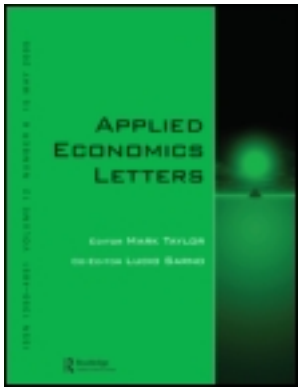

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Patents and the faster introduction of new drugs in developing countries

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Patents and the faster introduction of new drugs in developing countries

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This paper finds that product patent regimes spur faster introduction of new HIV/AIDS drugs only in those developing countries with relatively equally distributed incomes.

I. Introduction

Very little attention has been devoted to studying the impact of patent rights on the introduction of new drugs across countries. It is expected for patents to imply higher prices, and greater profits, which in turn, encourage patent holders to launch new drugs in low and middle-income countries soon after they are launched in the USA.[1] It is hypothesized that the patent owner will be more prone to enter if patents are granted than if not. In a patent regime, the marketing efforts of the patent owner will not spill over to other potential entrants during the patent term that would otherwise eventually come into the market. This spillover effect within products that contain the same drug is important because drugs are experience goods in which firms invest heavily in to inform doctors and patients about the characteristics of each drug.

This paper uses sales data on HIV/AIDS drugs in a sample of 34 low and middle-income countries between 1995 and 1999. It estimates a reduced-form probit model to assess empirically the impact of market exclusivity on introduction of new drug therapy. The main finding is that the patent regime had a positive effect on the introduction of new HIV/AIDS drugs in the subset of countries of the sample used with relatively equally distributed incomes.

II. Method

The probability of having any ARV drug locally available is modelled using the model of entry proposed by Bresnahan and Reiss (1987, 1990, 1991a, 1991b). n^i_{jt} is denoted as the number of competitors that supply drug j in country i at time t. Any ARV drug is available locally if – and only if – the *ex ante* expected value of offering that drug by at least one potential entrant is positive. That is, if the present discounted value of the flow of profits minus the fixed costs of entering the market for at least one firm is positive,

$$E\left[V(n^i_{jt} \geq 1)\right] = V\left(x^i_{jt}, r^i_j; \theta\right) - F^{\,i}_{jt} > 0 \qquad (1)$$

where V denotes the value function (the present discounted value of the flow of profits of selling drug j in country i at time t) as a reduced form function of a set of market shifters and profit drivers (x^i_{jt})

[1]Lanjouw and Cockburn (2001) report that interviewed drug firm executives believed that faster introductions of new products and greater investments in marketing and educating the local medical community about new therapies were the major benefits from the introduction of product patents in developing countries.

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and the patent regime indicator (r_j^i) that is equal to one, if the government of country i offered a patent right option to the developer of drug j, and zero if not, and a set of parameters (θ). It is expected that the reduced form value function (V) to be increasing with respect to the patent regime indicator (r_j^i). F_{jt}^i is the annual fixed cost of marketing drug j in market i at time t.

Assuming that F_{jt}^i is a log-normal random draw,

$$\ln F_{jt}^i = \mu_j^i + \sigma \upsilon_{jt}^i \quad \upsilon_{jt}^i \sim N(0,1) \tag{2}$$

and taking the natural log of inequality 1, any drug j will be available in any country i at time t if – and only if – inequality 2 holds:

$$\ln V(x_{jt}^i, r_j^i; \theta_1) - \mu_{jt}^i - \sigma \upsilon_{jt}^i > 0 \tag{3}$$

Then, the probability of having drug j available in country i at time t is the following,

$$\Pr\left(\ln V(x_{jt}^i, r_j^i; \theta_1) - \mu_{jt}^i - \sigma \upsilon_{jt}^i > 0\right) = \Phi\left(\frac{\ln V(x_{jt}^i, r_j^i; \theta) - \mu_{jt}^i}{\sigma}\right), \tag{4}$$

where Φ denotes the cumulative distribution of the normal standard.

The key identification assumption of the paper is that the patent regime indicator corresponding to each country and drug pair is exogenous to government and decisions of firms in regard to the market for HIV/AIDS drugs. The patent regime indicates whether patent or other market exclusivity status was attainable, to the best of knowledge. It depends on two dates: (1) the key patent priority date of each drug; (2) the date from which each country adopts the product patent system.

Drugs are in a patent regime when the drug key patent priority date is posterior to the date from which each country should grant patent protection according to local legislation, the WTO-TRIPS agreement, and international conventions. Governments should grant product patents within a year from the key priority date of each molecule. Additionally, WTO-TRIPS provisions on Exclusive Marketing Rights (EMR) affect four of the 14 HIV/AIDS molecules because these four ARV's fall into the so-called 'TRIPS-net'. The patent regime indicator is set to be 1 for these four drugs in all countries in the sample because all the local governments of the sample would be obligated to provide EMR or product patents to the innovators of these molecules under TRIPS rules.[2]

The patent regime is then exogenous to the decisions of firms regarding introduction of HIV/AIDS drugs across countries. The patent regime indicator does not report the actual patent status of the drug. By taking into account the value of patent protection, innovators may decide whether or not it pays to apply in each one of the countries that make available such rights. Nor does it report whether the drug is in-patent, or if it has already gone out-of-patent. It only shows that the patent status was attainable for some time during the life of the product. The patent regime is also exogenous to each local government HIV/AIDS policy. Changes in local patent legislations were the result of national policy developments, or international agreements (bilateral or multilateral).

IMS Health, the leading collector of data on unsubsidized drug sales worldwide, provided annual sales data for 15 antiretroviral drugs (ARV's, see Table 1) in 21 different countries and in two country groupings. Table 2 shows that there is wide variation with respect to the number of HIV/AIDS drugs available across countries, and with respect to the patent regime of those drugs. Argentina leads the table in terms of the number of drugs available in 1999 (14 out of 15), while South Africa leads the table in terms of the number of drugs introduced under a patent regime in 1999 (10 out of 10).

III. Results

Table 3 shows the results from estimating the probit model of drug introduction. The parameters of the probit equation were estimated by maximum likelihood, and by computing robust standard errors clustered by country. Drug heterogeneity, country differences, and heterogeneity of potential alternative drug treatments were controlled for. Complex interactions of the indicator of interest (the patent regime) and the control variables were looked for. The estimates that include the interaction between the patent regime indicator and the dummy of countries with relatively equally distributed income are reported. This interaction was the only one that was statistically significant.

According to the estimates, the patent regime only has a positive impact on drug availability in the

[2]See Articles 70.8 and 70.9 of the TRIPS Agreement. The four molecules in the TRIPS net are Nelfinavir, Delavirdine, Ritonavir, and Efavirenz.

Table 1. ARV's approved in the USA by June 2000 (from older to newer in the USA)

Molecule generic name	Brand name in the USA	Firm name in the USA	Year of key patent application	Launch Year in the USA
Zidovudine (AZT)	Retrovir®	Glaxo Wellcome	1985	1987
Didanosine (DDI)	Videx®	BristolMyer	1987	1991
Zalcitabine (DDC)	Hivid®	Roche Labs	1987	1992
Stavudine (D4T)	Zerit®	BristolMyer	1986	1994
Lamivudine (3TC)	Epivir®	Glaxo Wellcome	1989	1995
Saquinavir	Invirase® and Fortovase®	Roche Labs	1990	1995
Indinavir	Crixivan®	Merck	1993	1996
Nevirapine	Viramune®	Roxane	1993	1996
Ritonavir	Norvir®	Abott Pharm	1995	1996
Delavirdine	Rescriptor®	Agouron	1994	1997
Lamivudine & Zidovudine	Combivir®	Glaxo Wellcome	1989	1997
Nelfinavir	Viracept®	Agouron	1994	1997
Abacavir	Ziagen®	Glaxo Wellcome	1989	1998
Efavirenz	Sustiva®	Du Pont Pharm.	1995	1998
Amprenavir	Agenerase®	Glaxo Wellcome	1993	1999

Source: PDR (2000), Balasubramaniam (2000), and FDA (2000).

Table 2. Number of drugs available by country and year (of which under patent regime)

	1995	1996	1997	1998	1999
USA	6(6)	9(9)	12(12)	13(13)	15(15)
Argentina	4(0)	7(1)	10(2)	12(3)	14(4)
Chile	0	1(0)	5(0)	9(3)	12(5)
Colombia	1(0)	4(1)	6(1)	10(2)	12(3)
Thailand R&H	3(1)	6(4)	8(6)	10(8)	12(10)
Mexico	3(2)	3(2)	5(4)	8(7)	10(9)
South Africa R&H	3(3)	4(4)	6(6)	9(9)	10(10)
French West Africa	2(2)	2(2)	4(4)	8(8)	9(0)
Brazil	1(0)	4(0)	4(0)	5(0)	7(0)
Malaysia	1(1)	2(2)	5(5)	6(6)	7(7)
Uruguay	1(0)	1(0)	1(0)	5(1)	7(2)
Central America	1(1)	1(1)	4(4)	5(5)	5(5)
India	n.d.	n.d.	1(0)	2(0)	5(0)
Venezuela	0	0	2(0)	3(0)	5(0)
Philippines R&H	1(1)	2(2)	2(2)	3(3)	4(4)
Dominican Republic	0	0	0	0	3(0)
Ecuador	0	1(0)	1(0)	1(0)	3(0)
Peru	0	0	1(0)	3(0)	3(0)
Indonesia R&H	1(0)	3(0)	4(1)	2(1)	2(1)
Bangladesh	0	0	0	0	0
Egypt	0	0	0	0	0
Morocco	0	0	0	0	0
Pakistan	0	0	0	0	0
Tunisia	0	0	0	0	0

Notes: N.d.: no data. R&H: Retail & Hospital sales included. Otherwise, retail sales only.
Source: Author's calculations based on IMS health data.

Table 3. Probit model of drug introduction, probability of having a sample mean drug locally available

	Coefficient (robust standard errors)
Patent	0.03 (0.28)
Patent * equal group (Gini < 47.6%)	1.12 (0.38)**
Income group 1 (Inc ≤ $2754)	–
Income group 2 ($2754 < Inc ≤ $3693)	0.02 (0.44)
Income group 3 ($3693 < Inc ≤ $5599)	0.08 (0.39)
Income group 4 ($5599 < Inc ≤ $7719)	1.52 (0.42)**
Income group 5 (Inc > $7719)	1.82 (0.55)**
Equal group (Gini < 47.6%)	−0.41 (0.33)
Dosage	−0.53 (0.27)**
Efficacy	−0.001 (0.05)
Adverse reactions	−0.05 (0.04)
Less than a year in the USA	–
1 year in the USA	1.01 (0.22)**
2 years in the USA	1.59 (0.30)**
3 years in the USA	2.06 (0.37)**
4 years in the USA	2.28 (0.44)**
5 years in the USA	2.33 (0.51)**
6 years in the USA	2.17 (0.50)**
7 years in the USA	2.28 (0.52)**
8 years in the USA	2.70 (0.57)**
9 years in the USA	3.03 (0.51)**
10 years in the USA	3.35 (0.43)**
11 years in the USA	3.40 (0.46)**
12 years in the USA	3.75 (0.52)**
Log likelihood	−444.07
Pseudo R^2	41.64%
Observations	1273

Note: The hypothesis that each coefficient is zero is rejected at the two-sided 1% (**) significance level. Sum of characteristics other drugs in USA included. Drug type, year, and hospital sales fixed effects included. US$ at PPP. Robust standard errors clustered on country.

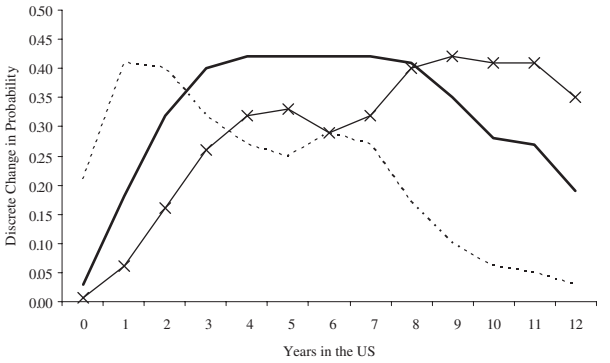

Fig. 1. Marginal effect of the patent regime on the probability of having a sample mean drug locally available (countries with Gini < 47.6): (——) mean income, (—×—) low income, (- - - -) high income

subset of countries with relatively equally distributed incomes. This result is consistent with the inverse relationship between expected prices and the Gini coefficient obtained in Borrell (2004). Countries with large income inequalities do not support the price premiums that encourage an early launch of new drugs by patent holders in developing countries.

For the subset of relatively equal income distribution, the marginal effect of patent regime across time has also been completed. Figure 1 also shows that the marginal effect of the patent regime on drug availability is convex with respect to the number of years the drug has been available in the USA. This result suggests that the value function of the patent holder increases initially from the date that the new drug is launched in the USA. The hypothesis is that costs of marking a drug in patent regimes might be decreasing initially. This spurs the patent effect on drug availability initially. In contrast, as the patent term comes to a finish, and entry by competitors gets closer, the value function of the patent holder gets smaller, which implies that the marginal effect on drug availability eventually decays.

The evidence shows that apart from the likely effects of patents on the incentives to innovate, on drug pricing and on access to new drug therapy, the patent regime also has a strong positive impact on the availability of drug therapy in developing countries with relatively equally distributed incomes. It is found that the impact of patents is convex over time from the launch date of a new drug in the USA, and that it is initially larger in the high-income group of countries of the sample.

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References

Balasubramaniam, T. (2000) *Background Information on Fourteen FDA Approved HIV/AIDS Drugs, Consumer Project on Technology*. Published online: http://www.cptech.org/, version 1.41, June 8.

Borrell, J. R. (2004) Pricing and patents of HIV/AIDS drugs in developing countries, *mimeo*.

Bresnahan, T. F. and Reiss, P. C. (1987) Do entry conditions vary across markets? *Brookings Papers on Economic Activity*, **3**, 833–71.

Bresnahan, T. F. and Reiss, P. C. (1990) Entry in monopoly markets, *The Review of Economic Studies*, **57**(4), 531–53.

Bresnahan, T. F. and Reiss, P. C. (1991a) Empirical models of discrete games, *Journal of Econometrics,* **48**(1–2), 57–81.

Bresnahan, T. F. and Reiss, P. C. (1991b) Entry and competition in concentrated markets, *Journal of Political Economy,* **99**(51), 977–1009.

FDA (2000) *Electronic Orange Book. Approved Drug Products with Therapeutic Evaluations,* US Department of Health and Human Services, Federal Drug Administration, Rockville, (MD, USA). Published online: http://www.fda.gov/cder/ob.

PDR (2000) *Physicians' Desk Reference: PDR*, 54th edn, Medical Economics, Oradell, NJ, USA.