

# Comparing Domestic and Cross-Border Mergers and Acquisitions in the Pharmaceutical Industry

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**Abstract** This paper considers the determinants and effects of domestic versus cross-border mergers and acquisitions (M&As) in the pharmaceutical industry. Results show that companies that have had large research and development (R&D) expenditures as a percentage of sales in the past, but which have not had a significant number of drug approvals in the previous five years, tend to merge with foreign firms. Domestic mergers are formed between two firms within the same country, which typically have lower R&D expenditures as a percentage of sales and drug approvals in the previous five years. In addition, results show that domestic mergers increase drug approvals in the short run, but the effect diminishes three years after an M&A is finalized. However, cross-border mergers, which occur between two companies from different countries, largely have long-lasting (five years or more) positive effects on new drug approvals.

**Keywords** Mergers · Pharmaceutical industry · Drug approval · Cross-border

**JEL** L24 · L65

## Introduction

The pharmaceutical industry is characterized by high investments in research and development (R&D), which, in turn, yield high returns when a new drug is successfully introduced. Pharmaceutical companies remain competitive by expending significant resources to maintain their research pipeline in order to introduce new drugs to the market. In response to tough competition, the arduous Food and Drug Administration

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approval process, and the high cost of research, most pharmaceutical companies form deals with one another. Antitrust regulators give special scrutiny to pharmaceutical deals, specifically merger and acquisition (M&A) deals in the pharmaceutical industry. While in some industries, one may argue that the welfare effects of a merger outweigh the negative competition effects, it is difficult to determine the welfare effects of mergers in this industry. The effect of mergers on consumers is an important topic of research, because consumers will benefit when the merging firms enjoy R&D collaboration, control development costs, and are able to introduce new drugs more easily. However, when mergers reduce competition, increase market power, and increase prices, then consumers suffer the consequences.

In this paper, detailed M&A data from 1997 to 2007 are matched with R&D and drug approval data to compare the evolution of drug introductions between merged companies and non-merged companies. The analysis also compares the approval rate of new drug applications for domestic and cross-border merged firms. Domestic mergers involve two companies within the same country, while cross-border mergers (also referred to as international mergers) are made between two companies from different countries. This research will demonstrate the effects of mergers in the pharmaceutical industry and provide background for antitrust cases.

The academic literature focuses on various aspects of pharmaceutical mergers. Koenig and Elizabeth (2004), Ornaghi (2009) and Danzon, et al. (2007) showed a weakly negative association of mergers and productivity in pharmaceutical companies. A new study by Grabowski and Kyle (2008), with detailed R&D project level data, shows a positive effect of mergers on R&D productivity, especially for small companies.<sup>1</sup> Our paper contributes to the literature by comparing domestic mergers and international mergers and by evaluating the effects of mergers on new drug applications.

## Literature Review

Mergers and acquisitions (M&As) have regularly been observed in such different industries as pharmaceutical, semiconductor, and metals. Many experts argue that M&As are a robust solution to the declining productivity and problems of uncertain innovation. In the pharmaceutical and other innovative industries, several studies have shown that M&As do not affect R&D productivity in the same way for all organizations. For example, Munos (2009) analyzed the effect of mergers on small and large pharmaceutical companies and concluded that new drug approvals decline slightly following significant mergers for large firms, while small firms benefit from mergers and increase their new drug approvals following mergers.

Our study went beyond considering the effect of company size on M&As to exploring the differences in motivation and effects of domestic mergers compared with cross-border mergers. This surpasses previous studies by demonstrating the increase in international mergers within the pharmaceutical industry. Comanor and Scherer (2013) depicted that duplicative innovative projects are reduced for merged companies.

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<sup>1</sup> Other studies include Dixit (1984), Barros and Cabral (1994), Long and Vousden (1995), Head and Ries (1997), Richardson (1999), Horn and Levinsohn (2001), Collie (2003).

Comanor and Scherer (2013) did not provide the motivation for R&D concentration, and the direction of causation is not clear. Our study provides the motivation for R&D collaboration and analyzes the correct causation of increasing R&D productivity after the collaboration.

Danzon et al. (2007) found negative effects of M&A in the pharmaceutical industry. Following this trend, a number of studies identified a clear, negative effect of mergers on R&D activity in various industries [for example see Hitt and Hoskisson (1990), Miller (1990), Hitt et al. (1991, 1996), Blonigen and Taylor (2000), Paruchuri, et al. (2006) and Ornaghi (2009)]. On the other hand, such studies as Ernst and Vitt (2000), Bresman et al. (1999) and Capron (1999) showed that horizontal mergers improve R&D productivity through rationalization and redeployment of resources. In an in-depth study, Cassiman et al. (2005) showed that for European Union (EU) tech firms, ex-ante complementary technologies between R&D performers increase active R&D performance following mergers, whereas product market rivalry reduces R&D after the merger. Ahuja and Katila (2001) and Prabhu et al. (2005) found that mergers help pharmaceutical firms share their knowledge base and improve R&D activities. Therefore, the effect of M&A on R&D productivity is mixed for pharmaceutical and other industries.

Our study advances the current literature by analyzing the domestic and international R&D collaborations for the pharmaceutical industry and making the argument for different observations regarding R&D productivity following mergers. Our analysis also demonstrates the motivations for domestic versus international M&A deals. Our analysis also explains the different effects of R&D collaborations using detailed M&A data from the pharmaceutical industry.

Researchers also studied the influence of the acquiring firm's negotiating power, as well as the value of any prior knowledge the acquiring firm has about the target firm's internal productivity. Higgins and Rodriguez (2006) illustrated that these are important positive influences for the acquiring firm on the post-merger return on investment (ROI). Higgins and Rodriguez (2006) showed that deteriorating R&D is the main motivation for acquiring research-intensive target firms. This result is vital to understanding the incentive and the channel for positive influence of M&A deals.

M&As can, in fact, have a positive influence on the R&D productivity, as merged firms can share each other's knowledge base and R&D facilities. In a related study, Ornaghi (2009) highlighted the importance of similarities in products and technology between the acquiring firm and target firm in influencing the R&D productivity after the merger. Ornaghi (2009) controlled for the similarities as well as differences between firms considering mergers by using the propensity score matching (PSM) estimation technique. Ornaghi (2009) raised doubt about the post-merger firms' increase in patenting activities. However, none of the studies before ours depicted the collaborative effect on R&D as it varies depending on pre-merger R&D capacity. We fill this gap in the literature.

While empirical studies on M&As are common, there are very few studies that have established distinctions between domestic and cross-border mergers. Conyon et al. (2002) analyzed the differences between labor productivity for domestic and foreign-acquired firms in the United Kingdom (UK) and concluded that foreign acquisitions create more productivity. Arnold and Smarzynska (2005) supported the results of Conyon, et al. (2002) by showing that, for Indonesian target companies, productivity

increases after foreign acquisition. Bertrand and Zitouna (2008) showed that cross-border M&As enjoy gains in efficiency and productivity. In contrast to the aforementioned positive effects of cross-border M&As, Gugler et al. (2003) found no significant differences in profit between cross-border and domestic mergers. Given these contradictory results, a thorough study is needed to explain the different motivations and effects of international mergers.

Fewer studies exist that consider the effect of domestic and cross-border M&As on R&D productivity than research about the effects on profit and labor productivity. One of the earlier studies in this area is by Bertrand and Zuniga (2006), who looked at domestic and cross-border mergers from 1990 to 1999 for manufacturing firms in countries belonging to the Organisation for Economic Co-Operation and Development (OECD). Bertrand and Zuniga found that cross-border mergers create more innovative industrial performance than domestic mergers for medium-technology industries. Following this study, Bertrand (2009) used data from cross-border mergers of innovative French manufacturing firms and applied PSM to control for the decision and selection bias of the endogenous mergers. Bertrand (2009) also supports the result that cross-border mergers are more likely to enhance R&D following the mergers, and his analysis demonstrated the importance of foreign mergers and the acquiring firms' access to international innovation of target firms and their systems.

Takechi (2011), on the other hand, used data from Japanese electronics firms to show that cross-border mergers that are formed by more research-active firms have more post-merger R&D activities and vice versa. The opposite is true for domestic mergers. Bertrand and Zuniga (2006), Bertrand (2009) and Ornaghi (2009) showed why PSM is the best technique to control for the endogenous merger formation and the selection bias in merger decisions.

The current literature on domestic and cross-border M&As is still new and calls for a detailed empirical investigation to distinguish between domestic and cross-border mergers in the pharmaceutical industry. We observed a growing trend in M&As within pharma, and these mergers occur increasingly among companies across borders. Through international mergers, pharmaceutical firms are able to access international target firms' innovative capabilities and international research facilities (often less stringent international laws for clinical trials). It is important to explore the motivation as well as the effects of domestic and cross-border M&As within the innovative pharmaceutical industry in order to understand the short-term and long-term effects of mergers.

## Data Description

The main objective of this paper is to evaluate the effects of M&As on the introduction of new drugs. Information on M&As was collected from the Thomson One Mergers and Acquisition database for the years 1997 to 2007. The database focuses on mergers between US and global companies. We restricted our dataset to US acquiring companies (678 cross-border mergers and 983 domestic mergers), because financial and other company-specific information was the most readily available. We matched the M&A data from Thomson One with company-specific information, including R&D expenditure, sales and number of employees, with Standard & Poor's Compustat

Industrial files for the years 1996 to 2012. We took R&D expenditure, as a percentage of total sales, as a means to measure R&D intensity for companies. This controls for companies with large sales that spend more on R&D. For all other pharmaceutical companies that did not form a merger between 1996 and 2012, we extracted the R&D expenditure, total sales, and number of employees from the Thomson One and Standard & Poor's Compustat Industrial files.

Because we wanted to evaluate the effects of M&As on the number of new drugs introduced by the acquiring companies, we collected new drug application (NDA) approval data for all companies from the Food and Drug Administration (FDA) website. After a pharmaceutical company completes the R&D process, it must submit the new drug application to the FDA. The FDA evaluates the data presented in the NDA and, if approved, decides the future market introduction of the drug. NDA approval, therefore, captures the R&D productivity of pharmaceutical companies. We used company names to match the company level database with the FDA database for the years 1992 to 2012, because we wanted to evaluate the effects of M&As over time (five years after the mergers occurred). The number of drugs approved within the past five years is used to measure the drug portfolio of pharmaceutical companies (as presented by Danzon et al. 2007).<sup>2</sup> A drug portfolio that indicates lack of sufficient drugs can influence the M&A decision (Danzon et al. 2007).

The descriptive statistics are presented separately in Table 1 for domestic and international mergers. Table 1 shows that, following international mergers, firms have a higher number of employees, higher R&D as a percentage of sales, and more drugs approved as compared with domestic mergers. International firms that merge have higher R&D than domestic ones, but their standard deviation is much lower than merging domestic firms. The firms in cross-border M&As are typically more analogous in terms of their R&D capacity. Both international and domestic firms are comparable with respect to the employment variable. R&D productivity is much higher for cross-border M&A firms, but they are more similar before the merger in terms of productivity compared with domestic M&A companies, which are more diverse for their productivity.<sup>3</sup>

## The Model and Estimation

To analyze the effects of M&As on the number of new drugs introduced, we used a binary M&A variable taking the value one when a company acquired another company in a given year. The final estimation equation is:

$$Y_{it} + j = \alpha_1 + \alpha_2 m_{it} + \alpha_3 EMP_{it} + \alpha_4 RDS_{it} + \sum \alpha_t Time_{it} + \nu_{it}, \quad (1)$$

<sup>2</sup> It is important to include target firms' pre-merger R&D productivity in the counterfactual and compare the change in targets' pre-merger R&D productivity after the merger. But for international mergers, targets' pre-merger R&D productivity is not observable due to inaccessibility of appropriate data. The comparison of the acquiring companies' R&D productivity captures how companies are able to obtain more NDA approvals after the merger. We thank an anonymous reviewer for this comment.

<sup>3</sup> The size of the target firm, the nature of the molecules (branded vs. generic, small molecule vs. large molecule) and target locations are not observable in the data. Our estimation technique controls for the level of the firm's heterogeneity and controls for unobserved effects. For future studies, we plan to expand this analysis by including this information. We are thankful to an anonymous reviewer for these comments.

**Table 1** Descriptive statistics

| Domestic    |       |           | Cross-border |           |
|-------------|-------|-----------|--------------|-----------|
| Variable    | Mean  | Std. Dev. | Mean         | Std. Dev. |
| $EMP_{t-1}$ | 2.192 | 1.212     | 3.439        | 1.226     |
| $RDS_{t-1}$ | 0.558 | 0.082     | 0.735        | 0.948     |
| NDA         | 3.001 | 1.119     | 8.231        | 0.580     |

Computed from Thomson One and FDA drug approval data. Mean and standard deviations are presented for the variables used in this paper

where  $j=1, 2, 3, 4, 5$ . The dependent variable,  $Y$ , represents the outcome variables, such as the number of new drug applications approved, and  $m_{it}$  is the M&A decision dummy variable.  $EMP_{it}$  represents the log of total employees, and  $RDS_{it}$  captures the R&D expenditure as a percentage of sales in time  $t$ . We controlled for fixed, time-specific effects using time dummies ( $Time$ ).

Our main interest was to estimate the coefficients  $\alpha_2$ . We needed to take a careful approach to our identification strategy. In Eq. 1, identification of the coefficient  $\alpha_2$  is not a problem, when the M&A decision is an exogenous variable. But if it is endogenous, then the stochastic dependence between  $m_{it}$  and the error term may bias the estimation.<sup>4</sup> We used a heterogeneous treatment effect model to correct for this bias.<sup>5</sup> Whether a company chooses to form an M&A or opts not to, a selection bias is formed. By comparing similar companies within a group or strata, the heterogeneous treatment effect can correct this bias for both companies that choose to forge M&As and those that do not.

We first estimated the probability of completing a merger, given company-specific observations, using the following equation:

$$m_{it}^J = I[m^* = \beta_1 EMP_{it-1} + \beta_2 RDS_{it-1} + \beta_3 NDA_{it} + \beta_4 Time_{it} + u_{it} + c_i > 0], \quad (2)$$

where  $J=Domestic, International$  and  $I$  is the indicator function. The variable  $NDA_{it}$  represents the total number of drugs approved for company  $i$  in the past five years. As shown by Danzon et al. (2007), the risk of patent expiration influences a company's decision to engage in an M&A, because when a company anticipates the expiration of a patent for one of their own drugs, then it is more likely to form an M&A to expand their research pipeline. We included this variable as an additional control. We also controlled for the time-specific fixed effects as an additional control. Two separate regressions were estimated, one to determine the probability of domestic mergers and another to determine the probability of international mergers. After estimating Eq. 2, we used the estimated probability that a company will complete the M&A to create the PSM strata and arrange companies with similar probability and other explanatory variables into groups. We then estimated Eq. 1

<sup>4</sup> See Griliches (1977), Brand and Xie (2010), Brand and Thomas (2013).

<sup>5</sup> As shown by Bertrand and Zuninga (2006), Bertrand (2009), and Ornaghi (2009), M&A decisions are an endogenous variable and the heterogeneous treatment effect model corrects the endogenous nature and other selection problems.

within these groups and compared the change in the number of drug approvals over time of companies that participated in a merger versus non-participating companies, which are otherwise similar.<sup>6</sup> This estimation technique corrects for selection biases by comparing similar companies and indicates whether the M&A will affect the new drug approvals. Because we only observed companies that sign deals and companies that do not sign deals, but not both for a given company, this approach is the most appropriate one to eliminate the estimation biases.

## Empirical Results

Estimation results of Eq. 2, the determinants of the probability of forming an M&A, are presented in Table 2. Columns 2 and 3 present the marginal effects for the engagement of both domestic companies and cross-border companies in mergers. The insignificant coefficient of employment indicates that a company's operating size does not influence either the domestic or cross-border companies' decisions whether to merge. Rather, it is the lack of R&D intensity and the number of drug approvals within the past five years that increase the M&A probability. For every one-unit decrease in R&D expenditure as a percentage of sales, the probability of finalizing a domestic merger increases by 26 %. The effect is the opposite for cross-border M&As. When there is a one-unit increase in R&D expenditure as a percentage of sales, the probability of executing an international M&A increases by 32 %. This is an important finding, because it shows that international mergers are motivated by the expectation of future market expansion rather than by the current lack of R&D resources.

In addition, the effect of the number of drug approvals over the past five years increases the probability of successful domestic and cross-border mergers. If the drug approval for the company in the past five years decreases by one unit, the probability of domestic M&As goes up by 1.4 %, while the increase is 16.8 % for international mergers. This is a 15.4 % difference in probability between domestic and international M&As and, therefore, we can conclude that the cross-border merger decisions are affected more significantly by the lack of drug portfolio than are domestic merger decisions. If companies have fewer drug approvals in the past five years, then they are more likely to sign cross-border M&As. The p-values of ( $< 0.0001$ ) for the likelihood ratio chi-square coefficients for both domestic and international M&A models indicate that, as a whole, the models are statistically significant.

In summary, companies that conduct more R&D but do not have a sufficient number of drug approvals merge with foreign firms to get more financial and intellectual resources as well as to access the international markets. Domestic merger decisions, on the other hand, are motivated by the need to increase the drug pipeline and to share R&D costs. There could be another interpretation for this result. Because more R&D means companies generally have better resources and money, it is possible for them to consider international mergers that are more costly than domestic mergers.

Other company characteristics can also play a role in motivating the decision to merge. To control for other non-geographical effects, as a check for robustness, we included the mean of the independent variables as additional right-hand-side variables. This controls for the unobserved heterogeneity bias as explained by Wooldridge (2002).

<sup>6</sup> We repeated the second stage for domestic and international mergers in two separate analyses.

**Table 2** Marginal effect result of decision to sign M&As

| Variables          | Domestic         | Cross-border      |
|--------------------|------------------|-------------------|
| EMP <sub>t-1</sub> | 0.003 (0.019)    | 0.048 (0.022)     |
| RDS <sub>t-1</sub> | -0.258** (0.010) | 0.320*** (0.720)  |
| NDA                | -0.014* (0.001)  | -0.168*** (0.070) |
| Time dummies       | Yes              | Yes               |
| Company dummies    | Yes              | Yes               |
| LRchi2             | 42.62            | 32.51             |
| Prob > chi2        | 0.000            | 0.000             |
| Observations       | 983              | 678               |
| Loglikelihood      | -4317            | -4942             |

Standard errors are shown in the parenthesis. \*\*\* and \*\* denote 99 and 95 % levels of confidence

There are no significant changes in the results, other than that the *R&D* and *NDA* coefficients decrease. We also estimated a bivariate probit model in stage 1 to determine the joint probabilities of forming domestic and international M&As. The estimated correlation of the residuals from the two models is 0.38, but the parameter is not significant with *Prob>chi2*=0.11. Therefore, we can estimate the probabilities of forming domestic and international M&As in two separate models in stage 1 as presented in the main paper.

## Effects of M&A Deals on New Drug Approvals

Using the strata created by the above probit estimation, we estimated Eq. 1 using linear regression within the strata. The strata quartiles are defined by company-year level observations. Lower strata indicates lower propensity to sign M&As while higher strata indicates a higher propensity. Table 3 shows the estimated

**Table 3** Effects of M&A deals on new drug approvals using propensity score modeling

|              |           | Strata1  | Strata2  | Strata3 | Strata4  |
|--------------|-----------|----------|----------|---------|----------|
| Domestic     | $y_{t+1}$ | 0.021*   | 0.110**  | 0.001*  | 0.305**  |
|              | $y_{t+2}$ | 0.038*   | 0.218*** | 0.052   | 0.400**  |
|              | $y_{t+3}$ | 0.140**  | 0.220**  | 0.055*  | 0.405*** |
|              | $y_{t+4}$ | 0.003    | 0.174*** | 0.147*  | 0.305*   |
|              | $y_{t+5}$ | 0.001*   | 0.002**  | 0.090*  | 0.000    |
| Cross-border | $y_{t+1}$ | 0.116*** | 0.006**  | 0.003*  | 0.111**  |
|              | $y_{t+2}$ | 0.124*** | 0.009**  | 0.010*  | 0.109**  |
|              | $y_{t+3}$ | 0.220*** | 0.201*** | 0.110*  | 0.186**  |
|              | $y_{t+4}$ | 0.231**  | 0.330**  | 0.201*  | 0.201**  |
|              | $y_{t+5}$ | 0.319*** | 0.349*** | 0.248*  | 0.228**  |

Standard errors are shown in the parenthesis. \*\*\* and \*\* denote 99 and 95 % levels of confidence. The estimation equation is Equation

impact of M&As on the number of new drug approvals for domestic and cross-border mergers in the upper and lower panels respectively. A movement along the strata, strata 1 to strata 4, shows the effects on drug approvals for companies that are less to more likely to accept M&As. A company in a higher stratum is more likely to sign a deal.

The upper panel of Table 3 shows that domestic M&A deals increase the number of new drugs introduced in the short run. The effect diminishes after three years. The collaboration of knowledge and financial resources enables merged companies to introduce new drugs in the short run. But domestic mergers do not enjoy a lasting effect. Companies get financial assistance and research assistance, but the acquiring companies do not have high R&D expenditures as a percentage of sales as presented in Table 2. Therefore, the positive effect of M&As for domestic companies does not endure over time. However, from the lower panel of Table 3, we observe an interesting effect of cross-border mergers. The initial impact of M&A deals are similar for both domestic and cross-border mergers, but the benefits of cross-border mergers increases over time. This is a new result, which shows that international mergers are formed among companies with high R&D expenditures as a percentage of sales which can also manage the synergy effect of mergers more efficiently. Companies in higher strata are more likely to sign M&A deals. We find in both panels of Table 3 that we cannot draw any conclusions about any specific trend on the effect of domestic and cross-border M&A deals for companies in lower strata versus higher strata. The effects are the same for both lower and higher strata.

## Conclusion

The determinants and effects of mergers and acquisitions are an attractive topic in the industrial organization literature. Pharma is an apt industry in which to study M&As, because the large innovation costs and intense competition make collaboration unusually vital in the industry. Other interesting industry characteristics include high uncertainty over product development, high R&D costs, cross-border sales restrictions, and various types of collaborations. We studied the determinants and effects of domestic and cross-border mergers in this industry. Our estimation results show that companies that have high R&D as a percentage of total sales, but that have inadequate numbers of drug approvals are more likely to form international M&As. Domestic mergers tend to occur between firms doing less R&D as a percentage of sales and with smaller drug portfolios. That is, domestic mergers are motivated by the need to increase the drug pipeline and share R&D costs. We also find that domestic mergers increase the number of drug approvals in the short run, but the effect diminishes within three years. However, cross-border mergers have long-term (for at least five years) positive effects on new drug approvals. This result shows that companies with high R&D expenditures as a percentage of sales gain from cross-border mergers by increasing their market access and R&D cooperations.

This study shows an important insight into the motivation and effect of M&As on the pharmaceutical industry. This analysis is one of the first to contrast the effects of domestic versus cross-border mergers, but further research is required to address more policy issues. It would be interesting to analyze the M&As separately within various

drug market areas. In addition, the effect of M&As on the ultimate prices of the developed drugs is an important consideration. It also would be interesting to analyze the impact of M&As on the future R&D of merged firms. These studies, however, are beyond the scope of our paper and our current data availability.

## Discussion

It will be more appropriate to compare the R&D productivity of merged companies with that of the unmerged acquiring company and the unmerged target company. But the main motivation of this paper is to investigate the effects of mergers on (R&D) productivity for domestic versus international M&As. For international mergers, the target company's pre-merger R&D productivity is very difficult or impossible to construct, because of the unavailability of international firms' R&D productivity data. Next, it is difficult to identify unmerged targets. We could identify the pre-merger R&D productivity of domestic targets, but that would make the analysis incomplete or inconsistent, because we must compare the domestic versus international mergers and similar counterfactual needed for both groups. Therefore, the comparison of post-merger R&D productivity in acquiring companies captures how the M&A helps in increase NDA approvals.

In addition, our sample is restricted to US headquartered companies. Through more information about the multinational status, foreign market access, research facilities and acquiring companies could add strength to the empirical analysis, this information was not available in the data. The lack of this information does not change the direction of results, because we have controlled for unobserved heterogeneity.

As mentioned before, there is very little information about international target firms. Therefore, we were unable to include the size of target firms, the nature of the molecules (branded vs. generic, small molecule vs. large molecule) and target locations in the analysis. Our estimation technique controlled for the firm-level heterogeneity and unobserved effects. For future studies, we plan to expand this analysis by including this information.

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