Market Power and Regulation in Pharmaceutical Markets

Klaus Gugler, Lukas Pirnbacher & Florian Szücs

JEEA Teaching Slides

WIRTSCHAFTS
UNIVERSITÄT
WIEN VIENNA
UNIVERSITY OF
ECONOMICS
AND BUSINESS

Motivation

- **Pharmaceutical markets** are complex and often heavily **regulated**
  - Market entry (drug authorization, patent protection)
  - Price regulation
  - Reimbursement rules (coverage by social insurance, co-payments)
- Substantial changes to market structure induced by **M&A**
  - 56 large, international M&A affected the Austrian pharma market in the 2009–2017 period (34 deals with overlap in ATC4 markets)
  - 439 drugs changed owner in overlapping markets

Research Questions

What are the price, variety and welfare effects of ownership changes with and without price regulation? Can regulation mitigate the adverse effects of increased market power?

- Diff-in-Diff estimation
- Case study based on structural model

Related Literature

- Price effects of mergers (Ashenfelter & Hosken, 2010; Björnerstedt & Verboven, 2016; Dafny, 2009)
- Non-price effects of mergers (Berry & Waldfogel, 2001; Fan, 2013; Sweeting, 2010)
- Effects of regulation in pharma markets (Branstetter et al., 2016; Dubois & Lasio, 2018)

Contribution

- Joint analysis of mergers and regulation
- Estimate effects of regulation in a within-country setting

Main Results

Diff-in-Diff

Merging firms ...

- increase prices by 7.1% in unregulated market segments
- do not increase prices in regulated segments
- decrease product variety (−5.6% in unregulated market segments, −2.6% in regulated segments)

Structural Model

- Consumers value drug variety and are less price-sensitive in the regulated market segment
- Price regulation is binding and generates significant savings (30%–40% higher prices without regulation)
- M&A does not decrease consumer surplus under regulation

The Austrian Pharma Market

- **Unregulated segment:** free price setting + consumers pay privately
- **Regulated segment**: external reference pricing ($\approx$ EU average price) + pricing rules for generics + consumers reimbursed by social insurance
  - 99% of the population covered by social insurance
  - Around 2/3 of drugs are reimbursable
- Drug approval, clinical trials and pharmacovigilance by AGES
  - New drugs are approved if expected benefits exceed expected side effects (comprehensive clinical tests required)
  - New variants of existing drugs (dosages, consumption forms) can be approved relatively quickly without a new authorization process

The Data

- Monthly data on all drugs sold in Austrian pharmacies and hospitals between 2004 and 2017 (IMS Health)
  - Product = all package sizes, consumption forms and dosages of a drug
  - Revenues and quantities sold (in standardized units, i.e. "doses")
  - Drug characteristics (active substance, prescription status, ...)
  - Variety = number of available dosages and consumption forms
- Distinguish sales in regulated and unregulated market segments
- Market definition based on medical area: ATC4 (chemical subgroup; well-defined disease indication)
- Largest players: Novartis (12%), Pfizer (6%), AstraZeneca (5%)
- Largest mergers: Allergan/Actavis (68 bn USD), Pfizer/Wyeth (67 bn USD), Teva/Allergan (39 bn USD, case study)
  - ▶ Likely exogenous w.r.t. regulation in Austria

Summary statistics across years

		Products		Market Share				Variety			
				Overall		Treated		Overall		Treated	
Year	Firms	Reg	UnReg	Reg	UnReg	Reg	UnReg	Reg	UnReg	Reg	UnReg
2004	294	1448	1721	0.23	0.29	.	.	2.01	1.52	.	.
2005	302	1524	1724	0.23	0.29	.	.	2.03	1.52	.	.
2006	304	1591	1701	0.22	0.29	.	.	2.05	1.53	.	.
2007	313	1607	1696	0.22	0.30	.	.	2.08	1.54	.	.
2008	313	1634	1704	0.22	0.30	.	.	2.09	1.53	.	.
2009	313	1668	1722	0.21	0.31	0.21	0.29	2.11	1.52	1.94	1.80
2010	319	1704	1734	0.21	0.30	0.08	0.22	2.13	1.54	2.34	1.57
2011	323	1774	1744	0.20	0.30	0.13	0.24	2.13	1.55	2.36	1.59
2012	328	1853	1757	0.20	0.31	0.02	0.15	2.16	1.56	2.41	1.68
2013	322	1897	1773	0.20	0.30	0.00	0.00	2.19	1.57	2.44	1.68
2014	324	1954	1780	0.19	0.30	0.36	0.10	2.19	1.56	2.42	1.56
2015	333	2040	1853	0.19	0.30	0.04	0.06	2.18	1.55	2.46	1.47
2016	335	2113	1883	0.19	0.28	0.07	0.14	2.16	1.56	2.48	1.50
2017	334	2162	2002	0.19	0.28	0.03	0.38	2.14	1.56	2.47	1.49

Ownership changes by year

			Treated products	
Year	Deals	Total value	Merging firms	Rivals
2009	7	106125	36	67
2010	7	23375	185	146
2011	3	20076	27	55
2012	1	6003	54	24
2013	2	13796	3	17
2014	4	17749	19	20
2015	5	103553	51	38
2016	3	45922	53	51
2017	2	371	11	40
Total	34	336971	439	458

Oligopoly Model

- Each firm $f \in F$ sets prices and variety for all drugs $j \in J_f$ to maximize (variable) profits:

$$\max_{\{p_j, v_j\}} \Pi_f = \sum_{j \in J_f} \left[p_j - c_j(v_j) \right] q_j(\mathbf{p}, \mathbf{v})$$

- **Nash equilibrium** in the unregulated segment is characterized by

$$\frac{\partial \Pi_f}{\partial p_j} = q_j + [p_j - c_j] \frac{\partial q_j}{\partial p_j} + \sum_{k \in J_f \setminus \{j\}} [p_k - c_k] \frac{\partial q_k}{\partial p_j} = 0$$

$$\frac{\partial \Pi_f}{\partial v_j} = -\frac{\partial c_j}{\partial v_j} q_j + [p_j - c_j] \frac{\partial q_j}{\partial v_j} + \sum_{k \in J_f \setminus \{j\}} [p_k - c_k] \frac{\partial q_k}{\partial v_j} = 0$$

- Under regulation, firms face the price constraint $p_j \in [0, \bar{p}_j]$

Price Effects of Mergers: No Regulation

Bertrand competition à la Björnerstedt and Verboven (2016). Equilibrium prices satisfy:

$$\mathbf{p} = \mathbf{c} - \left(\theta^F \odot \Delta\mathbf{p}\right)^{-1} \times \mathbf{q}(\mathbf{p}, \mathbf{v}) \tag{1}$$

After the merger ...

- Number of non-zero elements in ownership matrix θ^F increases
- In case of substitutes, the number of products with positive cross-price elasticities in $\theta^F \odot \Delta\mathbf{p}$ increases

$\Rightarrow$ Merging firms' optimal **prices increase** (UPP)

Note: This reasoning abstracts from merger efficiencies, reactions of rivals or non-price effects (e.g. product repositioning).

Price Effects of Mergers: Regulation

Following Dubois and Lasio (2018), equilibrium prices satisfy:

$$\mathbf{p} = \mathbf{c} - \left(\theta^F \odot \Delta\mathbf{p}\right)^{-1} \times (\mathbf{q}(\mathbf{p}, \mathbf{v}) - \lambda) \quad (2)$$

After the merger . . .

- If regulation is binding ($\lambda_j > 0$), prices cannot increase
- But: Wedge between the prices firms would like to set (equation (1)) and the prices they can set (equation (2)) increases

$\Rightarrow$ **Price constraints** become **more binding**

Variety Effects of Mergers

Firms' optimal variety choices are characterized by (Crawford et al., 2019):

$$\frac{\partial \Pi}{\partial v_k} = \underbrace{-\frac{\partial c_k}{\partial v_k} q_k}_{\text{cost effect}} + \underbrace{(p_k - c_k)\frac{\partial q_k}{\partial v_k}}_{\text{demand effect}} + \underbrace{\sum_{j \neq k, j \in F_f} (p_j - c_j)\frac{\partial q_j}{\partial v_k}}_{\text{cannibalization effects}} = 0 \qquad (3)$$

After the merger ...

- Additional cannibalization effects due to larger product portfolio of merged entity ⇒ optimal level of product **variety decreases**
- Under binding **price regulation**: Incremental cannibalization effects are smaller due to lower markups ⇒ optimal **variety adjustment** is **smaller**

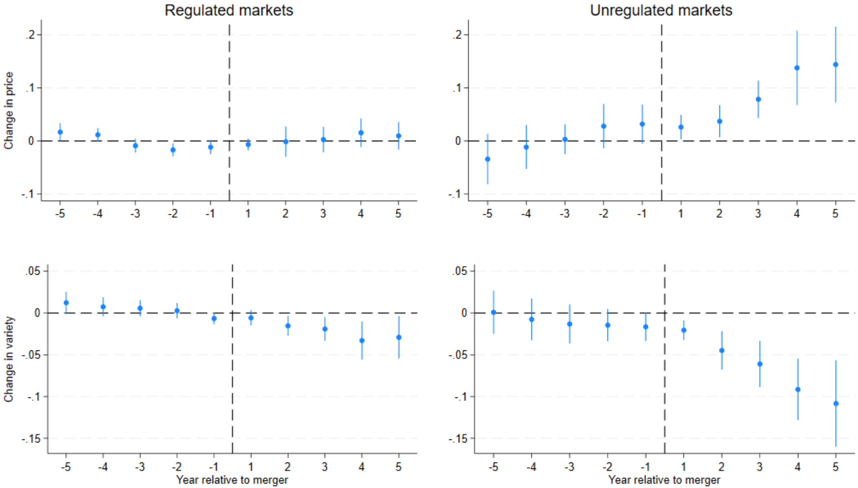
Estimating Merger Effects

- Mergers occur at different points in time $\Rightarrow$ Sun and Abraham (2021) estimator to account for **staggered treatment adoption**
- Separate treatment effects for
  - regulated and unregulated segments
  - merging firms and rival
- Estimation equation:

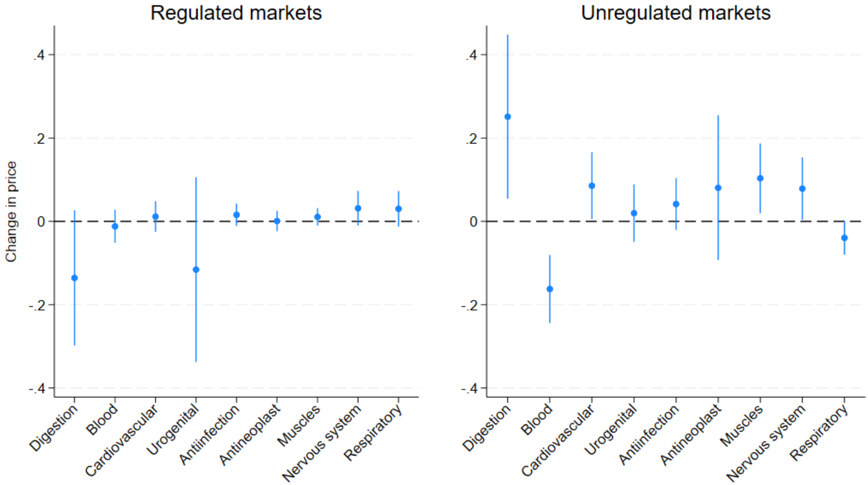
$$log(y_{i,t,c,m}) = \alpha_{i,c,m} + \tau_t + \gamma^M \left(\text{post}_{i,t,c,m} \times H_{i,t,m}\right) + \mathbb{X}_{i,t,m}\Gamma + \epsilon_{i,t,c,m}$$

  - $y \in \{p, v\}$
  - i, t, c, m: drug, month, company, market (regulated/unregulated)
  - 2-way fixed effects (product and month) plus controls for generic entry, drug age, protection status, patent expiry
  - Standard errors clustered at firm level

Period-specific treatment effects for acquirer and target drugs



Price effects by medical indication (ATC1)



Price and variety effects for merging firms

	Price		Variety	
	Reg	UnReg	Reg	UnReg
ATT	0.003	0.069***	−0.026**	−0.058***
S.E.	0.01	0.02	0.01	0.02
Observations	297428	255134	297036	253729
R^2	0.99	0.98	0.96	0.93

Notes: Standard errors allow for clustering at the firm level; *p<0.1, **p<0.05, ***p<0.01. All regressions include fixed effects at the drug- and period-level and control for additional covariates.

Price and variety effects for rivals

	Price		Variety	
	Reg	UnReg	Reg	UnReg
ATT	0.012	0.022	0.010	0.059
S.E.	0.02	0.04	0.01	0.06
Observations	297428	255134	297036	253729
R^2	0.99	0.98	0.96	0.93

Notes: Standard errors allow for clustering at the firm level; $^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$. All regressions include fixed effects at the drug- and period-level and control for additional covariates.

Case Study

We focus on the acquisition of **Allergan** by **Teva** and its impact on the market for **platelet aggregation inhibitors**.

- Third largest transaction in our sample (39 bn USD)
- Most important ATC4 among all antithrombotic agents
- Majority of drugs sold in parallel in regulated and unregulated segment
- Both market segments affected by the merger

Objectives

Use empirically calibrated oligopoly model to

(1) test if **price constraints** are binding

(2) simulate merger effects and conduct **welfare analysis**

Calibration of the Structural Model

(1) Separately **estimate demand** in regulated and unregulated segments

(2) Combine demand estimates in unregulated segment with Nash equilibrium (NE) assumption in prices to recover marginal cost

(3) **Estimate marginal cost function**

$$\log c_{jt} = \gamma v_{jt} + w_{jt}\delta_S + \omega_{jt},$$

taking the endogeneity of v_{jt} into account

Demand Estimation

- We model demand for drugs using a **nested logit model** (Berry, 1994), with nests defined by the active substance
- IV estimation of segment-specific demand:

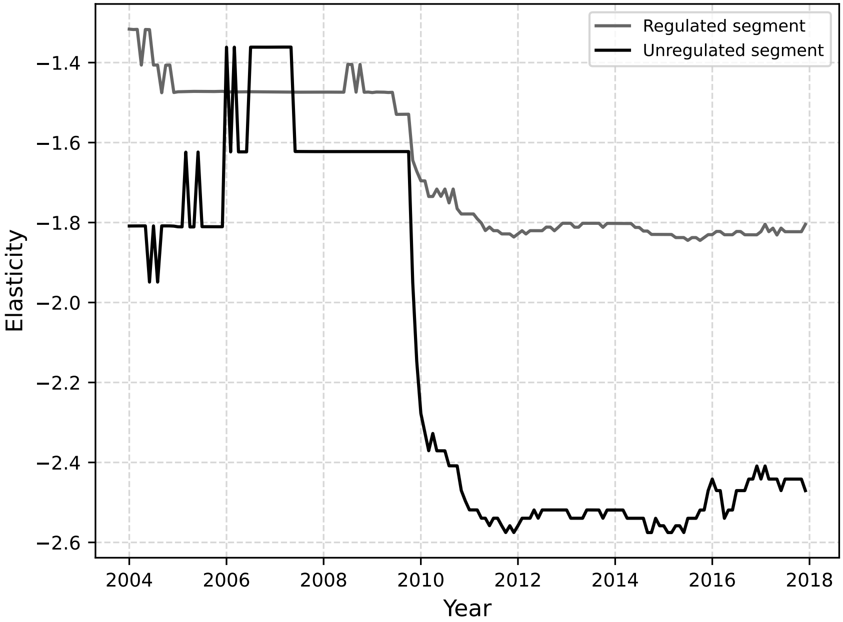
$$\log\left(\frac{s_{jt}}{s_{0t}}\right) = \alpha \log p_{jt} + \beta \log v_{jt} + \rho \log s_{jt|g} + x_{jt}\delta + \xi_{jt}$$

  - Instruments for prices, variety and within-nest market shares $s_{jt|g}$
  - Demand shifters x_{jt} include a generic dummy, product age, product age^2, firm and molecule fixed effects
- Exogenous product characteristics are used to construct **Differentiation IVs** (Gandhi & Houde, 2020)

Demand and supply estimates

	Unregulated		Regulated	
	Coefficient	SE	Coefficient	SE
Demand				
log(Price)	-0.317	(0.049)	-0.495	(0.067)
log(Variety)	0.336	(0.110)	0.896	(0.107)
Generic	-0.920	(0.117)	-0.926	(0.147)
Product age	0.014	(0.019)	0.062	(0.015)
$(\text{Product age})^2$	-0.002	(0.001)	-0.002	(0.000)
Nesting parameter	0.892	(0.038)	0.756	(0.035)
Supply				
Variety	0.434	(0.064)		
Generic	0.170	(0.039)		

Notes: Demand regressions include firm, molecule and year fixed effects. The supply-side regression uses all drug-period observations where recovered marginal costs are positive and includes year × molecule fixed effects. Robust standard errors are reported in parentheses.


Regulated segment
Unregulated segment
−1.4
−1.6
−1.8
−2.0
−2.2
−2.4
−2.6
Elasticity
2004
2006
2008
2010
2012
2014
2016
2018
Year

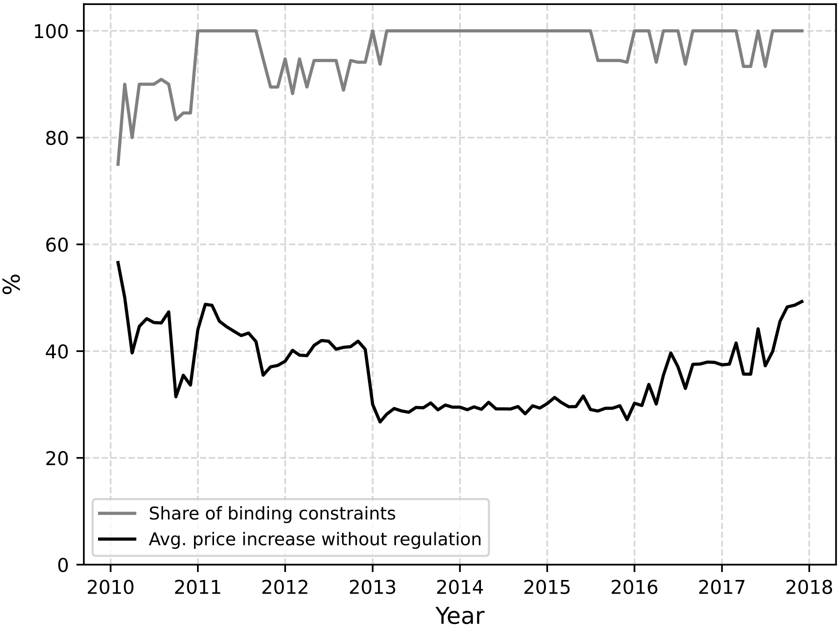
Are Price Constraints Binding?

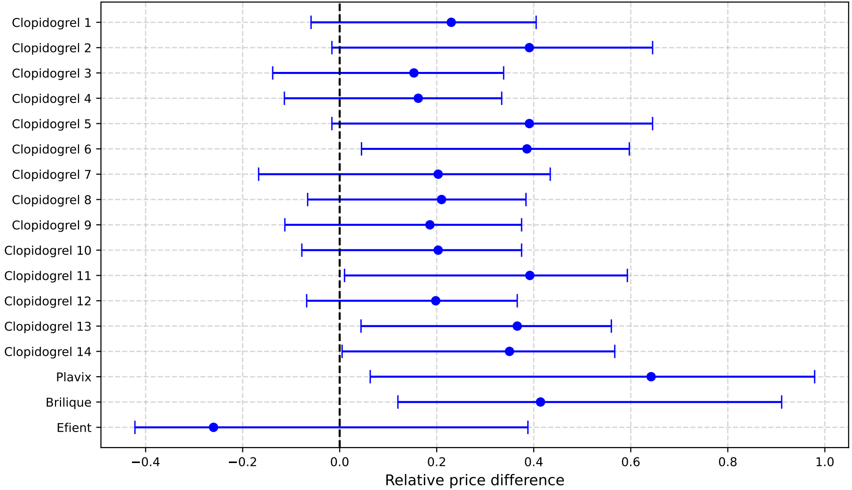
Strategy

(1) Combine demand estimates in unregulated segment with Bertrand assumption to recover marginal costs

(2) Combine marginal costs with market structure and demand estimates in the regulated segment and simulate the (unrestricted) Nash-Bertrand equilibrium

(3) Compare simulated with observed prices


100
80
60
40
20
0
%
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Share of binding constraints
Avg. price increase without regulation



Relative differences (with 80% CI) between observed and simulated Bertrand prices in the month before the Teva-Allergan acquisition.

Welfare Effects of the Teva-Allergan Merger?

Strategy

(1) Combine demand estimates with estimated marginal cost function and simulate the pre-merger NE in prices and variety

- Model not calibrated to reflect an exact NE in variety, since we do not exploit firms' variety first-order conditions in the estimation

(2) Simulate the post-merger NE taking the change in ownership structure into account

(3) Compare the simulated pre- and post-merger equilibria

Price and variety effects of the Teva-Allergan merger

	Price (in %)	Variety (in %)	
	UnReg	Reg	UnReg
Merging firms	5.3	-0.5	-0.4
	(1.1, 11.7)	(-0.6, -0.0)	(-0.6, 0.0)
Rivals	0.5	0.2	0.2
	(0.1, 1.4)	(0.0, 0.4)	(0.0, 0.4)

Notes: Relative differences between simulated pre- and post-merger equilibrium (with 80% CI in parentheses). Reported price and variety changes are mean values across all drugs sold by merging firms and rivals, respectively.

Profit and consumer surplus effects of the Teva-Allergan merger

	Variable profit (in %)		Consumer surplus (in %)
	Merging firms	Rivals	
Reg	0.4	-0.1	0.01
	$(-0.1, 1.0)$	$(-0.3, 0.0)$	$(-0.00, 0.02)$
UnReg	1.1	2.8	-0.36
	$(0.4, 2.9)$	$(0.7, 4.7)$	$(-0.69, -0.10)$

Notes: Relative differences of variable profits and consumer surplus between the simulated pre- and post-merger equilibrium. 80% CI reported in parentheses.

Conclusions

- Price and non-price effects of mergers are sizable
  - Merging firms increase prices by 7.1% in the unregulated segment
  - Merging firms reduce drug variety by 2.6% in regulated and 5.6% in unregulated market segments
- Price regulation matters
  - Price constraints are binding and generate substantial savings
  - Regulation dampens variety decreases after M&A and prevents price increases as well as consumer surplus losses

$\Rightarrow$ Regulation can successfully mitigate the adverse effects of increased market power induced by mergers

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