance (National Planning Commission of South Africa, 2012); local subsidiaries of foreign multinational firms are not eligible for preferential treatment. To reduce the risk of supply disruptions, the national government sometimes splits contracts between multiple firms if bids are close to each other in points. The national government may also split awards, regardless of point differentials, if (a) the required volume is high, meaning there is a greater risk of supply disruptions, (b) the product is of high public health importance, such as first-line anti-retroviral drugs used to treat human immunodeficiency virus, or (c) the highest scoring bidder had a poor performance history in previous years.

A full account of the evaluation criteria can be found in the "special requirements and conditions of contract" sections of the agreements, which are published online with each tender. Once the winning companies have been announced, provincial health departments and other institutions are responsible for ordering medicines directly from these companies at the prices set in the contracts.

We have two objectives. First, we present evidence on the impact of the South African tendering system on prices and market concentration over a 14-year period. This is some of the first evidence on the long-term effects of pharmaceutical tenders, and it allows us to analyze the validity of the key criticisms of tendering. Second, we compare the drug quantities the South African government estimated it would need to meet patient demand during tender periods and the quantities the government went on to procure. These findings provide insight into the effectiveness of tendering in improving access to medicines in low- and middle-income countries.

2. Methods

2.1. Data sources

We reviewed all tender contracts awarded by the national government between 2003 and 2016 via the National Treasury and National Department of Health websites; some contracts were retrieved in person from National Department of Health archives (Pretoria, South Africa). Tender contracts contain information on medicine prices, estimated quantities, and winning manufacturers. We excluded data on diagnostic agents, packaging materials, and intravenous administration accessories (categories 5, 14, and 15 in Box 1), as these categories do not include medicines. Each line item in a tender corresponds to a molecular or biological entity in a certain strength, form, and pack size.

We identify individual tender contracts, which cover periods ranging from two to three years, by their starting year. For example, the 2012 solid-dose tender refers to the tender for solid-dose drugs covering the period from 1st August 2012 to 31st July 2014. Appendix A lists tender contracts and their starting years, durations, and numbers of line items.

Data on the prices of medicines in the private health care system were obtained from the Private-Sector Database of Medicine Prices (2009–2016), which is published on the National Department of Health website and updated regularly; some of the historical data were obtained in person from departmental archives. Data on the quantities the government went on to procure in individual tenders were obtained from the Republic of South Africa Pharmaceutical Database (2011–2016). This database is generated from a web-based reporting platform through which contracted suppliers give information on all orders received and delivered to allow the national government to monitor stock levels. The dataset is not publicly available and was obtained in person from National Department of Health archives.

All data were analyzed in Stata 15 (StataCorp), with prices reported in 2016 rand based on consumer price index adjustments to account for inflation (Statistics South Africa, 2017). In all price analyses, we calculated weighted prices for split awards. For instance, if one firm was asked to supply 60% of the contracted volume at a price of 5 rand per pack, and another was asked to supply 40% of the volume at a price of 10 rand per pack, the weighted price was 7 rand.

The manuscript does not contain data collected from human subjects, so ethical approval was not required. As a precaution, we obtained ethical approval from the research ethics committee at the London School of Economics and Political Science (application no. 404–2015).

2.2. Analysis of market concentration

We calculated Herfindahl-Hirschman indexes to measure the degree of market concentration in each medicine tender issued by the government since 2003. A Herfindahl-Hirschman index is a summary statistic of the amount of competition in a market: the index reflects the number of firms in a market and their relative market shares. These indexes are calculated by summing the squared market shares of every manufacturer.

For a market with a given number of firms, the index score is minimized if all firms have equal market shares. Index scores increase—indicating greater market concentration—if (a) firms exit the market or (b) the distribution of market shares between firms grows uneven. The indexes are measured on a scale of 0–10,000, with a score of close to 0 indicating perfect competition, and a score of 10,000 indicating a monopoly. We adopted the US Department of Justice definition of market concentration: a score of 1499 or lower indicates a competitive or unconcentrated market, a score of 1500 to 2499 indicates a moderately concentrated market, and a score of 2500 or higher indicates a highly concentrated market (U.S. Department of Justice & Federal Trade Commission, 2010).

We considered tenders for each of the categories in Box 1 as distinct pharmaceutical markets. These categories are defined by the national government, and each tender is subject to individual "special requirements and conditions of contract". Each tender thus represents an opportunity for a firm to decide whether or not to compete in a market. We calculated the market share of each firm in a tender by dividing the projected value of all products awarded to that firm by the projected value of all products in the tender.

A parent drug company and its divisions and subsidiaries were treated as one firm. For example, Adcock Ingram Critical Care is a division of the South African drug firm Adcock Ingram, while Sandoz is the generic drug division of Novartis, a multinational pharmaceutical company. Appendix B details mergers, acquisitions, and company name changes that occurred between 2003 and 2016. The appendix also lists the names of parent companies and their subsidiaries and gives additional information on the Herfindahl-Hirschman index calculations.

2.3. Analysis of price trends

To track how the prices of medicines in each tender category evolved between 2003 and 2016, we calculated three types of weighted price indexes: Laspeyres, Paasche, and Fisher indexes (Danzon and Kim, 1998; Wouters and Kanavos, 2017). The formulas are presented in Appendix C.

In a weighted index, the prices of widely used drugs are given greater weight in the calculations than those of less consumed drugs. Each index relies on a different weighting strategy. The difference between Paasche and Laspeyres indexes has to do with the quantity measures: the former applies quantity weights from the first period,

Table 1
Estimated budget impact of each tender in billions of rand (2003–2016).

	2003/04	2005/06	2007/08	2009/10	2011/12	2013/14	2015/16
Anti-tuberculosis medicines	–	–	0.63	0.17	0.60	1.05	0.98
Anti-infective medicines	2.08	2.45	1.16	2.53	1.23	1.64	2.07
Family planning agents	0.87	0.56	0.45	0.31	0.38	0.27	0.32
Oncological products	0.42	0.76	0.46	0.50	0.57	0.38	0.42
Small-volume parenterals	–	–	2.16	1.72	1.45	1.91	–
Drops and inhalers	–	0.66	0.68	0.86	0.70	0.79	–
Semi-solid medicines	0.48	0.59	0.69	0.71	0.53	0.58	–
Solid-dose medicines	2.87	2.85	4.06	3.32	3.14	2.95	4.73
Biological products	–	–	–	–	0.69	0.93	0.84
Large-volume parenterals	–	–	0.92	–	0.56	0.96	–
Liquids and spirits	–	–	0.59	0.20	1.10	0.68	–
Anti-retroviral therapies	6.33	–	6.41	5.29	–	6.66	14.84
Total	13.05	7.87	18.21	15.61	10.95	18.80	24.20

Note: The first row shows the starting years of contracts. The period covered by each tender is listed in Appendix A. For example, the 2014 tender for semi-solid medicines covered the period from 1 July 2014 to 30 April 2017, which is why there is no budget impact figure for 2015/16. All values are reported in 2016 rand based on consumer price index adjustments.

while the latter applies weights from the most recent period. The choice of index reflects assumptions about the relationship between prices and consumption, which have been described elsewhere (Goodridge, 2007; International Labour Office, 2004; Statistics South Africa, 2013). If the weighted price and quantity changes are negatively correlated, the Laspeyres index will be greater than the Paasche index. If these changes are positively correlated, the inverse is true. Yet according to a publication from the U.K. Office for National Statistics, "the choice of whether to use a Laspeyres or Paasche is fairly arbitrary. The decision will probably make very little difference to the final index, unless there has been a substantial change to the weighting of the variable" (Goodridge, 2007).

However, because the prices and quantities of some medicines could, in theory, differ substantially between the base and current periods in our sample, we also calculated a Fisher index. This index is the geometric average of the other two indexes, and it therefore lies between them. It is generally preferred when the Laspeyres and Paasche indexes may produce widely discrepant results (Goodridge, 2007). Thus, we view the Fisher index as the primary result in this paper, and we present Laspeyres and Paasche indexes as sensitivity analyses.

A price index shows the average percentage change in the prices of products between two periods (International Labour Office, 2004). They are interpreted as price ratios. In our case, the first tender in each category is assigned an index value of 100, and indexes in subsequent years are interpreted in relation to the base year. For example, a Fisher score of 80 in a given year means that prices were, on average, 20% lower than in the base year; Laspeyres and Paasche indexes are interpreted in the same way. There is one caveat: the results of Laspeyres indexes in different years can be compared with each other, since the denominator is constant, whereas the results of Fisher and Paasche indexes in given years can only be compared with the base year (Goodridge, 2007).

In our analysis of every tender since 2003, we kept the sample constant over time by restricting the price-index analyses to medicines in the same form, strength, and pack size. This was done to examine the impact of tendering on the prices of individual products over a longer period. We accepted minor changes in pack size (e.g., from 28 to 30 tablets), as documented in Appendix C. The resulting sample consisted of 7 anti-tuberculosis medicines, 39 anti-infective medicines, 7 family planning agents, 32 oncological products, 117 small-volume parenterals, 32 drops and inhalers, 34 semi-solid medicines, 116 solid-dose medicines, 11 biological products, 12 large-volume parenterals, 20 liquids and spirits, and 8 anti-retroviral therapies. As a further sensitivity analysis, we dropped the first two tender contracts in each category to increase the sample size and recalculated all the indexes.

2.4. Analysis of government forecasts of drug demand

We compared the quantities the national government estimated it would need between 2012 and 2016, as declared in the tender contracts issued during this period, to the quantities the government went on to procure over the course of each contract. We selected the tenders issued during these years because of the availability of complete data for each contracted period.

We focused on medicines in seven therapeutic classes: angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, atypical antipsychotics, calcium channel blockers, proton-pump inhibitors, selective serotonin reuptake inhibitors, and statins. These medicines, which are some of the most widely consumed globally, have been selected as tracer drugs in other studies of the impact of tendering on drug prices (Kanavos et al., 2012, 2009). We also looked at procurement data for first- and second-line therapies for human immunodeficiency virus and tuberculosis, given the importance of these products to public health in South Africa.

2.5. Analysis of public versus private-sector prices

For the medicines included in the analysis of government forecasts of drug demand, we compared the prices set through tenders in the public health care system to the corresponding prices in the private system. If a product was sold by multiple firms in the private health care system, then the lowest price was used for the comparison. We did not examine the private-sector prices of anti-tuberculosis medicines since these products are sold almost exclusively in public facilities.

3. Results

3.1. Summary statistics

Between 2003 and 2016, the South African government tendered for 2198 medicines. This totaled 7645 line items across the 14-year period, ranging from 63 biologics to 3004 solid-dose medicines. Solid-dose and anti-infective medicines, the two largest tender categories, accounted for roughly half the products (51%, 3920/7645). Counting split awards, the national government issued a total of 8701 contracts.

Table 1 shows the projected budget impact of tenders issued between 2003 and 2016, based on the prices and estimated quantities listed in the contracts. The projected values of the tenders for solid-dose, anti-retroviral, and anti-tuberculosis medicines rose by 65% (4.73/2.87 billion), 124% (14.19/6.33), and 49% (0.94/0.63) respectively between the first and last tenders, based on inflation-adjusted costs. In most other categories, projected values remained similar over

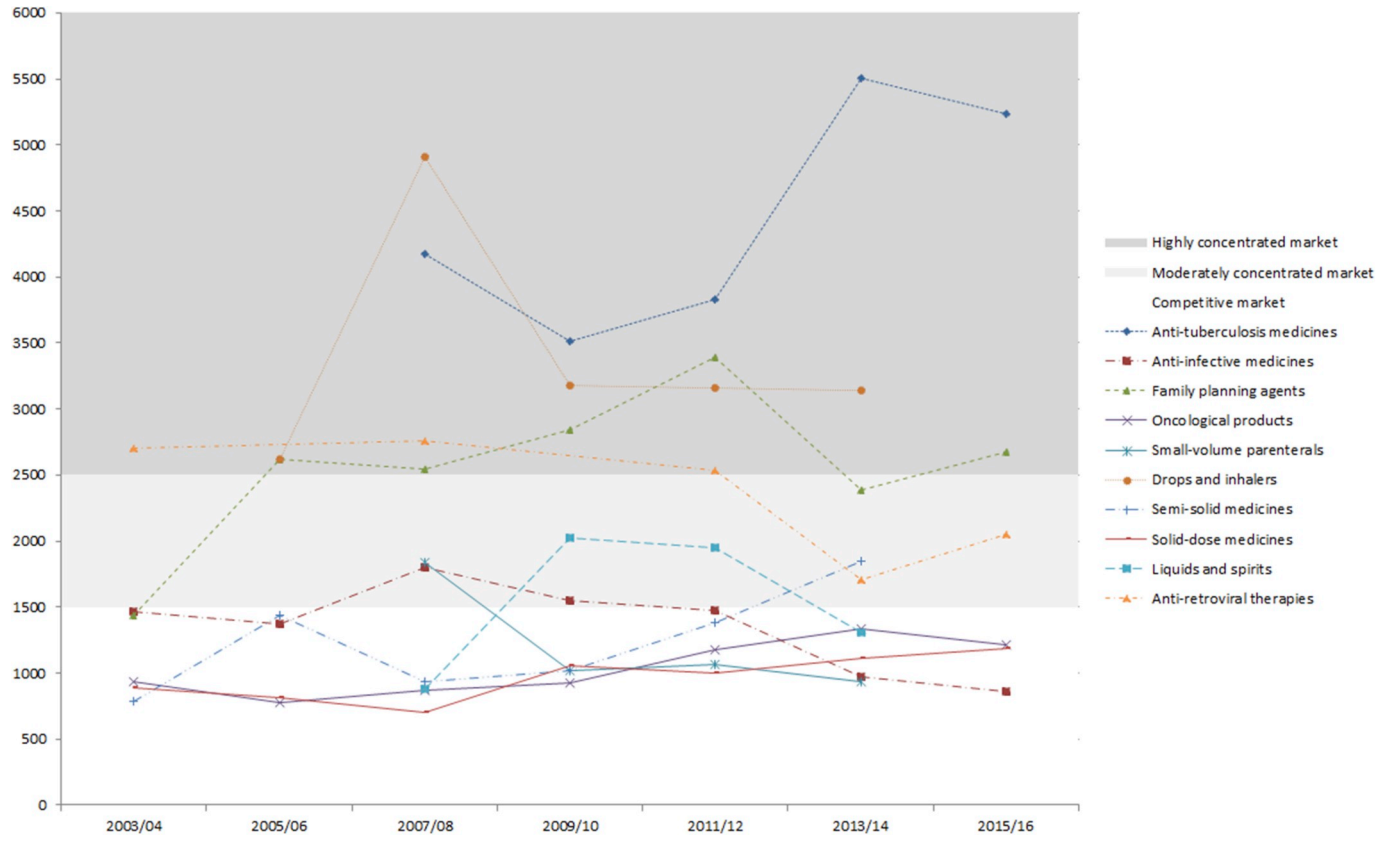

Fig. 1. Herfindahl-Hirschman indexes for each tender (2003–2016).
Note: We excluded categories with three or fewer tenders (i.e., large-volume parenterals and biologicals); full results can be found in Appendix B.

time or, in a few cases, decreased slightly.

Over time, the government has split a growing number of contracts. From 2003 to 2010, the South African government split 195 contracts, whereas it split 218 contracts between 2011 and 2016. Over the entire 14-year period, most split contracts were awarded in one of six categories: solid-dose (185 split contracts), anti-infective (94), small-volume-parenteral (29), oncological (25), family planning (21), and anti-retroviral medicines (21).

3.2. Market concentration

Between 2003 and 2016, 167 different companies were awarded at least one tender contract. About half the contracts (50%, 4345/8701) were awarded to 10 companies: Aspen Pharmacare (965 contracts), Adcock Ingram (761), Novartis (536), Pfizer (380), Fresenius (366), Sanofi (319), Ranbaxy (307), Cipla Medpro (276), GlaxoSmithKline (243), and Biotech Laboratories (192). Aspen Pharmacare, Adcock Ingram, Cipla Medpro, and Biotech Laboratories are South African firms that mostly supply generic products.

Fig. 1 shows the Herfindahl-Hirschman indexes for each category since 2003. The results indicate that many markets remained highly or moderately competitive, including those for solid-dose, semi-solid, oncological, and anti-infective medicines. For instance, the solid-dose tender had a score of 886 in 2003, compared to 1187 in 2016, both of which are smaller than the benchmark of 1499 or lower set by the US Department of Justice to indicate a highly competitive market. The market for anti-retroviral therapies grew more competitive between 2003 and 2015, over which time the index decreased from 2701 (highly concentrated market) to 2054 (moderately concentrated market).

The markets for biologicals, drops and inhalers, large-volume parenterals, anti-tuberculosis medicines, and family planning agents were highly concentrated in most years. The largest percentage increases between the earliest and latest tenders occurred in the markets for semi-solid medicines (785 in 2003 to 1848 in 2014) and family planning agents (1439 in 2003 to 2676 in 2015). The market for family planning agents was the only one to go from highly competitive to highly concentrated at any point during this period.

With the exception of anti-retroviral therapies, the number of pharmaceutical products procured through tenders decreased in all categories between 2003 and 2016 (Appendix A). The number of manufacturers winning at least one contract has also decreased over time in most categories (Appendix B). For example, the number of winners in the solid-dose tender dropped from 49 to 32 between 2003 and 2016, while the number of winners in the oncological tender fell from 25 to 13.

The full results of the market concentration analyses can be found in Appendix B.

3.3. Price trends

Fig. 2 shows price trends by tender category. The results were largely consistent across the three types of price indexes, although trends varied between medicine categories. The prices of anti-retroviral therapies, oncological products, family-planning agents, small-volume parenterals, and solid-dose medicines fell consistently over time. For example, the Fisher results indicate that the prices of medicines in the oncological tenders dropped by an average of 70% between 2003 and 2016, while the prices of anti-retroviral therapies fell by an average of 85% between 2004 and 2015.

The prices of anti-infective medicines and drops and inhalers decreased by approximately 40% between the first and last tenders, though there were price increases for these products in some of the intervening years. The prices of anti-tuberculosis and semi-solid medicines dropped by around 15% over this period, whereas the prices of

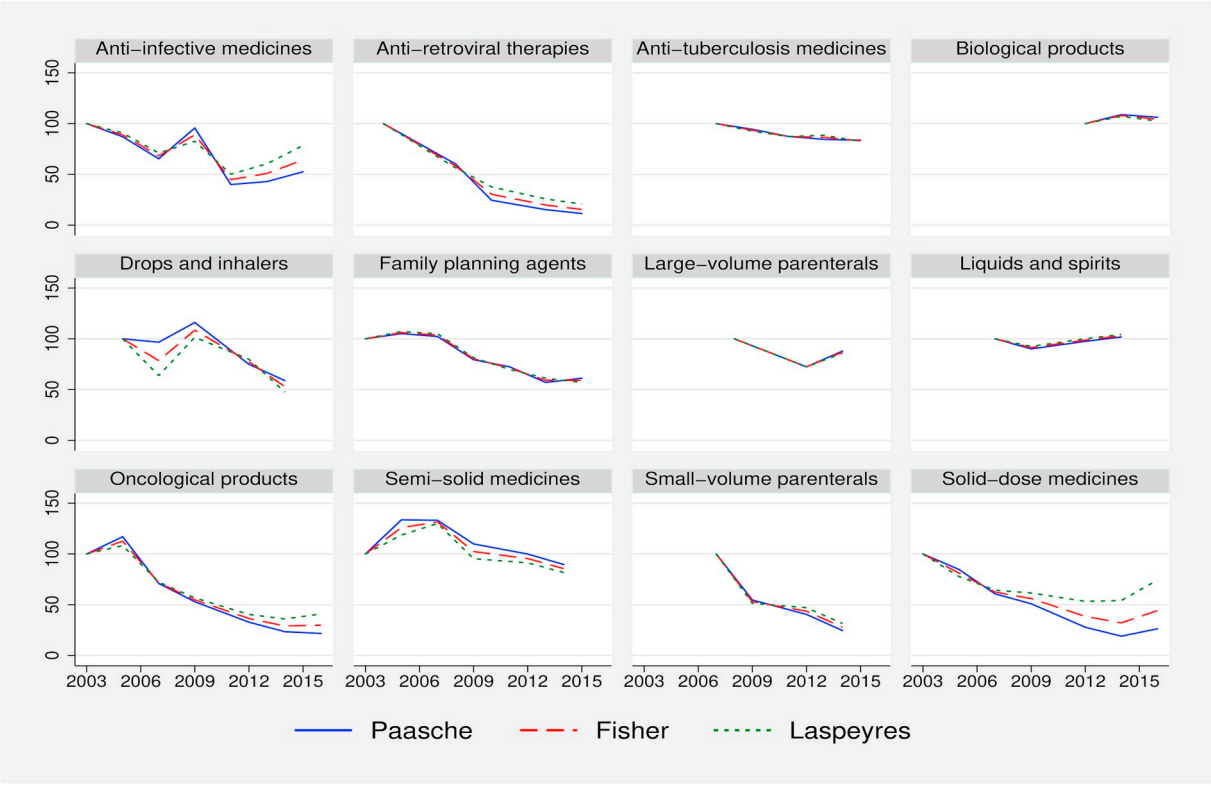

Fig. 2. Price trends by medicine category (2003–2016).

biological products, semi-solid medicines, and liquids and spirits remained stable. The figure shows spikes in the prices of anti-infective and solid-dose products in the most recent tenders. Appendix C includes the raw figures for all the price indexes in the primary and sensitivity analyses. The results of the sensitivity analysis in which the first two contracts are omitted are comparable to those shown in Fig. 2.

3.4. Government forecasts of drug demand

Table 2 gives the total estimated and procured quantities for solid-dose medicines in seven therapeutic classes, as well as for anti-retroviral and anti-tuberculosis medicines. Large discrepancies between the two quantities are evident in most cases. In 2012, for example, the South African government underestimated demand for proton-pump inhibitors by over 55%, whereas it overestimated demand for this class of drugs by more than 40% in the next tender.

In the 2012 tender, the South African government estimated it would need 34,594,171 packs of the medicines in all seven therapeutic classes, and 121,566,800 packs in the 2014 tender. Ultimately, the government procured 16,640,339 packs (52% less than predicted) in the 2012 tender, and 83,593,114 packs (31% less) in the 2014 tender. The government overestimated demand for anti-retroviral and anti-tuberculosis medicines by 22% and 57% respectively in the corresponding 2013 tenders. Yet aggregate estimates for solid-dose medicines in each of the seven therapeutic classes improved in accuracy, in absolute terms, between 2012 and 2014. Appendix D presents the full results for every medicine included in the government forecast analysis for which data were available.

Table 2
Estimated versus actual procurement figures for anti-retroviral, anti-tuberculosis, and solid-dose medicines in tenders issued between 2012 and 2014.

	2012			2013			2014		
	Estimated volume	Procured volume	% change	Estimated volume	Procured volume	% change	Estimated volume	Procured volume	% change
Angiotensin receptor blockers	172,100	41,136	−76.1%	–	–	–	355,000	437,229	23.2%
Angiotensin-converting enzyme inhibitors	1,262,900	2,043,530	61.8%	–	–	–	44,920,200	35,005,480	−22.1%
Anti-retroviral therapies	–	–	–	130,871,700	101,796,577	−22.2%	–	–	–
Anti-tuberculosis medicines	–	–	–	16,821,770	7,295,537	−56.6%	–	–	–
Atypical antipsychotics	1,319,900	329,702	−75.0%	–	–	–	2,398,700	2,380,170	−0.8%
Calcium channel blockers	20,555,972	7,942,279	−61.4%	–	–	–	31,182,400	26,681,543	−14.4%
Proton-pump inhibitors	2,978,299	4,617,333	55.0%	–	–	–	7,055,100	4,053,951	−42.5%
Selective serotonin reuptake inhibitors	1,752,100	807,596	−53.9%	–	–	–	2,302,400	2,418,752	5.1%
Statins	6,552,900	858,763	−86.9%	–	–	–	33,353,000	12,615,989	−62.2%
Total	34,594,171	16,640,339	−51.9%	147,693,470	109,092,114	−26.1%	121,566,800	83,593,114	−31.2%

Note: The percentage change is the procured volume minus the estimated volume, expressed as a proportion of the estimated volume. The formula is $\frac{Procured - Estimated}{Estimated} * 100$.

3.5. Public vs. private-sector prices

With the exception of atazanavir (150 mg) in 2015, the prices of all solid-dose and anti-retroviral medicines were higher in the private health care system than in the public one. For example, a 30-tablet pack of atorvastatin 20 mg cost 511% more in the private system in 2009, and 178% more in 2016, than in the public system. Other cholesterol-lowering drugs cost between 127% (atorvastatin 40 mg in 2014) and 996% (pravastatin 20 mg in 2014) more in the private system than in the public one. Appendix E gives the private- and public-sector prices of every medicines included in our analysis for which data were available in both sectors.

4. Discussion

Pharmaceutical tenders aim to improve the quality, efficiency, equity, and responsiveness of pharmaceutical care. Yet critics argue that centralized purchasing of medicines may cause firms to exit the market and increase market concentration. This could, over time, drive up the prices of medicines in therapeutic areas with decreasing competition and increase the likelihood of supply disruptions, in part due to misestimates of drug demand.

The results of this study suggest that tendering can achieve large price decreases for medicines, and that such decreases can be sustained over time. Between 2003 and 2016, we observed price drops in many drug categories. The prices of medicines in the South African public health care system remained considerably lower than those in the private health care system, where no tendering system exists. These findings are consistent with those of earlier, shorter studies that found that the introduction of pharmaceutical tenders was associated with decreases in the prices of medicines (Baldi and Vannoni, 2015; Bartels, 2016; Bergman et al., 2017; Curto et al., 2014; Danzon et al., 2015; Garattini et al., 2012; Kanavos et al., 2012, 2009; Petrou and Talias, 2014; Raventós and Zolezzi, 2015), although some studies found no relationship between tender volumes and prices (Danzon et al., 2015; Garattini et al., 2012). Further work is needed to better understand the mechanisms by which tendering systems achieve price reductions, which may allow policymakers to improve the designs of these systems.

In this paper, we did not seek to explain differences in market concentration trends in individual drug categories, which would require detailed market analyses. Instead, we note that the pharmaceutical tendering system in South Africa seems to have maintained adequate levels of competition in many of the tender categories, as evidenced by our Herfindahl-Hirschman index results over a 14-year period. Yet there remain regulatory barriers to market entry in South Africa which may threaten competition in the pharmaceutical sector. Notably, registering a medicine with the government agency in charge of granting drug firms marketing authorization has historically been a slow and laborious process for companies (Leng et al., 2015). Applications for new drugs can take up to three years (Leng et al., 2015), while changes to existing registrations (e.g., to register a new source of an active ingredient) can take two years to be approved (Chorley, 2014). There is little coordination of tender issuance and the registration of products, which leads to some items being excluded from tenders, further weakening competition. For tendering systems to sustain competition, it may be important to put in place policies that make it easy for drug companies to take part in tenders.

Though most tenders remained moderately to highly competitive during the study period, there were exceptions: the prices of some products increased over time, and certain tender categories grew less competitive, such as those for anti-tuberculosis and family planning agents. The latter finding might be explained by the inability of firms producing anti-tuberculosis and family planning agents to manufacture other products at the same facilities, due to risk of cross-contamination. Consequently, losing bidders for these products must often shut down their facilities as a direct result of the loss, which adds financial risk and may discourage current and prospective market participants from engaging.

Our results further suggest that the South African government would benefit from improved accuracy of its drug demand forecasts. The estimated quantities in tender contracts sometimes far exceed the amounts needed, whereas in other cases they fall well short of the required quantities. Discrepancies between estimated and procured quantities were observed for a wide range of products, including therapies used to treat tuberculosis and human immunodeficiency virus, cholesterol-reducing and anti-hypertensive drugs, and anti-psychotic medicines. Poor demand forecasts can make it difficult for suppliers to plan production and delivery schedules, which may raise the risk of supply disruptions.

Fiscal federalism in South Africa means that although tendering is conducted centrally by the national government, the procurement of, and payment for, medicines is done by provinces, with provincially held budgets (Magadzire et al., 2017). Representatives from each provincial health department are involved throughout the tender process, as are stakeholders from policy and finance units in the national government. Yet in the past decade, delays in the awarding of tenders by the national government (Magadzire et al., 2017), late payments by provincial bodies (Bateman, 2013; Steyn et al., 2009), failures of some suppliers to meet contractual agreements (Gray, 2014; Magadzire et al., 2017), and government corruption (Bateman, 2013) have contributed to supply disruptions. Information systems are not standardized across provinces (Steyn et al., 2009), resulting in usage and demand data which are poor and patchy. Improved dialogue between different levels of government and suppliers may help the government to ensure adequate stock levels and improve supply chain policies in the public sector (Bateman, 2013; Gray, 2014; Magadzire et al., 2017; Magadzire et al., 2015; Steyn et al., 2009).

The adverse effects of supply disruptions are significant. In the event of shortages, the South African government can procure medicines off-contract from approved suppliers, but such orders usually come at steep premiums. For patients, a reliable supply is critical to therapeutic efficacy, as many infection management regimes rely on regular doses. This point is particularly relevant to South Africa as a country with a high infectious disease burden (Pasquet et al., 2010; Schowalter and Conradie, 2012). More generally, stock-outs can harm patient trust in the health care system (Goudge et al., 2009).

Tendering policies differ between countries, so the results of this study cannot necessarily be applied to other settings. Studies from more countries are needed to validate these findings. For example, the South African government attaches considerable weight to broad-based black economic empowerment scores for historical reasons: the dual aims of redressing past injustices and promoting equitable development lie at the heart of industrial policies in the country. The combination of enormously unequal income distribution (Mooney and Gilson, 2009), low education levels (Coovadia et al., 2009), and lack of access to essential health care services (Mayosi and Benatar, 2014) results in a vicious cycle of poverty and social exclusion for many, tracing back to the structural inequalities inherited from the racially divided apartheid state. By contrast, many other countries rely on pharmaceutical tendering to try to extract the lowest possible prices from firms (Dylst et al., 2011). Similarly, the frequency of tendering varies considerably between European countries, and some countries do not split contracts between multiple firms as done in South Africa (Dylst et al., 2011). And while the national government is in charge of the tendering system in South Africa, health insurance companies administer tenders in some settings (Leopold et al., 2008).

This study has limitations. First, the procurement data are self-reported by suppliers, without independent verification. No validation of the completeness and quality of reporting has been conducted to date, so the data may be incomplete. The information relating to high-priority items (e.g., anti-retroviral and anti-tuberculosis medicines) is likely to be more reliable given greater pressure from the government

on firms to comply with tendering regulations. Nevertheless, even if the point estimates might not be exact for all products, the results indicate large discrepancies between estimated and procured quantities in many cases. Second, we did not examine within-contract price adjustments for exchange rate fluctuations due to lack of data for many of the older tenders. Third, some line items were missing in the published tender contracts. Omissions may have reflected cases where no bids were received or no contract could be awarded. In such instances, the national government sometimes chose to retender for missing items and to announce the winners in subsequent addenda. We did not have access to all addenda dating back to 2003, so these were excluded from our analyses. Fourth, the sample sizes for some of the price indexes were small, given the need to track a common sample of products over time. Results for those medicine categories, notably anti-tuberculosis, family-planning, and anti-retroviral therapies, should be interpreted with caution. Finally, the Herfindahl-Hirschman indexes may over or understate competition in some drug classes, since the results are presented at the tender-wide level and may obscure different trends in individual classes. Also, some local drug distributors collaborate with many international suppliers but were counted as unique firms in the analyses. This may have resulted in an overestimation of the degree of market concentration in some tenders.

5. Conclusion

Tendering allows central buyers to aggregate drug demand across many patients and increases their leverage against companies. It can be an effective measure for securing low medicine prices on a sustainable basis. It may allow drug purchasers to achieve economies of scale and scope, realize administrative savings, and improve price transparency. The price decreases observed in this study are likely due in large part to the ability of a monopsony—in this case a single purchaser of medicines on behalf of many patients—to negotiate aggressively with suppliers.

Yet there is room for error and unforeseen issues as the system relies on accuracy of forecasting that is not always achievable. We found large discrepancies between the drug quantities the South African government estimated it would need to meet patient demand and the quantities the government went on to procure during tender period. The number of different firms winning contracts decreased over time in most tender categories, which potentially increases the sensitivity of the system to supply disruptions. Policymakers and other health stakeholders should regularly examine the functioning of tendering policies to quickly catch and address problems like price hikes and supply disruptions to preserve the integrity of tendering-based pharmaceutical care systems.

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Ethical considerations

The manuscript does not contain data collected from human subjects, so ethical approval was not required. As a precaution, we obtained ethical approval from the research ethics committee at the London School of Economics and Political Science (application no. 404-2015). At the time of writing, Dale Sandberg was Deputy Director for Sector Wide Procurement at the National Department of Health of South Africa. Dr. Anban Pillay is the Deputy Director General for Health Regulation and Compliance at the National Department of Health. The authors have no conflicts of interest to declare.

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Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2018.11.029.

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