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Financing decisions following negative shocks in the product market: A matrix-completion study of the U.S. pharmaceutical industry

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ABSTRACT

We investigate whether firms adjust their financing policies in response to a negative shock affecting their product market. Focusing on the pharmaceutical industry, we leverage the U.S. Inflation Reduction Act (IRA) of 2022 as an exogenous shock, marking the government's inaugural authority to negotiate drug prices. Using a matrix completion approach, a supervised machine-learning methodology that allows to compare treatment outcomes against predicted counterfactual values in absence of the treatment, our analysis reveals that pharmaceutical firms react to this regulatory intervention by issuing more equity. This finding suggests that firms raise fresh capital to mitigate the adverse impact of IRA on the product market.

1. Introduction

A firm's ability to respond to negative shocks is crucial for its survival and growth. Among various types of exogenous shocks, negative shocks in the product market, such as the erosion of existing products, have drawn considerable attention due to their fundamental implications for a firm's growth prospects (e.g., Krieger et al., 2022). Most of these studies have focused on pharmaceutical firms as the large investments, long time to market, and highly uncertain payoffs associated with their business model make them particularly vulnerable to adverse shocks (Hermosilla, 2021).

However, while the responses of pharmaceutical firms in terms of innovation policy have been extensively examined, relatively little attention has been devoted to how these firms recalibrate their financing decisions, an equally crucial domain due to the market frictions faced by (pharmaceutical) firms when raising capital (Giambona et al., 2021; Thakor and Lo, 2022). Therefore, we investigate how negative shocks to product markets influence the financing policies of pharmaceutical firms.

To identify whether firms change their financing decisions, we rely on a quasi-experimental setting and exploit the U.S. Inflation Reduction Act (IRA) of August 2022 as an exogenous shock to firms' existing products. Although primarily framed to address climate and inflation issues, the IRA substantially affects the pharmaceutical market by empowering the U.S. government to negotiate prices for drugs covered by Medicare (Vogel et al., 2024). This puts pressure on firms' margins by reducing the profitability of products subject to negotiation and forces firms to adjust their drug development portfolios. Some firms have even initiated legal actions against the IRA, arguing that the government is coercing them to sell medicines below market value.[1]

We investigate whether and how firms modify their financing decisions following the passage of the IRA, particularly regarding equity issues. Our focus on equity arises from existing literature extensively documenting that pharmaceutical firms rely almost exclusively on equity financing due to the lack of tangible assets for collateral and high cash flow uncertainty, which exacerbates the agency frictions that impede debt financing (e.g. Brown et al., 2009; Lo and Thakor, 2022).

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[1] See, e.g., "U.S. Plan to Negotiate Drug Prices Faces Fresh Industry Fire", Wall Street Journal, June 2021 (www.wsj.com/articles/u-s-plans-to-negotiate-drug-prices-face-fresh-industry-fire-9838a14e).

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Table 1
Total equity issued by U.S. firms in each Fama-French 5 industry category (in $bn).

		Consumer	Manufacturing	Technology	Healthcare	Other
Pre-treatment	Aug21-Oct21	5.72	6.26	21.37	2.64	15.95
	Nov21-Jan22	17.96	2.64	8.65	2.96	12.84
	Feb22-Apr22	1.52	2.21	1.06	0.68	3.49
	May22-Jul22	1.57	0.95	0.88	1.12	4.11
Post-treatment	Aug22-Oct22	1.73	1.44	3.77	3.52	4.44
	Nov22-Jan23	2.72	1.85	3.37	4.56	2.05
	Feb23-Apr23	1.06	2.49	4.92	1.56	2.78
	May23-Jul23	8.16	5.91	5.61	5.08	4.12

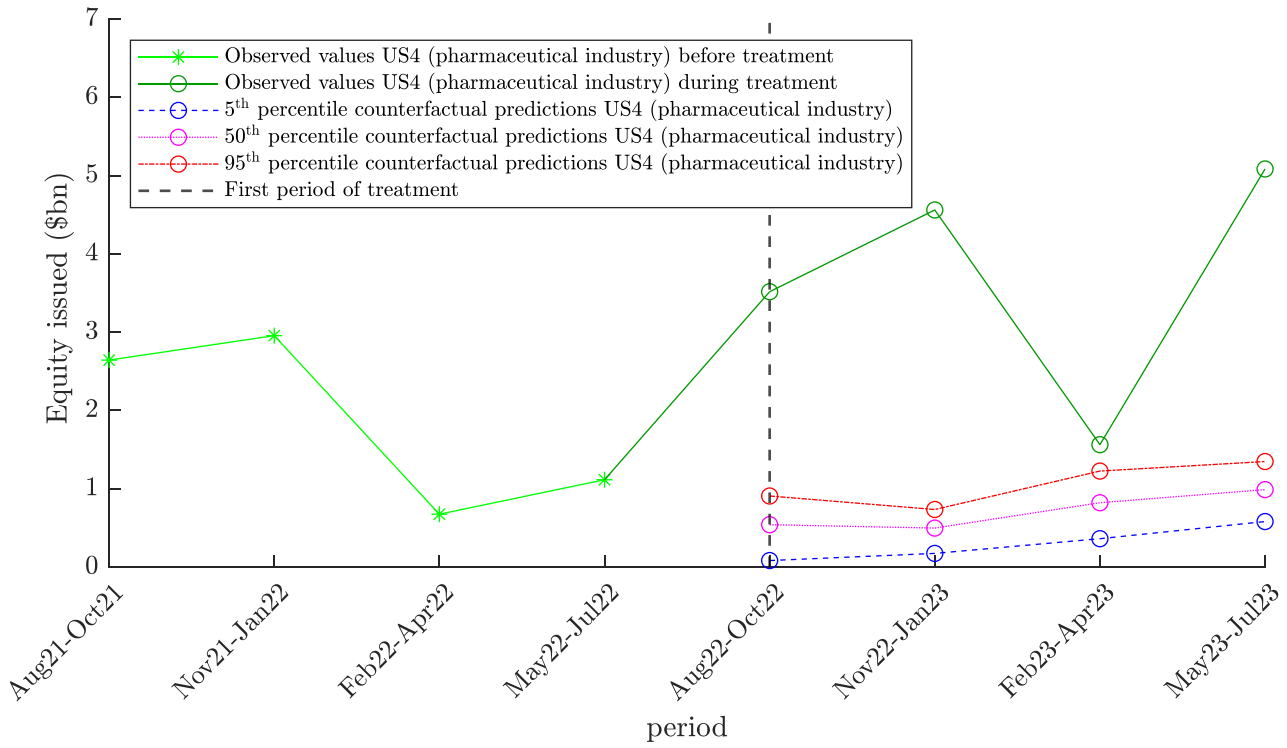

Fig. 1. Results of the main analysis (with matrix completion).

2. Sample and methodology

Using LSEG (formerly Refinitiv) as data source, we build a dataset of equity issues, including both Initial Public Offerings and Seasoned Equity Offerings, completed by firms in the U.S., Europe (EU-15 plus Norway), and Australia from July 2021 to September 2023. We aggregate proceeds by Fama-French macro-sectors every quarter, with the U. S. pharmaceutical industry being the treated group (additional details on the dataset construction are in Appendix B). As reported in Table 1 for the U.S., each industry-quarter unit is observed for 8 quarters (4 before and 4 after IRA adoption). By comparing pre-treatment/post-treatment periods, we note a general decrease across industries in the volume of equity issuance from 2021 to 2022, but the pharmaceutical industry seems to exhibit an increase from August 2022 to October 2022 (the first treated quarter) onward. Data for the other regions are in Tables A1 and A2 in Appendix A.

Our identification strategy is based on measuring the change in firms' equity issuance decisions relative to a set of control observations at the country-industry level. Initially, we considered employing the Difference-in-Differences (DiD) approach, a traditional econometric technique used to examine the differential effect on a treatment group compared to a control group. However, we discarded this method because the parallel trend assumption, which is crucial for its validity, is not satisfied in this context (see Figure A1 in Appendix A).

Given this premise, more extensively motivated in Appendix C, machine-learning methods such as the Synthetic Control Method (SCM, Gilchrist et al., 2023) and Matrix Completion (MC, Athey et al., 2021) represent feasible alternative methods of analysis. In SCM, untreated subjects serve as potential "donors" to construct a synthetically treated subject. An optimization algorithm assigns a weight between 0 and 1 to each donor, thus creating the synthetically treated subject (the sum of all these weights is constrained to 1). The treated subject during the pre-treatment phase should not exhibit extreme values. This is known as the convex hull restriction assumption (Goh and Yu, 2022), which holds in our case. Figure A2 in Appendix A shows that the observed values are above the counterfactual estimated for the U.S. pharmaceutical industry. However, the challenge lies in assessing the statistical significance of the SCM results.

For this reason, we adopt the MC methodology. MC predicts unobserved counterfactual values of an outcome variable – the values that would have been observed in the treatment group during the treatment period in the absence of the treatment (or policy). This prediction relies on the observed values of the outcome variable in the treatment group during the pre-treatment period and in the control group throughout the entire observation period. Consequently, the policy effect is estimated by comparing the observed values of the outcome variable in the treatment group during the treatment period (in the presence of the policy) with the predicted counterfactual values for the same period (in

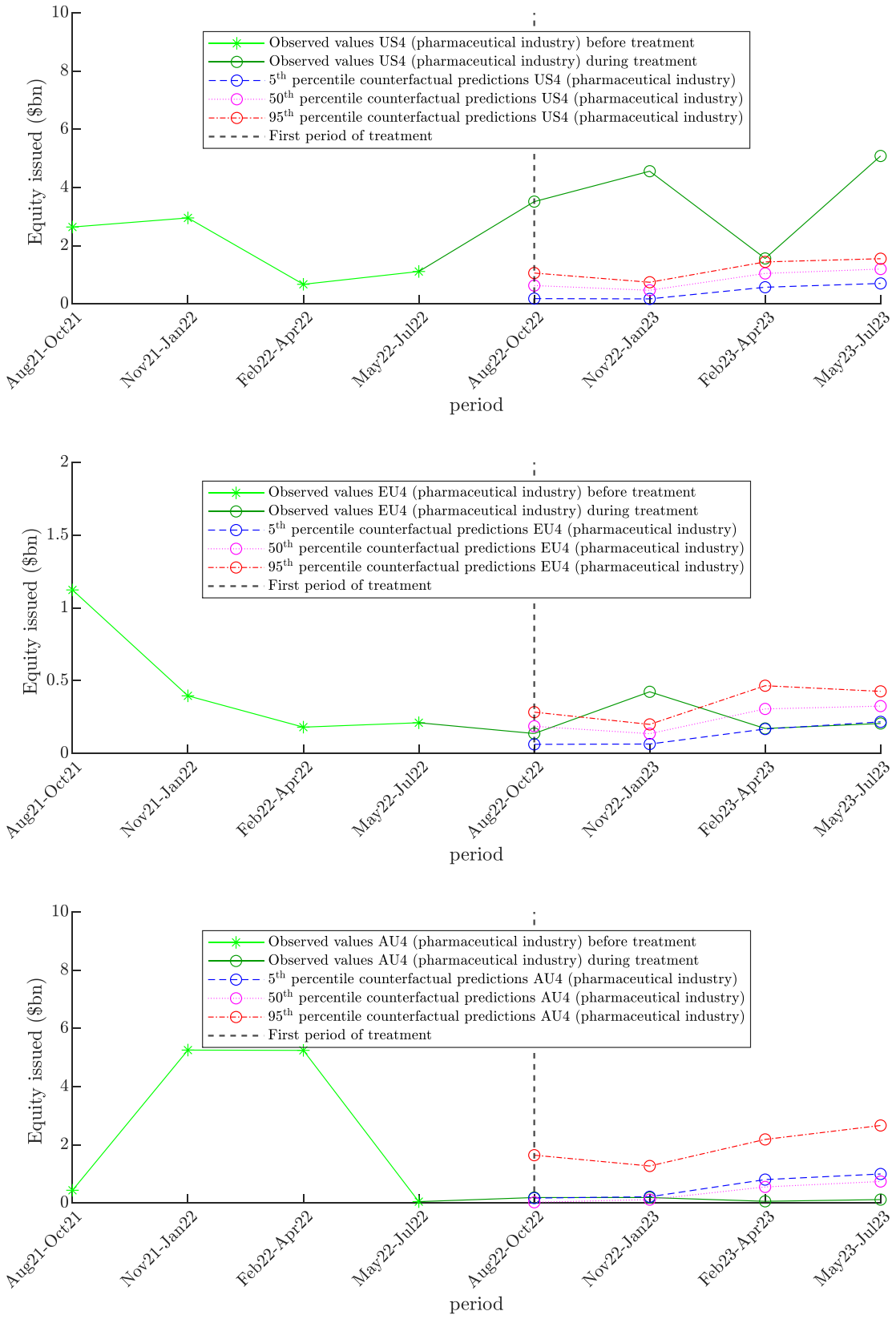

Fig. 2. Results of the in-space placebo test.

the absence of the policy).

We regard the treated observations, specifically those of the U.S. healthcare industry after the enactment of the IRA in August 2022, as missing data (because we do not know their values if the treatment did not enter into force). In essence, we have four periods during which the U.S. healthcare industry undergoes treatment following the approval of IRA, resulting in four counterfactual values to predict. All observations in the pre-treatment period are considered part of the training set, which

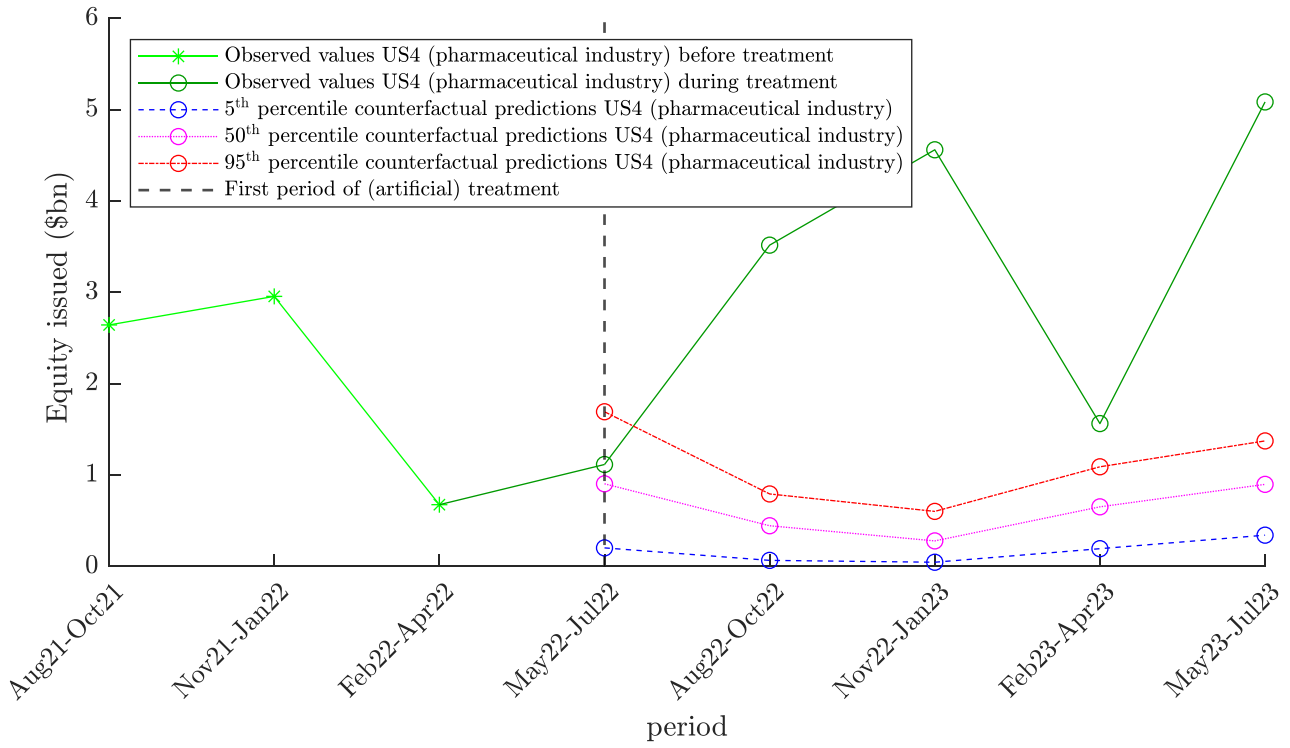

Fig. 3. Results of the in-time placebo test.

is utilized to fit the MC model. During the treatment phase, observations from untreated industries are randomly divided into two groups: 75 % are allocated to the training set, and the remaining 25 % to the validation set. This allocation aids in optimally determining a regularization parameter utilized by MC (Athey et al., 2021). Since the validation set is obtained randomly, we can conduct multiple simulations (specifically, 250) to generate diverse outcomes. This enables us to assess whether the observed values of the treated group fall within the range between the 5th and 95th percentiles.[2] Should this condition be satisfied, the results indicate a lack of statistical significance. This would mean that the regulatory intervention did not significantly affect the equity issuance of pharmaceutical firms in the U.S.A.

3. Results

Fig. 1 presents the results of our main analysis, employing the MC methodology. The x-axis denotes time, encompassing four quarters before and four quarters after treatment (passage of IRA). The y-axis represents the amount of equity issued in each quarter ($bn). The continuous line is positioned above the 5th and 95th percentiles of counterfactual predictions. This indicates that pharmaceutical firms in the U.S.A. *did* increase capital issuance following the implementation of IRA. The plausibility of these results is further discussed in Appendix D.

We perform two robustness tests. First, an *in-space* placebo test is performed where not only the U.S. pharmaceutical industry is considered treated, but also the EU and Australian healthcare industries. Fig. 2 documents that only the observations about the U.S. healthcare industry consistently exceed the 95th percentile of simulation results. Conversely, EU and Australian observations during the same period often fall between the 5th and 95th percentiles of simulation results. This indicates that the increase in equity investments post-August 2022 is not inherent to healthcare itself.

Second, an *in-time* placebo test is conducted to check that the observed trend in the U.S. healthcare industry did not commence before treatment. While policy interventions fail to meet strict exogeneity, this is not a major concern in our setting because the seasoned equity issuance process takes, on average, about a month, and our data's quarterly frequency captures firms' reactions effectively (see Appendix E for a more extensive discussion). In the in-time placebo test, the treatment is artificially anticipated one period before its actual commencement. Consequently, Fig. 3 represents five quarters as treated, due to this artificial anticipation.[3] We find that for the first period of artificial treatment, the observed value (1.12 $bn) in that period lies between the 5th percentile (0.20 $bn) and 95th percentile (1.70 $bn) of our simulation results, confirming the impact of IRA on U.S. pharmaceutical firms' equity issuance.

4. Conclusions

We investigate whether companies alter their financing policy in response to a negative cash flow shock affecting their existing products. The U.S. IRA of 2022 marks a significant shift in the pharmaceutical industry, as it grants the government the authority to negotiate drug prices, thereby reducing margins on existing products. Using IRA as an exogenous shock, we employ matrix completion for our analysis, uncovering a significant increase in equity issuance at the industry level, which cannot be attributed to cross-industry differences or common trends. This evidence suggests that firms are raising fresh capital to mitigate the adverse IRA effects on the product market.

Data availability

Data will be made available on request.

[2] As a robustness, we repeat this analysis by considering the range between the 1st and 99th percentiles, as depicted in Figure A3 in appendix.

[3] Specifically, in our application, this is achieved by treating the observation of the U.S. healthcare industry in that period as missing.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.econlet.2024.111936.

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