MUTUAL FORBEARANCE IN THE INDIAN PHARMACEUTICAL INDUSTRY: STRATEGIC RESPONSES TO PRICE-CAP REGULATION INDUCED MARKET ASYMMETRIES AND THE ROLE OF MULTIMARKET CONTACT

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The present study examines the effect of multimarket contact (MMC) on regulation-induced strategic firm behavior. Throughout the literature, multimarket contact has been argued to create a condition of collectively reduced rivalry generally referred to as *mutual forbearance.* This collusive behavior is theorized to arise when asymmetries are present in either markets, firms, or products (Bernheim & Whinston, 1990). The current study considers the Indian price-cap regulation on essential medicines (DPCO 2013) to cause market asymmetries in terms of regulated and unregulated dosage markets. While this regulation has been confirmed to instigate price coordination (Bhaskarabhatla, Chatterjee, Anurag, & Pennings, 2016), the role of multimarket contact has remained unaddressed. Based on the model developed by Bernheim and Whinston (1990) and recent empirical work (Bowers, Greve, Mitsuhashi, & Baum, 2014), it is expected that MMC further induces collusive behavior. Using data from the Indian pharmaceutical industry on two medicines (Metformin and Cefixime), the strategic use of pricing behavior (wholesale- as well as retail prices) and promotional behavior (provision of bonus units) in response to DPCO 2013 is investigated. The results indicate collusive behavior to exist in the form of price coordination for Metformin and a combined strategic pricing and promotional strategy for Cefixime. This behavior is found to be specifically prevalent in regulated dosage markets and generally reinforced by high levels of MMC. Moreover, collusion is more prominent in the period leading up to the regulation and particularly visible among large firms. To sum up, these findings confirm the previous literature and present a unique new study in the research area of multimarket contact and mutual forbearance.

1. Introduction

Probably one of the most widely studied topics in economics is competition. Although commonly assumed by many (neoclassical) scholars, competition is not always perfect. In fact, numerous situations and conditions have been identified in the literature where competition is knowingly decreased to serve a higher purpose.

One such strand of literature considers the case of multimarket contact (MMC). MMC has been argued to create a condition of *'mutual forbearance'*. This condition predicts that, when firms meet other firms in multiple markets (high MMC), incentives to lower competition increase. Generally, high MMC therefore implies low rivalry. While the mutual forbearance hypothesis has been confirmed in many different scenarios, unexplored components of the dynamics of MMC and mutual forbearance are endless. Specifically, the variability of the MMC effect within regulation-imposed market asymmetries has remained largely unaddressed in the literature.

To reduce this gap, the current study will investigate multimarket contact and the robustness of the mutual forbearance hypothesis in the context of the Drug Price Control Order 2013 (DPCO 2013), a government-imposed price-cap regulation within the Indian pharmaceutical industry. Earlier work on this specific regulation has uncovered strategic responses to DPCO 2013 in the form of price coordination (Bhaskarabhatla, Chatterjee, Anurag, & Pennings, 2016). However, this strategic behavior has not been investigated yet in the context of multimarket contact. Drawing insights from the most influential theoretical paper in MMC literature by Bernheim and Whinston (1990) and recent empirical work by Bowers, Greve, Mitushashi, and Baum (2014), among others, the present study will uncover the dynamics of the mutual forbearance hypothesis under regulation-induced market asymmetries.

The remainder of the paper is organized as follows. Firstly, relevant literature on multimarket contact and the Indian price-cap regulation will be reviewed and reflected upon. Subsequently, hypotheses will be derived through the combination of different theoretical insights and earlier empirical work. A description of the data and methodology will provide the reader with a better understanding regarding the details of the current study and how it aims to investigate the different hypotheses. Next, a detailed review of the obtained results will follow and be discussed in light of the formulated hypotheses. Finally, the study will conclude with a general discussion and conclusion.

2. Theoretical background: multimarket contact, price-cap regulation and resale price maintenance

Multimarket contact (MMC) and its effects on interfirm (strategic) behavior have been extensively studied. Various strands of research have evolved over the years and shed light on different aspects of MMC and how it affects firm competition. The four central themes in this research are identified by Yu and Cannella (2013) and include the *antecedents* as well as the *outcomes* of multimarket contact, the *moderators* of the effect of multimarket contact on mutual forbearance, and finally *untraditional extensions* of this research field.

The current study will focus on MMC of horizontally related firms in geographic markets and treat MMC as an explanatory variable. This implies that the focus will be on the outcomes and interaction effects of MMC rather than its antecedents. More specifically, the role of MMC in price-cap regulation induced strategic firm behavior will be investigated.

In this section, the literature on MMC and how it affects strategic firm behavior will be discussed. First, the necessary conditions for MMC to cause collusive behavior will be reviewed, broadly following the model by Bernheim and Whinston (1990). Next, an overview of the Indian price-cap regulation DPCO 2013 will be provided, along with theoretical and empirical evidence on how this regulation has been found to stimulate collusive behavior of pharmaceutical firms. Finally, theoretical insights will be combined into a hypothesis on the expected role of MMC on DPCO 2013 induced collusive behavior.

2.1 Multimarket contact and the mutual forbearance hypothesis

Before diving deeper into the effects of multimarket contact and its interactions, it is important to clarify the definition of multimarket contact. Generally, multimarket contact implies that two firms operate in more than one similar market at the same time (Yu & Cannella, 2013). Although some research on multimarket contact recently explored the effects of MMC in *vertical* relationships on market power (Reimann, Shen, & Kaufman, 2017), vertical multimarket contact is rightfully classified as an 'extension beyond traditional multimarket competition research' by Yu and Cannella (2013). The common interpretation of MMC includes *horizontally* related firms, and generally distinguishes between two types of markets: product and geographic markets. Therefore, multimarket contact can be defined as two horizontally related firms that meet in either multiple product markets, or in multiple geographic markets at the same point in time.

Throughout the literature, the general school of thought predicts that MMC creates a condition that is referred to as mutual forbearance. This concept captures the idea that multimarket contact leads to collusive behavior (lower rivalry) because competitors fear that rivalrous behavior in one market will evoke reprisals in other markets as well (Yu & Cannella, 2013). Being one of the first and among the most influential papers in the field, Bernheim and Whinston (1990) assessed the crucial conditions of what is broadly known as the 'mutual forbearance hypothesis'. By comparing a single market scenario to its multimarket equivalent, the authors were able to identify the drivers of mutual forbearance. According to their analyses, horizontally related firms that meet in multiple markets engage in collusive behavior when asymmetries arise in the form of heterogeneous markets, firms, and products. How these asymmetries exactly generate mutual forbearance will now be discussed.

In their model, Bernheim and Whinston (1990) first develop a baseline model in which markets and firms are identical and technology is constant returns to scale. Here, the potential 'gain' from deviating is set against the outcome of the non-deviating scenario and together make up the incentive constraint. Both the deviating and non-deviating scenario are valued by discount factor δ, which captures the weight of future outcomes, and the effects are measured by analyzing the consequences on prices. By comparing these scenarios for a single-market situation to a multimarket situation, the baseline model shows that under symmetric circumstances no multimarket collusion occurs. Depending on the discount factor, a single market will either generate a monopolistic outcome with price p^m, or reach an equilibrium where $p=c$. This result is replicated in a multimarket context since every market in the multimarket situation is essentially an identical copy of the single market. Therefore, the multimarket context does not generate any exciting opportunities as long as no profitable asymmetries arise. Regarded as 'the irrelevance result', Bernheim and Whinston (1990) provide a basis from which the impact of any asymmetry in a multimarket context can be analyzed.

Subsequently, the impact of *asymmetric markets* is analyzed. In their paper, Bernheim and Whinston (1990) focus on two sources of market heterogeneity: asymmetric number of firms (*N*) and asymmetric weight to future outcomes (δ). Both asymmetries essentially show similar results. Accounting for either differences in the number of competitors or differences in weight to future outcomes (due to differences in growth rates, response lags, and demand fluctuations), it is demonstrated that higher prices are attainable under multimarket contact. In the case of differences

in *N*, higher prices can be charged under MMC when firms collude by strategically aligning their market shares. Furthermore, when markets differ in terms of weight to future outcomes, this implies that the impact of reprisals contingent on potential deviations also differs across markets. In the case of MMC, firms can decide to strategically collude and deviate in those markets where the consequences will be relatively less bad.

However, asymmetries do not only exist between markets but can also be induced by *firm heterogeneity*. One source of firm heterogeneity that is highlighted in the Bernheim and Whinston (1990) paper is the case of cost differences. Whether these cost differences are symmetric or absolute, multimarket contact creates the possibility to develop so-called 'spheres of influence' and create a situation where firms acknowledge their competitors' interests in certain markets which allows for higher profits in general and a lower possible gain from deviating. So again, MMC presents profitable collusion opportunities in the form of shifting market power.

Finally, the impact of *product differentiation* induced asymmetry on prices and profits is assessed. From the analyses it appears that, in the case of product heterogeneity, multimarket collusive gains from shifting market power between markets are possible and therefore MMC causes firms to increase prices in one market while decreasing them in other markets. In addition, product differentiation allows for more severe punishments for deviating firms. In contrast to the homogeneous product case, MMC makes that firms operating in markets with product heterogeneity can afford high punishments in one market because of their slack in other markets.

By allowing for different types of asymmetries, collusive effects of MMC are analyzed from different perspectives and the model by Bernheim and Whinston (1990) nicely uncovers different outcomes of MMC. To summarize, the mutual forbearance hypothesis essentially predicts relatively higher prices under multimarket contact compared to the single market contact situation. These higher prices are induced by lower rivalry since multimarket connected firms are aware of the far-reaching consequences of undercutting their rivals. Subsequently, this effect translates into related effects such as higher profits and higher margins, which are also a consequence of multimarket contact induced collusion.

2.2 Asymmetries in the Indian pharmaceutical market: DPCO 2013

As presented in the model by Bernheim and Whinston (1990), asymmetries exist in three different aspects of market competition (market-, firm-, and product heterogeneity) and can take

many different forms (e.g. differences in the number of competitors, cost differences, discount factor differences). When exposed to multimarket contact, these asymmetries can cause collusive behavior and induce monopolistic/oligopolistic pricing.

Throughout the literature, alternative forms of asymmetries have been examined in the context of multimarket contact. Most of these asymmetries have developed naturally, such as e.g. differences in metropolitan area size. Feinberg (2014) did exploit this asymmetry by specifically addressing rural areas where MMC is less commonplace, proving that the mutual forbearance hypothesis also holds in relatively remote areas. However, asymmetries are not by definition natural irregularities but can also be artificially imposed. A study by Chicu and Ziebarth (2013) addressed such an artificially created asymmetry by examining the impact of the *"Codes of Fair Conduct"[1]* on the price increasing effect of MMC in the US cement industry of the Depression-era. Their results not only show the general MMC-effect of collusive price increases, but additionally demonstrate how this collusive effect is further reinforced due to the government-induced asymmetry.

While a variety of asymmetries have been addressed and their effects examined in the context of MMC, the Indian pharmaceutical industry poses an interesting and quite unique asymmetry. Officially imposed by the Drug Price Control Order (DPCO) 2013, a price-cap regulation has been introduced in July 2013. Aiming to ensure accessibility of essential drugs, this regulation has implemented a ceiling price on a list of drugs congruent to the National List of Essential Medicines (NLEM) 2011 (National Pharmaceutical Pricing Authority, 2015). In contrast to earlier DPCOs, the 2013 version used a market-based approach to determine ceiling prices, as opposed to a cost-based approach. According to this market-based approach, ceiling prices are calculated by taking the simple average of the wholesale prices (price to retailer: PTR) of brands holding at least one percent market share and subsequently adding a retailer margin of 16 percent (Ministry of Chemicals and Fertilizers, 2013).

An interesting feature of DPCO 2013 however is that it involves a *partial* price-cap regulation. Since essentiality classification is based on NLEM 2011, only certain dosages are regarded as essential and therefore regulated. This partial price-cap regulation therefore allows to isolate the DPCO 2013 effects from medicine-related confounding variables. Because only some

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[1] *The Codes of Fair Conduct* was an act created by the Roosevelt Administration in 1933 in response to major deflation and intended to reduce competition.

dosages are regulated and others are not, these confounding variables are held constant since the partial regulation allows to compare regulated dosages with non-regulated dosages *within* a specific drug type.

In contrast to the Codes of Fair Conduct act, DPCO 2013 is not directly designed to either increase or decrease competition, but instead focused on the consumer side and created to guarantee access to essential drugs. However, even though it is not the policy's main aim, Bhaskarabhatla et al., (2016) have shown that DPCO 2013 does induce coordination. Using data on prices of 500 MG, 850 MG, and 1000 MG dosages Metformin from March 2007 to March 2015, the authors provide evidence for price coordination in the period before the price-cap implementation. Specifically, being aware of the market-based approach of determining ceiling prices, firms artificially drive up the prices of the to-be regulated dosages (500 MG) in order to achieve a higher eventual ceiling price, leaving the prices of unregulated dosages (850 MG & 1000 MG) untouched.

Translating this asymmetry into Bernheim and Whinston (1990) terminology, it can be stated that DPCO 2013 presents a unique case of market heterogeneity. Employing the product market approach (as opposed to the geographic market approach) and defining "market" as the dosage of a specific medicine, a partial price-cap regulation implies heterogeneity in the form of regulated and unregulated markets. Moreover, given the fact that this regulation is an imposed condition and its implementation is tied to a certain date, separate time periods can be defined which refer to different phases of DPCO 2013. Hereby extending the definition of "market" to a specific dosage of a specific medicine *in a specific time period*, heterogeneity arises not only between regulated and unregulated dosages, but also across time periods.

Having regarded DPCO 2013 as a market asymmetry, another parallel with the mutual forbearance literature should be mentioned. In their paper, Bowers et al., (2014) have investigated mutual forbearance in the context of competitive parity and status disparity. While this paper used data on securities analysts' stock estimates, the set up does show some similarities with the current study. Specifically, the authors did theorize how the imposed *Regulation Fair Disclosure[2]* (Reg FD) creates a condition of 'competitive parity', which is essentially an asymmetry between the pre- and post Reg FD situation. The regulated situation, which is regarded as competitive

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[2] Stock market regulation that aims to eliminate privileged access to essential firm information and hereby places all investors on an equal footing.

parity, implies the absence of considerable competitive advantages. Interestingly, Bowers et al. (2014) have shown that this condition of competitive parity does enhance the mutual forbearance effect of MMC. Following this paper, it is therefore reasonable to expect that, within the Indian pharmaceutical industry, the MMC effect is more prevalent and potentially stronger for *regulated* dosages as opposed to *unregulated* dosages.

Furthermore, the paper by Bowers et al. (2014) also addresses the concept of status disparity, which relates to hierarchically structured markets. Empirical evidence on analysts' stock estimates has shown that under competitive parity, high ranked analysts tend to coordinate more compared to less influential actors. Moreover, the mutual forbearance effect has been proved to be stronger for these influential analysts. Translating this to the present study, this would imply that more significant firms (i.e., those holding over one percent market share) engage in more coordinating behavior, especially when MMC values are high.

Taken together, the Indian price-cap regulation of essential medicines articulated by DPCO 2013 poses an interesting new research direction in the area concerning MMC effects on collusive pricing. By regarding DPCO 2013 as an asymmetry which creates market heterogeneity, a new extension of the Bernheim and Whinston (1990) model arises. DPCO 2013 is particularly interesting to study in relation to MMC because it is in the first place an artificially created (government-induced) asymmetry, in contrast to the usually addressed natural asymmetries. Secondly, the non-intended collusive consequences (price coordination) of DPCO 2013 raise questions on the robustness of the mutual forbearance hypothesis. Finally, insights from earlier empirical work by Bowers et al. (2014) suggests a potential interaction effect between MMC and DPCO 2013 on collusive pricing behavior in the Indian pharmaceutical industry.

2.3 Strategic responses to price-cap regulation: price coordination & insights from the RPM literature

As already shortly mentioned before, Indian pharmaceutical firms did not just passively await the DPCO 2013 price-cap regulation. Instead, they have been found to engage in strategic behavior *prior* to the actual implementation. According to Bhaskarabhatla et al. (2016), firms selectively increase the prices of the to-be regulated dosages Metformin (500 MG) to mitigate the DPCO 2013 regulatory impact. Such a selective increase manipulates a higher ceiling price and is commonly referred to as price coordination. Multiple studies have found evidence for price

coordination as a strategic response to price regulation (see Sappington & Sibley, 1992; Abott, 1995; Foreman, 1995; Bhaskarabhatla, 2016).

However, an important connection between the concept of price coordination and a phenomenon called *resale price maintenance* (RPM) has remained unaddressed in the literature thus far. The practice of resale price maintenance is a vertical strategy exercised by upstream incumbent firms (in this case: Indian pharmaceutical manufacturers). Aiming to protect their own market power from potential new entrants, incumbents create quasi rents (retail margins: maximum retail price − price to retailer) beneficial to retailers and hereby aspire to ensure the retailer's loyalty. Following the rationale of the model developed by Asker and Bar-Isaac (2014), these quasi-rents are the incumbent's transfers (T_i) that have to compete against the entrants' transfers (T_e). Since retailers in the end simply favor the highest transfers, it is important for incumbents to maintain high retail margins.

Exactly this insight – the usage of retail margins as a strategic way to secure retailer loyalty – is what makes RPM essential to consider in the context of price coordination as a strategic response to the Indian price-cap regulation. More specifically, resale price maintenance implies that if pharmaceutical firms increase PTR in order to effectuate a higher ceiling price, MRP should be increased accordingly to maintain the same retail margins. Moreover, since the price-cap regulation can evoke quite some market unrest, firms might also decide to increase (instead of maintain) their retail margins (quasi-rents) in order to prevent any negative sentiments. This would imply a disproportional increase of MRP during the period leading up to the price-cap implementation.

The policy neutralizing strategy described above involves the deployment of RPM as a response to price-cap regulation. Reverting to the earlier mentioned strategy of price coordination, a parallel can be drawn. More specifically, RPM provides a theoretical basis for this repeatedly observed strategic behavior and contributes to a better understanding of how this phenomenon works and why it occurs. In addition, placing price coordination within a broader theoretical context allows for a wider scope of applications and opportunities to analyze this strategic behavior in interaction with other theoretical concepts such as MMC.

To sum up, this study considers the Indian price-cap regulation as an asymmetry and will examine the effect of MMC on firms' strategic responses to this regulation. Based on the model by Bernheim and Whinston (1990), this asymmetry is expected to induce collusive behavior in the

form of higher prices. In addition, the Indian price-cap regulation has already been proved to spur strategic behavior in the form of price coordination in order to realize higher ceiling prices (Bhaskarabhatla et al., 2016). Furthermore, inferring from the literature on resale price maintenance and specifically the model by Asker and Bar-Isaac (2014), price coordination is hypothesized to be part of a policy neutralizing strategy in which firms use retail margins to secure their retailer's loyalty and thereby their own market power. Price increases are therefore expected to be observable in both MRP and PTR. However, it has not been investigated yet whether MMC does play a role in this DPCO 2013 induced strategic behavior. The current study will assess this gap by examining the role of MMC on firms' strategic responses to DPCO 2013 and integrating insights from the MMC model by Bernheim and Whinston (1990) and the RPM model by Asker and Bar-Isaac (2014).

2.4 Multimarket contact as strategic moderator: the MMC*DPCO 2013 interaction

When integrating the MMC model with the RPM model to predict the moderating effect of MMC on DPCO 2013 induced collusive behavior, it is important to first review each model's contribution in isolation. These contributions are the relevant aspects of both models that are necessary to assess the MMC*DPCO 2013 interaction. Once these contributions are clear, parallels can be drawn and ultimately a hypothesis can be derived.

First, it is important to note that the MMC model by Bernheim and Whinston (1990) attributes MMC-induced collusions to asymmetries on either market-, firm-, or product level. As mentioned before, the Indian price-cap regulation is considered to cause a certain form of market heterogeneity because of the market differences it generates due to differences between regulated/unregulated dosages and the period before/after regulation. Therefore, it is justifiable to expect that DPCO 2013 induced market heterogeneity will cause MMC to instigate collusive behavior.

Next, the nature of this collusive behavior is explained by an interaction between the design of the price-cap regulation itself and the RPM model developed by Asker and Bar-Isaac (2014). First, the DPCO 2013's market-based approach for the determination of ceiling prices essentially encourages firms with at least one percent market share to engage in price coordination in order to achieve a higher eventual ceiling price in the period before the implementation. Secondly, the RPM model predicts that this price coordination not only applies to PTR, which is the price used to

determine the eventual ceiling price, but also to MRP since firms use retail margins as a means to maintain market power. To maintain retail margins at the same level, prices have to increase simultaneously. Moreover, to prevent any negative market sentiments firms might even disproportionately increase MRP and create somewhat higher quasi-rents (retail margins) for the retailers. In short, the RPM model predicts firms to increase PTR and MRP in the period *before* the price-cap implementation. It is important to note here that this is the predicted behavior for *regulated* dosages.

Considering the contributions of both models collectively, the overlapping theme between the two is easily observed: collusive behavior. More specifically, while the MMC model predicts that price-cap regulation will cause MMC induced collusive behavior because of market heterogeneity, the RPM model explains what this behavior will look like: price coordination of wholesale and retail prices (PTR and MRP). Although the study by Bhaskarabhatla et al. (2016) has provided evidence for price coordination as a strategic response to the Indian price-cap regulation, no control for MMC was included here. Based on insights from Bernheim and Whinston (1990) it is reasonable to expect that MMC further reinforces this collusive behavior. In line with Bowers et al. (2014), the reinforcing effect of MMC on collusive behavior is expected to be more prominent for regulated dosages (where a condition of competitive parity has been created by the government-induced asymmetry) and among large firms (status disparity).

3. Framing the current study

Combining insights from the MMC model (Bernheim & Whinston, 1990), the RPM model (Asker & Bar-Isaac, 2014), empirical evidence from the stock market (Bowers et al., 2014), and evidence on price coordination in the Indian pharmaceutical industry (Bhaskarabhatla et al., 2016), the present study will examine the (moderating) effect of MMC on DPCO 2013 induced collusive behavior in the Indian pharmaceutical industry. It is hypothesized that the price-cap regulation imposed by DPCO 2013 induces market heterogeneity which causes collusive behavior among firms with high levels of MMC. This collusive behavior is expected to show in the form of price coordination for regulated dosages in the period before the price-cap implementation, which is subsequently expected to be reinforced by multimarket contact. Moreover, it will be investigated whether this effect is more prominent among firms that hold over one percent market share, since only the prices of these firms will be eventually used to determine the ceiling price.

Furthermore, although the MMC*DPCO 2013 interaction effect is hypothesized for regulated dosages only, this does not automatically imply that nothing changes for unregulated dosages. A recent working paper by Bhaskarabhatla, Anurag, Chatterjee, and Pennings (2017) has studied effort diversion as a firm's strategic response to DPCO 2013. They found evidence for an increased focus on unregulated dosages paracetamol due to the imposed price-cap regulation. An interesting feature of this paper is that it also considers non-price dependent variables, such as total number of sales and drug prescriptions. Inspired by this approach, the current study will aim to capture the DPCO 2013 induced MMC effects on collusive behavior not only on prices, but will additionally consider the usage of volume promotions (bonus units).

Previously conducted research in the airline industry has found evidence for a negative mutual forbearance effect on service quality (Prince & Simon, 2009; van Reeven & Pennings, 2016), which is subsequently amply offset by a network coordination effect (van Reeven & Pennings, 2016). To my knowledge, the effect of MMC on promotions as non-price dependent variable has not been investigated yet and would therefore be an interesting additional focus within the present study. Although one would expect MMC to reduce promotions because of an increase in collusive behavior due to the mutual forbearance effect, previous literature does suggest that this effect might not be as straightforward as expected and in fact be the other way round.

Based on the reviewed literature, the following hypotheses have been formulated. Using data from the Indian pharmaceutical industry from the period 2007-2013, these hypotheses will be tested.

Hypothesis 1: The mutual forbearance hypothesis is present in the Indian pharmaceutical industry. This implies that in general, pharmaceutical manufacturers that engage with others in multiple different regional markets (high MMC) are expected to collude and charge relatively higher prices compared to manufacturers with low levels of MMC. Moreover, this MMC induced collusive behavior is expected to be affected by the price-cap regulation of essential medicines (DPCO 2013): mutual forbearance is expected to be more prominent for regulated dosages.

Hypothesis 2: Pharmaceutical firms will engage in price coordination as a strategic response to DPCO 2013 before the implementation of this price-cap regulation. Specifically, prices of regulated products are expected to be increased significantly in the period prior to the ceiling price implementation imposed by DPCO 2013.

Hypothesis 3: Multimarket contact moderates the general DPCO 2013 effect. Because the price-cap regulation imposed by DPCO 2013 creates market heterogeneity, MMC will (further) induce collusive behavior in the period before the price-cap implementation. This moderating effect is expected to differ for regulated versus unregulated dosages.

Hypothesis 4. The collusive behavior induced by MMC and (the interaction with) DPCO 2013 is more prominent among firms with over one percent market share. Due to the market-based approach of determining ceiling prices, firms with high market shares know they can in fact influence the ultimate ceiling prices. This knowledge is expected to affect the firm's behavior.

Hypothesis 5. The MMC and DPCO 2013 induced collusive behavior, which is further affected by the firm's own market share, is also observable in promotional behavior. While most research has been focusing on prices, it is plausible that MMC affects non-price strategic responses to DPCO 2013 as well. Specifically, firms are expected to adjust volume promotions due to higher levels of MMC, the imposed price-cap regulation, and an interaction of both.

4. Data and methodology

4.1 Data

In line with earlier studies on price-cap regulation in the Indian pharmaceutical industry (see Bhaskarabhatla et al., 2016; Bhaskarabhatla et al. 2017), the current study will use data obtained from the All India Organization of Chemists and Druggists (AIOCD). The data contain highly accurate and detailed information for a large number of medicines produced and sold by a variety of pharmaceutical firms.

Data are recorded monthly in 23 regions from March 2007 until September 2013. With DPCO 2013 being officially implemented in July 2013, the data thus contain only three months of post-regulation observations. Since this period is too short to draw conclusions from, all data recorded after June 2013 will not be included in the analyses.

The focal medicines of the current study will be the anti-diabetic drug Metformin and the antibiotic Cefixime. Firstly, Metformin is selected in correspondence with previous research on price coordination in the Indian pharmaceutical industry (Bhaskarabhatla et al., 2016). According to this study, coordination incentives are large in the Metformin market due to expired patents, the nature of the disease (diabetes is rather chronic), and medicine-specific characteristics (Metformin

is a worldwide preferred antidiabetic). Since the current study essentially extends the earlier study by Bhaskarabhatla et al. (2016), Metformin as focal medicine is an obvious choice.

Subsequently, the current study will consider Cefixime as an additional focal medicine. Just like Metformin, Cefixime is only partly regulated, which allows to compare differences in pricing and promotional behavior for regulated dosages to unregulated dosages. However, in contrast to Metformin, Cefixime is newly added to the National List of Essential Medicines in 2011, which implies that the price-cap regulation of this drug was rather unexpected at first. Moreover, since Cefixime is an antibiotic, it treats rather acute diseases. It is very much plausible that differences exist in base line behavior (e.g., general provision of bonus units) and strategic behavior (in response to DPCO 2013) for chronic medicines compared acute medicines and therefore interesting to study together in the context of MMC and DPCO 2013. Finally, analyzing two different medicines will give a sense of the scope of this DPCO 2013 induced collusive behavior.

4.2 Methodology

Dependent variables

The current study considers multiple dependent variables. The two most important variables are maximum retail price (MRP) and price to retailer (PTR) that represent retail- and wholesale prices, respectively. Additionally, the present study will also consider non-price behavior and specifically consider the usage of bonus units as a strategic tool. Accounting for the extra units issued, the *effective* MRP and PTR will be calculated, and, together with the bonus units, used to assess the impact of MMC and DPCO 2013 on non-price behavior. The exact definitions of the variables are included below.

1. *MRP (normalized)*. The maximum retail price (MRP) indicates the maximum price retailers are allowed to charge and is given per SKU (stock keeping unit). This implies that an MRP is defined for a specific medicine, dosage, delivery type (e.g. tablet/slow release tablet), and package size. In order to make comparisons between different SKUs possible, prices have to be normalized. In line with Bhaskarabhatla et al. (2016), prices will be normalized at 500 MG following equation 1 below.

$$MRP \ per \ 500 \ mg = \frac{MRP \ per \ pack}{numbers \ of \ tablets \ per \ pack} * \frac{500}{dosage \ strength} \tag{1}$$

2. *PTR (normalized).* Price to retailer (PTR) indicates the price at which a product is sold to the retailer and essentially represents the wholesale price. Just like MRP, PTR is provided per SKU and will therefore be normalized at 500 MG, as defined in equation 2.

$$PTR \; per \; 500 \; mg = \frac{PTR \; per \; pack}{numbers \; of \; tablets \; per \; pack} * \frac{500}{dosage \; strength} \qquad (2)$$

3. *Effective MRP, Effective PTR.* As mentioned before, firms do not only use prices to make their products more attractive for consumers but instead also promote their products through bonus units. Bonus units are 'free' extra units that lower the effective price. In order to examine the role of non-price promotions in firm's strategic responses to DPCO 2013, effective prices (MRP/PTR) are calculated following equation 3 and subsequently normalized at 500 MG.

$$Effective \; price = \frac{Actual \; Sales \; Value}{Actual \; Sales \; Units + BonusUnits} \qquad (3)$$

4. *Bonus units, promoshare.* Finally, (strategic) non-price behavior will also be observed by treating bonus units as dependent variable. In addition, promoshare, which is the ratio bonus units/actual sales units will be used as well.

Explanatory variables

1. *Multimarket contact.* Reiterating the earlier formulated definition, multimarket contact arises when two horizontally related firms meet in either multiple product markets, or in multiple geographic markets at the same point in time. As shortly mentioned before, the present study will focus on geographic markets and treat India's 23 regions as separate markets.

   However, the discussion of DPCO 2013 as a new application of the Bernheim and Whinston model employs a product market approach. Specifically, price-cap regulation is hypothesized to create an asymmetry in the form of market heterogeneity because some dosages are regulated and others are not. The reason to nevertheless focus on MMC in geographic markets is that this allows for a better, more straightforward definition of MMC. While India's geographic markets are clearly defined by 23 regions, it is much harder to delineate product markets. First, the most straightforward product market definition, a simple regulated/unregulated distinction, does not allow for much variation in the MMC variable since it would leave just two product markets. Since most firms sell

both the regulated and non-regulated dosages of a specific medicine, this would not make much sense. However, extending the product market definition to the different dosage strengths makes comparisons between different medicines more complicated. Not only do the available dosages differ across medicines, one medicine's regulated dosage strength might be unregulated for another medicine.

Although Indian geographic markets are not characterized by the exact same market heterogeneity as the pharmaceutical product markets, it is assumed that this pharmaceutical *product market heterogeneity* does induce *geographic market heterogeneity* since not every region has similar product shares. Using the regulated/unregulated product market definition, Table 1 and 2 (Appendix A) show the product market distribution for every geographic market for Metformin and Cefixime, respectively.

Therefore, the current study defines MMC as "*the average amount of times that two firms, who are meeting in a specific region in a specific month, also meet in other regions*". This definition can be expressed in mathematical terms as follows. First, consider a specific region $r \in R$, in a specific month $t \in T$. The firms that are operating in that specific market can be defined as a set: $F_{rt} = \{i, j_1, \ldots, j_{N_{rt}-1}\}$, with the total number of firms being denoted as N_{rt}. MMC is subsequently calculated by counting how many times two firms i and j, who both operate in region r in month t also meet each other in other regions than r in the same month t. Before expressing this in a formula, two subsets have to be defined. First, the total set of regions R exists of our region of interest r, and all other regions (23-1). This implies that $R = \{r, s_1, \ldots, s_{22}\}$, with the remaining regions being denoted as: $-r = \{s_1, \ldots, s_{22}\}$. Next, the set of firms operating in a specific region in a specific month was already defined by F_{rt}, but it is useful to separately define firm i's competitors in region r and month t: $-i_{rt} = \{j_1, \ldots, j_{N_{rt}-1}\}$. Next, MMC of firm i in region r and month t can be calculated using the formula in equation 4, with 1[·] taking value one if two firms meet in both markets and zero if not.

$$MMC_{irt} = \frac{\sum_{j \in -i_{rt}, \ s \in -r} 1[i,j \in F_{rt} \ ; \ i,j \in F_{st}]}{N_{rt}} \qquad (4)$$

2. *Price-cap regulation: Regulated and Period.* In order to assess the effect of price-cap regulation, two variables have to be defined. First, 'Regulated' simply distinguishes between regulated and unregulated dosages. In the case of Metformin, only the 500 MG

dosage is regulated under DPCO 2013, leaving the other dosages (250, 500, and 1000 MG) unregulated. Concerning Cefixime, 100 and 200 MG dosages are regulated and 50, 125, 250, 400, 500, and 1000 MG are left unregulated. The variable Regulated will be used to create two sub samples and thereby allows to compare regression results for regulated dosages to unregulated dosages.

Next, 'Period' identifies the time period that is crucial to be recognized separately with respect to DPCO 2013. Specifically, it is defined as a dummy variable that identifies the period after the disclosure of the National List of Essential Medicines 2011 until DPCO 2013 is implemented. This period starts July 2011 and lasts for two years until June 2013. During this period, pharmaceutical firms are aware of the essential medicines identified by the Indian government as well as the upcoming price-cap regulation that targets those medicines. Potential strategic responses such as price coordination are expected to be observed in this time period. The actual price-cap regulation effect can subsequently be examined by comparing the Period effect on regulated prices to its effect on unregulated prices.

3. *Moderating role of MMC on DPCO 2013 induced strategic behavior.* As formulated in hypothesis three, MMC is expected to play a moderating role on price-cap regulation induced strategic responses (e.g. price coordination) of Indian pharmaceutical firms. This moderating role can be examined by first considering the main effects of MMC and DPCO 2013 as described above, and additionally including an interaction MMC*Period. Comparing this effect on regulated prices to the effect on unregulated prices will provide insights into the moderating role of MMC. Here, a significant interaction effect would imply that the effect of the price-cap regulation on strategic behavior is larger for firms that meet other firms in multiple markets.

4. *Market share.* Since the ultimate ceiling prices are determined based on actual prices of firms holding over one percent market share, different effects for small versus large firms (smaller/larger than the 1% threshold) are plausible. Therefore, a market share dummy is computed based on the actual MRP sales value, that takes value 1 for firms holding over one percent market share in a specific month. This dummy is included individually as well as in interaction with MMC and Period. To control for a small delay in the effect on behavior, these market shares are lagged by one month.

5. *Control variables.* Next to the main explanatory variables, some additional variables will be included to account for the natural variation present in the data. Firstly, company fixed effects will be included to control for company-specific characteristics that might affect pricing and promotional behavior (e.g., the company's age and number of employees). Next, month fixed effects will account for any time effects that are independent from the price-cap regulation (e.g., a natural disaster). Finally, region fixed effects will account for any geographic differences.

Analyses

The existence of the mutual forbearance hypothesis in the Indian pharmaceutical industry, the effect of DPCO 2013 on firm strategic behavior, and the (moderating) role of MMC in this behavior are examined by estimating different models. These models will be estimated using two techniques. First, the main results are obtained using Fixed Effects with clustered error terms. In addition, the models using MRP and PTR as dependent variable will be re-estimated using a Seemingly Unrelated Regression (SUR). This technique estimates related models simultaneously and hereby assumes the error terms of the models to be correlated. This is a plausible assumption in the case of MRP and PTR since these prices are highly correlated ($r_{Metformin} = .988$ and $r_{Cefixime} = .968$). Generally, SUR results will be used as robustness check, unless the main results cannot be estimated using Fixed Effects. Using Fixed Effects and SUR techniques, three main models (equation 5-7) will be estimated for firm *i,* region *r,* and month *t.*

$$y_{irt} = \beta_0 + \beta_1 \cdot MMC_{irt} + \gamma_i + \gamma_r + \gamma_t + \varepsilon_{irt} \tag{5}$$

$$y_{irt} = \beta_0 + \beta_1 \cdot MMC_{irt} + \beta_2 \cdot Period_t + \beta_3 \cdot MMC_{irt} * Period_t + \gamma_i + \gamma_r + \gamma_t + \varepsilon_{irt} \tag{6}$$

$$y_{irt} = \beta_0 + \beta_1 \cdot MMC_{irt} + \beta_2 \cdot Period_t + \beta_3 \cdot MMC_{irt} * Period_t + \beta_4 \cdot L.MS_{it} + \beta_5 \cdot MMC_{irt} * L.MS_{it} + \beta_6 \cdot Period_t * L.MS_{it} + \beta_7 \cdot MMC_{irt} * Period_t * L.MS_{it} + \gamma_i + \gamma_r + \gamma_t + \varepsilon_{irt} \tag{7}$$

Depending on the hypothesis that is being assessed, the dependent variable differs. For hypotheses 1-4, MRP and PTR will serve as dependent variables. For interpretation purposes, all models will in addition be estimated using the natural log of MRP and PTR as dependent variable. Subsequently, hypothesis 5 will be tested by re-estimating all three models on effective MRP and

PTR, bonus units, and promo share, using the Fixed Effects estimation method with clustered error terms.

The models will be estimated for different sub samples, containing either *regulated* dosages or *unregulated* dosages. Estimating the models separately for regulated and unregulated dosages allows to compare MMC and DPCO 2013 effects per category. To test for the presence of a general mutual forbearance effect, the first model will in addition be estimated for the full sample as well.

Furthermore, some additional analyses will be conducted to confirm the robustness of the results obtained, provide additional insights, and verify the causal direction of the MMC effect. Firstly, the market level control variable market concentration, measured using the Herfindahl-Hirschman Index (HHI), is included in the full model (equation 7). Next, the development of the MMC effect over time will be investigated in further detail by estimating and visualizing MMC coefficients *per month.* Finally, an instrumental variable analysis will be performed to check the causal direction of the MMC effect.

5. Results

5.1 Descriptives & Figures

To visualize the development of prices of to-be regulated dosages and compare them to unregulated dosages, MRP and PTR have been plotted over time. The graphs in Figure 1 and 2 (Appendix B) show the development of regulated and unregulated wholesale- and retail prices for Metformin and Cefixime respectively. The disclosure of NLEM 2011 is marked by a vertical reference line. From the graphs it can be observed that while Metformin prices increase over time, the opposite is true for Cefixime prices. Moreover, MRP and PTR appear to generally move together in both medicines and both type of markets. However, the distance between these two prices (retail margin) appears to increase over time, in particular for regulated dosages. Although no hard claims can be made based on these graphs, the plots do suggest some type of collusive behavior as the prices of regulated products develop considerably different in the period after NLEM 2011 got disclosed compared to their unregulated counterparts.

This seemingly collusive behavior is also visible in the development of bonus unit provision over time, separated for regulated and unregulated dosages (Figure 3 & 4, Appendix B). Especially in the case of Cefixime, firms appear to increase the amount of bonus units specifically for regulated dosages, which hints at collusive promotional behavior in the context of DPCO 2013.

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Next to the data visualizations in Figures 1-4, the data is also described numerically in Tables 3 and 4 (Appendix B). Means, standard deviations, and total number of observations of MMC, MRP, PTR, bonus units, and promoshare are given for the full sample, the regulated subsample, and the unregulated subsample of Metformin and Cefixime. The descriptive statistics in these tables show a couple of things. First, MMC seems to be pretty constant between medicines and across samples, which implies that this is a pretty stable factor. In contrast, the dependent variables do differ for Metformin and Cefixime and are considerably less stable across samples. In the case of Metformin, both prices as well as bonus units and promoshare show higher averages in the regulated sample compared to the unregulated sample. While this is also true for Cefixime bonus units and promoshare, Cefixime prices seem to be pretty constant across dosages. Finally, even though Metformin and Cefixime prices are both normalized at 500 MG, Cefixime appears to be a lot more expensive than Metformin and also shows more variability in prices.

5.2 Mutual forbearance hypothesis

As a first analysis, the presence of a general mutual forbearance effect of MMC in the Indian pharmaceutical industry is examined. The effect of MMC has been assessed for both Metformin and Cefixime, using the full sample (including both regulated and unregulated dosages). The results are presented in Table 5 below.

Table 5. *Mutual forbearance effect full sample*

| | METFORMIN | | CEFIXIME | |
	MRP	PTR	MRP	PTR
MMC	0.002**	0.002**	-0.107	-0.048
	[0.00]	[0.00]	[0.11]	[0.08]
Constant	1.310***	1.053***	40.331***	31.709***
	[0.03]	[0.02]	[1.74]	[1.28]
Observations	159,100	159,100	220,172	220,172
R-squared	0.510	0.497	0.495	0.523
Month FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

From the table it can be observed that there is a general MMC effect on prices for the chronic medicine Metformin, while this effect does not show for the newly added acute medicine Cefixime. The MMC effect on Metformin prices is positive and strongly significant for wholesale prices as well as retail prices. The coefficients indicate that one unit increase in MMC (one additional market) increases both wholesale and retail prices normalized at 500 MG with RS 0.002. Accounting for a different range in prices, the same model was estimated using the natural log of normalized MRP and PTR (Table 6 in Appendix C). From these results, it can be observed that one unit increase in MMC increases both prices by 0.1 percent.

In addition, both models are also estimated using a Seemingly Unrelated Regression (SUR) model. The results are included in Appendix C (Table 7) and indicate the MMC effect on Metformin prices to be pretty robust. More striking however are the strongly significant *negative* effects on Cefixime prices. According to these results, it seems that MMC induces collusive behavior in both markets, though the direction of these effects are the complete opposite. While MMC *increases* Metformin prices, Cefixime prices are *decreased* due to higher MMC.

After having established a *general* effect of MMC in the Indian pharmaceutical industry, an interesting feature to explore is whether this effect differs between regulated and unregulated dosages, or in other words, is affected by the price-cap regulation imposed by the Indian government. The results are depicted in Table 8.

Table 8. Mutual forbearance effect split sample

| | METFORMIN | | | | CEFIXIME | | | |
| | Regulated | | Unregulated | | Regulated | | Unregulated | |
	MRP	PTR	MRP	PTR	MRP	PTR	MRP	PTR
MMC	0.003**	0.003***	0.002	0.001	-0.221*	-0.125	0.353*	0.250
	[0.00]	[0.00]	[0.00]	[0.00]	[0.13]	[0.09]	[0.20]	[0.16]
Constant	1.395***	1.117***	1.207***	0.975***	39.870***	31.197***	38.233***	30.867***
	[0.03]	[0.02]	[0.03]	[0.02]	[1.99]	[1.49]	[2.56]	[2.08]
Observations	87,662	87,662	71,438	71,438	173,169	173,169	47,003	47,003
R-squared	0.588	0.574	0.653	0.654	0.482	0.518	0.808	0.813
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

The split sample results reveal some interesting findings. First, regarding the chronic medicine Metformin which was not newly added to the list of essential medicines, MMC appears to affect only regulated prices. Both the effect on wholesale prices as well as retail prices are significant and seem to be pretty robust, as they also show when the is estimated using the natural log of MRP as dependent variable (see Table 9, Appendix C). The non-significant effects of MMC on unregulated MRP and PTR hint at an influence of the price-cap regulation on MMC induced collusive behavior. Furthermore, re-estimating the model using SUR provides further evidence for the robustness of these effects (see Table 10, Appendix C).

More intriguing are the results for Cefixime. While MMC did not have significant effects on MRP and PTR in the full sample, split sample analyses indicate a marginally significant effect of MMC on MRP for regulated as well as unregulated dosages. However, this effect has opposite directions in the two samples. While an increase in MMC decreases regulated retail prices, the opposite is true for unregulated retail prices. These effects become even stronger when the same estimations are performed using the SUR method (see Table 10, Appendix C). Moreover, although smaller, these results also indicate an effect of MMC on wholesale prices. Just like for retail prices, MMC appears to decrease regulated PTR whilst increasing unregulated PTR.

Taking these results together, the existence of the mutual forbearance hypothesis in the Indian pharmaceutical industry seems evident. Moreover, this MMC induced collusive behavior is further affected by the price-cap regulation of essential medicines introduced by the Indian government. In addition, it should be noted that this effect is on top of a general regulation effect which is visible in higher prices for regulated products (higher constant terms). Although this implies the first hypothesis to be generally confirmed, the nature of this collusive behavior is less straightforward as initially expected. While MMC induces collusive behavior in the regulated Metformin market in the form of higher prices, this effect is the other way round for Cefixime prices. The absence of a general MMC effect in the full sample is explained by the results of the split sample analyses: while MMC negatively affects regulated prices, the effect on unregulated prices is positive. The exact dynamics of these results are further explored in the next analyses.

5.3 Price coordination as a strategic response to DPCO 2013 and the role of MMC

After having established the presence of the mutual forbearance hypothesis in the Indian pharmaceutical market, and in particular how this MMC induced collusive behavior seems to

depend on whether it concerns regulated or unregulated dosages, the effects of the DPCO 2013 price-cap regulation are further explored. By including a time period dummy that demarcates the period after the disclosure of NLEM 2011 but before the actual implementation of DPCO 2013, the effects of the regulation are assessed in more detail. The results are shown in the Table 11 below.

Table 11. *Multimarket contact and price coordination*

| | METFORMIN | | | | CEFIXIME | | | |
| | Regulated | | Unregulated | | Regulated | | Unregulated | |
	MRP	PTR	MRP	PTR	MRP	PTR	MRP	PTR
MMC	0.002	0.002	0.001	0.001	-0.281*	-0.224**	0.363*	0.250
	[0.00]	[0.00]	[0.00]	[0.00]	[0.15]	[0.11]	[0.22]	[0.18]
Period	0.468***	0.277***	0.444***	0.260***	-6.047**	-8.547***	-4.801*	-5.362**
	[0.08]	[0.05]	[0.07]	[0.05]	[2.55]	[1.76]	[2.69]	[2.21]
MMC*Period	0.003	0.003	0.002	0.001	0.144	0.239**	-0.033	0.000
	[0.00]	[0.00]	[0.00]	[0.00]	[0.16]	[0.11]	[0.17]	[0.14]
Constant	1.412***	1.129***	1.217***	0.981***	40.556***	32.330***	38.106***	30.868***
	[0.04]	[0.03]	[0.03]	[0.03]	[2.15]	[1.64]	[2.71]	[2.19]
Observations	91,443	91,443	74,464	74,464	173,169	173,169	47,003	47,003
R-squared	0.582	0.568	0.645	0.646	0.483	0.519	0.808	0.813
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

The results indicate strong significant effects for the period dummy, which implies that firms engage in collusive behavior in the period after the list of essential medicines got disclosed but before the regulation was actually implemented. Although the effects are somewhat larger for regulated dosages, the period dummy effect turns out strongly significant in both samples. However, the directions of this effect are again inconsistent across medicines: while Metformin prices appear to increase in the period prior to the actual implementation, Cefixime prices decrease. Running the same model on the natural log generates approximately similar results and additionally indicates that the average percentage price changes in the period before the implementation (approx. β_{period}*100%) are generally larger for regulated dosages compared to unregulated dosages in both drug markets (see Table 12, Appendix D)

Furthermore, while the previous results did show (marginally) significant effects of MMC on Metformin prices, these have largely disappeared in the current analyses. Both the main effects as well as MMC*Period interaction turn out non-significant. In contrast, the results for Cefixime do indicate a role for MMC. In particular, the main effect on regulated wholesale and retail prices is marginally significant and negative, whereas the main effect on regulated retail prices is marginally significant and positive. Interesting however is the positive significant effect of MMC*Period for regulated PTR. This effect indicates that although prices significantly drop in the period prior to the regulation, high MMC values decreases this drop or even turn it into a price increase.

Accounting for correlated standard errors by estimating the same model using SUR reveals that this reversing mechanism of MMC on the period effect might also be present in regulated Cefixime retail prices. Moreover, SUR results for Metformin also indicate marginally significant effects of MMC*Period for regulated prices (both wholesale and retail) (Table 13, Appendix D).

Together, these results provide evidence for the existence of price coordination among Indian pharmaceutical firms in the period before the implementation of DPCO 2013. In both Metformin as well as Cefixime, regulated prices are adjusted relatively more compared to their unregulated counterparts. In the case of Metformin, these price adjustments consider an increase in prices, which is larger for regulated dosages. This effect is in line with earlier results found by Bhaskarabhatla et al. (2016). However, in the case of Cefixime the price coordination effect is somewhat surprising. While this effect is larger for regulated dosages, which is in line with the expectations, the effect is negative. Although additional analyses are required to further explore this effect, the nature of this drug (acute and newly added to the list of essential medicines) might play a role here. Finally, the results indicate a potential moderating role of MMC in the DPCO 2013 induced price coordination effect.

Based on the performed analyses, it can be concluded that the second hypothesis (price coordination as a strategic response to DPCO 2013) and third hypothesis (a moderating role of MMC on DPCO 2013 induced price coordination) are (partially) confirmed. First, the results indicate compelling evidence for collusive behavior in the period prior to the actual implementation. Although the nature of this price coordinating collusive behavior is somewhat unexpected in the case of Cefixime, firms seem to adjust their pricing in the period before the DPCO 2013 implementation and additionally treat regulated dosages differently from unregulated dosages. Next, although the evidence is less compelling than for the second hypothesis, the results indicate a moderating role of

MMC on price coordination of *regulated* dosages. Additional analyses accounting for the firms' market share will have to reveal the exact working of these dynamics.

5.4 The role of market share on MMC and DPCO 2013 induced collusive behavior

With the first three hypotheses being generally confirmed, it has been established that both MMC as well as DPCO 2013 induce collusive behavior. In addition, the results indicate that the price coordination instigated by DPCO 2013 is further affected by MMC. While the moderating role of MMC on the price-cap regulation effect for *regulated* dosages only shows in the SUR results of Metformin, the analyses on Cefixime show somewhat more dramatic effects. Not only are these effects more robust, they also reverse the main effect of MMC and period.

In order to examine these outcomes in more detail, the variable 'MS' is included in the model to indicate disparity in firm status. The dummy variable MS takes value one if a company holds over one percent market share in a specific month and zero otherwise. The one percent threshold is based on the new approach taken in DPCO 2013: while ceiling prices used to be determined using a cost-based approach, the current price-cap regulation applies a market-based approach and considers prices of firms that hold over one percent market share in the determination of ceiling prices. In addition, these market shares have been lagged by one month to account for a small delay in the influence on prices. Because of collinearity issues, the full model could not be estimated using the regular Fixed Effects model and therefore only SUR estimations are reported.

Previous results have indicated a considerably big institutional influence on wholesale and retail prices. As already has been established, MMC and the prospect of an upcoming price-cap regulation makes firms adjust their prices. Moreover, these effects are more prevalent, overall stronger, and tend to be larger when it comes to prices of *regulated* dosages as opposed to *unregulated* dosages. When subsequently the firms' market shares get accounted for, and in particular whether a firm did hold over one percent market share in the previous month, the extent of this institutional effect on drug prices becomes visible. The results are reported in Tables 14 below.

Table 14. *Market share & collusive behavior*

| | METFORMIN | | | | CEFIXIME | | | |
| | Regulated | | Unregulated | | Regulated | | Unregulated | |
	MRP	PTR	MRP	PTR	MRP	PTR	MRP	PTR
MMC	-0.006***	-0.004**	-0.002*	-0.001	-0.414***	-0.330***	0.233***	0.133***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.02]	[0.04]	[0.03]
Period	0.310***	0.176***	0.310***	0.163***	-6.311***	-8.531***	-3.525***	-4.148***
	[0.05]	[0.04]	[0.03]	[0.02]	[0.47]	[0.35]	[0.75]	[0.59]
MMC*Period	0.008***	0.006***	0.004**	0.003**	0.219***	0.288***	-0.286***	-0.223***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.01]	[0.04]	[0.03]
L.MS	-0.226***	-0.153***	-0.119***	-0.080***	-3.684***	-3.227***	-1.611**	-1.736***
	[0.03]	[0.03]	[0.02]	[0.02]	[0.44]	[0.33]	[0.66]	[0.52]
MMC*L.MS	0.014***	0.009***	0.006***	0.004***	0.430***	0.359***	0.276***	0.259***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]	[0.02]	[0.04]	[0.04]
Period*L.MS	0.372***	0.216***	0.185***	0.137***	6.816***	6.524***	1.009	1.133
	[0.06]	[0.05]	[0.04]	[0.03]	[0.77]	[0.57]	[1.05]	[0.83]
MMC*Period* L.MS	-0.014***	-0.008***	-0.004*	-0.003**	-0.505***	-0.472***	0.160**	0.119**
	[0.00]	[0.00]	[0.00]	[0.00]	[0.05]	[0.04]	[0.07]	[0.05]
Constant	1.891***	1.520***	1.243***	0.982***	39.998***	32.005***	26.979***	22.053***
	[0.04]	[0.03]	[0.02]	[0.02]	[1.18]	[0.88]	[0.78]	[0.62]
Observations	82,379	82,379	67,486	67,486	158,337	158,337	42,457	42,457
R-squared	0.590	0.574	0.674	0.674	0.510	0.549	0.781	0.785
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Seemingly Unrelated Regression (SUR) Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

First, in the case of Metformin, the results show that MMC and DPCO 2013 induced collusive behavior on regulated prices is particularly prevalent among larger firms. Although the main time period effect and its interaction with MMC do turn out significant, these effects are considerably smaller compared to the previous results. However, the interaction effect of time period and lagged market share indicates that this is probably because the pre-regulation price increase is particularly prevalent among large firms. Furthermore, the coefficients indicate the price increase for regulated dosages to be relatively larger compared to unregulated dosages (see also Table 15 in Appendix E for price increases in percentages).

Subsequently, even though the Period*L.MS effect indicates that large firms increase their prices in the period prior to regulation, the main effect of lagged market share shows that in general large firms charge lower prices compared to smaller firms. Although this difference between small and large firms is somewhat smaller when large firms meet each other in multiple markets, it is still quite prominent.

Finally, the triple interaction between MMC, time period, and lagged market share shows that although high levels of MMC generally drive up prices in the period prior to the regulation, this is not the case for large firms in this time period. In fact, being a large firm in the period prior to the price-cap implementation and meeting a lot of companies in multiple markets actually slightly decreases prices. Furthermore, this effect is prevalent and about equally large in both regulated and unregulated markets, which suggests this effect to be non-institutional. However, the upcoming price-cap regulation might play a role in the sense that it makes large firms, who are all over the place, to become a little more cautious when it comes to collusive price increases.

Next, the results for Cefixime are again a little bit more unexpected compared to the Metformin outcomes. Previous analyses have indicated that high levels of MMC tend to decrease prices for regulated dosages, while unregulated prices are increased due to MMC. In addition, it appears that firms drastically decrease the prices of both regulated and unregulated dosages after NLEM 2011 got disclosed and a new price-cap regulation was upcoming. The current model extends the previous analyses by including a firm's lagged market share as well as its interactions with MMC, Period, and the interaction MMC*Period. Although the results indicate a considerable institutional impact, which was also observed for Metformin, the nature of this impact is less obvious.

First, the significant effects of lagged market share show that large firms charge significantly lower prices compared to small firms. Subsequently, while the main effect of lagged market share shows that large firms tend to treat both categories in a similar way, the significant positive interaction terms MMC*L.MS and Period*L.MS indicate institutionally induced collusive price increases of predominantly regulated products. Although the results show that high levels of MMC make large firms increase Cefixime prices in general, the coefficients indicate a disproportionate increase of regulated prices. Also, with the knowledge of Cefixime being on the list of essential medicines and the corresponding threat of a price-cap regulation, large firms appear to collectively increase prices of to-be regulated dosages only in the period prior to the regulation and hereby influence the ultimate ceiling prices.

Interestingly, the Period*MMC interaction turns out strongly significant in the current model, in contrast with the model reported in Table 11. Although the interaction is significant for both regulated and unregulated products, it is found that high levels of MMC in the period before the regulation increase regulated prices, while unregulated prices get decreased. This period-bound collective price increase of regulated dosages however becomes weaker when it is large firms that

meet others in multiple markets. Moreover, the period-bound *collective* price increase can be completely offset or even turned around by relatively high MMC levels. Although this effect is unexpected, a similar trend was observed in Metformin and might indicate some kind of cautiousness in the collusive behavior of large firms.

5.5 Collusive promotional behavior and the role of MMC and DPCO 2013

As mentioned before, an earlier study by Bhaskarabhatla et al. (2017) has focused on the effect of DPCO 2013 on non-price dependent variables. In addition, the literature on multimarket contact suggests a relation between MMC and non-price behavior (Prince & Simon, 2009; van Reeven & Pennings, 2016). The current study incorporates this non-price dimension by looking at promotional behavior in the context of DPCO 2013 and the role of MMC. Specifically, to investigate the role of MMC and DPCO 2013 on collusive promotional behavior, volume promotions (the provision of free 'bonus' units by drug manufacturers) will be considered as a new dependent variable. As explained in the methodological part, this variable is defined in three different ways.

It is important to note here that there is a substantial difference in bonus units provision between the two medicines. While Cefixime counts almost 60,000 records of promotional behavior, which represents a solid quarter of the total amount of observations, bonus units are only provided in 1.6 percent (~2,800) of the Metformin observations. Still, the observations that record zero bonus units are not removed as these are also necessary to obtain insights in promotional behavior of pharmaceutical firms. Subsequently, the same models have been estimated as discussed in 5.2-5.4 by solely replacing the dependent variable, using Fixed Effects estimation with clustered error terms. The results will now be discussed.

First, the models were re-estimated using *effective prices* as dependent variable. As opposed to the actual prices, effective prices account for any free bonus units given out by the company as shown in equation 3. The results are included in Appendix F and show no substantial changes compared to the outcomes of actual prices. This implies that there is no evidence that firms use bonus units to drastically influence actual prices. However, other motives might still play a role and cause firms to strategically use volume promotions in the context of DPCO 2013, which might subsequently also be affected by MMC.

Next, instead of effective prices, plain promotional behavior has been analyzed by looking at the total bonus units given out by pharmaceutical firms for a specific product in a specific month

and region. In addition, the same analyses have been performed using the variable 'promoshare', which is the ratio bonus units divided by the actual units sold for a given firm in a specific month and region for a specific product. These latter analyses merely serve as robustness check and are included in Appendix G. The results on bonus units are depicted below.

Table 20. *Mutual forbearance effect promotional behavior, full and split sample*

	METFORMIN			**CEFIXIME**		
		Regulated	Unregulated		Regulated	Unregulated
	BonusUnits	BonusUnits	BonusUnits	BonusUnits	BonusUnits	BonusUnits
MMC	0.250	0.824	-0.365	-0.164	-0.325	-0.868
	[0.52]	[0.73]	[0.66]	[1.61]	[1.95]	[1.21]
Constant	-0.898	-6.579	5.125	23.533	24.990	32.072*
	[6.77]	[9.21]	[8.23]	[25.29]	[29.76]	[18.44]
Observations	159,100	87,662	71,438	221,545	174,542	47,003
R-squared	0.005	0.007	0.017	0.123	0.172	0.166
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes

*Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** $p<0.01$, ** $p<0.05$, * $p<0.1$.*

The results in Table 20 show no mutual forbearance effect on bonus units, neither in the full sample nor in the two sub samples of both Metformin and Cefixime. The considerable difference in constant terms as well as MMC coefficients between regulated and unregulated products for both medicines however suggests a potential influence of MMC on promotional behavior. Running the same analyses on promoshare generates similar results for Metformin, but shows significant positive effects of MMC in the Cefixime full sample as well as the regulated Cefixime sub sample. This suggests a potential role of MMC in DPCO 2013 induced promotional behavior, which is further analyzed in the next analyses by including the time period after NLEM 2011 got disclosed and before the actual price-cap regulation got implemented. The outcomes are presented in Table 21 below.

Table 21. *Multimarket contact and price coordination: promotional behavior*

| | METFORMIN | | CEFIXIME | |
| | Regulated | Unregulated | Regulated | Unregulated |
	BonusUnits	BonusUnits	BonusUnits	BonusUnits
MMC	1.295	-0.417	-2.883	-0.639
	[0.96]	[0.87]	[2.37]	[1.19]
Period	45.391*	1.366	114.760***	48.271***
	[26.25]	[12.20]	[39.73]	[16.58]
MMC*Period	-1.638	0.181	6.113***	-0.769
	[1.32]	[0.80]	[1.81]	[0.65]
Constant	-13.490	5.891	54.146**	29.081
	[12.18]	[11.38]	[27.02]	[18.88]
Observations	87,662	71,438	174,542	47,003
R-squared	0.007	0.017	0.173	0.166
Month FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

Including the period dummy as well as its interaction with MMC indicates that firms not only use volume promotions as a strategic response to DPCO 2013, but in addition that MMC plays a role in this strategic promotional behavior. In particular, this behavior seems to be predominantly present in the acute medicine Cefixime, which was newly added to the list of essential medicines in 2011. For Cefixime, the period dummy indicates a large increase in the provision of bonus units in the period after NLEM 2011 got disclosed. Although this effect is present in both regulated and unregulated dosages, the coefficients indicate a considerable larger increase in bonus units provision for *regulated products,* which is additionally further increased for high levels of MMC. The analyses on promoshare indicate similar results.

While the outcomes for Cefixime are quite convincing, the results for Metformin are less dramatic. Table 20 shows only a marginally significant positive effect of the period dummy on bonus units. Even though this effect is stronger in the Metformin model using promoshare (Table 24, Appendix G), which shows an additionally significant interaction effect with MMC, the coefficients indicate that this effect is considerably smaller compared to Cefixime.

These results not only show interesting insights regarding promotional behavior, but also with respect to DPCO 2013 induced strategic behavior in general. Specifically, collectively considering the results on promotional behavior and pricing behavior exposes a potential relation

between these two forms of strategic behavior in the case of Cefixime. While the negative period dummy coefficients in Table 11 were a little surprising at first, the current results indicate that this is probably related to the firms' promotional behavior. It appears that after Cefixime got added to the list of essential medicines, firms not only reacted by decreasing their prices but also by giving out more bonus units. Since these effects are also more prominent for regulated dosages, it is reasonable to assume that DPCO 2013 has evoked this behavior. Although the literature does not provide a clear explanation for these findings, it is plausible that the nature of the medicine (acute) has something to do with it, considering the fact that Cefixime was newly added to the list of essential medicines and the absence of similar results in the Metformin sample. More specifically, it is imaginable that firms try to make their product more attractive for consumers and thereby ensure their loyalty to prevent any negative drawbacks from an upcoming price-cap regulation. The positive MMC*Period interaction effect might subsequently imply that bonus units are not only used to guarantee the consumer's loyalty, but additionally serve a strategic goal with respect to price-cap regulation neutralizing behavior. According to the results, volume promotions are relatively more increased in response to NLEM 2011 when firms meet in multiple markets. To what extent this strategic behavior can be linked to the nature of DPCO 2013 is further analyzed by including lagged market share. The results of these analyses are presented in Table 22.

Table 22. *Market share and collusive promotional behavior*

| | METFORMIN | | CEFIXIME | |
| | Regulated | Unregulated | Regulated | Unregulated |
	BonusUnits	BonusUnits	BonusUnits	BonusUnits
MMC	1.238	0.529*	0.543	-0.069
	[0.80]	[0.27]	[1.14]	[0.84]
Period	46.536*	7.848	-15.599	-6.614
	[24.96]	[4.97]	[35.84]	[7.68]
MMC*Period	-2.035*	-0.422	1.070	-0.102
	[1.13]	[0.26]	[0.75]	[0.31]
L.MS	1.540	19.819	73.534	32.357
	[18.81]	[16.45]	[66.95]	[30.54]
MMC*L.MS	0.268	-1.312	-6.964	-1.594
	[1.49]	[1.05]	[5.05]	[2.16]
Period*L.MS	-5.061	-9.965	697.288**	118.592**
	[41.22]	[16.18]	[325.97]	[47.60]
MMC*Period*	0.557	0.750	-33.194*	-6.588**
L.MS	[2.21]	[0.96]	[17.63]	[2.78]
Constant	-10.767	-6.618	166.296***	60.465***
	[8.78]	[4.38]	[29.20]	[17.01]
Observations	82,379	67,486	159,533	42,457
R-squared	0.007	0.017	0.185	0.174
Month FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

The Metformin results indicate comparable outcomes to those in Table 21 and show no different behavior for bigger firms. Considering the Cefixime results however, the opposite seems true. While the main effect of the period dummy and its interaction with MMC have disappeared, these effects do show for large firms. According to Table 22, large firms appear to give out remarkably more bonus units for regulated dosages compared to unregulated dosages in the period after NLEM 2011 got disclosed. Even though this increase is somewhat weakened by high levels of MMC, which again might point at some cautiousness among large firms who meet others in multiple markets, the difference in promotional behavior for unregulated dosages is enormous. The robustness of these effects is shown by the comparable results found for the model using promoshare (see Table 25, Appendix G).

Reflecting on the findings regarding (the role of MMC in) collusive promotional behavior in the context of an upcoming price-cap regulation, it can be concluded that volume promotions are used as a strategic tool in response to DPCO 2013. The employment of volume promotions in the context of an upcoming price-cap regulation is specifically observed for the acute medicine Cefixime, which was

newly added as an essential medicine in NLEM 2011. The results indicate that for the regulated dosages, the main effects of the period dummy as well as lagged market share dummy on *prices* are negative, while these effects are absent for *volume promotions*. Moreover, the significant Period*L.MS interaction effect on volume promotions is considerably large and positive. This implies that on average, large firms try to make their (regulated) products more attractive compared to similar products of smaller firms by reducing prices and increasing bonus units.

However, the discrepancy in the interaction terms for regulated products versus unregulated products indicates collusion among large firms after NLEM 2011 disclosure in the form of price coordination (price increases) and an exceptional rise in volume promotions. The combined strategy of price and volume promotion increases of regulated Cefixime dosages among large firms in the period after Cefixime got marked essential somewhat weakens the *effective* price increase (see Table 19, Appendix F). Although similar effects are observed for effective prices and regular prices, the coefficients are somewhat smaller here than for regular prices. This insinuates that even though bonus units are not used to in fact neutralize price coordination effects for consumers (this would imply no significant effects on effective prices), strategic promotional behavior complements strategic pricing behavior.

With regard to the fifth hypothesis it can be concluded that DPCO 2013 induced collusive behavior is indeed observable in promotional behavior as well. Moreover, this behavior is reinforced by high levels of MMC and also appears to be more prevalent among large firms. However, a general effect of MMC on volume promotions has not been found. Though the results for Cefixime promoshares do indicate some kind of relation, these outcomes are not robust over all models. This insinuates that MMC in general does not generate collusive promotional behavior, unless it is employed as a strategic response to unwelcome policies. Collusive promotional behavior should therefore be regarded as a strategic tool and distinguished from collusive pricing behavior, which is used both as strategic tool but also employed as a simple self-benefiting activity.

5.6 Additional analyses

In addition to the main analyses, additional analyses have been conducted to check the robustness and gain a better understanding of the results obtained. As a first check, market concentration (HHI) is included as a market level control variable. Secondly, the interaction between MMC and time period is analyzed in more detail by the visualization of the MMC effect per month. Finally, in order to confirm the causality of the effects found, an instrumental variable analyses has been conducted.

HHI robustness check

To check the robustness of the results obtained, Herfindahl-Hirschman Index (HHI) is included as a market level control variable in the model specified in equation 7. HHI is computed for every geographical market (region) per month and included. The results are reported in Table 26 in Appendix H. Comparing these outcomes to the original models in Table 14, HHI does not seem to alter the initial effects found. Both the main effects of MMC, Period, and lagged market share as well as its interactions are almost identical across both estimations. This confirms the robustness of the results found.

With respect to the effects for HHI, the outcomes are quite interesting. While high values of HHI do seem to negatively affect both regulated as well as unregulated Metformin prices, Cefixime prices do not seem to be dependent on the level of market concentration. Considering the fact that HHI is a market level control, it is important to note that Cefixime and Metformin are different types of medicines in the sense that Cefixime treats acute diseases while Metformin targets the chronic disease diabetes. Since both drugs are targeting different types of diseases, the markets of these medicines are naturally different. With market concentration being a market characteristic, it therefore makes sense that HHI affects prices differently in both markets.

Visualization development MMC effect over time

Even though the models in equations 5-7 did include an interaction between MMC and the time period prior to the actual regulation, these effects do not provide much detail about the development of the MMC effect over time. While the results in Table 11 do not convincingly indicate MMC to affect prices differently over time and across dosages (regulated/unregulated), the outcomes in Table 14 suggest otherwise. In order to get a better grasp of the actual nature of this interaction, the effect of MMC on MRP and PTR is estimated separately for every month and the coefficients are plotted in Figures 5-8 (see Appendix I). Again, a vertical reference line is added to mark the period after NLEM 2011 disclosure and before the actual implementation.

In line with the previously obtained results, the Cefixime plots do turn out quite dramatic. The graphs clearly show that initially, high levels of MMC used to decrease prices of to-be regulated dosages, while unregulated prices are increased by MMC. However, when the firms started to become aware of the inclusion of Cefixime in NLEM 2011, these effects changed. In fact, the MMC effect on prices have converged to a slightly positive effect, with observable periods where the effect on regulated prices was even larger than the effect on unregulated prices.

With respect to the Metformin graphs, the results are less dramatic. However, both graphs do indicate a significant drop due to high MMC for regulated prices, while this effect is absent for unregulated prices. Although this effect is remarkable, it is not part of a bigger trend and therefore nothing troublesome. More interesting is the development of the MMC effect on regulated prices: while this effect is slightly negative at first, it does become positive right before the actual price-cap implementation. This is not the case for unregulated prices, where the effect of MMC remains slightly negative over time.

In addition to the results that have been reported already, the current graphs provide the following additional insights. Firstly, evidence for the 'surprise-effect' for the newly added medicine Cefixime is compelling. Starting somewhat before the disclosure of NLEM 2011, firms clearly change their (collusive) pricing behavior. Although this sudden change is absent in the Metformin market, a small increasing trend is visible in the MMC effect on regulated prices. Furthermore, it should be noted that in general, effects on Metformin prices are much smaller compared to the effects on Cefixime prices. This is due to a bigger range in Cefixime prices, which makes it easier to observe trends.

Causality check: instrumental variable analysis

Although the results do indicate MMC to affect pricing and promotional behavior, it cannot be concluded from the current analyses that this effect is *causal.* In fact, this correlation might be described by a third variable, which is in some way related to MMC. Therefore, an instrumental variable analysis has been conducted to investigate the 'true' relation between MMC and pricing/promotional behavior. In this analysis, MMC of a substitute drug does serve as instrument. While it is plausible to assume that MMC values of a substitute drug are correlated to MMC of the focal medicine, it is highly unlikely that MMC values of other drugs affect pricing and promotional behavior for Metformin and Cefixime. This implies that the instrument is considered to be exogenous as it is assumed to be unrelated to (other determinants of) Metformin and Cefixime pricing and promotional behavior.

As mentioned before, it is reasonable to expect a correlation between Metformin- and Cefixime MMC and MMC values of related medicines, which would imply the instruments to be relevant. In the case of Metformin, MMC of Glimepiride is considered a relevant instrument. Both drugs are antidiabetics and the correlation between MMC values of Metformin and Glimepiride is notable ($r = 0.324$). With respect to Cefixime, MMC of the combination drug with the largest sales value (Cefixime + Clavulanic Acid) has been employed as an instrument as a Cefixime combination is the closest substitute to Cefixime. Again, the correlation between the MMC values of both medicines is prominent ($r = 0.367$)

and the instrument can therefore be considered relevant.

Results obtained from the instrumental variable analyses are reported in Tables 27 and 28. Since the full model (equation 7) would require additional instruments, only the initial model (equation 5) is estimated using instrumental variable analysis. Two variants of the initial model are included: one model with only month and company fixed effects, and one model with month, company, and region fixed effects. These models have been estimated three times, using MRP, PTR, and bonus units as dependent variables. Since the regressions have been run using clustered error terms, only the robust regression test statistic could be estimated and is therefore the only endogeneity test statistic reported. Furthermore, R^2 values for the Cefixime result including region fixed effects have been suppressed as they turned out negative, which is possible in a two-stage least squares estimations since the model sum of squares are estimated differently compared to a regular estimation.

With respect to the outcomes, the first thing that should be noted is that although most MMC effects turn out non-significant, this is in line with the previous results. The only models that show a significant (positive) effect of MMC are the models without region fixed effects, estimated on Metformin MRP and PTR. In fact, the only main effects of MMC that are confirmed have been found in the models estimating Metformin prices. The absence of this effect in the model including region fixed effects is intriguing and might be related to the nature of the MMC variable itself. Since MMC is calculated employing a geographic market definition, it is plausible that including region fixed effects in the current setting absorbs too much variation that is essential for the main MMC effect.

Finally, none of the endogeneity test statistics turn out significant. In fact, p-values are actually quite high and it is therefore fair to conclude that MMC is exogenous. This implies that the previously reported effects can be considered causal.

6. Discussion

The present study has provided evidence for the (causal) effect of multimarket contact on collusive behavior in the Indian pharmaceutical industry in the context of DPCO 2013. The results indicate the presence of the mutual forbearance hypothesis in the Indian pharmaceutical industry. MMC is found to reinforce regulation-induced collusive (strategic) pricing- and promotional behavior. Although the nature of these effects are different for Metformin compared to Cefixime, the results indicate collusive behavior to be present in both drug markets.

The results provide compelling evidence for collusive pricing behavior in the period leading up the actual price-cap implementation. In the case of Metformin, this takes the form of price coordination and is observed in disproportionate (wholesale- and retail) price increases for regulated dosages, aimed at affecting the ultimate ceiling price. Regarding Cefixime, the phenomenon of price coordination does not show in the same manner as it shows for Metformin. However, the results do indicate DPCO 2013 induced collusive pricing behavior, which in addition seems to be combined with collusive *promotional* behavior. Analyses for both medicines suggest that this DPCO 2013 induced collusive behavior in the period prior to the actual implementation is further affected by MMC in *regulated dosages only.* This finding proves a moderating role of MMC in DPCO 2013 induced collusive behavior.

Subsequently, MMC and DPCO 2013 induced collusive behavior is proven to be specifically prominent among large firms in the regulated market. It has been shown that large firms (firms holding over one percent market share) are different from smaller firms both in general pricing behavior as well as in strategic policy neutralizing behavior instigated by DPCO 2013. The results indicate compelling evidence for collusive pricing and promotional strategies specifically in the period leading up to the price-cap implementation. Furthermore, multimarket contact seems to be an important determinant for large firms to engage in collusive behavior in regulated markets.

Connecting the current findings to the reviewed literature, the following comments can be made with respect to the models by Bernheim and Whinston (1990) and Asker and Bar-Isaac (2014). First, the presence of MMC induced collusive behavior in the context of DPCO 2013 does suggest that price-cap regulation can indeed be regarded as an asymmetry that causes firms who meet in multiple markets to collude because of the market heterogeneity that is being created. This finding makes the present study an extension of the original MMC model developed by Bernheim and Whinston (1990). Moreover, the fact that this MMC induced collusive behavior is more prominent and generally stronger for regulated dosages is in line with the findings by Bowers et al. (2014), who proved a situation of competitive parity (such as the regulated condition) to generate mutual forbearance.

Secondly, the nature of this collusive behavior is shown to take the form of price coordination in the case of Metformin and a combined pricing/promotional collusive strategy in the case of Cefixime. Regarding the first finding, the price coordination strategy observed in Metformin prices, a clear explanation can be formulated based on the model by Asker and Bar-Isaac (2014) and insights from Bhaskarabhatla et al. (2016). It appears that firms collectively increase wholesale prices (PTR) to effectuate a higher ultimate ceiling price and hereby increase retail prices (MRP) accordingly to prevent

retailer's quasi-rents (retail margin) to decrease. In fact, the results even suggest a disproportionate increase of MRP, which results in an increase in quasi-rents and might be part of a strategy to keep retailers loyal.

However, the results for Cefixime are a little less straightforward and even confusing at times. Instead of a coordinated price *increase*, the results indicate that firms decrease Cefixime prices in the period leading up to the regulation. This seems somewhat counterintuitive as this will ultimately result in lower ceiling prices. However, the results still confirm the theory formulated by Asker and Bar-Isaac (2014), as the coefficients indicate a relatively larger drop in PTR compared to MRP. This disproportionate decrease of PTR implies that even though prices are decreased, retail margins are being relatively increased which shows that firms actively try to maintain the retailer's loyalty. Furthermore, results from Cefixime volume promotions suggest that promotional behavior and pricing behavior might in fact be a combined strategy here. Based on the findings, it is very much likely that firms counter any negative drawbacks from the price-cap regulation by making their product more attractive for consumers (lower prices, more volume promotions) instead of manipulating the ceiling price.

The different outcomes for Cefixime and Metformin might be related to the nature of the medicine: while Cefixime is acute, Metformin is a chronic drug. This implies that Metformin consumers are pretty stable as they are life-long consumers, while Cefixime consumers are rather variable since they use the medicine for a delineated time period (as long as they are sick). Therefore, Cefixime consumers are generally more flexible compared to Metformin consumers, simply because this group keeps renewing itself and new users will always look for the best deal. It is therefore plausible to assume that this difference in consumer groups requires a different policy neutralizing strategy. While collective price coordination seems ideal for a chronic drug as Metformin, the acute nature of Cefixime requires a consumer focused approach that combines pricing and promotional behavior. In both cases, this strategy is reinforced by multimarket contact and more prominent among large firms, which is in line with the theory developed by Bernheim and Whinston (1990) and earlier findings on MMC-induced collusive behavior in situations of (dis)parity in competition and status (Bowers et al., 2014). On a side note, this natural difference between both drug markets also shows in the different results obtained for market concentration (HHI). While Cefixime prices are not affected by different levels of market concentration, high levels of market concentration decrease Metformin prices. Again, the difference in consumer groups might explain this discrepancy. Since the Metformin market is pretty stabe, firms do know what to expect in terms of demand and strategically lower prices as market concentration rises to keep new firms from

entering. In contrast, the Cefixime market is somewhat more unpredictable and strategic behavior aimed at blocking new entrants is therefore less rewarding.

Furthermore, the present study also poses some shortcomings. While the disproportionate price in- and decreases validate the predictions regarding the nature of DPCO 2013 induced collusive behavior by the RPM model developed by Asker and Bar-Isaac (2014), it simultaneously exposes one of its biggest limitations. The RPM model predicts that manufacturing firms use retail margins as a means to keep retailers loyal and therefore in-/decrease wholesale- and retail prices to maintain or even increase these margins. Though the development of retail margins is indirectly observed through the difference in changes of wholesale and retail prices, DPCO 2013 induced collusive behavior and the role of MMC herein have not been examined directly on retail margins. Further research is necessary to make more bold statements about the usage of retail margins by manufacturing firms in the context of DPCO 2013 and how this is affected by MMC.

7. Conclusion

Proved by a series of sequential analyses in two drug markets and backed up by several robustness checks, it has been confirmed that multimarket contact plays a crucial role in DPCO 2013 induced collusive behavior. It can be stated that the present study has provided valuable insights concerning the strategic responses that Indian pharmaceutical firms employ to counter any potential negative drawbacks from the price-cap regulation formulated in DPCO 2013. These strategic responses include collusive pricing and promotional behavior and are reinforced by MMC. The exact nature appears to depend on type of medicine that is being regulated. According to the results obtained, price coordination seems a popular strategy for chronic medicines, while a combined pricing/promotional strategy is employed when the drug treats diseases that are acute in nature.

From a scientific perspective, the current study provides valuable insights in the dynamics of multimarket contact and mutual forbearance and is a useful addition to the existing literature. From a societal perspectives, useful insights can be derived by interested parties such as policy makers. In particular future policies can be significantly improved in terms of efficacy using the findings of the present study.

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APPENDIX A – DISTRIBUTION REGULATED/UNREGULATED PRODUCT MARKET PER GEOGRAPHIC MARKET

Table 1. *Distribution product markets per region: Metformin*

METFORMIN	Number of observations		
Region	Unregulated	Regulated	Total
AP COASTAL	3,258	4,185	7,443
AP REST	2,999	3,747	6,746
BIHAR	3,041	3,712	6,753
CHATTISGARH	2,534	3,206	5,740
DELHI	3,201	3,545	6,746
GUJARAT	3,826	4,648	8,474
HARYANA	3,097	3,670	6,767
JHARKHAND	2,454	3,079	5,533
KARNATAKA	3,113	4,335	7,448
KERALA	3,150	4,108	7,258
KOLKATA	3,199	3,652	6,851
MADHYA PRADESH	3,073	3,768	6,841
MARATHWADA	3,325	4,421	7,746
MUMBAI	3,478	4,381	7,859
NORTH EAST	2,302	2,711	5,013
ODISHA	2,898	3,223	6,121
PUNJAB	3,146	3,666	6,812
RAJASTHAN	3,353	3,768	7,121
TAMIL NADU	3,501	4,660	8,161
UP EAST	3,214	3,829	7,043
UTTARAKHAND UP WEST	3,303	4,033	7,336
VIDARBHA	3,157	4,280	7,437
WEST BENGAL REST	2,816	3,035	5,851

Table 2. *Distribution product markets per region: Cefixime*

CEFIXIME	Number of observations		
Region	Unregulated	Regulated	Total
AP COASTAL	2,052	7,343	9,395
AP REST	1,841	7,160	9,001
BIHAR	2,038	7,027	9,065
CHATTISGARH	1,937	7,051	8,988
DELHI	1,699	6,220	7,919
GUJARAT	2,786	9,963	12,749
HARYANA	1,849	6,975	8,824
JHARKHAND	1,646	6,103	7,749
KARNATAKA	2,265	7,645	9,910
KERALA	1,860	6,837	8,697
KOLKATA	2,120	6,938	9,058
MADHYA PRADESH	2,120	8,304	10,424
MARATHWADA	2,246	8,486	10,732
MUMBAI	2,083	7,455	9,538
NORTH EAST	1,221	6,044	7,265
ODISHA	1,866	6,939	8,805
PUNJAB	2,118	8,283	10,401
RAJASTHAN	1,979	8,414	10,393
TAMIL NADU	2,327	8,278	10,605
UP EAST	2,230	7,712	9,942
UTTARAKHAND UP WEST	2,459	9,372	11,831
VIDARBHA	2,289	9,426	11,715
WEST BENGAL REST	1,972	6,567	8,539

Figure 1. *Metformin prices normalized at 500 MG, separated for regulated and unregulated dosages*
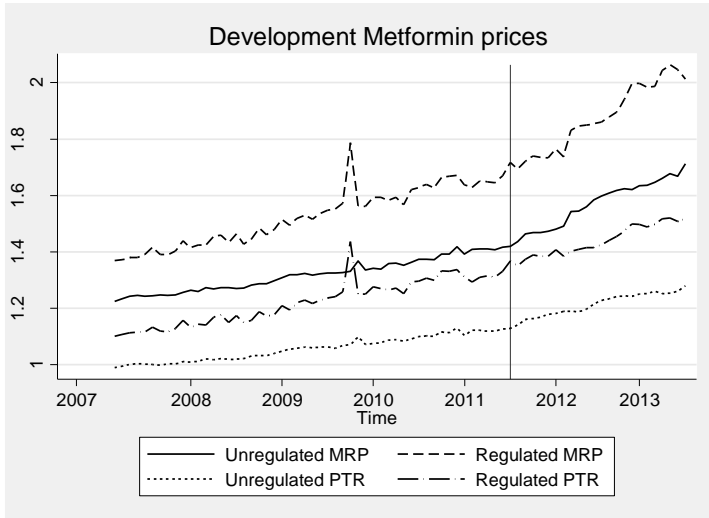
Figure 2. *Cefixime prices normalized at 500 MG, separated for regulated and unregulated dosages*
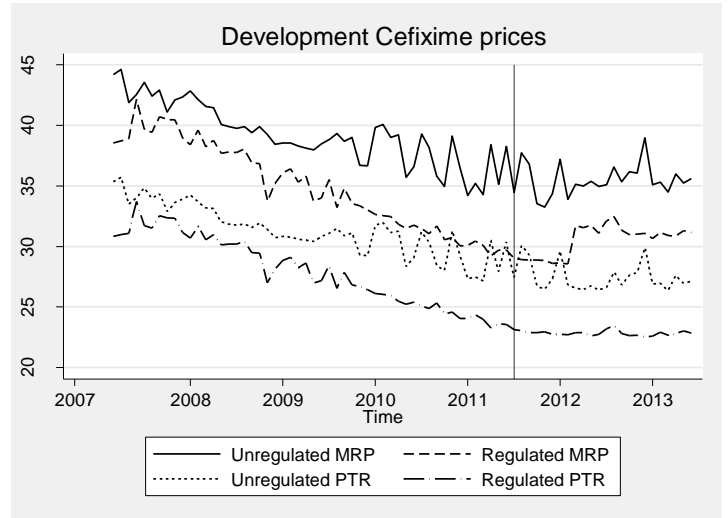
Figure 3. *Metformin bonus units, separated for regulated and unregulated dosages*
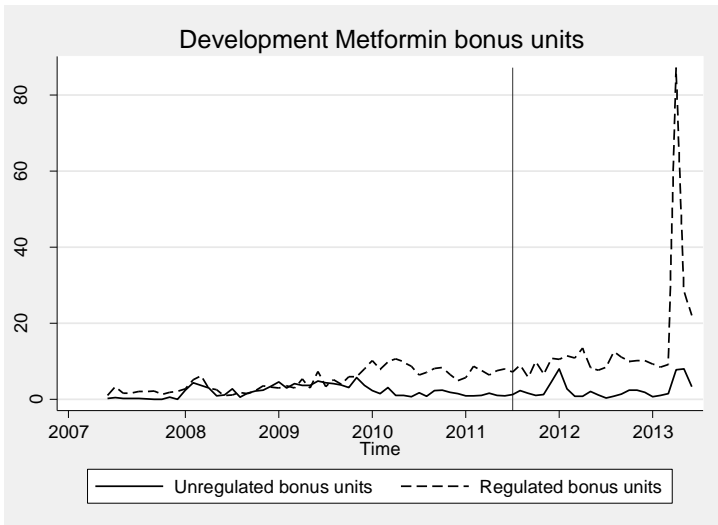
Figure 4. *Cefixime bonus units, separated for regulated and unregulated dosages*
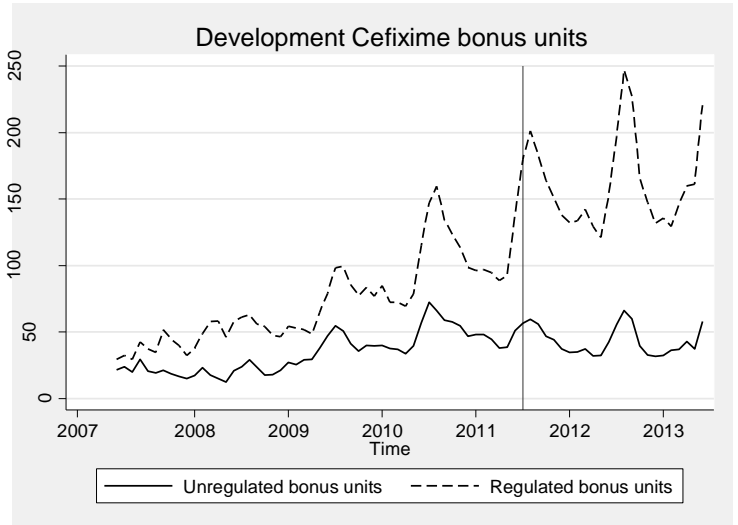
Table 3. *Descriptive Statistics variables Metformin*

METFORMIN	Full sample			Regulated			Unregulated		
Variable	Mean	SD	N	Mean	SD	N	Mean	SD	N
MMC	15.5402	2.04	159,100	15.5039	2.04	87,662	15.5847	2.04	71,438
MRP (Rs)	1.5418	0.60	159,100	1.6503	0.70	87,662	1.4088	0.3948	71,438
PTR (Rs)	1.2162	0.46	159,100	1.3000	0.55	87,662	1.1132	0.3006	71,438
Bonus units	5.4430	216.58	159,100	8.1408	288.55	87,662	2.1325	47.69	71,438
Promoshare	0.0008	0.01	159,100	0.0012	0.01	87,662	0.0003	0.01	71,438

Table 4. *Descriptive Statistics Cefixime*

CEFIXIME	Full sample			Regulated			Unregulated		
Variable	Mean	SD	N	Mean	SD	N	Mean	SD	N
MMC	12.1261	34.05	221,545	11.8472	5.11	174,542	13.1617	4.02	47,003
MRP (Rs)	34.0461	19.57	220,172	33.0028	19.07	173,169	37.8901	20.88	47,003
PTR (Rs)	26.7385	15.23	220,172	25.8628	14.68	173,169	29.9651	16.73	47,003
Bonus units	92.4879	393.97	221,545	107.1454	436.64	174,542	38.0581	140.80	47,003
Promoshare	3.0462	6.53	221,545	3.3021	6.90	174,542	2.0960	4.84	47,003

APPENDIX C – GENERAL AND SPLIT SAMPLE MUTUAL FORBEARANCE HYPOTHESIS

Table 6. *Mutual forbearance effect full sample*

| | METFORMIN | | CEFIXIME | |
	lnMRP	lnPTR	lnMRP	lnPTR
MMC	0.002**	0.002***	-0.002	-0.001
	[0.00]	[0.00]	[0.00]	[0.00]
Constant	0.210***	-0.010	3.607***	3.366***
	[0.02]	[0.02]	[0.04]	[0.04]
Observations	159,100	159,100	220,172	220,172
R-squared	0.566	0.547	0.488	0.504
Month FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1. Coefficients can be interpreted as follows: a unit in the explanatory variable increases the dependent variable by 100*(exp(β)-1)%

Table 7. *Mutual forbearance effect full sample*

| | METFORMIN | | CEFIXIME | |
	MRP	PTR	MRP	PTR
MMC	0.002*	0.002*	-0.107***	-0.048***
	[0.00]	[0.00]	[0.02]	[0.01]
Constant	1.347***	1.083***	40.843***	32.505***
	[0.02]	[0.02]	[1.15]	[0.87]
Observations	159,100	159,100	220,172	220,172
R-squared	0.510	0.497	0.495	0.523
Month FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes

Note. Seemingly Unrelated Regression (SUR) Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

Table 9. Mutual forbearance effect split sample

	METFORMIN				CEFIXIME			
	Regulated		Unregulated		Regulated		Unregulated	
	lnMRP	lnPTR	lnMRP	lnPTR	lnMRP	lnPTR	lnMRP	lnPTR
MMC	0.002*	0.002***	0.001*	0.001	-0.005	-0.003	0.007*	0.007
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Constant	0.251***	0.026	0.162***	-0.051**	3.597***	3.353***	3.566***	3.348***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.05]	[0.04]	[0.06]	[0.06]
Observations	87,662	87,662	71,438	71,438	173,169	173,169	47,003	47,003
R-squared	0.633	0.613	0.673	0.664	0.529	0.550	0.590	0.597
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1. Coefficients can be interpreted as follows: a unit in the explanatory variable increases the dependent variable by $100*(exp(\beta)-1)\%$

Table 10. Mutual forbearance effect split sample

	METFORMIN				CEFIXIME			
	Regulated		Unregulated		Regulated		Unregulated	
	MRP	PTR	MRP	PTR	MRP	PTR	MRP	PTR
MMC	0.003*	0.003*	0.002	0.001	-0.221***	-0.125***	0.353***	0.250***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.01]	[0.03]	[0.02]
Constant	1.741***	1.403***	1.155***	0.928***	40.274***	32.036***	28.545***	23.118***
	[0.03]	[0.02]	[0.02]	[0.01]	[1.15]	[0.86]	[0.68]	[0.54]
Observations	87,662	87,662	71,438	71,438	173,169	173,169	47,003	47,003
R-squared	0.588	0.574	0.653	0.654	0.482	0.518	0.808	0.813
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Seemingly Unrelated Regression (SUR) Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

APPENDIX D – PRICE COORDINATION AND MUTUAL FORBEARANCE

Table 12. *Multimarket contact and price coordination*

| | METFORMIN | | | | CEFIXIME | | | |
| | Regulated | | Unregulated | | Regulated | | Unregulated | |
	lnMRP	lnPTR	MRP	PTR	lnMRP	lnPTR	MRP	PTR
MMC	0.002	0.002*	0.001	0.001	-0.006	-0.005*	0.008*	0.007
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Period	0.309***	0.215***	0.294***	0.223***	-0.158***	-0.279***	-0.114	-0.167**
	[0.05]	[0.04]	[0.04]	[0.03]	[0.05]	[0.05]	[0.07]	[0.07]
MMC*Period	0.000	0.002	0.000	0.000	0.002	0.006*	-0.001	-0.000
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Constant	0.255***	0.034	0.165***	-0.049**	3.609***	3.379***	3.562***	3.348***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.05]	[0.05]	[0.06]	[0.06]
Observations	87,662	87,662	71,438	71,438	173,169	173,169	47,003	47,003
R-squared	0.633	0.613	0.673	0.664	0.529	0.551	0.590	0.597
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1. Coefficients can be interpreted as follows: a unit increase in the explanatory variable increases the dependent variable by $100*(exp(\beta)-1)\%$

Table 13. *Multimarket contact and price coordination*

| | METFORMIN | | | | CEFIXIME | | | |
| | Regulated | | Unregulated | | Regulated | | Unregulated | |
	MRP	PTR	MRP	PTR	MRP	PTR	MRP	PTR
MMC	0.002	0.002	0.001	0.001	-0.281***	-0.224***	0.363***	0.250***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.02]	[0.03]	[0.02]
Period	0.468***	0.277***	0.444***	0.260***	-6.047***	-8.547***	-4.801***	-5.362***
	[0.04]	[0.03]	[0.02]	[0.02]	[0.50]	[0.37]	[0.69]	[0.55]
MMC*Period	0.003*	0.003*	0.002	0.001	0.144***	0.239***	-0.033	0.000
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.01]	[0.03]	[0.02]
Constant	1.761***	1.416***	1.164***	0.933***	40.401***	32.246***	28.420***	23.119***
	[0.03]	[0.02]	[0.02]	[0.01]	[1.15]	[0.86]	[0.69]	[0.55]
Observations	91,443	91,443	74,464	74,464	173,169	173,169	47,003	47,003
R-squared	0.582	0.568	0.645	0.646	0.483	0.519	0.808	0.813
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Seemingly Unrelated Regression (SUR) Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

APPENDIX E – THE ROLE OF MARKET SHARE ON MMC AND DPCO2013 INDUCED COLLUSIVE BEHAVIOR

Table 15. *Market share & collusive behavior*

	METFORMIN				CEFIXIME			
	Regulated		Unregulated		Regulated		Unregulated	
	lnMRP	lnPTR	lnMRP	lnPTR	lnMRP	lnPTR	lnMRP	lnPTR
MMC	-0.004***	-0.003**	-0.000	0.000	-0.009***	-0.008***	0.003***	0.002
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Period	0.204***	0.135***	0.217***	0.151***	-0.173***	-0.286***	-0.067***	-0.118***
	[0.03]	[0.03]	[0.02]	[0.02]	[0.01]	[0.01]	[0.02]	[0.02]
MMC*Period	0.004***	0.004***	0.001	0.001	0.006***	0.008***	-0.007***	-0.006***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
L.MS	-0.151***	-0.129***	-0.064***	-0.054***	-0.030***	-0.036***	-0.035	-0.050**
	[0.02]	[0.02]	[0.01]	[0.01]	[0.01]	[0.01]	[0.02]	[0.02]
MMC*L.MS	0.009***	0.008***	0.003***	0.002**	0.007***	0.008***	0.008***	0.009***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Period*L.MS	0.225***	0.154***	0.108***	0.104***	0.095***	0.115***	-0.025	-0.024
	[0.03]	[0.03]	[0.03]	[0.03]	[0.02]	[0.01]	[0.03]	[0.03]
MMC*Period* L.MS	-0.010***	-0.006***	-0.002	-0.002	-0.009***	-0.010***	0.007***	0.007***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Constant	0.616***	0.401***	0.197***	-0.033**	3.700***	3.476***	3.335***	3.120***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]
Observations	82,379	82,379	67,486	67,486	158,337	158,337	42,457	42,457
R-squared	0.643	0.622	0.684	0.674	0.551	0.574	0.594	0.601
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Seemingly Unrelated Regression (SUR) Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1. Coefficients can be interpreted as follows: a unit in the explanatory variable increase the dependent variable by 100*(exp(β)-1)%

APPENDIX F – EFFECTIVE PRICES

Table 16. *Mutual forbearance effect full sample*

| | METFORMIN | | CEFIXIME | |
	eMRP	ePTR	eMRP	ePTR
MMC	0.002**	0.002**	-0.123	-0.062
	[0.00]	[0.00]	[0.11]	[0.08]
Constant	1.309***	1.052***	39.925***	31.395***
	[0.03]	[0.02]	[1.72]	[1.27]
Observations	159,100	159,100	220,172	220,172
R-squared	0.510	0.497	0.501	0.529
Month FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

Table 17. *Mutual forbearance effect split sample*

| | METFORMIN | | | | CEFIXIME | | | |
| | Regulated | | Unregulated | | Regulated | | Unregulated | |
	eMRP	ePTR	eMRP	ePTR	eMRP	ePTR	eMRP	ePTR
MMC	0.003**	0.003***	0.002	0.001	-0.241*	-0.140	0.358*	0.250
	[0.00]	[0.00]	[0.00]	[0.00]	[0.13]	[0.09]	[0.20]	[0.16]
Constant	1.395***	1.116***	1.206***	0.975***	39.512***	30.905***	37.562***	30.424***
	[0.03]	[0.02]	[0.03]	[0.03]	[1.98]	[1.48]	[2.60]	[2.13]
Observations	87,662	87,662	71,438	71,438	173,169	173,169	47,003	47,003
R-squared	0.588	0.574	0.653	0.653	0.489	0.525	0.810	0.815
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

Table 18. *Multimarket contact and price coordination*

	METFORMIN				CEFIXIME			
	Regulated		Unregulated		Regulated		Unregulated	
	eMRP	ePTR	eMRP	ePTR	eMRP	ePTR	eMRP	ePTR
MMC	0.002	0.002	0.001	0.001	-0.294**	-0.234**	0.363	0.246
	[0.00]	[0.00]	[0.00]	[0.00]	[0.15]	[0.11]	[0.22]	[0.18]
Period	0.457***	0.266***	0.438***	0.255***	-6.514**	-8.891***	-5.483**	-5.885***
	[0.08]	[0.05]	[0.07]	[0.05]	[2.55]	[1.76]	[2.68]	[2.19]
MMC*Period	0.004	0.003	0.002	0.001	0.126	0.225**	-0.018	0.013
	[0.00]	[0.00]	[0.00]	[0.00]	[0.15]	[0.11]	[0.17]	[0.14]
Constant	1.411***	1.129***	1.215***	0.980***	40.112***	31.974***	37.491***	30.474***
	[0.03]	[0.03]	[0.03]	[0.03]	[2.15]	[1.64]	[2.78]	[2.25]
Observations	87,662	87,662	71,438	71,438	173,169	173,169	47,003	47,003
R-squared	0.588	0.574	0.653	0.653	0.489	0.526	0.810	0.815
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

Table 19. *Market share & collusive behavior*

	METFORMIN				CEFIXIME			
	Regulated		Unregulated		Regulated		Unregulated	
	eMRP	ePTR	eMRP	ePTR	eMRP	ePTR	eMRP	ePTR
MMC	-0.006***	-0.004**	-0.003*	-0.002	-0.432***	-0.344***	0.220***	0.115***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.02]	[0.04]	[0.03]
Period	0.304***	0.171***	0.306***	0.159***	-6.845***	-8.920***	-4.124***	-4.641***
	[0.05]	[0.04]	[0.03]	[0.02]	[0.47]	[0.35]	[0.75]	[0.59]
MMC*Period	0.008***	0.006***	0.004**	0.003**	0.219***	0.287***	-0.274***	-0.207***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.01]	[0.04]	[0.03]
L.MS	-0.228***	-0.152***	-0.123***	-0.083***	-3.629***	-3.181***	-2.404***	-2.414***
	[0.03]	[0.03]	[0.02]	[0.02]	[0.44]	[0.33]	[0.66]	[0.52]
MMC*L.MS	0.014***	0.009***	0.006***	0.004***	0.424***	0.353***	0.314***	0.293***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]	[0.02]	[0.04]	[0.04]
Period*L.MS	0.371***	0.214***	0.186***	0.139***	4.876***	4.977***	-0.349	0.242
	[0.06]	[0.05]	[0.04]	[0.03]	[0.78]	[0.58]	[1.05]	[0.83]
MMC*Period* L.MS	-0.014***	-0.008**	-0.004*	-0.003**	-0.414***	-0.397***	0.229***	0.160***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.05]	[0.04]	[0.07]	[0.05]
Constant	1.891***	1.518***	1.245***	0.985***	39.874***	31.909***	25.803***	21.346***
	[0.04]	[0.03]	[0.02]	[0.02]	[1.19]	[0.88]	[0.78]	[0.62]
Observations	82,379	82,379	67,486	67,486	158,337	158,337	42,457	42,457
R-squared	0.590	0.574	0.673	0.674	0.516	0.556	0.784	0.788
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Seemingly Unrelated Regression (SUR) Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

APPENDIX G – PROMOSHARE

Table 23. *Mutual forbearance effect promotional behavior, full and split sample*

	METFORMIN			CEFIXIME		
		Regulated	Unregulated		Regulated	Unregulated
	Promoshare	Promoshare	Promoshare	Promoshare	Promoshare	Promoshare
MMC	0.000	0.000	0.000	0.101***	0.118***	0.002
	[0.00]	[0.00]	[0.00]	[0.03]	[0.03]	[0.06]
Constant	0.000	0.001	-0.000	0.936	0.869	1.664
	[0.00]	[0.00]	[0.00]	[0.62]	[0.61]	[1.08]
Observations	159,100	87,662	71,438	221,545	174,542	47,003
R-squared	0.150	0.222	0.017	0.247	0.257	0.286
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

Table 24. *Multimarket contact and price coordination: promotional behavior Metformin*

	METFORMIN		CEFIXIME	
	Regulated	Unregulated	Regulated	Unregulated
	Promoshare	Promoshare	Promoshare	Promoshare
MMC	0.000	0.000	0.080**	0.021
	[0.00]	[0.00]	[0.04]	[0.06]
Period	0.004***	0.003	2.288***	2.983***
	[0.00]	[0.00]	[0.65]	[0.91]
MMC*Period	-0.000**	-0.000	0.090*	-0.065*
	[0.00]	[0.00]	[0.05]	[0.04]
Constant	0.001	-0.001	1.297**	1.411
	[0.00]	[0.00]	[0.57]	[1.10]
Observations	87,662	71,438	174,542	47,003
R-squared	0.222	0.017	0.258	0.287
Month FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

Table 25. *Market share and collusive promotional behavior*

	METFORMIN		CEFIXIME	
	Regulated	Unregulated	Regulated	Unregulated
	Promoshare	Promoshare	Promoshare	Promoshare
MMC	-0.000	0.000**	0.111***	0.075*
	[0.00]	[0.00]	[0.03]	[0.04]
Period	0.002**	0.003	0.155	0.705
	[0.00]	[0.00]	[0.64]	[0.86]
MMC*Period	-0.000	-0.000	-0.024	-0.066
	[0.00]	[0.00]	[0.03]	[0.05]
L.MS	-0.001	0.002**	-0.556	2.473*
	[0.00]	[0.00]	[1.31]	[1.42]
MMC*L.MS	0.000	-0.000**	0.025	-0.128
	[0.00]	[0.00]	[0.08]	[0.10]
Period*L.MS	0.001	0.000	8.338***	5.710**
	[0.00]	[0.00]	[2.36]	[2.52]
MMC*Period* L.MS	-0.000	-0.000	-0.355***	-0.288**
	[0.00]	[0.00]	[0.13]	[0.14]
Constant	0.002	-0.003*	3.889***	2.366***
	[0.00]	[0.00]	[0.76]	[0.85]
Observations	82,379	67,486	159,533	42,457
R-squared	0.248	0.020	0.275	0.303
Month FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes

Note. Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

APPENDIX H – ROBUSTNESS CHECK HHI

Table 26. *Robustness check HHI full model*

	METFORMIN				CEFIXIME			
	Regulated		Unregulated		Regulated		Unregulated	
	MRP	PTR	MRP	PTR	MRP	PTR	MRP	PTR
MMC	-0.006***	-0.004**	-0.002*	-0.001	-0.414***	-0.330***	0.232***	0.132***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.02]	[0.04]	[0.03]
Period	0.310***	0.175***	0.313***	0.165***	-6.311***	-8.530***	-3.525***	-4.148***
	[0.05]	[0.04]	[0.03]	[0.02]	[0.47]	[0.35]	[0.75]	[0.59]
MMC*Period	0.008***	0.006***	0.004*	0.003*	0.219***	0.288***	-0.286***	-0.222***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.01]	[0.04]	[0.03]
L.MS	-0.228***	-0.154***	-0.120***	-0.081***	-3.684***	-3.226***	-1.611**	-1.736***
	[0.03]	[0.03]	[0.02]	[0.02]	[0.44]	[0.33]	[0.66]	[0.52]
MMC*L.MS	0.014***	0.009***	0.006***	0.004***	0.430***	0.358***	0.275***	0.259***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]	[0.02]	[0.04]	[0.04]
Period*L.MS	0.374***	0.217***	0.184***	0.136***	6.816***	6.521***	1.007	1.131
	[0.06]	[0.05]	[0.04]	[0.03]	[0.77]	[0.57]	[1.05]	[0.83]
MMC*Period* L.MS	-0.014***	-0.008***	-0.004*	-0.003**	-0.505***	-0.471***	0.160**	0.119**
	[0.00]	[0.00]	[0.00]	[0.00]	[0.05]	[0.04]	[0.07]	[0.05]
HHI	-0.033***	-0.029***	-0.029***	-0.015**	0.031	-0.440	-1.228	-0.965
	[0.01]	[0.01]	[0.01]	[0.01]	[1.03]	[0.77]	[1.38]	[1.09]
Constant	1.910***	1.536***	1.259***	0.991***	39.996***	32.041***	27.075***	22.129***
	[0.04]	[0.03]	[0.02]	[0.02]	[1.19]	[0.88]	[0.79]	[0.62]
Observations	82,379	82,379	67,486	67,486	158,337	158,337	42,457	42,457
R-squared	0.590	0.574	0.674	0.674	0.510	0.549	0.781	0.785
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Seemingly Unrelated Regression (SUR) Fixed Effects model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

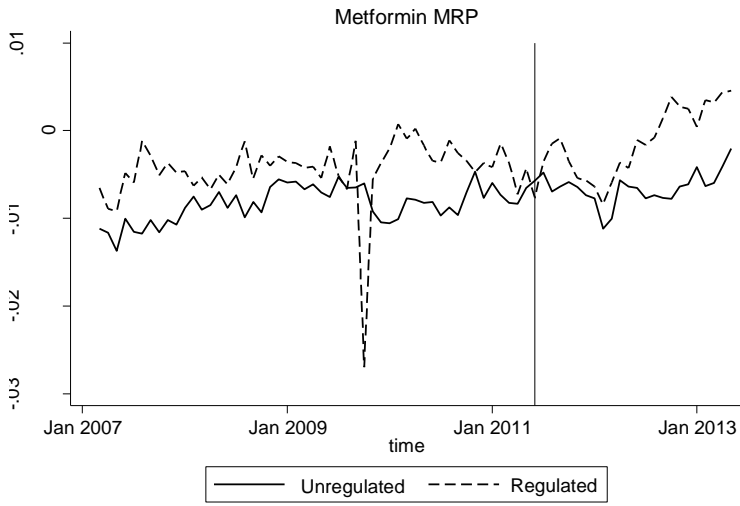Figure 5. *Metformin MMC effect on MRP, per month*

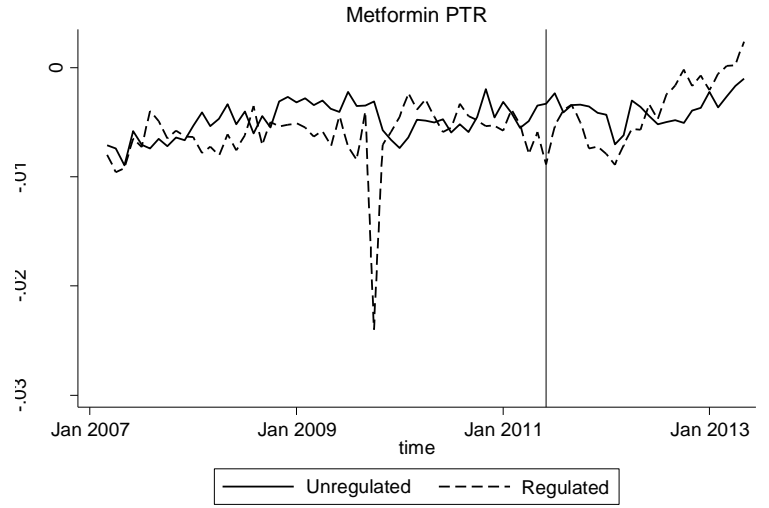Figure 6. *Metformin MMC effect on PTR, per month*

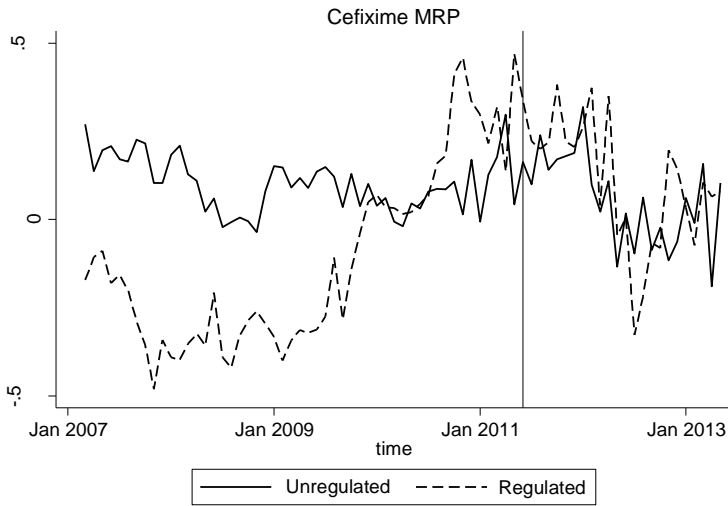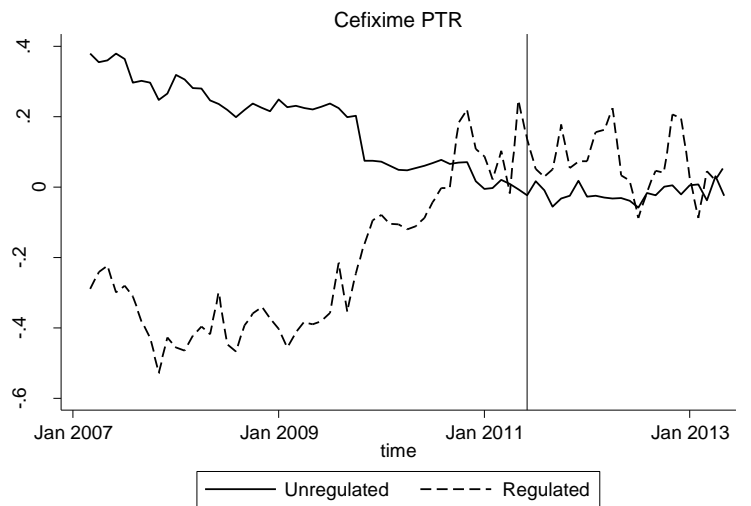Figure 7. *Cefixime MMC effect on MRP, per month*

Figure 8. *Cefixime MMC effect on PTR, per month*

APPENDIX J – INSTRUMENTAL VARIABLE ANALYSIS

Table 27. *Results Instrumental Variable analysis: full sample Metformin*

METFORMIN	MRP	MRP	PTR	PTR	Bonusunits	Bonusunits
MMC	0.015**	0.052	0.011**	0.037	-2.330	5.622
	[0.01]	[0.06]	[0.01]	[0.05]	[1.51]	[6.32]
Constant	1.171***	0.706	0.959***	0.641	53.171**	-49.157
	[0.10]	[0.79]	[0.08]	[0.64]	[20.71]	[81.72]
Observations	123,474	123,474	123,474	123,474	123,474	123,474
R-squared	0.490	0.485	0.473	0.469	0.004	0.005
Region FE	No	Yes	No	Yes	No	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes
Endogeneity test						
Regression F	1.48	0.61	1.22	0.46	0.30	0.74
P value	0.22	0.44	0.27	0.50	0.59	0.40

Note. 2sls instrumental variable model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

Table 28. *Results Instrumental Variable analysis: full sample Cefixime*

CEFIXIME	MRP	MRP	PTR	PTR	Bonusunits	Bonusunits
MMC	-1.071	-14.911	-0.582	-8.321	-6.726	295.116
	[0.95]	[73.32]	[0.69]	[41.50]	[14.92]	[1,445.30]
Constant	49.166***	276.667	35.110***	162.349	245.590	-4,711.268
	[14.61]	[1,201.60]	[10.53]	[680.05]	[241.24]	[23,707.42]
Observations	119,396	119,396	119,396	119,396	119,632	119,632
R-squared	0.344		0.422		0.092	
Region FE	No	Yes	No	Yes	No	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Company FE	Yes	Yes	Yes	Yes	Yes	Yes
Endogeneity test						
Regression F	1.34	1.27	0.77	0.70	0.33	2.43
P value	0.25	0.26	0.39	0.40	0.57	0.12

Note. 2sls instrumental variable model estimated using Month, Region, and Company FEs. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.