“The impact of platforms in the healthcare industry; a case study of platform “1mg” reducing the cost of medicine in India”

In this case study, the impact of an online pharmacy platform in India called 1mg.com on the availability and price of regulated versus unregulated formulations of certain essential medicines, is investigated. Although this paper cannot make an absolute statement that 1mg.com does promote the sale of regulated medicine formulations, it provides evidence that the platform facilitates the sale of regulated formulations when patients cannot buy them in physical pharmacies. Furthermore, the paper provides a small overview of platform businesses in general and the troubled Indian pharmaceutical sector.

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1. Introduction

Platform businesses have taken the world by storm. With the use of internet, platforms are able to bundle and connect two sides of the market on one website or mobile app. The most famous platforms, such as Uber, Netflix, Spotify or Airbnb, are focussed on the consumer market. However, platform technology is also being used to revolutionize healthcare. While there has been many research to platforms regarding network effects, pricing strategy, the sharing economy, the global scale of platforms or regarding the way platforms boost innovation (Armstrong, 2006; Botsman & Rogers, 2011; Ceccagnoli, Forman, Huang, & Wu, 2012; Eisenmann, Parker, & Van Alstyne, 2006; Evans & Schmalensee, 2008; Gawer & Cusumano, 2002; Evans & Gawer, 2016; Hagiu, 2009; Rochet & Tirole, 2003; Rysman, 2009), there has been very little research about the impact of the platform concept in the healthcare industry. That is why this paper provides a case study in which the impact of an online pharmacy platform in India, called 1mg.com, is investigated.

This research is focused on whether 1mg.com is able to contribute to lowering the costs of medicines, by making use of recent partial price regulation imposed by the government of India, which has facilitated effort diversion by pharmaceutical producers, moving their effort from the price controlled formulations of medicines towards the unregulated formulations, causing a lack of supply of the regulated and cheaper formulations of essential medicines (Bhaskarabhatla, Anurag, Chatterjee, & Pennings). I investigate this, using order data from 1mg.com spanning from the first of November 2015 to the 24th of May 2016 and complement this data with the Compendium of Notified Ceiling Prices of Scheduled Drugs 2015 (NPPA, 2015), in which the partial price regulation of certain medicines is documented.

A strength of this paper, is that it is one of the first papers considering the impact of platform businesses on the healthcare industry. However, due to a lack of comparability with sales numbers of both regulated and unregulated formulations of price regulated medicines, I cannot make an absolute statement on whether 1mg.com increases the sale of regulated formulations and therefore lowers the costs of medicines. Nonetheless, this paper provides an overview of several aspects of platform business models in general, the Indian pharmaceutical industry and its problems and gives insight to healthcare related platforms and the way they try to revolutionize healthcare.

The paper is organized as follows. In section 2, I describe platforms in general, give some examples of healthcare related platforms, describe the Indian pharmaceutical industry and introduce the case of 1mg.com and the related hypothesis. In section 3, I give an overview of the data and provide descriptive and econometric evidence considering the hypothesis, and section 4 concludes.

2. On platforms, the Indian pharmaceutical industry and 1mg.com

The global rise of platforms

The exponential growth of internet connectivity around the globe has enabled a new kind of business model to disrupt the global consumer economy: platforms. The definition of a platform is a business model that creates value by facilitating exchanges between two or more interdependent groups, usually consumers and producers (Moazed & Johnson, 2016). With the use of network effects, platforms like Uber, Spotify, AirBnB and many others have proven to be able to be fierce competitors of established players and to transform industries, while making huge revenues. In 2015 there were 176 platforms around the globe with a market capitalization of at least 1 billion USD, with a grand total of 4,303 billion USD (Evans & Gawer, 2016).

The reason why platforms are able to grow in such enormous rates, is due to a self-reinforcing cycle created by network effects. The success of a platform is derived from the number of participants on both sides of the market. Having many providers of a service or product attracts customers, which in turn will increase the number of providers. The more users join a network, the more products and services will be supplied and the more users will want to join, giving the platform leader the opportunity for increasing returns to scale. (Eisenmann, Parker, & Van Alstyne, 2006) At the foundation of the growth of platforms however, is the possibility for scalability; thanks to the digitization of products and the increasingly connected world population, joining a platform is often as simple as downloading an app.

Platform business models have many important benefits for the global economy. First, they are raising productivity by facilitating easy matching between two sides of the market, effectively lowering transaction costs (Evans & Schmalensee, 2008). E-commerce website E-bay is an example, but LinkedIn is as well. Secondly, platforms have made the global asset utilization more productive, by creating the possibility of people and businesses using others' spare assets through the sharing-economy. Unused bedrooms, office spaces, cars or equipment; anything can be rented or put up for rent with a dedicated platform. Customers can do a background check on their renters and vice versa, using social media or reviews of earlier transactions, and online payment systems take care of the billing. Because of the ease, relative security and significantly lower prices than traditional providers, the online peer-to-peer market is estimated to be worth over 26 billion USD, which is only expected to grow (Botsman & Rogers, 2011).

Thirdly, platforms are huge drivers of innovation; in 2014 alone, 11,585 patents were given to just nine U.S. platforms; Microsoft, Google, Apple, Intel, Amazon, Yahoo!, Facebook, eBay and Salesforce (Evans & Gawer, 2016). The enormous drive for innovation amongst these companies, seems to be derived from the desire for platform leadership; being the firm whose products are used as a foundation on which other firms build their products, effectively giving the platform leader a competitive advantage (Gawer & Cusumano, 2002). An important factor in facilitating this innovation boost, is the innovation ecosystem; the entirety of private contributors or companies, developing complementary and new products for the platform technology. Since anybody with internet access is able to work with, and contribute to the platform technology, the aggregate activity and level of innovation of the platform community is far greater than could ever be achieved by the platform leader with solely internal resources (Gawer & Cusumano, 2002). Joining an innovation ecosystem has also shown to be beneficial to the independent contributors, increasing sales and improving the chances for an IPO (Ceccagnoli, Forman, Huang, & Wu, 2012).

Platforms have also created new ways for raising capital. Instead of traditional ways of capital raising, through banks, traditional lenders, investment companies or angel investors, it is now possible to raise money online from thousands of individuals who are willing to contribute in making your dream a reality, using crowdfunding platforms like Kickstarter or Indiegogo. The popularity of this concept has proven itself, with over 3.17 billion USD pledged and over 128 thousand successfully funded projects on Kickstarter alone since its start in April 2009 (Kickstarter, 2017).

Another positive aspect of the rise of platforms, is the increase of competition. AirBnB has disrupted the global hotel industry, Uber has made taxi companies redundant in many cities all over the world, Netflix has had an important contribution in the downfall of video rentals and LinkedIn has taken a lot of business away from many employment agencies. However, besides disrupting traditional service providers and producers, the possibility of increasing returns for the platform leader, allowing the platform leader to leverage its higher margins to invest in R&D or lower its prices, also leads to high competition within a network industry (Eisenmann, Parker, & Van Alstyne, 2006). Platforms compete in getting the most of both sides of the market on board with their technology. For example, gaming platforms such as Sony's Playstation compete with Microsoft's Xbox on having as many third-party game developers as possible, in order to attract as many consumers as possible and vice versa. An important factor in this competition is the pricing strategy, of which research has shown that the best strategy in obtaining a large market share on both sides of the market, is to place the bigger part of the burden at the producers rather than the consumers (Rochet & Tirole, 2003; Armstrong, 2006; Rysman, 2009). Especially when there is a high demand for product variety from the consumers, the

price burden can best be placed on the producers: Again, using the example from the gaming industry, consumers have a big demand for variety since a game can be 'finished', in contrast to for example corporate software, which can be used indefinitely. Due to the high demand for variety amongst gamers, there is little competition between game developers and therefore higher rent extraction power by these producers, an effect which is internalized by a two-sided platform in its pricing structure (Hagiu, 2009).

Although platform businesses provide an easier way for consumers to find what they are looking for, by matching them on their platform to a large body of producers or service providers, there has not been any research indicating that the bundling of consumers and suppliers in one platform increases product variety. However, it is very likely that with the creation of platforms, search costs, the costs induced by searching for the right provider of a product or service and costs induced by suppliers by reaching potential consumers, have been lowered. Thanks to the popularity of platforms, it is easier and cheaper for a supplier to connect to a large body of potential customers, effectively reducing entry barriers. With lower entry barriers, there will be more producers entering a market, and therefore it is likely product variety indeed is increased by the rise of platforms.

Platforms in the health sector

Besides platforms accelerating innovation or providing new ways for capital raising, platforms have also been formed to try and revolutionise healthcare. Many healthcare platforms like Doctor.com, MDLive, 1DocWay, America Well and others, have been created in North America in response to excessive healthcare costs, utilizing the new possibilities of technology to improve the affordability and availability of healthcare. Fortunately, it is not only in North America that people had the idea of revolutionising healthcare using a platform setup; lower-middle income countries, where availability and affordability of healthcare is an even bigger problem, are innovating as well. An example of a lower-middle income country with a thriving platform start-up environment and a high necessity for improvement the healthcare sector, is India. With just 0.9 hospital beds per 1000 people in 2005, compared to a world average of 2.919 (The World Bank, 2017), the world's second biggest population (Census India, 2011) and impoverishing high healthcare costs (Berman, Ahuja, & Bhandari, 2010), India was ripe for the disruption of the healthcare industry by platforms.

An example of an Indian platform in the healthcare industry is Care24, a platform which has been funded for 4 million USD by SAIF Partners in 2016 (Shu, 2016). Care24 specializes in healthcare at home, by providing nurses, physiotherapists and other caretakers to help with neuro rehabilitation, a healthy recovery after surgery or cancer treatment and infant or elderly care. Additionally, Care 24

rents or sells medical equipment such as wheelchairs (Care24, 2016). With the use of platform technology, the company is able to serve over 4000 patients a day, by facilitating easy communication between caretakers and patients, training for the caretakers and even remote blood pressure readings using the dedicated app of Care24. The founding of the platform by Vipin Pathak, Abhishek Tiwari, Garima Tripathi, and Pranshu Sharma in 2014, was a response to a macro change going on in India. For centuries, multiple generations of a family used to live together and the elderly were taken care of by their younger relatives. However, with an aging population of which the number of over-60s is expected to triple from 100 million to 300 million by 2050 (United Nations Population Fund, 2012), and the youth moving into urban areas to seek job opportunities, there was need for a different solution for (elderly) people in need of healthcare in rural areas (Shu, 2016).

Apollo Hospitals, situated in Chennai, is another example, having established an online 24/7 platform for remote patient care, called Ask Apollo. By keeping track of a patient's medical diary and storing it in the cloud, presenting a large body of doctors and specialists available for online consultation who can immediately write a prescription, and even offering home delivery of diagnostic tests and medicines, Ask Apollo is trying to change the face of the troubled healthcare system in India (Apollo Hospitals, 2015).

A fairly similar platform to Ask Apollo, is Practo, a healthcare platform founded in Bengaluru, India, in 2008. Just like Ask Apollo, Practo is a platform connecting patients to medical professionals using an app. It offers online consultation, home delivery of medicines in 24 hours, online medical records storage, and even sells its software for business analytics to health companies. Practo's revenue model is primarily based on the sale of this software. The use of the platform is free for both medical professionals and patients, but Practo is able to make a little money by placing contextual advertisements, similar to the way Google does (Mehta, 2014). Today, Practo is operating not only in India, but in Singapore, the Philippines, Brazil and Indonesia as well, and has sold its enterprise software to businesses in ten more countries (Practo, 2017).

Unfortunately, I do not have any data of these companies to investigate the impact of these platforms on the Indian healthcare industry. I do however, have data from 1mg.com, a platform focussed on the online sale of medicines and current market leader in its segment when looking at online-pharmacy-app installations, with a share of 56%, outperforming previously discussed platform Practo (ET Bureau, 2017). In this study, I will therefore focus on 1mg.com and narrow down the problematic Indian healthcare to the expertise of 1mg: the online sale of medicines. First, in order to

properly assess the situation of the pharmaceutical industry and the mechanisms causing expensive medicines, I will give a description of the Indian pharmaceutical sector.

The Indian pharmaceutical sector

The Indian pharmaceutical industry accounts for 10% of the global pharmaceutical market in volume terms and is expected to expand with a compound annual growth rate (CAGR) of 12.89% to reach revenues of 45 billion USD by 2020, making it the 6th largest pharmaceutical market in the world by absolute size (IBEF, 2017). However, this growth appears to go at the costs of the national health of the poor population of India. Ironically, one of the main reasons for the high poverty in India seems to be the costs of drugs, since 72% of out-of-pocket (OOP) expenditures, or even higher in the poorest states, are drug-related (Garg & Karan, 2008). Research by (Berman, Ahuja, & Bhandari, 2010) shows that as much as 63 million people are forced below the poverty baseline due to healthcare expenditures, which accounts for nearly 7% of the population. These 'catastrophic' healthcare costs, in the sense of having a disrupting effect on household living standards, have a specifically big impact on the population living in the rural areas (Van Doorslaer, et al., 2007). Even more worrying, the number of households being forced under the poverty line is growing, according to a 2015 Government of India report: "incidence of catastrophic expenditure due to health care costs is growing and is now being estimated to be one of the major contributors to poverty. The drain on family incomes due to health care costs can neutralize the gains of income increases and every Government scheme aimed to reduce poverty." (Ministry of Health and Family Welfare, 2014).

One possible explanation of this problematic situation, could be the low public investment in healthcare. According to data of the World Health Organisation, out of 191 countries, India is 184th considering expenditure on health as a percentage of GDP, spending a mere 1.2% in 2009-2010 (The World Bank, 2017).

An additional explanation for the high costs of medicine is the lack of competition in the industry. This is due to several factors. One cause for the high prices of medicine, is doctors prescribing expensive branded drugs instead of cheaper generic alternatives, because of incentives given by pharmaceutical companies (Aditya & Sindhwani, 2014). Since pharmaceutical companies in India are not allowed to market their prescription drugs at a consumer level, a lot of money is put in marketing expensive branded drugs at the prescribing side of the equation: doctors (Aditya & Sindhwani, 2014). Meanwhile, doctors only write down the brand of the drug they prescribe, making it difficult for the patient to choose a cheaper, generic alternative. Just recently, the government announced a law which will force doctors to write down the generic name of the drug they describe, as well as forcing

manufactures to show the generic name of their branded medicine on the packaging, in a yet unproven effort to deal with this problem (Dey, 2017).

Another cause for the lack of competition is the collusion by Indian producers and pharmacists, for example in the All India Organisation of Chemists and Druggists (AIOCD), spanning over 750,000 pharmacies throughout the country. While these pharmacies only stock medicine pre-sale and add no real measurable value whatsoever, they exercise a 30% trade margin (10 % for wholesalers and 20% for retailers). The cartel is able to enforce this margin through asymmetric punishment strategies, using sales embargoes to punish its suppliers and supply embargoes to punish its members when they refuse to act in the cartels interests (Bhaskarabhatla, C., & Karreman, Hit Where It Hurts: Cartel Policing Using Targeted Sales and Supply Embargoes, 2016).

Furthermore, partial regulation of the industry by putting price ceilings on some, but not all formulations of the same medicine listed on the National List of Essential Medicines (NLEM), has opened the door to producers for effort diversion into unregulated products. By lowering the production of regulated formulations of drugs, creating a supply shortage, they are able to sell more of the relatively higher priced, unregulated formulations of the same drug (Bhaskarabhatla, Anurag, Chatterjee, & Pennings). The intended results the regulations should have, are hereby avoided, which speaks in favour of the sceptical school of thought questioning whether the actual benefits of regulations outweigh the effort and costs of designing and implementing them (Peltzman, 1975), especially when there are strong interest groups involved (Dal Bó & Di Tella, 2003), like the AIOCD. This firm behaviour raises the costs of medicine, since patients have more trouble finding the regulated formulation of the medicine which has been prescribed to them, or worse; doctors prescribe the unregulated medicine on purpose because of incentives given to them from producers. Besides these economic costs, the effort diversion of firms might also cause health costs for consumers, for example with the unregulated 650 mg formulation of Paracetamol (Soma, 2013; Morgan, Griffiths, & Majeed, 2005).

Another factor enhancing the problem of overpriced medicine is the relatively undeveloped population of India. With literacy at just 74%, well below the world average of 84%, India has the biggest illiterate population in the world (Cencus India, 2011). This, in combination with an education system ranking 102nd out of 149 on the Legatum Prosperity Index (Legatum Institute, 2016) and doctors prescribing unregulated formulations of medicine or using only the brand name without the generic name in the prescription, creates an information asymmetry for the patients considering which brands and formulations of medicine to buy in order to reduce the costs of health.

The case of platform 1mg.com and hypothesis

With the growth of internet connectivity in India, the nation with the second largest internet connected population (Statista: The statistics portal, 2017), many people recognized the importance and possibility of improving the Indian healthcare system by informing the public and reducing the information asymmetry discussed above, by creating platforms. There have been all different kinds of platforms created, providing service to the population in all sectors of healthcare, but as stated earlier, I will use platform 1mg.com as a case study for the impact of platforms on the Indian pharmaceutical industry.

1mg.com, originally called HealthKartPlus, was founded by Prashant Tandon, Gaurav Agarwal and Vikas Chauhan in 2012. They started the e-commerce health care platform, by operating the generic drug-search business of Healthkart, an online store for health products. After separating from Healthkart and rebranding as 1mg, acquiring Homeobuy.com in 2015 to enter the homeopathy market and acquiring Medd.in in 2016 to add the radiology segment, 1mg.com now positions itself as the one health app for all consumers in India (1mg, 2017). The core business of 1mg is the online sale of (prescription) drugs, but most importantly; providing information about the usage, function, side effects and substitutes for these drugs. The customer is able to search the brand written on a doctor's prescription and select a cheaper, equally good alternative out of a list of brands selling the same drug. 1mg shows how much money a customer is able to save and finds the nearest trusted pharmacy which delivers the selected medicine to the customer, effectively educating customers and offering the possibility of lowering the costs of drugs. Besides this online sale, 1mg allows customers to schedule appointments with nearby doctors or specialists online, and offers diagnostic tests, where a customer can request a diagnostic test from a verified lab, which picks up the necessary sample from the customer, tests it and after processing, sends the customer a (digital) result (1mg, 2017).

It has been argued that in low and middle-income countries, the formation of innovative, informal institutional arrangements might be a solution for making expert knowledge widely available and reducing the information asymmetry which characterises healthcare (Bloom, Standing, & Lloyd, 2008). The question however, is whether 1mg indeed does provide a platform which is capable of diminishing the information asymmetry, and, in doing so, lowering the costs of drugs.

To be able to investigate this matter, this paper is focused on the recently imposed partial regulation of medicine listed on the National List of Essential Medicines (NLEM). In this regulation, some, but not all formulations (strengths) of a selection of medicines in the NLEM, have been imposed a price ceiling. In response, the pharmaceutical industry has engaged in effort diversion; producing less of the formulations of medicines under price control and moving their effort into the unregulated

formulations, where they are able to charge well above the price per mg ratio used for the price ceiling (Bhaskarabhatla, Anurag, Chatterjee, & Pennings).

Based on the assumption that people who use 1mg.com will see that they can save money if they buy the regulated formulation of the drug they are searching for, and that people who are unable to find regulated formulations in physical pharmacies, caused by too little supply due to the effort diversion behaviour of pharmaceutical producers, can order and home deliver these medicine from a nearby pharmacy using 1mg.com, the following hypothesis is formulated:

Hypothesis: 1mg.com provides a platform which facilitates the sale of more orders for regulated medicines over orders for unregulated formulations of that same medicine.

To be able to test this hypothesis, order data from 1mg.com is used to examine the relation between regulated and unregulated medicine sales graphically, and for econometric analysis, in which a regulated dummy is regressed on the total sales of a selection of 9 regulated medicine.

3. Data and evidence

The data

1mg.com, as the market leader in app downloads (ET Bureau, 2017), handles quite a lot of orders and is still growing fast. The order data of 1mg.com used to test the hypothesis spans 205 days, from the first of November 2015, until the 24th of May 2016. The dataset contains 373,753 orders, contains 48,355 unique customers from 812 different area codes, ordering 15,662 different medicine brands from 806 manufacturers. If we look at the number of orders a day during the time of the dataset, displayed in figure 1, we can see a clear rise in average orders a day from 1500 to around 3600. When looking at the number of different kinds of medicines sold each day over time, displayed in figure 2, we can see a rise as well, from an average of 1000 to about 1500 different kinds of medicines, indicating that during the period spanning the dataset 1mg has expanded its offer of medicines. When looking at the mean price of the medicines sold each day over time however, we can see a clear decrease, from an average of around 240 Indian Rupees to around 190 Indian Rupees, which is displayed in figure 3. Despite of the drop in the average price of medicines sold, and probably due to the increase of orders, we can see in figure 4 that the total gross sales each day over the dates spanning the dataset has been growing, in fact almost doubled, from an average of around 300,000 Indian Rupees to about 600,00 Indian Rupees. The total gross sales over the entire dataset amount to 75,223,419.11 Indian Rupees, which translates to over 1 million euros.

As discussed earlier, besides the online medicine sale, 1mg.com also offers the customer to schedule appointments with health professionals and offers patients the possibility of diagnostic tests

home delivery. Unfortunately, I do not have any data on these activities. I therefore focus on the order data which was described above. The dataset contains the following variables; a timestamp, accurate up until the second an order is made, a unique order id for each order, a unique customer id, the pincode (area code) of where the order was made, the price of the drug in Indian Rupee (₹), name of the formulation of the drug in the order, the brand of the drug, manufacturer name, generic name of the medicine, the drug form (injection, tablet or otherwise), strength of the drug in milligrams, and whether the medicine is sold over the counter or only with a prescription.

I have complemented the order data with the Compendium of Notified Ceiling Prices of Scheduled Drugs 2015, composed by the National Pharmaceutical Pricing Authority from the Department of Pharmaceuticals of the Government of India (NPPA, 2015). In this document, certain formulations of certain medicines selected from the National List of Essential Medicines 2011, have been imposed a price ceiling. For example, one 500 mg tablet of Paracetamol, has a ceiling price of 1.04 Indian Rupee, as of 26-02-2015. However, other formulations of Paracetamol, for example the 650 mg tablet, have not been subjected to a price ceiling, which gives pharmaceutical producers the chance for effort diversion into these unregulated formulations. I have used the NPPA Compendium 2015 to see which medicines that have been ordered on 1mg.com, have been imposed a price ceiling and for which formulations, in order to be able to make the distinction between regulated and unregulated formulations in the 1mg.com order dataset.

Since this research is only interested in comparing the difference in orders between regulated and unregulated strengths of the same generic medicine, I dropped all the observations without a generic medicine name, which leaves us with 138,978 orders of 984 different medicine. From this selection, I searched for medicine formulations which were put under price control in the NPPA Compendium 2015 and matched them with medicines from the order data with as many observations possible. Next, in order for drug-form preferences not to play a role in the selection of medicines by customers, I only kept the medicines sold in regular tablet form, which is also the most ordered option of the selection of medicines. Subsequently, I dropped the medicines with too little observations in either orders of regulated or unregulated strengths, since having too little observations will make econometric analyses unreliable, leaving me with the top nine most ordered medicines on 1mg.com which are also listed in the NPPA Compendium 2015 as having price controlled formulations. The selected generic medicines are Atorvastatin, Amlodipine, Metoprolol, Paracetamol, Metformin, Hydroxychloroquine, Levothyroxine, Atenolol and Allopurinol. The respective number of regulated and unregulated orders, can be found in table 1.

Descriptive evidence

First, we will look at the total orders, regulated orders and unregulated orders over time, by plotting the number of sales over the period the dataset spans in figure 5. The data shows a slightly rising trend, while the unregulated orders stay below the regulated orders for almost the entire data. If we look at the trend of regulated versus unregulated orders of each selected medicine separately, we see roughly the same. With Amlodipine, Metoprolol, Hydroxychloroquine and Allopurinol it is clear that there normally are more orders for the regulated formulations than for the unregulated formulations, as can be seen in the respective figures 6, 7, 8, and 9. However, the difference between regulated and unregulated orders for the formulations of Atorvastatin, Paracetamol, Metformin, Levothyroxine and Atenolol, which are plotted in figures 10, 11, 12, 13 and 14, are less big. Interestingly enough, the difference between these two groups is not due to the fact that regulated formulations are cheaper. If we look at the mean price of regulated versus unregulated formulations of the latter selection, we see that the regulated formulations have a mean price of 51.36 Indian Rupees and that the unregulated formulations have a mean price of 130.02 Indian Rupees. In the first group of medicine the difference between these mean prices are way smaller, with 61.67 and 77.03 Indian Rupees for the regulated and unregulated formulations respectively (see table 2.). Despite of this, the ratio of ordered unregulated over regulated formulations of medicines is lower in the group where the mean price difference is bigger. Therefore, there must be another factor, or other factors, besides price, influencing the buyer decision for regulated versus unregulated formulations.

Then again, if we look at the total amount of orders of regulated medicine formulations versus unregulated formulations, there is a clear difference; 71% percent of orders were formulations under price control, against 29% of unregulated orders, as can be seen in figure 15. This indicates that 1mg.com provides a platform which facilitates the sale of regulated medicines over unregulated medicines.

Econometric Evidence

In order to investigate the relation between the regulation of a formulation and the number of orders, I have created a "Regulated" dummy variable to function as an independent variable, which has the value 1 when a formulation of medicine is regulated, meaning the formulation of the ordered medicine has been imposed a price ceiling in the NPPA 2015, and 0 when an ordered formulation is not regulated. Besides, I have performed a log transformation on the dependent variable, the number of orders, to make the data comply better to the assumptions of ordinary least-square (OLS) regressions. Next, I executed a linear regression based on the following basic equation:

$$Log\ of\ orders = \alpha + \beta * Regulated + \gamma + .. + \varepsilon$$

in which α stands for the intercept, β for the coefficient which is added when the Regulated dummy has the value of 1, γ for the coefficient for different factors and ε as the residual of the error term. I estimated this equation for each selected medicine from the order data separately, as well as a regression with the entire selection of medicines.

Looking at the separate medicine regressions, which can be found in table 3, we see that 8 out of 9 have a positive, significant coefficient for the regulated formulation. This means that regulated formulations are being ordered more than the unregulated formulations of the same medicine, implying that 1mg.com facilitates a platform where there is a higher demand for regulated medicine formulations compared to unregulated formulations. The only medicine with a negative regulated coefficient is Atenolol, which is also the only medicine with more unregulated formulations ordered than regulated formulations. However, this negative coefficient is not significant, meaning that we cannot differentiate the order difference in unregulated formulations over regulated formulations from chance.

When looking at the aggregated regression results of the entire selection of medicine, displayed in table 4, we see that the regulated dummy has a significant positive coefficient of .9793973. In order to interpret this when the depended variable is a log, we have to take the exponent of the coefficient, subtract 1 and multiply the residual with 100 to get the percentage influence of regulated formulations on the number of orders. This means that:

$$e^{.9793973} = 2.66285$$

$$(2.66285 - 1) * 100 = 166.285\%$$

a regulated medicine therefore, is ordered 166% more than unregulated formulations of that same medicine. Based on this, I can confirm the hypothesis and conclude that 1mg.com indeed does provide a platform which facilitates the sale of more orders for regulated medicines over orders for unregulated formulations of that same medicine

4. Limitations and conclusion

Limitations

There are some important limitations to this research, which might cause an over-or under estimation of the effect of partial regulation of medicines on the number of sales. First of all, because of a lack of data, I have not used any control variables in the regressions besides the dummy, while there are certainly other factors apart from whether a medicine is regulated or not, that influence the number of orders of a medicine. For example, I do not have any information on a patient level, while

patient characteristics such as height, age, gender or other conditions a patient may have or medication a patient might be using, are likely to have a big factor in the selection of a formulation of a medicine. While the regulated formulations of medicines might be best in general, in specific cases it could be that the unregulated formulation is the best option for a patient. Also, I have no information on the extend of incentives doctors are receiving from producers to prescribe unregulated formulations, which means I have no insight to how many patients have been prescribed unregulated formulations of drugs when a regulated formulation would have been equally good, if not better. Lastly, I have no data on the marketing efforts of producers, which could also potentially influence the number of prescriptions, and therefore orders, of regulated and unregulated formulations of medicine. Not accounting for any of these variables in the regressions, may have caused an over- or underestimation of the impact 1mg.com has on promoting the sale of regulated formulations of medicines over unregulated formulations.

Another factor compromising the interpretation of results, is the prescription system of medicine in India. Often, medicines require prescriptions, wherein the doctor indicates the formulation, which could either be a formulation under price control or an unregulated formulation. The patient has no possibilities of changing the formulation, besides asking the doctor to change the prescription after finding out on 1mg.com that a regulated formulation is cheaper. However, the doctor has his own incentives for prescribing a formulation, in which I have no insights, and therefore might not change the prescription. Since 1mg.com cannot change prescriptions, the only thing it is able to do is facilitate the information about medicines, compare prices and offer the possibility of ordering a regulated formulation of a medicine online, when a patient is unable to find the regulated medicine himself, which might be due to the effort diversion behaviour of pharmaceutical producers discussed earlier.

Conclusion

There has been many research on different aspects of platforms, trying to get an overview of the world's platforms or examining network effects, the ideal pricing strategy, the way platforms use the sharing economy or the innovation boost platforms give an industry with their ecosystem (Armstrong, 2006; Botsman & Rogers, 2011; Ceccagnoli, Forman, Huang, & Wu, 2012; Eisenmann, Parker, & Van Alstyne, 2006; Evans & Gawer, 2016; Gawer & Cusumano, 2002; Hagiu, 2009; Rysman, 2009), but there has not been much research on the impact of platform business models in the healthcare industry. In this paper, I have used a case study of an online pharmaceutical platform in India, 1mg.com, to illustrate the possible impact which the newly emerged business model of platforms can have on the healthcare industry. I have focussed on how 1mg.com is able to reduce the

information symmetry in healthcare by offering information on its digital platform about medicines and with this, is able to make a contribution in lowering the impoverishing high costs of medicines. I have narrowed the subject of costs of medicines down to the sale of regulated, cheaper formulations of medicines versus the sale of unregulated, more expensive formulations, following the partial price regulation of medicines imposed by the government of India imposed in 2013.

Using order data spanning nearly 7 months, I have proved that 1mg.com does process more orders for regulated formulations of medicines compared to unregulated formulations of the same medicine. Therefore, I conclude that 1mg.com does indeed provide a platform which facilitates the sale of more orders for regulated medicines over orders for unregulated formulations of that same medicine. Unfortunately, due to a lack of comparability, I cannot make the statement that 1mg.com promotes the sale of regulated medicines, despite the platform providing price comparisons which show regulated formulations to be cheaper. Instead, I can only state that 1mg.com provides the possibility of ordering regulated formulations online, when they cannot be found in physical pharmacies, a lack of supply which might be caused by the effort diversion behaviour of pharmaceutical producers (Bhaskarabhatla, Anurag, Chatterjee, & Pennings), which can be seen as an important step forward.

Further (empirical) research in this field, could focus on whether platform businesses are able to effectively improve the quality of healthcare, make healthcare more available in less dense populated areas or lower the costs of medicines or healthcare as a whole, by lowering the transaction costs incurred in healthcare using digitalization of service and communication, using for example mobile applications.

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Figures and tables

Figure 1. Number of orders a day, from the 1st of November 2015 until the 24th of May 2016

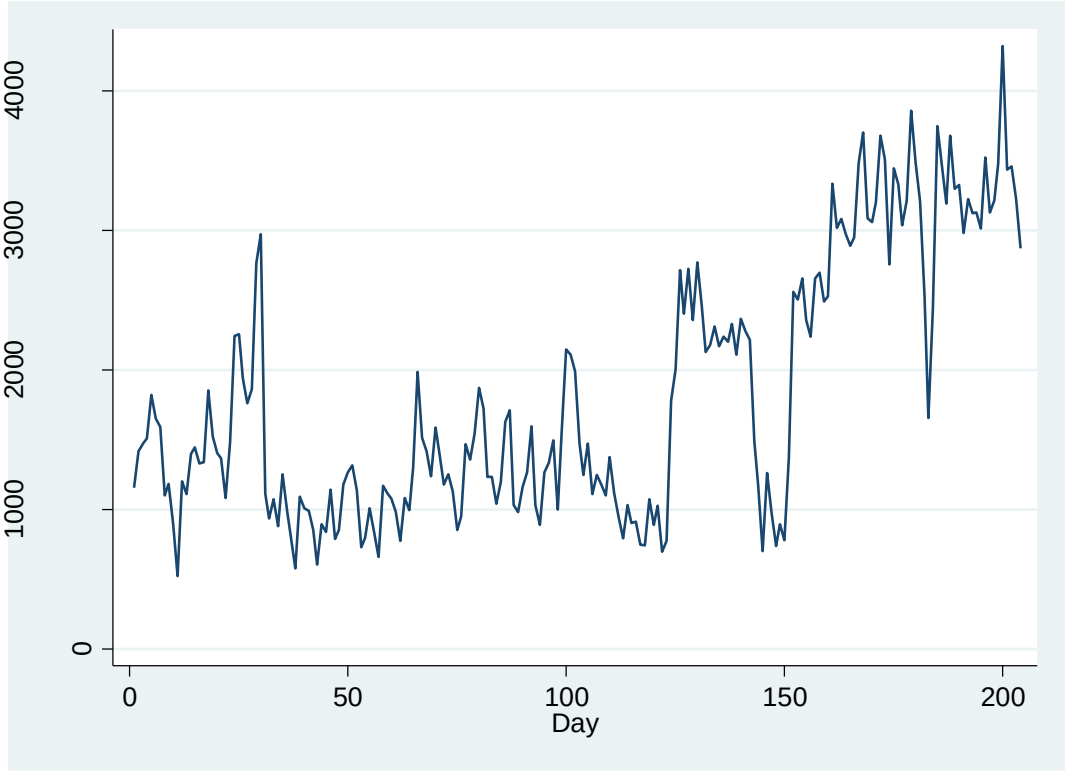

Figure 2. Number of different medicines sold from the first of November 2015 until the 24th of May 2016

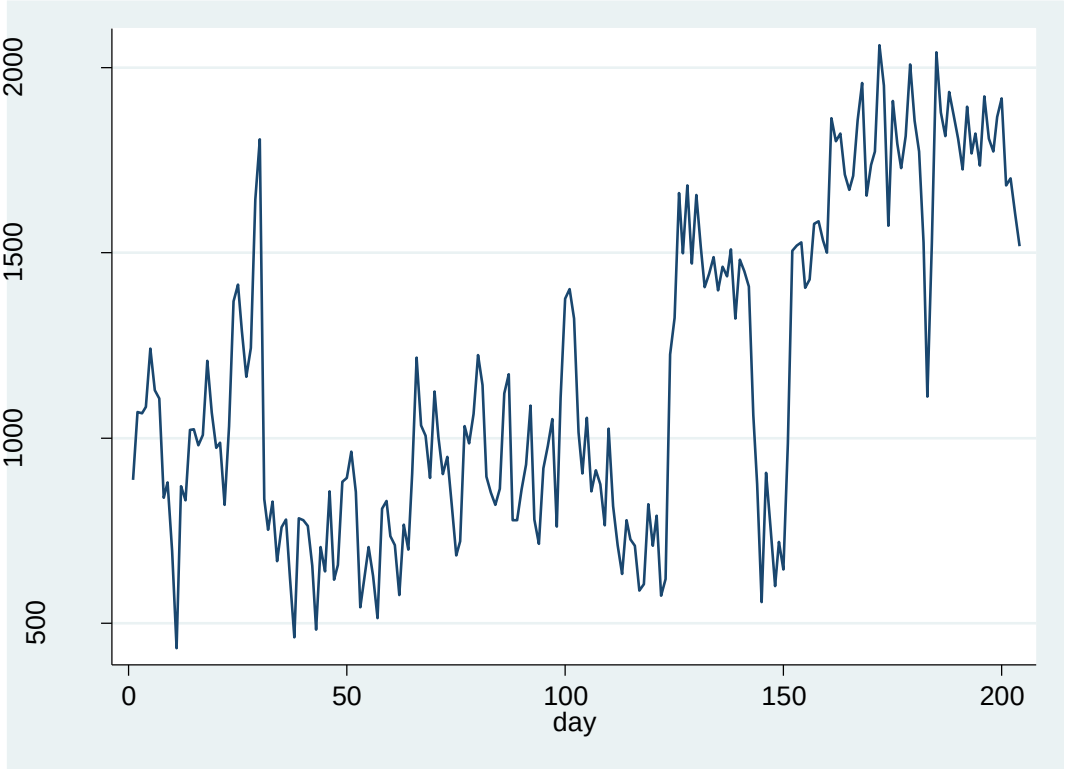

Figure 3. The mean price of medicines sold each day in Indian Rupees, from the first of November 2015 until the 24th of May 2016

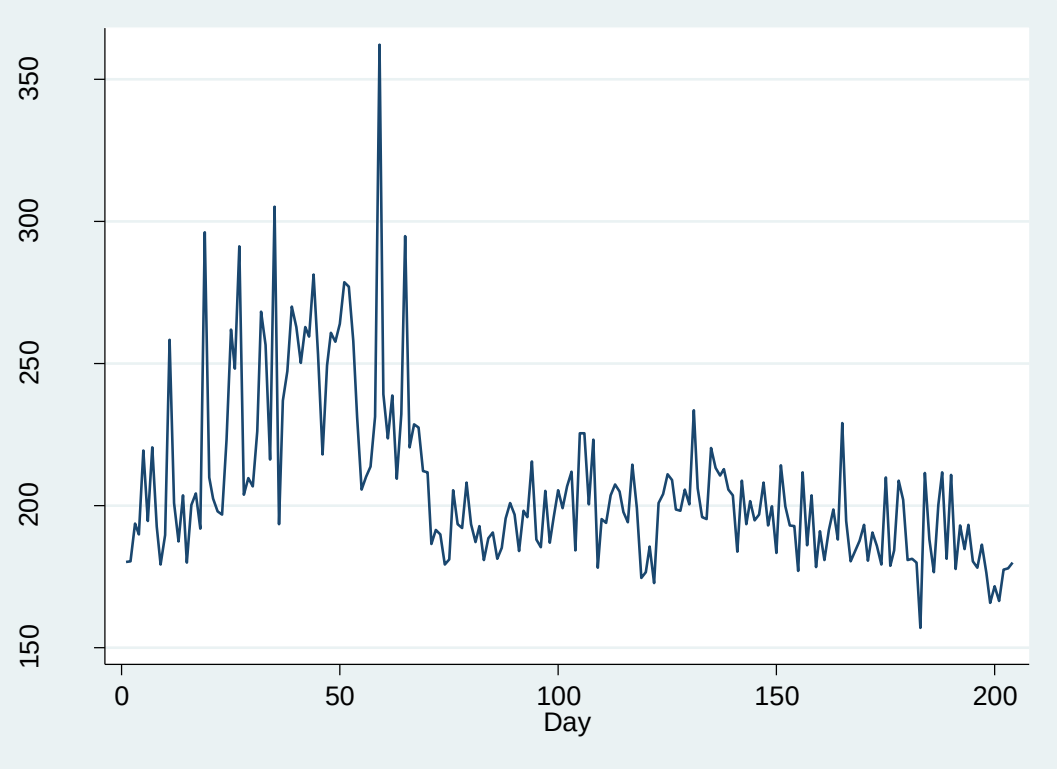

Figure 4. Total gross sales each day in Indian Rupees, from the first of November 2015 until the 24th of May 2016

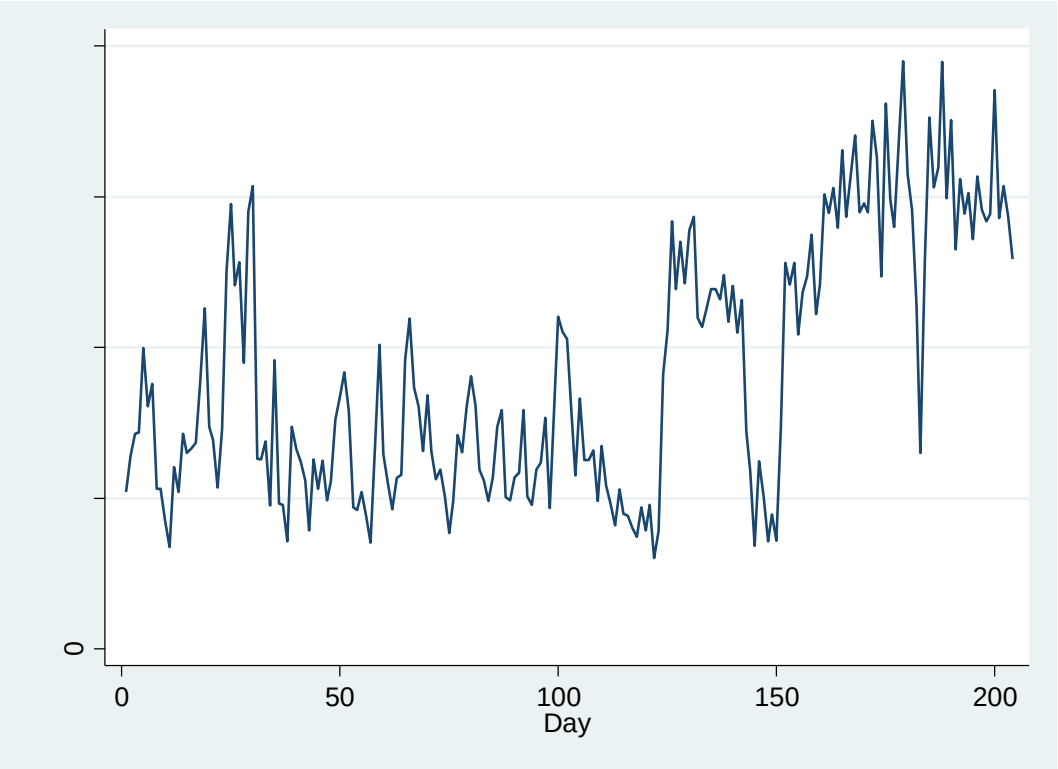

Figure 5. Number of orders from the first of November 2015 until the 24th of May 2016, divided by regulated and unregulated ordered formulations.

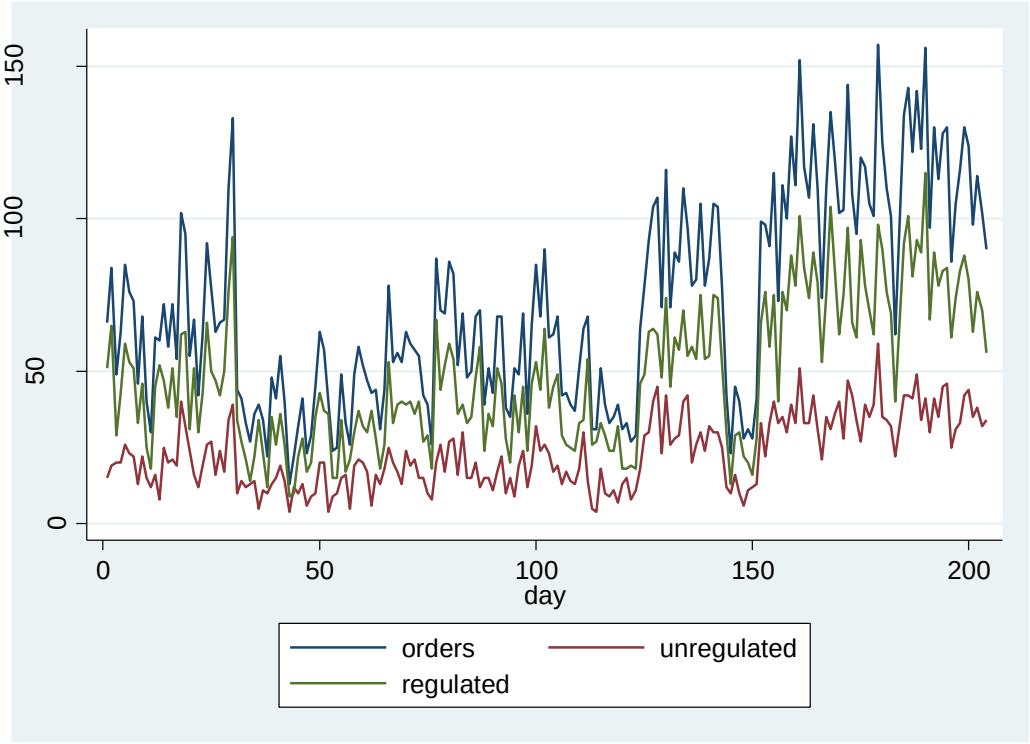

Figure 6. Number of orders of regulated versus unregulated formulations of Amlodipine from the first of November 2015 until the 24th of May 2016.

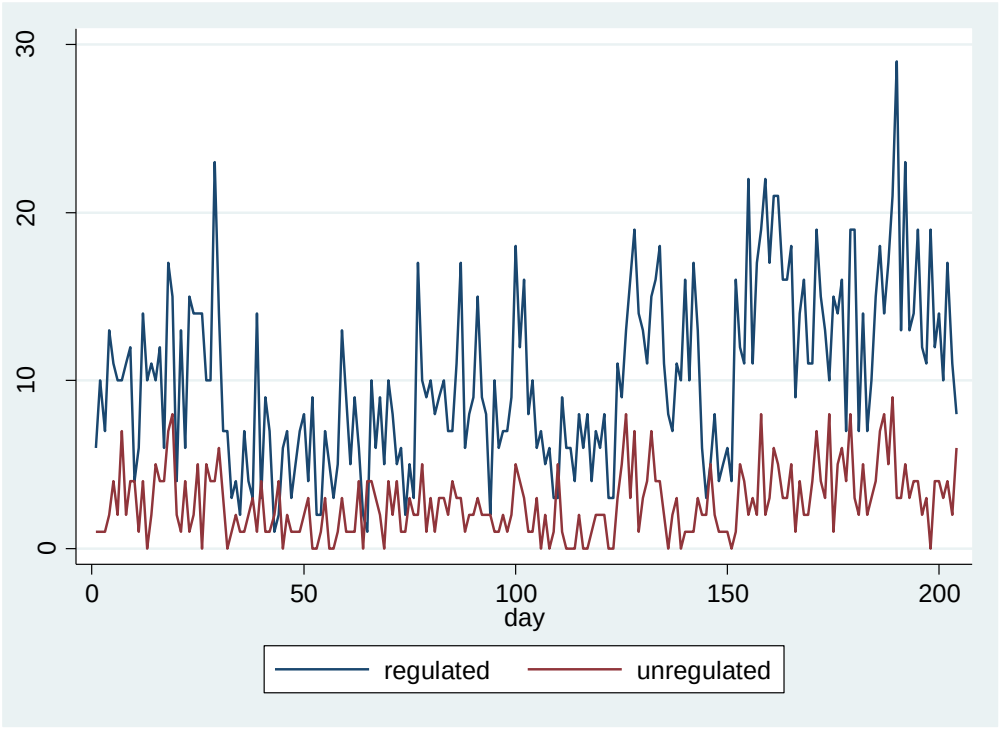

Figure 7. Number of orders of regulated versus unregulated formulations of Metoprolol from the first of November 2015 until the 24th of May 2016.

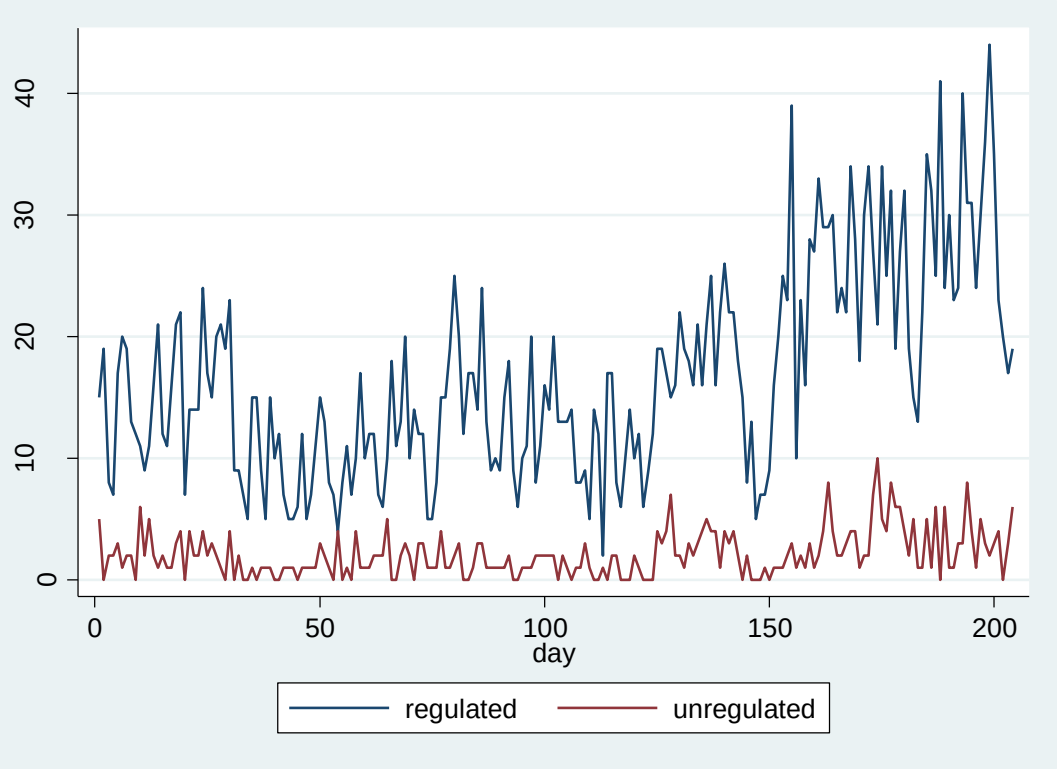

Figure 8. Number of orders of regulated versus unregulated formulations of Hydroxychloroquine from the first of November 2015 until the 24th of May 2016.

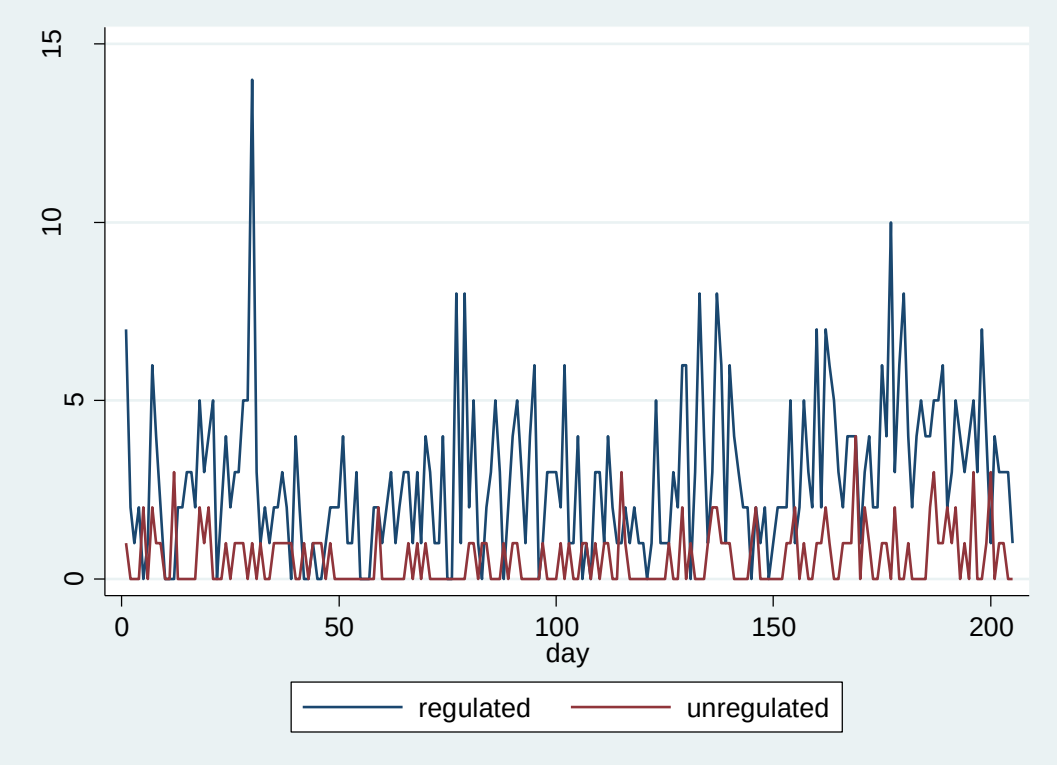

Figure 9. Number of orders of regulated versus unregulated formulations of Allopurinol from the first of November 2015 until the 24th of May 2016.

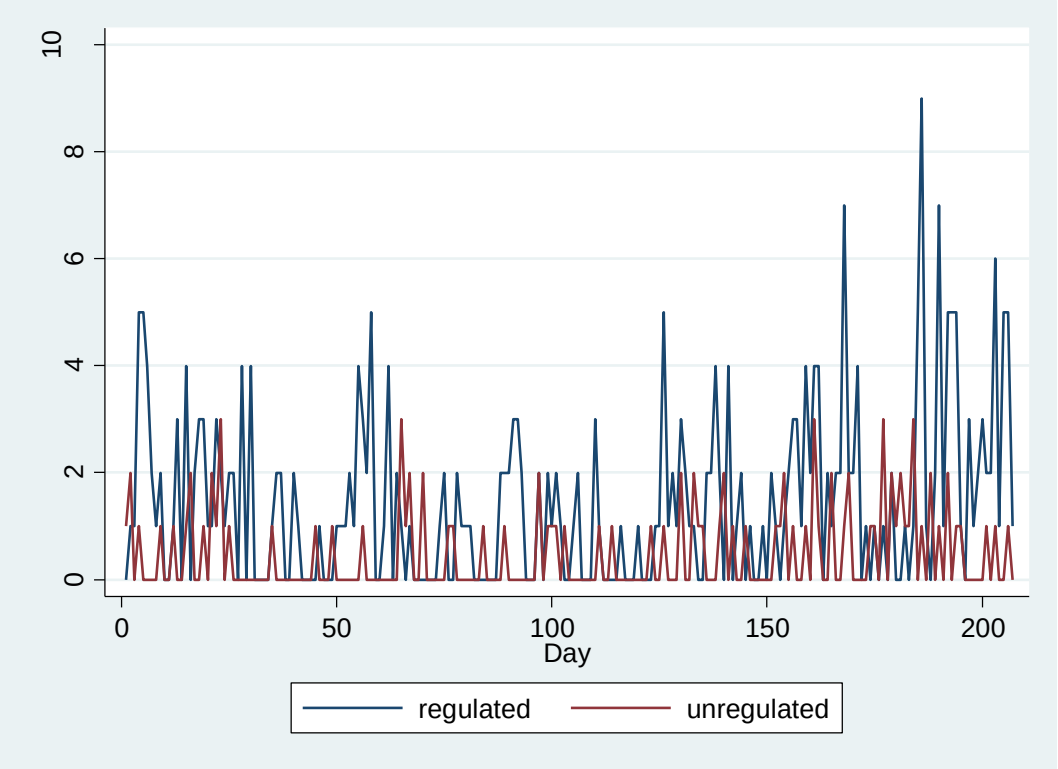

Figure 10. Number of orders of regulated versus unregulated formulations of Atorvastatin from the first of November 2015 until the 24th of May 2016.

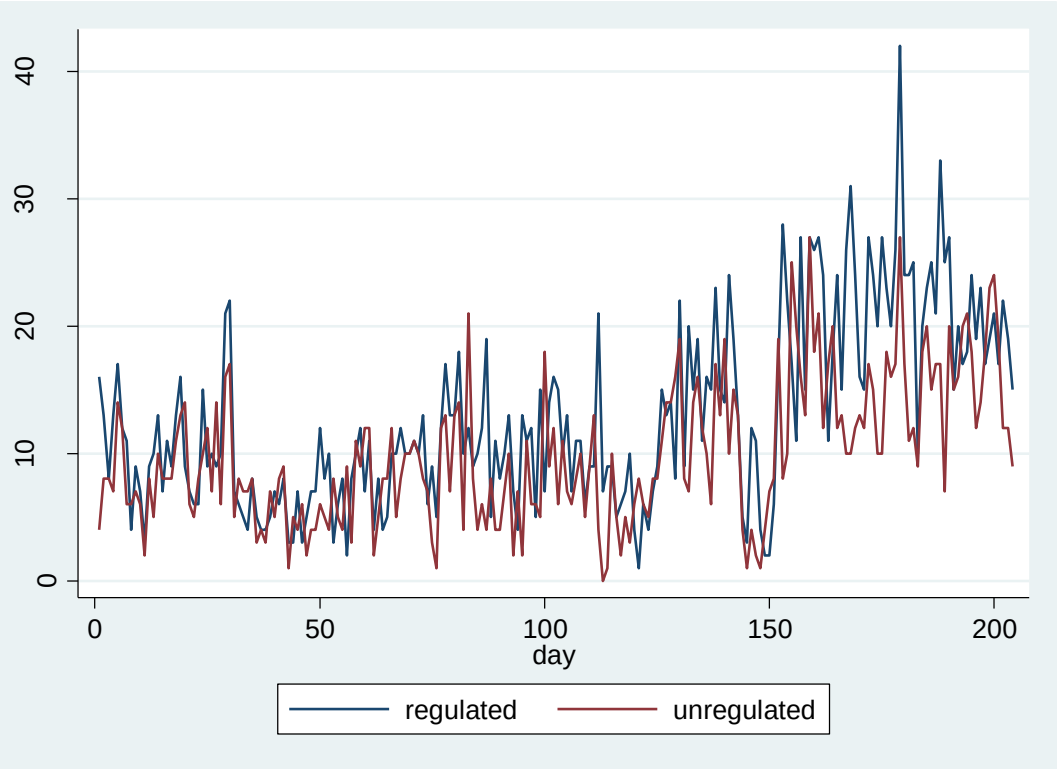

Figure 11. Number of orders of regulated versus unregulated formulations of Paracetamol from the first of November 2015 until the 24th of May 2016.

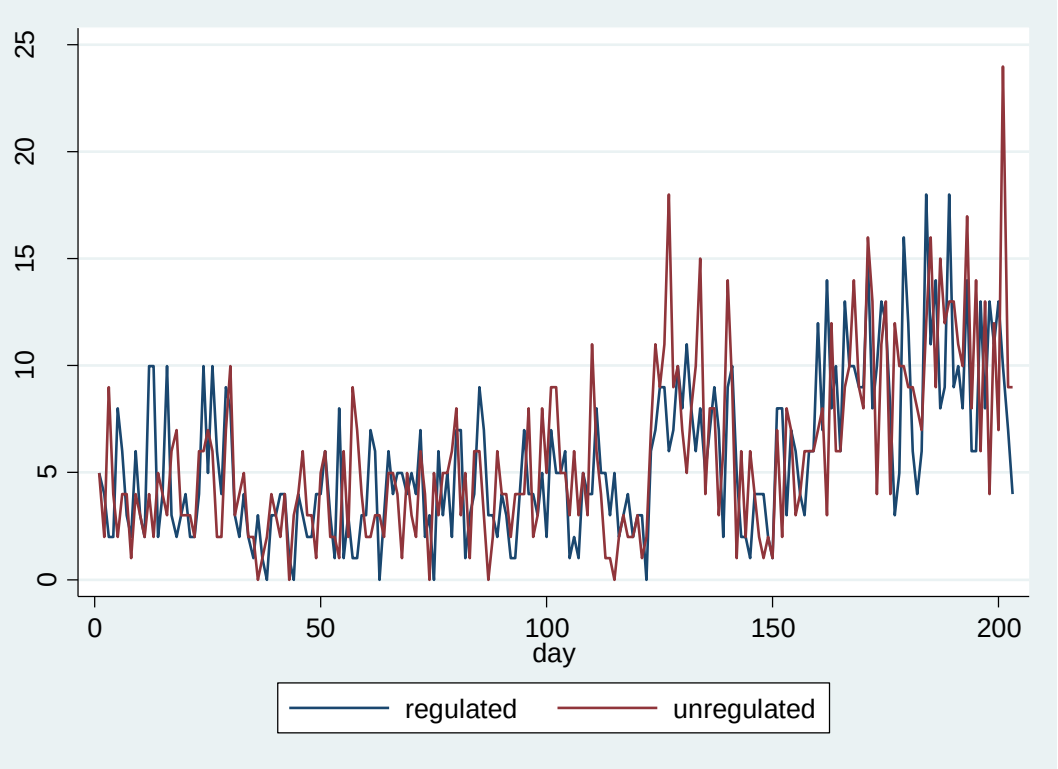

Figure 12. Number of orders of regulated versus unregulated formulations of Metformin from the first of November 2015 until the 24th of May 2016.

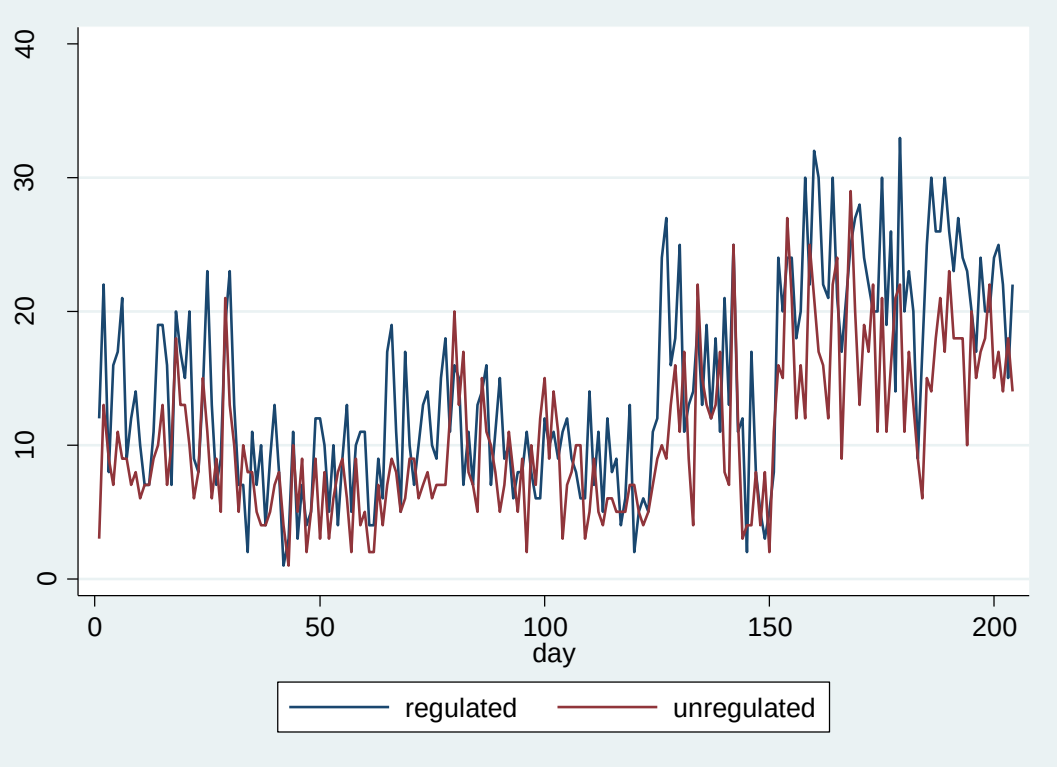

Figure 13. Number of orders of regulated versus unregulated formulations of Levothyroxine from the first of November 2015 until the 24th of May 2016.

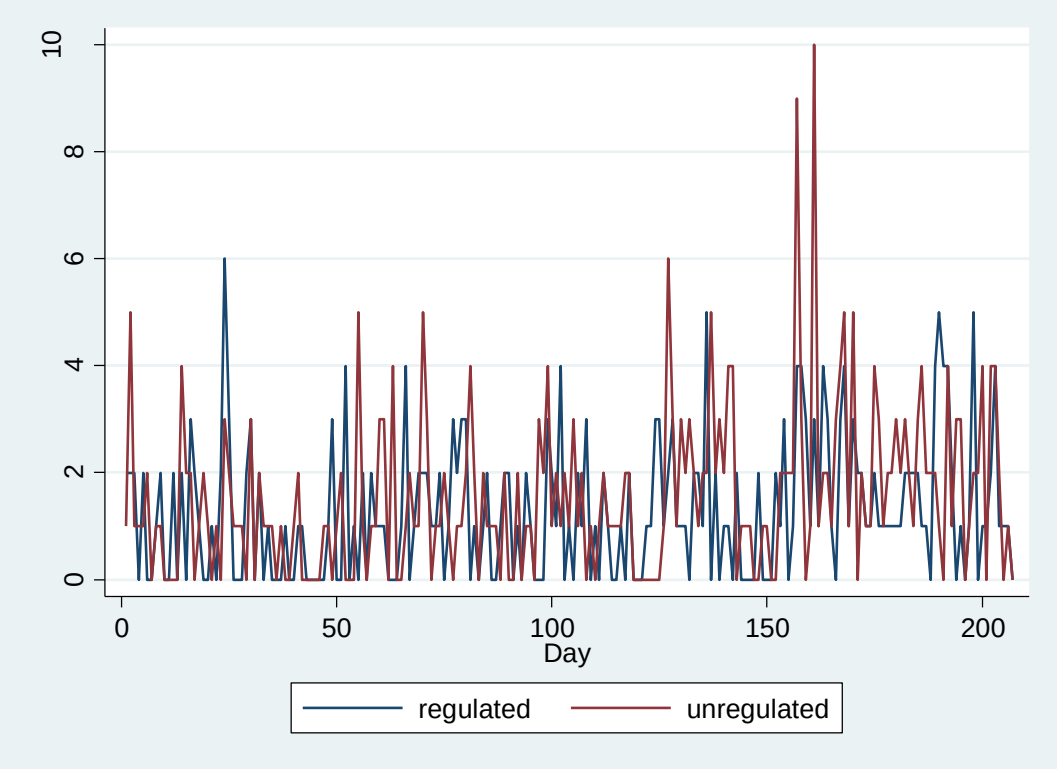

Figure 14. Number of orders of regulated versus unregulated formulations of Atenolol from the first of November 2015 until the 24th of May 2016.

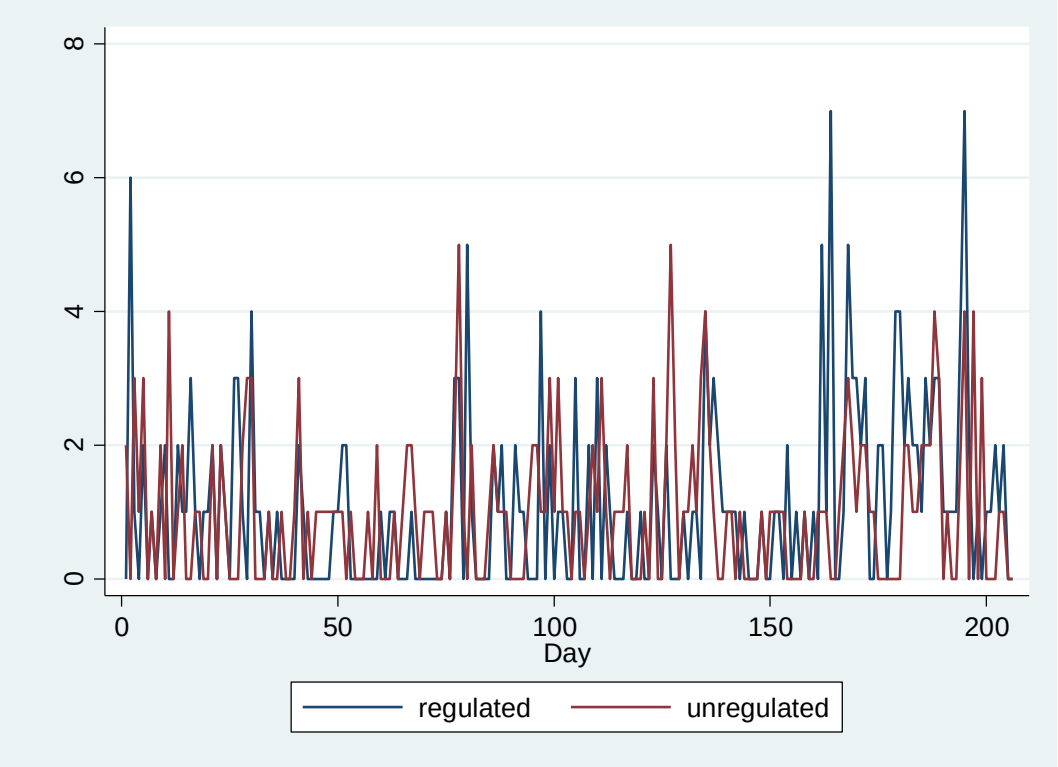

Figure 15. Share of regulated vs unregulated orders of the total orders of selected medicines from the dataset.

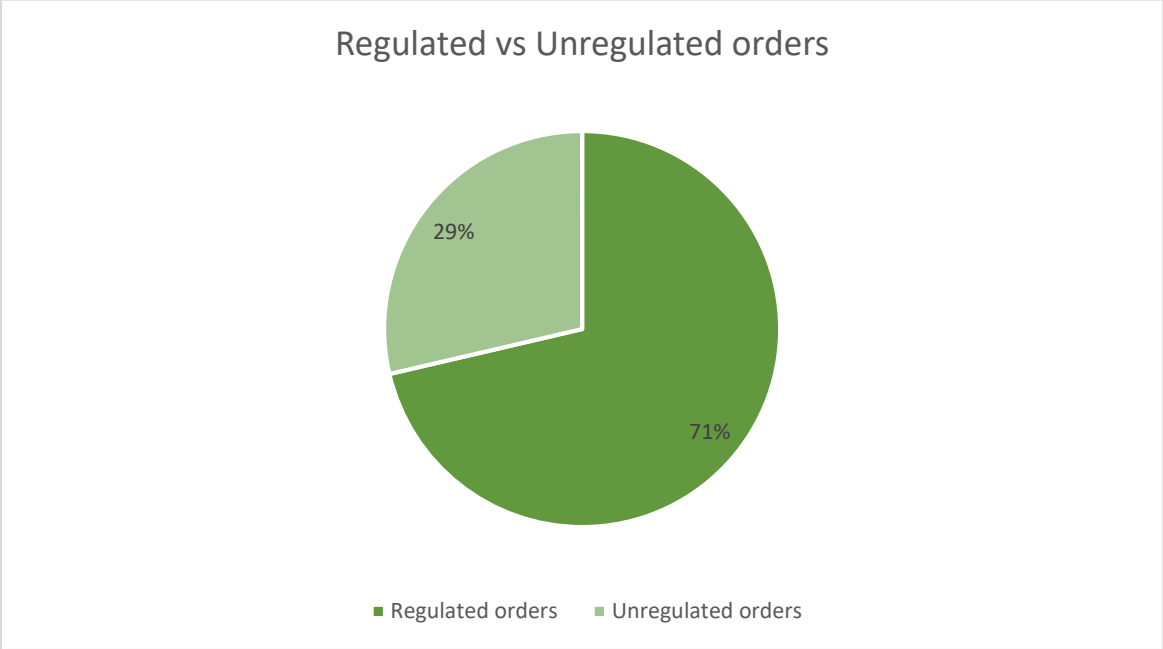

Table 1. Top 9 most frequent ordered medicine featured in the NPPA compendium 2015

Generic name	Regulated strengths	Ordered unregulated strenghts	Orders in dataset	# regulated orders	# unregulated orders
Atorvastatin	5 / 10 mg	20 / 40 / 80 mg	4670	2634	2036
Amlodipine	2.5 / 5 mg	1.25 / 10 mg	2250	2074	176
Metoprolol	25 / 50 mg	1 / 2.5 / 12.5 / 75 / 100 mg	3836	3410	426
Paracetamol	500 mg	170 / 250 / 650 / 1000 mg	1861	1132	729
Metformin	500 mg	250 / 750 / 850 / 1000 mg	1466	935	531
Hydroxychloroquine	200 mg	300 / 400 mg	689	572	117
Levothyroxine	50 / 100 microg	12.5 / 25 / 75 / 88 / 125 / 150 mcg	582	262	320
Atenolol	50 / 100 mg	12.5 / 25 mg	420	220	200
Allopurinol	100 mg	10 / 250 / 300 mg	389	294	95

Table 2. Mean prices and number of observations of regulated versus unregulated formulations of a selection of two groups of medicines

Variable	Observations	Mean price	Std. Dev.	Min	Max
Group 1					
Regulated formulations	4,819	**61.66782**	40.84161	5	174.3
Unregulated formulations	884	**77.02947**	42.38884	13.5	389.5
Group 2					
Regulated formulations	5,183	**51.35994**	39.07619	0.27	204.3
Unregulated formulations	3,816	**130.023**	103.6691	3.31	702.57

Table 2 Notes. Group 1 consists of the medicines Amlodipine, Metoprolol, Hydroxychloroquine and Allopurinol. Group 2 contains the medicines Atorvastatin, Paracetamol, Metformin, Levothyroxine and Atenolol

Table 3. Regression results of each medicine selected from the NPPA 2015

Medicine	**Atorvastatin**	**Amlodipine**	**Metoprolol**	**Paracetamol**	**Metformin**	**Hydroxychloroquine**	**Levothyroxine**	**Atenolol**	**Allopurinol**
Variable:	log_orders	log_orders	log_orders	log_orders	log_orders	log_orders	log_orders	log_orders	log_orders
Regulated	**0.780*** **	**1.920*** **	**2.189*** **	**0.599*** **	**2.006*** **	**2.261*** **	**0.525*** **	**-0.014**	**1.624*** **
Robust standard error	[0.018]	[0.031]	[0.031]	[0.026]	[0.054]	[0.018]	[0.045]	[0.062]	[0.086]
Constant	6.722***	5.135***	5.260***	6.436***	5.958***	4.088***	4.378***	5.147***	4.059***
Robust standard error	[0.012]	[0.029]	[0.031]	[0.026]	[0.054]	[0.018]	[0.043]	[0.043]	[0.086]
Observations	4,670	2,250	3,836	1,862	1,466	689	582	420	389
R-squared	0.281	0.578	0.891	0.314	0.61	0.991	0.165	0	0.742

Table 4. Aggregated regression of all selected medicines

log_orders	Coef.	Robust Std. Err.	t	P>t	[95% Conf. Interval]
Regulated	0.9793973	0.0170766	57.35	0.000	0.945925 - 1.01287
_cons	5.95171	0.0155012	383.95	0.000	5.921326 - 5.982094
Number of observations	14,702				
F(1, 14700)	3289.37				
Prob > F	0				
R-squared	0.2271				
Root MSE	0.84278				