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Working Paper

Determinants of drug launch delay in pre-TRIPS India: A survival analysis approach

Working Papers on Innovation and Space, No. 05.11

Provided in Cooperation with:
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Suggested Citation: Bhaduri, Saradindu; Brenner, Thomas (2011) : Determinants of drug launch delay in pre-TRIPS India: A survival analysis approach, Working Papers on Innovation and Space, No. 05.11, Philipps-University Marburg, Department of Geography, Marburg

This Version is available at:
https://hdl.handle.net/10419/111874

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Marburg Geography

Working Papers on
Innovation and Space

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Impressum:

Working Papers on Innovation and Space
Philipps-Universität Marburg

Herausgeber:

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Erschienen: 2011

Determinants of drug launch delay in pre-TRIPS India: A survival analysis approach

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Abstract:

The dynamics of drug launch has been an under-researched area. Most of the studies in this field focus on developed countries, quite uniform in terms of disease profile and regulatory framework, and analyse whether stringency in regulation influences launch delay. Developing countries, in contrast, have diverse disease profiles and weaker forms of regulation. A limited set of studies, undertaken in recent years, on the diffusion of new drugs in developing countries indeed conjectures importance of such factors in shaping drug launch dynamics. We investigate the delay of new drug launch in India for drugs launched in the German market during 1990-2004, when, due to weak IPR, not only the innovators but also the domestic firms could launch new drug molecules in the country, making drug launch dynamics interesting to explore. The paper finds that global commercial success of a new drug, market share, first mover advantage, and the threat of imposition of strong IPR system shortens delay. Innovativeness of a new drug, surprisingly, does not have much significant impact on delay.

Keywords: Drug launch delay, Germany, India, survival analysis.

JEL Classifications: O10, O30, O33, O34, 053, L20, C14, L65

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Determinants of drug launch delay in pre-TRIPS India: A survival analysis approach

1. Introduction:

Although the introduction of new drugs in the market is not without problems, new drugs, generally, imply better treatment of illnesses. It is widely accepted that access to modern medical therapies have immensely contributed to the developmental catch up process of many less developed countries (Kremer 2002). A delay, therefore, can prove to be detrimental to economic development of a region or country.

Many studies on drug launch have revolved around one central question: to what extent do the various regulations of new drug approval contribute to delays in their launch? Wardell (1973) examined whether stringency in the regulation, post-Thalidomide, resulted in a longer delay of the launch of new drugs in the United States (US). Motivated by this study, many other empirical studies were conducted to understand the dynamics of drug launch across countries[1]. A strong point of these studies is their use of comprehensive proprietary cross country databases. However, one can identify two broad limitations of these studies. First, these studies mainly focus on the launch of new drugs in the major pharmaceutical markets of developed countries, and confine themselves primarily to examining whether stringency in regulation causes delay.

Major pharmaceutical markets in the industrialized countries are largely homogeneous in terms of disease profile and institutional arrangement (Cullen 1983: 74). If one roughly categorises diseases into two broad groups, communicable tropical diseases and non-communicable systemic diseases, then developed industrialised countries have a disproportionately high share of non-communicable diseases. Concerning the institutional structure, most of the countries have a very stringent, perhaps uniform, set of norms for new drug approval. They also have a strong product patent system in place. Due to this strong

1 See, for instance, Peltzman (1973), Grabowski (1980), Cullen (1983), Parker (1989).

product patent system, only the innovator or its licensee(s) can launch a new innovation in any of these markets. A second limitation is methodological in nature. Most of these studies, perhaps with the only exception of Danzon et at (2005), do not intend to deal with the right censorship problem, which arises from the finite length of their data set.

In recent years, a number of studies explored the dynamics of drug launch in developing countries. Broadening the sample and incorporating these countries enhances the scope of research in two ways. First, being located in tropical regions, the disease pattern in these countries is quite different (Lanjouw 1999, Lanjouw 2002). The majority of population in these countries suffer from communicable tropical diseases. Demand differences are thus a key verifiable determinant of the diffusion of new drugs in these countries. Secondly, pharmaceutical markets in many of these countries, until very recently, were under weak patent system, which permitted reverse engineering and incremental innovations. Therefore, new drugs in these countries can be launched by any firm present in the market, and not only by the innovating firm. Issues like competitive pressure to launch, and first mover advantages can, thus, also be incorporated in the analyses of drug launch (Bhaduri and Ray 2006, Ray and Chakravorty 2007).

Although these studies make an interesting set of conjectural hypotheses, there is not much attempt to subject these conjectures to rigorous empirical analyses. Our paper contributes to this growing literature by analysing the drug launch pattern in India. We use continuous and discrete time survival analyses to understand the determinants of drug launch delay in India for drugs launched in Germany during 1990-2004.[2] The final year of analysis was chosen to be 2004, as this is the last year under weak intellectual property rights regime in India. In the next section we develop the conceptual framework of our study and construct hypotheses. In section 3 we describe the sample and give a detailed account of the estimation methods. Results are describes in section 4. Section 5 concludes.

2 In a yet unpublished paper, Varol et al (2010) shows that Germany witnessed the least average drug lag during 1960-1995, and has been only after the US in drug lag since 1995.

2. Background and hypotheses

The studies on drug launch have identified stringency in regulation, market size and opportunity costs as major determinants of delay in major pharmaceutical markets of industrialised countries. However, few studies have attempted to understand the diffusion of new drugs in developing countries. There is more prevalence of tropical communicable diseases in developing countries, as opposed to a high prevalence of non-communicable diseases in the industrialised countries. Furthermore, these countries often have weaker forms of patent protection[3], enabling competition even for patented drugs. Many of these aspects have remained unexplored in the literature. Hence, we discuss the existing literature on these issues and propose some hypotheses for our study.

2.1 Regulation

Most studies on drug launch have analysed how/whether stringency in regulation leads to delay in launches[4]. The conclusion, however, varies. While studies by Wardell (1973) and Cullen (1983) found that stricter regulation led to drug delay in the USA, Parker (1989) does not find any evidence of delay in drug launch in the USA compared to other countries in his sample. He also found that average delay declined in the 1980s, compared to 1970s. Grabowsky and Wang (2006) find that the US is becoming the country of first launch for a majority of drugs in recent years.

The literature on technology transfer, on the other hand, emphasises that stricter patent regulation reduces delay in transfer of new technologies[5]. However, both these sets of literature only visualise the innovating firms or their licensees as the main agents of technology transfers. In the absence of a strong patent regulation, however, a new technology can also be introduced in the market by other firms through process engineering and imitation. An announcement of stronger regulation, in this situation, can have mixed

3 Implying, for instance, giving protection only to processes and not product innovations.
4 Peltzman (1973(, Wardell (1973), Grabowski (1980), Cullen (1983), Parker (1989), Danzon et al (2005).
5 See, for instance, Mansfield (1994).

implication. In a simplified manner, one may assume that new drug discovery research is carried out only by multinationals firms, and domestic firms only carry out reverse engineering based minor innovations. When strong patent regulation is announced, multinational firms might postpone their launch in the market until such a system is in place to pre-empt competition, with the consequence of prolonging the delay. However, a product may be 'invented around' and launched by the domestic firms as well. In fact, the domestic firms would attempt to speed up the imitation process and launch new drugs before a strong patent regime comes forth. Hence, the impact of patent regulations on drug launch decisions depends on the composition of firms present on the market. Therefore, we set up two alternative hypotheses. If multinational firms dominate in the Indian market, we expect:

Hypothesis 1a: Patent announcement will increase the delay of drug launch in the Indian market.

If, instead, domestic firms dominate in the Indian market, we expect:

Hypothesis 1b: Patent announcement decreases the delay of drug launch in the Indian market.

However, given the fact that India had pursued an active policy to regulate foreign firms in the decade of 1970s and 1980s, and given the thrust on weak IPR systems during the period of study, the second hypothesis seems more plausible.

2.2 Market size

Besides regulatory framework, expected market size is also shown to influence the lag in drug launch. Larger expected market size reduces delay (Cullen 1983), and lower expected prices are shown to enhance delay due to the problems of external referencing and parallel exports (Danzon et al 2005). Hence, we expect:

Hypothesis 2a: Larger expected market sizes imply a reduction of the delay in drug launch in India.

One way for firms to estimate the potential market size is to consider the success of a drug in countries in which it has been already introduced; assuming that prescription pattern in major pharmaceutical markets would have demonstration effects in markets of developing countries. Such increase in potential demand might encourage either the innovating firm to speed up their launch, and/or encourage the domestic firms to speed up their R&D and process engineering. As a result, imitation may become faster, increasing the possibility of a faster launch in the domestic market. Accordingly, we hypothesize:

Hypothesis 2b: The delay in drug launch in India decreases with the commercial success of the drug elsewhere.

However, as has been mentioned above, most of the existing studies focus on developed countries with similar disease profile (hence, demand structure for health care) and similar institutional arrangements. Indeed, differences in medical, legal and commercial environments existing in developing countries were believed to have adversely affected the launch of new drugs in these countries (Cullen 1983).

Differences in demand pattern and institutional arrangements in developing countries can help explore a plethora of other issues related to the diffusion of drugs. Concerning demand pattern, broadly, there are two types of diseases, namely, non-communicable diseases and infective diseases (Troullier and Olliaro 2001). Non-communicable diseases, caused by intrinsic malfunctioning of our systems, are mostly non-curable and requires prolonged (life long) treatment. Infective diseases are caused by external pathogens (bacteria and virus due to pollution and bad hygiene). These diseases are generally short lived and completely curable through medicine. Being located in non-tropical regions and due to improved hygiene, communicable infective diseases do not pose any serious health problems in developed countries.[6] The main health burden of these countries remains in the area of various non-

6 This is true, occasional outbreaks of flues notwithstanding. Also, disease like AIDS is a communicable, yet not curable, disease. However, spread of AIDS does not depend on poor hygiene or climatic conditions. In

communicable systemic diseases. People in the developing countries, in contrast, suffer more from communicable diseases[7]. As an illustration, one may note that the share of communicable diseases in the total Disability Adjusted Life Years (DALY) for Germany is around 4%, while in India around 45% of total DALY is due to communicable diseases. On the other hand, non-communicable diseases count for around 90% of DALY in Germany. The relevant share for India is around 40%.[8]

Therefore, it is plausible that the time span between the launch in two countries (delay) will be shorter for drugs which have higher demand in the studied country.

Thus, in so far as infective diseases dominate the disease profile in India, the market for respective drugs would be comparably large. Therefore, another refinement of hypothesis 2a would suggest:

Hypothesis 2c: Drugs for infective diseases find a large market in India and, therefore, show a shorter delay in drug launch than drugs for non-communicable diseases.

2. First mover advantages

Danzon et al (2005) argue that the prevalence of high demand in a country raises the opportunity costs of delay by shrinking the discounted value of total patent-monopoly profits to be earned. However they take into consideration only those countries which have strong patent systems. Monopoly profit is ensured for the innovating firm during the length of the patent protection in these markets. In the absence of a strong product patent system, however, competition between brands becomes feasible even during the life of a patent, adding uncertainty to patent monopoly. The potential of first mover advantage may crucially determine the lag in such cases. The theory of industrial organisation highlights that the first mover advantage would be high when the scope of repeat purchase is high. Note that non-

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tropical conditions, however, AIDS patients may have higher possibility of getting other kinds of infections. Thus, drugs for AIDS may be needed more in tropical countries, compared to non-tropical countries.

7 These diseases are also known as tropical diseases.

8 See http://www.who.int/healthinfo/statistics/bodgbddeathdalyestimates.xls for details. Last accessed on 15 September, 2011.

communicable diseases are non-curable in nature. Medicines have been successful only in controlling their adverse effects on the body. On the other hand, most of the communicable diseases are often fully curable by medicine. Greater need for repeat purchases of drugs for non-communicable diseases, arising out of the need for long term treatment, have important consequence for first mover advantage in markets with weak patent protection, such as India.

Interestingly, some empirical studies (Gorekci 1986, Grabowsky and Vernon 1992, Hollis 2002) point out clear advantages of moving first in generic markets, where patent protection ceases to exist, of US and Canada. Such advantages emanate from 'switching costs' and various regulations[9]. However, they do not explore the possibilities of such advantages to depend on disease types.[10] Bhaduri and Ray (2006), in this context, argue that psychological costs of brand switching are higher for drugs for non-communicable diseases compared to the drugs for infective diseases due to higher repeat purchase requirements. Non-communicable diseases are also known as life style diseases. In the context of a developing country, demand for these drugs seem to emerge more from the upper socio-economic strata who are comparatively more quality conscious and litigious than people of lower socio-economic strata. The latter group, on the other hand, constitutes the major market for drugs for infective diseases due to their unhygienic living conditions. Due to higher level of quality awareness and the litigious nature of the patients, the physicians of non-communicable diseases would be reluctant to switch brands, solely on grounds of cost efficiency. This adds to the psychological costs of brand switching and strengthens first mover advantage for drugs of non-communicable diseases. As a consequence, fast entry might be more attractive for firms in the case of drugs for non-communicable diseases than for other drugs. Hence, delay for drugs for non-communicable diseases might, in fact, be shorter compared to anti-infective drugs.

9 See, for instance, Hollis 2002.

10 In both these countries, however, share of non-communicable diseases is much higher compared to communicable diseases. See http://www.who.int/healthinfo/statistics/bodgbddeathdalyestimates.xls for details. (Accessed on 15 September, 2011).

Therefore, we could expect:

Hypothesis 3: Due to the first mover advantage, drugs for non-communicable diseases show a shorter delay in drug launch than drugs for infective diseases.

2.4 Innovativeness of drugs

Commercially significant drugs diffuse faster, especially to non-leading countries like Israel, compared to 'all new drugs' (Sax 1989). However, commercially significant drugs may not necessarily bring about major therapeutic advancements. Most of the studies seem to overlook this distinction between the commercial significance of a drug and the therapeutic advancement it brings about. Grabowski and Wang (2006), for instance, argue that the drugs that are 'present in all G7 countries are also the drugs of 'high quality', or 'commercially successful' or 'both'. Roy and Chakraborty (2007) make a pioneering attempt to distinguish between these two characteristics of drugs. Drawing upon the categorisation of therapeutic advancement made by the United States Food and Drug Administration (USFDA), this study shows that the share of 'advanced therapy' is not significantly different from the share of 'non-advanced therapy' for 77 new drugs launched in India during 1995-2003[11]. This finding suggests that innovativeness of a drug has got little to do with its launch in India. However, for a more meaningful conclusion it would be necessary to study the launch pattern of commercially successful drugs and of innovative drugs separately. We conjecture:

Hypothesis 4: The delay in drug launch in India does not depend on the innovativeness of the drug.

3. Method and data

3.1 Sample

We collected data for India and Germany for the period 1990-2004. Note that December 2004 also marks the end of the era of weak patent protection in India.

11 From the set of 297 new drugs launched in the USA during the same period.

Our dataset reveals that 633 drugs were launched in Germany during this period. Among these, 201 drugs have been launched in the Indian market during the same period. The German data was collected from two corporate data bases: Rote Liste (official list of drugs in Germany) and Dimdi (German Institute of Medical Documentation and Information). Note that one molecule may be sold in different dosage forms. The Dimdi dataset contains the dates of first launch of all these individual entries. Among all these entries, we took the earliest entry pertaining to each molecule. However, both datasets share a common shortcoming: they only maintain records for drugs that are currently present in the market. We, therefore, cannot obtain any information about drugs which might have been withdrawn from the market, even if they were launched after 1990.[12] In addition, if a drug is re-introduced after some time, these datasets would only give us the date of re-introduction[13].

The list so obtained for Germany was pruned further to omit homoeopathic and plant medicines.

For India we have used the proprietary corporate database Pharmabiz (www.pharmabiz.com). This list matches with the list of drugs mentioned on the webpage of the Central Drug Standard Control Organisation (CDSCO), Government of India[14]. Like the German data, we have only considered the first entries for each molecule in the Indian market. For many drugs, especially for India, data were available only in a month-year format. Accordingly, we banded all launches in a month on the first day of the month, for both countries.

The selection of countries, Germany and India, requires an assumption that the date of launch in Germany represents the earliest possible launch date for India. Given that the European Union market in recent years has emerged as a key market, besides United States, for launch

12 This list is rather long, often including many blockbuster drugs as well. Nimesulide, Celecoxib, Refocoxib are some of the examples.

13 Please note that this problem is not present in the proprietary German corporate database called AMIS. However, financial resources at our disposal did not permit us to exploit this data source to the fullest possible extent.

14 This list is, however, available only from 1999.

of new drugs, such an assumption may not be unrealistic.[15]

3.2 Covariates

We define the following set of covariates.

Patent regulations Announcement [TRIPS]

India became a signatory to the World Trade Organisation in 1995 with the commitment to introduce a strong product patent system in line with Trade Related Intellectual Property Rights (TRIPS) in the year 2005. Thus, in the year 1995 it became common knowledge that India will adopt a strong patent regime, which might have altered the launch behaviour of firms as discussed above. We introduce a dummy variable (TRIPS) taking the value '1' for drugs which are launched in the global market (represented by launch in Germany) since 1995, and '0' for drugs launched in the pre-1995 period.

Expected market size [MARKET]

The true market share for a drug which is yet to be launched is non-existent. As a proxy we take the market share of the therapeutic category to which the prospective new drug belongs. Indian Credit Rating Agency (ICRA 2005, pp. 5-6) categorises all diseases into 14 therapeutic groups and provides market shares for each of them. Each drug in our data set, therefore, gets the value depending on which one of the 14 therapeutic categories it belongs to. This data is only available to us for the year 2003. We, therefore, have to make an additional assumption that relative market share for these 14 therapeutic areas have remained constant for the duration of the study.

Global commercial success [GLOBAL]

Global commercial success can be measured by the annual global sales of a drug. In particular, a drug is considered globally successful, unequivocally, if it gets the status of a blockbuster drug. A drug becomes a blockbuster drug if its global sales turnover reaches US$ 1 bn per annum (Landau et al 1999). We use the US sales reports of prescription drugs and

15 See also foot note 2.

the pharmacy magazine Drugtopics[16], which carried a list of top 200 branded drugs in various years[17]. We cross checked the global commercial status of these drugs by consulting the Annual Reports and company websites of the manufacturers of these drugs. Finally we find that 51 such blockbuster drugs are present in our list of drugs in Germany. The variable GLOBAL is a dummy variable that takes the value '1' for blockbuster drugs, and '0' otherwise.

Therapeutic category [DISEASE_TYPE]

Following Bhaduri and Ray (2006) and the above arguments, we categorise all drugs into two broad therapeutic categories, namely, infectious diseases (ID) and non-communicable diseases (ND). Chronic diseases have been merged with ND on the assumption that they, unlike infectious diseases, are not completely curable through medication. As argued above, ID are caused by external pathogens, often as a result of contaminated food, drinks or bad sanitation. ND, on the other hand, are not caused by external pathogens but by malfunctioning of the internal human system.

We assigned all drugs in our list to the two groups with the help of drug information available on the websites and the various issues of Indian Drug Review. We use a dummy variable *DISEASE_TYPE*, which takes the value '1' if a drug is for the treatment ND, and '0' if it is to treat ID.

Innovativeness of drugs [INV]

The US Food and Drug Administration (FDA) specifies their opinion on innovativeness of a new drug by marking drugs with high therapeutic advancement as 'Priority drugs' and drugs with insignificant therapeutic advancement as 'Standard'.[18] We used the CDER website to identify these drugs. We were able to classify the drugs for the period 1997-2004 in this

16 www.drugtopics.com.
17 We thank CDER for this suggestion. Other data sources are prohibitively expensive.
18 See also Ray and Chakravorty (2007).

way[19], and identified 48 drugs in our database as 'priority drugs'.[20]

We note that out of the 48 drugs that brought about major therapeutic advancements only 6 could attain the status of blockbuster drugs during our sample period. On the other hand, 20 out of 26 blockbuster drugs launched in the German market since 1997 did not bring about any major therapeutic advancement.

Therefore, there is ample reason to believe that little association exists between commercial success of a new drug (GLOBAL) and its innovativeness (INV).

The variable INV is a dummy variable taking value '1' for 'priority drugs' and '0' otherwise. The variable INV is available only for drugs launched since 1997. Therefore, any analysis using INV can be done only for the period 1997-2004.

3.3 Estimation method

We measure delay by the number of months elapsed between launch of a drug in Germany and its subsequent launch in India.[21]We use both *continuous time* (Cox proportional hazard model) and *discrete time* (Complementary log-log) models of survival analysis for our study. Survival analysis is primarily concerned with analysing 'time' (known as 'analysis time') to the 'occurrence of events' (or 'deaths' or 'failures'). In this paper, time is calculated in months and an event refers to the launch of a new drug in India *after* its launch in Germany. 'Death' ('failure') implies the launch of a drug in India. Cox proportional hazard models explain every such 'occurrence of event' with the help of a set of covariates (x). A typical Cox proportional hazard model is represented as: $h_j(t) = h_0 (t) \exp (B'X)$, where $B'X= b_0 + b_1X_1+ b_2X_2+\ldots+ b_kX_k$, $h_0 (t)$ is the base line hazard function.

19 Data from 1999 was available in http://www.fda.gov/cder/rdmt/. For the pre-1999 period, data were available in the Reports to the Nation and in http://www.fda.gov/cder/archives/default.htm#Archival.

20 Total number of such drugs in our list is 57. However, since data prior to 1997 are not comprehensively available, as reported by the CDER, we used only 48 innovative drugs, which have been launched in the German market since 1997.

21 For 47 drugs, the reported first date of launch in India precedes their launch in Germany. The variable in those cases takes negative values, and discarded from survival analysis. This includes 9 blockbuster drugs. So, our survival analyses use only 42 blockbuster drugs

The Cox model leaves h_0 (t) undefined.

For the present study, the Cox proportional model has a few limitations: we have realised the launch dates within a month on the first day of the month. Thus, launch data are discrete, and available with a *length of interval* of 1 month. We have data for 15 years suggesting that the *spell length* of our dataset is equal to (15x12 month) 180 months. Due to banding of launch dates we have many tied observations, which reduces the robustness of model. Complementary log-log (cloglog) models take care of this problem by treating the ties as interval censorship (Jenkins 2005: 21). Moreover, baseline hazard disappears in the cox model. Complementary log-log models retain baseline hazard, which summarise the duration dependence in the interval hazard. The presence of baseline hazard in the complementary log-log model, therefore, also checks for robustness of our Cox model specifications. The hazard function in complementary log-log model can be written as (ibid: 41-42)

$h(a_{j,} X) = 1- \exp [- \exp (b_j + B'X)]$,

where a_j is the duration of j'th interval and b_j is the log of the difference between the integrated baseline hazard (h_0 (t)) evaluated at the end and the beginning of the j'th interval.

If each interval is of unit length, dates can be replaced by interval number for indexing time intervals. Hence, we have

$h(j_{,} X) = 1- \exp [-\exp (b_j + B'X)]$.

We used STATA-11 for analysis.

4. Results and discussion

We divide this section into two subsections. In the first subsection we report and discuss the results for the entire period. In the second subsection we present the results for the shortened period of 1997-2004 analysing also the effect of INV.

4.1 Model-1-The entire period model (spell length 1990-2004)

Table 1: Model 1-Spell length 1990-2004 (Dependent variable: T_LAG)

	Cox model	Complementary loglog
Covariates	Hazard ratios (Z values in parentheses)	Coefficients (Z values in parentheses)
GLOBAL	7.87*** (9.98)	1.69***(8.42)
MARKET	1.06** (3.11)	0.039* (2.11)
DISEASE_TYPE	1.49* (1.98)	0.35 (1.78)
TRIPS	6.33*** (9.41)	0.89*** (5.19)
Baseline hazard		-6.9*** (-24.53)
Chi square	197.3***	94.51***
No. of failures	154	154
No. of Observation	45451(#)	45451(#)

Note: 1. *** - significant at 0.1% level, **- significant at 1% level, *- significant at 5% level

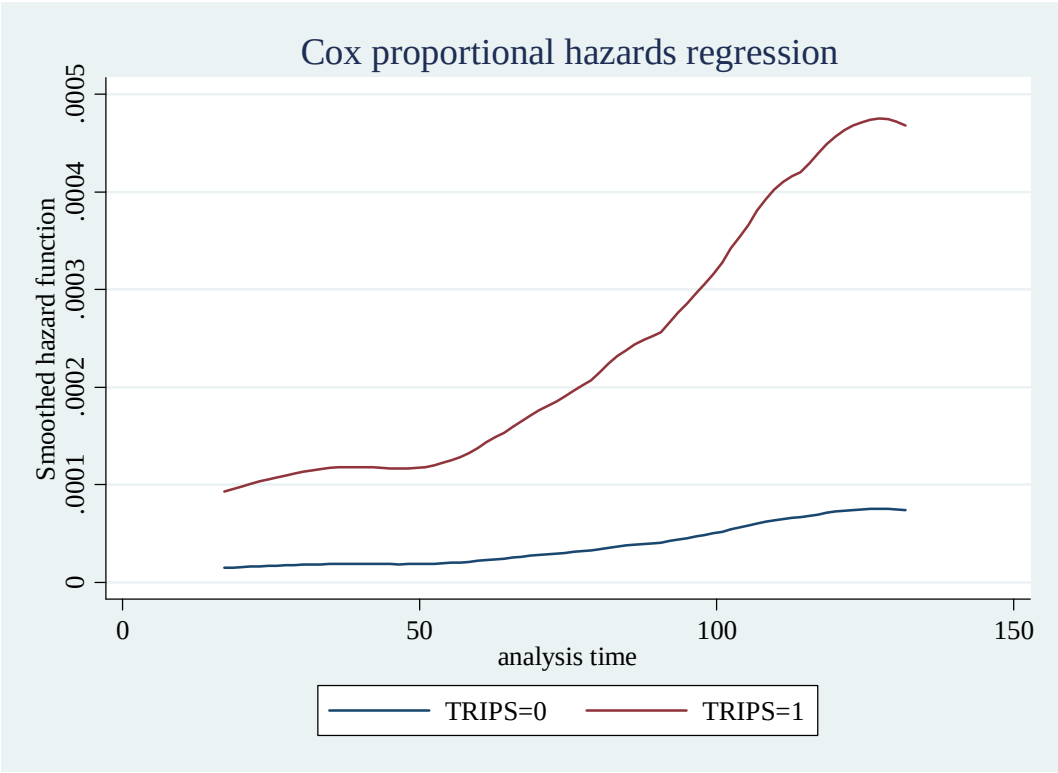
2. (#) data has been arranged in a person-period format (see Jenkins 2005: 73), where the number of entries received by a subject is equal to the time period it survives.

In this model three variables show significant relationships with drug launch delay in both approaches, namely GLOBAL, TRIPS and MARKET. DISEASE_TYPE shows a significant relationship only in the Cox model.[22] This means that we obtain very robust results for the variables GLOBAL, TRIPS and MARKET, while the results for DISEASE_TYPE should be interpreted with care.

Our analysis finds TRIPS to increase hazard by more than 6 times (figure 1). Hence, the launch delay has tremendously decreased after the announcement of stronger patent laws. In Section 2.1 we predicted that such an outcome would be possible if Indian firms, or their responses to new regulation, overwhelmingly dominate drug launches. The result can be seen as a confirmation to this conjecture, in the absence of data on firm names.

22 9 blockbuster drugs were, apparently, launched in India before their launch in Germany. So, our survival analyses use 42 blockbuster drugs.

Figure 1: Smoothened hazard function for different values of TRIPS-Announcements (1990-2004)



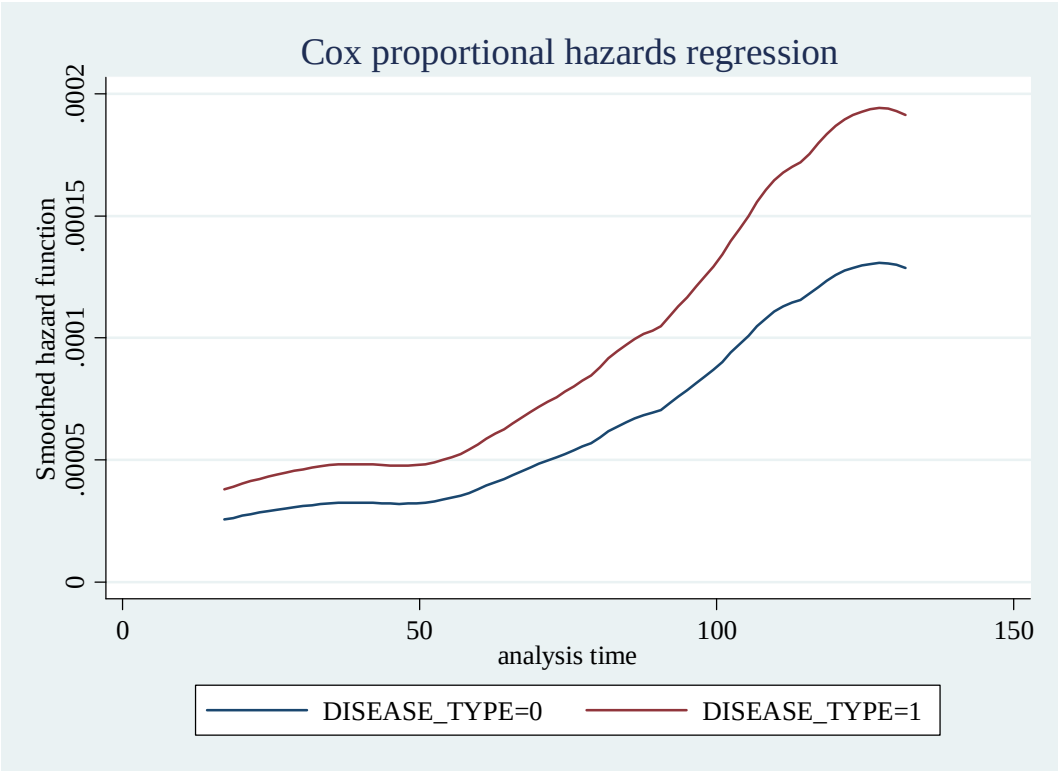
Another important determinant of delay seems to be the global commercial success of a new drug. A drug which attains a blockbuster status in the global market has an almost 10 times higher hazard ratio compared to non-blockbuster drugs. This confirms Hypothesis 2b. Indeed, success in other markets seems to cause a faster launch of these drugs in the Indian market.

The variable MARKET has a highly significant coefficient in the Cox model but significant only at 5% level in the Cloglog approach. Furthermore, the hazard ratio is only slightly above 1. Hence, Hypothesis 2a is confirmed, but the effect of the market share seems to be rather weak.

For the variable DISEASE_TYPE we find a weakly significant relationship in the Cox model, but no significant relationship is found in the CLogLog approach. Furthermore, the hazard ratio is small and the probability of drug launch is only approximately 1.5 times higher for non-communicable diseases. Hence, we find some confirmation for Hypothesis 3, but not a

very strong one. Given the two apparently contradicting Hypotheses 2c and 3 we might conclude while larger market share of infective diseases leads to shorter delay[23], for similar market size, drugs for communicable diseases are launched faster than the former group of drugs (figure 2).

Figure 2: Smoothened hazard function for different values of disease types (1990-2004)



4.2 Model-2-Shortened duration model (spell length: 1997-2004)

To examine the effect the innovativeness of a new drug has on launch probability, we estimated the Cox model and cloglog model for the duration 1997-2004[24]. A total of 302 drugs remained. The results of the two analyses are presented in Table 2.[25]

23 The average market share of drugs for communicable disease is 11.3%, whereas the drugs for non-communicable diseases have, on average, a market share of 6.92%.
24 Note that we have data for innovativeness of new drugs only from 1997.
25 The variable TRIPS cannot be included in this analysis.

Table 2: Model 2-Spell length 1997-2004 (Dependent variable: T_LAG)

	Cox model (Z values in parentheses)	Complementary log log (Z values in parentheses)
Covariates	Hazard ratios	Coefficients
GLOBAL	5.58*** (5.43)	1.51*** (5.18)
MARKET	1.04 (1.05)	0.029 (0.84)
DISEASE_TYPE	2.31* (2.51)	0.75** (2.19)
INV	1.72 (1.51)	0.56 (1.69)
Baseline hazard		-6.21*** (-12.28)
Chi square	42.9***	34.24***
No. of failures	69	69
No. of Observations	12017(#)	12017(#)

Note: 1. *** - significant at 0.1% level, **- significant at 1% level, *- significant at 5% level

2. (#) data has been arranged in a person-period format (see Jenkins 2005: 73), where the number of entries received by a subject is equal to the time period it survives.

Both models return statistically significant coefficients for GLOBAL and DISEASE_TYPE. Again, we find that blockbuster drugs are launched faster in the Indian market compared to not so commercially successful drugs with a hazard ratio of about 6. This confirms the strong results above for the variable GLOBAL.

The variable DISEASE_TYPE is significant at 5% level in both models. At any point, drugs for non-communicable diseases seem to be twice as likely to be launched in the Indian market compared to drugs for infective diseases during 1997-2004. Hence, Hypothesis 3 is further confirmed. Despite the larger market for drugs against infectious diseases, drugs against non-communicable diseases are launched in India with a shorter delay.

In this shortened period model, in fact, we find no significant results for the variable MARKET. This can be interpreted as a change in the importance of this variable. The market size of the respective drug category seems not to be a good predictor of drug launch in the more recent years. We cross checked this conjecture by analyzing the drug launch pattern for

drugs launched in Germany before 1997 (not reported). Indeed we find a completely different result. While MARKET is significant at 5% level, DISEASE_TYPE is not significant at all. In recent years, therefore, launch of new drugs in India is guided more by first mover advantage than simply the size of the market at a particular point in time. Innovativeness of a new drug (INV) does not seem to have any significant effect on its launch delay in the Indian market, confirming the predictions of existing studies.

5. Conclusions

Our analyses appear to be quite robust to specifications of time. The cox proportional hazard and its discrete time version – the complementary loglog model – return almost similar results. We briefly analyse our key results.

Our analyses reveal that the global commercial success of a drug shortens the delay in launch. Blockbuster drugs have an, approximately, 5 to 8 times higher probability to be launched at any point in time than other drugs. In contrast, the innovativeness of a drug does not influence its delay of launch. However, we find no significant overlap between commercial success of a new drug and therapeutic advancement it brings in. Indeed, out of 22 blockbuster drugs launched in India since 1997, 18 do not bring about any major therapeutic gains. Moreover, while only 40% of drugs which brought about major therapeutic advancement were launched in India, for the blockbuster drugs the respective share is 85%. Thus, it appears that launch in India is often highly influenced by the prospect of commercial success, and not by major therapeutic gains.

Another very clear result is that drugs introduced in the global market since 1995 have a significantly shorter delay compared to its predecessor drugs. In the absence of the names of firms associated with launch of new drugs in India, it may be conjectured that most of the drugs are launched in India by domestic firms, who successfully sped up their effort to innovate non-infringing processes for new drugs during the final years of the process-oriented patent regime.

We also find evidence that drugs for systemic diseases have quicker access to the Indian market than drugs for infective diseases, especially in the later years. This result is indeed apalling when one compares the DALY figures given by the WHO for India and Germany quoted in section 2.

In addition, out of 201 drugs launched in India, 127 belong to non-communicable diseases and 74 to infectious diseases. The relevant figures for the German market are 369 and 261, respectively. Thus, while a little more than 33% of the drugs for non-communicable diseases present in the German market have been launched in India, the similar share for the drugs for infective communicable diseases is only around 28%. Furthermore, while the ratio of drugs for communicable diseases to total drugs, launched during 1990-2004, in the German market is around 44%, in India the comparable share is 37%. This contrasts the share of the DALY for the two kinds of diseases. Indian firms, therefore, seem to be more concerned with consolidating a brand image in smaller markets with enduring business opportunities than in larger markets where business prospect is short lived.[26]

Although the policy environment has changed drastically since 2005, our results hold importance in identifying policy challenges even in this new environment. In somewhat generic manner, our key results show that firms in India respond more to (i) first mover advantage, and (ii) global commercial success.

Incidentally, drugs for the (infective) diseases contracted by the less well-to-do sections do not confer a high first mover advantage, and susceptible to longer delay. One may argue that TRIPS can compensate for this effect by removing generic drugs and, thereby, limiting competition for innovating firms. However, ironically, TRIPS also leads to monopoly pricing, which may keep drug prices beyond the reach of the poorer sections. As a result, potential market size for these drugs may shrink. In so far as market size promotes faster launch, a

26 Interestingly, of the 47 drugs whose launch dates in India precede their launch dates in Germany, 26 belong to systemic diseases and 21 belong to infective diseases!

shrink in market size would delay their launch.[27] Indeed, countries like Brazil have faced the problems of high pricing of new anti-HIV drugs, leading their governments to declare AIDS as 'national emergency' to revoke the provisions of TRIPs and make cheaper generics available to its population. Ironically, on the second issue, global commercial success does not seem to depend on the therapeutic advancement a new drug brings in. Decision to launch new drugs, solely, based on their global commercial success may, therefore, lead to increased health expenditure without matching increase in therapeutic gains.

Both issues perhaps call for increased responsibility on the part of medical professionals and the regulatory authority in the country. Research on medical practice in India is limited in numbers. In one such study, Ray (2004) seems to have found that physicians rely on therapeutic efficacy and academic references for demanding new drugs. If this is the case, information about therapeutic efficacy of a new drug should be disseminated more appropriately. A pro-active and vigilant drug regulatory authority may be the demand of the day!

27 Moreover, absence of competition will also confer similar advantages to drugs for systemic diseases. In so far as drugs for these diseases are demanded more by richer people, who might be less price sensitive, TRIPS-led increase in price may not reduce market size for these drugs considerably. Their launch in India is therefore expected to be less adversely affected (compared to drugs for infective diseases) in the new policy environment.

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