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Abstract

Market concentration in technology intensive industries has been a subject of interest to both scholars and policy analysts. This paper provides a first empirical assessment on how the patenting system contributes to market concentration and the generation of economic rents in three key sectors – pharmaceuticals, chemicals and ICTs. Using data for US multinationals and their foreign affiliates on the one hand, and locally registered private and public companies in Brazil, India and China, we conclude that the concentration of patent ownership is found significantly to relate to market concentration in the USA. In developing countries such as Brazil, India, and China, a strengthening of patent rights has contributed to greater returns for affiliates of U.S. companies but has not stimulated their R&D intensity. The affiliates of U.S. multinationals have enjoyed greater profitability relative to their local competitors in Brazil, India, and China. The paper draws implications for the setting of intellectual property policy and offers suggestions on the role of competition policy in curbing market concentration and related effects on inequality and access.

The statistical analysis of firm level data on U.S. multinational companies and their foreign affiliates, and U.S. affiliates of foreign multinational companies was conducted at the Bureau of Economic Analysis, United States (U.S.) Department of Commerce, under arrangements that maintain legal confidentiality requirements. Views expressed in this paper are those of the authors and do not necessarily reflect official positions of the U.S. Department of Commerce.

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1. Introduction

The rise in market concentration has come under considerable scrutiny in recent years. The concern is that it is fueling a redistribution of rents, contributing to rising inequality and reduced competition in global markets, with associated welfare implications for the global economy (OECD, 2018). This has become a particular concern in many technology-intensive industries, where profitable companies today are highly likely to remain profitable ten years later, with greater stratification and inequality among firms. In these industries, concentration trends are also often accompanied by a growing reliance on intellectual property rights (IPRs) protection, as demonstrated by a sharp ascendancy of IP filings over the past decade (WIPO 2018).¹

Technological change can potentially be a driver of such rents, and is often advanced as an explanation for the rise of ‘super star’ firms in the global economy that gain larger shares of sales in a particular industry.² But evidence on what creates such superstar effects is largely inconclusive, and key questions emerge. Is technological change the sole reason for the ‘winner takes all’ dynamic that has emerged across key industries globally today? Or does the recent rise in market concentration globally imply an increase in market power? And if so, to what extent are high profits observed across corporate sectors globally not entirely due to innovative investments but due to undue market power or reduced competition that accrue from a strategic use of dominant positions? Are incumbents in several technology sectors “becoming more entrenched” and is the global IPRs system hostage to those keen on amassing and retaining ‘excessive’ rents?

Historically, the patent system has motivated innovation by promising economic rents to a patent holder for a limited period. During this time, the holder is able to exclude imitation and competition within a certain sphere of product space,³ thus indicating that some degree of market power has been accepted as part of the workings of an intellectual property system. But in recent years, a series of sweeping IP reforms in the USA starting 2000 has culminated in the America Invents Act (of 2011) that strengthens the exclusive rights of intellectual property owners. Globally, over the same time period (from 2000 until 2011 and beyond), there has been an exponential increase in free trade agreements (FTAs) that provide similarly higher IP standards and expand its reach to newer subject categories when compared to what was negotiated in the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS Agreement).

These two trends – territorial strengthening of IPRs in some economies and a proliferation of FTAs –legitimize the strengthening of the patent system that is already ongoing in some industrialized countries such as the USA on a global scale in two ways: the provision of stronger patent protection that extends the duration and coverage; and the expansion of patent protection to newer subject areas, such as life forms, software and business and financial innovations (Cottier, 2017; Gehl Sampath and Roffe, 2017). Thus, although IP rights remain

¹ According to the official figures of the World Intellectual Property Organisation, patent applications worldwide have witnessed the eighth year of annual growth with 3.17 million patent applications in 2017, whereas trademark applications have witnessed a double-digit growth for the third year in a row, up by 26.8% when compared to 2016, with 12.39 million applications in 2017 (WIPO, 2018).

² The concept of ‘superstar firms’ was first introduced by Rosen (1981), arguing that in markets where quality advantages exist, a small number of suppliers dominate the market and command most of the returns.

³ In legal terms, the degree of product differentiation must be sufficient to avoid the application of the doctrine of equivalents.

territorial, the global reforms to date have made national IPRs protection more accountable to global standards, thereby reducing entry costs and opening up access to national markets. Reduced discrimination and national treatment as a result of these changes have helped facilitate patent filings across countries by global companies. Notwithstanding these changes, there is not much discussion on how much *rent* is productive and accrue to the inventor from the grant of such IPRs, and if this amounts to 'fair rewards' for the inventor? There are also concerns about whether the reforms and opening up of IP markets have disproportionately benefited incumbent players, or well-established firms (Stiglitz, 2016).⁴

This paper provides an early look at the effects of patent rights and related activity on market concentration and firm profitability using data on global companies in three key sectors of the global economy – pharmaceuticals, chemicals and the ICTs. Our contribution is two-fold. We link the expanding literature and evidence on market concentration with that on patents, to analyze when patenting leads to market concentration, and a related rise in market power. Secondly, we analyze the extent of market power that patents confer and how that affects market structures for competition and global welfare. Especially with the opening up of global IP markets, we examine whether there been more entry of, say, affiliates of foreign companies into industrialized markets and whether indigenous companies in the developing world gained participation in world technological markets. We also examine whether the increased rates of return from stronger patents foster positive investments from the incumbent firms, and if not, how this might adversely affect global welfare.

Section 2 provides a background on market concentration and intellectual property. Section 3 describes our data, followed by Section 4 on methodology and Section 5 on findings. We find that the concentration of patent ownership is significantly related to market concentration in the U.S. In developing countries such as Brazil, India, and China, a strengthening of patent rights has contributed to greater returns for affiliates of U.S. companies but has not stimulated their R&D intensity. Furthermore, we find that while the affiliates of U.S. multinationals have enjoyed greater profitability relative to their local competitors in Brazil, India, and China, stronger patent rights are also associated with dwindling profits for locally registered companies over time, who seem to be losing ground. These results raise the possibility of 'excess' rents from patent protection, without commensurate benefits for local economies. In Section 6, the paper draws implications for the setting of intellectual property policy and discusses the role of competition policy in curbing the misuse of patent rights in countries.

2. Market Concentration and Intellectual Property Rights: A Review

One of the early studies on the topic, Furman & Orszag (2015) show an increased rate of returns to capital across firms in the United States over time with a large number of firms obtaining supra-normal returns. They use the combined market share of the largest 50 firms in the US market to calculate the level of industry concentration and argue that although corporate consolidation could be at play, more exploration is needed of the other factors accounting for these changes. In 2016, the Council of Economic Advisors of the White House issued a brief about the decline in competition, noting similarly that industry concentration has risen and that firms enjoy greater rents. But the rising rents have not attracted firm entry. Autor et al. (2017), using micro panel data from the U.S. Economic Census since 1982, argue that the rise of

⁴ Stiglitz (2016) views competition – when firms are active across borders – as a “global public good” and calls for competition policy to be part of a broad global cooperation framework.

‘superstar’ firms in some sectors has led to a decline in labour share of income, thus pointing to important employment and social implications of ongoing consolidation.

A limitation of these studies, as noted in subsequent critiques (see Wright, 2018), is that while they bring to light a general trend, i.e., the increase in market concentration, they do not link it to specific markets or industries, and make a tenuous link between market concentration and market power in general. Market concentration by itself may not be such a problem if it does not lead to an accumulation of market power, with relevant effects of competition, allocation of resources and social welfare. De Leucker et al (2018) seek to answer this question by linking the rise in concentration to market power by studying the rise in mark ups, which simply put, represents any increase in a firm’s markups is a result of the increase in its prices relative to marginal cost. They conclude that average markup across all publicly listed US firms went from 18 percent in 1980 to 67 percent in 2014, thereby concluding that these increases in mark ups indicate market power. Gutierrez and Phillipon (2017) similarly conclude the rise in concentration by measuring mark ups, while Baqaee and Farhi (2018) show that firms with higher mark ups are also increasing in their size.

Linking market concentration directly to a decline in competition and inequality, Furman and Orszag (2018) suggest that market concentration and the rise in rents leads to reduced competition can play a role in declining productivity growth and inequality, while Gutiérrez and Phillipon (2017 and 2018) find a link between the slowdown of investment at the industry level to reduced competition. Given that conventional ways of measuring market concentration and mark ups are subject to some shortcomings, such as changes in fixed costs or costs of making new technological investments, Bouhia (2018) proposes a profit-oriented measure of market power at the firm level, based on a decomposition of profits as normal (against a benchmark) and surplus. In an analysis of data from publicly listed corporations in 56 industrialized and developing countries, the study finds that the share of surplus profits in total profits has increased from an average of 7% in 1995-2000 to 25 % in 2009-2015, arguing that there has been an overall decline in competition globally that is occurring hand-in-hand with a greater propensity of the top firms to redistribute rents.

On the question of intellectual property and market concentration, the Economist in 2016 focused on how corporate profits and returns on capital are at near record levels in the United States. Arguing that high profits may be a sign of a sickness, such as abuse of monopoly power, it advocated a “loosening of rules” that make intellectual property rights too strong (Economist, 2016a; 2016b). It estimated that half of the firms obtaining exceptional profits (which are defined as profits at and above 10 percent) were to be found in technology-intensive sectors, where IPRs played an important role. Many other studies make similar references to the role of technology-intensive sectors or ‘superstar’ firms in market concentration (Autor et al, 2017; De loeker et al, 2018), suggesting that their proliferation will reduce economic productivity (Van Reenen and Patterson, 2017).

But studies linking rise in rents to specific industries, or IP related practices, are still emerging. Shapiro (2016) notes that, as a share of total domestic profits from 1998-2016, profits grew mainly in the finance & insurance sector (from 13.6 percent to 18.3 percent) and health care & social assistance sector (from 2.1 percent to 5.2 percent), and the information technologies sector including both media and high-tech (from 5.3 percent to 7.8 percent). Reidenberg et al (2012) examines the smartphone industry and the impact of patenting on entry barriers and entry strategies, noting that for large companies, patenting is part of a defensive business strategy, whereas for small companies’ patents are part of their product development strategy.

Other studies similarly focus on the extensive issues raised by patent thickets, or trolls to business and industry, but do not examine the level of competition in the relevant industries ICT industry broadly nor conducts an econometric analysis of the effects of patents on market concentration.

In a study related to ours, Miller (2009) analyzes the relationship between market concentration on the level of patent grants across industries. He finds no significant direct relationship between them once industrial R&D expenditures are controlled for. The relationship is indirect: R&D and concentration are related, and R&D and patent grants are related. This, he suggests, indicates that firms use patents primarily to recoup R&D investments, rather than for say strategic uses. Our paper differs from Miller (2009) in that he uses market concentration as an independent variable to explain patenting, whereas we focus on the reverse: patents as a source of market power and concentration. Second, our analysis uses panel data, whereas Miller's analysis is based on a cross-section of 2002 data, which is somewhat dated and omits the impact of policy reforms that have taken place since. Lastly, we use not just the level of patents, but patent citations to account for quality differences across innovations and examine the concentration of patent ownership within industries, not just the quantity of patenting.

Finally, the impact of patent reforms in the developing world, how it might lead to market concentration or market power, and what anti-trust implications this might have for product price, availability, economic inequality and economic catch-up is an entirely understudied area. Briggs and Park (2014) show how patent reforms in the developing world have enhanced the exporting and licensing capacities of foreign affiliates of U.S. multinational companies operating there. They argue that local patent reforms provided a base for these affiliates to strengthen their technological positions. But what has not been explored is how these affiliate firms fare relative to local, indigenous companies, and whether the gains go disproportionately to foreign affiliates of multinational companies.

3. Data Sources

We utilize two data sources on global companies. The first is the U.S. Bureau of Economic Analysis (BEA), which conducts annual and benchmark surveys of U.S. multinational parent companies and their foreign affiliates around the world (*BE-10* and *BE-11* surveys), as well as annual and benchmark surveys of U.S. affiliates of foreign multinational companies (*BE-12* and *BE-15* surveys). The surveys provide detailed financial and operating data at the firm level.⁵ The second is Thomson Reuters *Eikon* and *Datastream*, which provide data on private and public companies, with headquarters around the world. The primary data we obtained from these sources are firm sales, net income, employees, assets, and research and development (R&D). We then supplement these firm level data with data on patents granted by the U.S. Patent and Trademark office (USPTO) and the associated data on patent citations. The patent and citations data are obtained from the National Bureau of Economic Research (NBER) Patent Data Project (PDP).⁶ The patent citation variable is constructed by creating a weighted count of patents, where we weight each patent by the number of citations it has received during the 1st five years, adjusting for truncation bias (as calculated by Hall, Jaffe, and Trajtenberg, 2001). The citations a patent receives is used to help control for patent quality.

⁵ For a guide, see <https://www.bea.gov/surveys/pdf/a-guide-to-bea-direct-investment-surveys.pdf>.

⁶ <https://sites.google.com/site/patentdataport/>

We combine BEA data on U.S. affiliates of foreign MNCs and U.S. parent companies operating in the U.S. in order to study how patenting relates to market concentration in the U.S. We then turn to BEA data on foreign affiliates of U.S. MNC in three developing countries – Brazil, India, and China – in order to study how patent reforms in those countries have affected the market sales and returns to those affiliate companies. These three countries represent regions where significant patent reforms have taken place and which constitute key markets for U.S. companies in the developing world. Multinational companies with valuable intellectual property assets have especially been concerned with the protection of those assets in those three key markets.

The purpose of the Thomson Eikon/Datastream data source is to help benchmark the performance of foreign affiliates of U.S. MNCs against local, indigenous companies. For that, we obtained sales and profitability data on Brazilian, Indian, and Chinese companies headquartered in Brazil, India, and China respectively. The reason for the benchmarking is as follows. It would be ideal to study how patent reforms and patenting activity have raised the market concentration levels in those three developing countries, but data limitations do not easily permit such an investigation for now. For example, we lack systematic sales data on all global firms that operate in those markets – local as well as foreign. The Thomson Eikon/Datastream database consolidates a firm’s sales and other measures globally. At best, we can derive a firm’s domestic sales; for example, we can obtain an Indian company’s sales in India (by subtracting its international sales from its total sales), or a Brazilian company’s sales in Brazil. However, Thomson Eikon/Datastream does not provide data on other companies’ sales in Brazil, India, or China, such as the sales of French, German, Korean, or Australian companies in those local markets.⁷ Thus, it is not possible to construct accurate measures of market concentration for these three countries. However, we can at least compare the local sales of foreign affiliates of U.S. MNCs to those of the local headquarter companies and see whether the affiliates are gaining markets relative to the Brazilian (Indian or Chinese) companies. We can also estimate rates of return to the affiliates in those markets relative to the rate of return of the headquarter companies in India, Brazil, or China.

4. Methodology

We focus on three industries, namely, the pharmaceuticals, chemicals, and information and communications technologies (ICT). Several studies note that these sectors are characterized by firms that patent heavily yet provide interesting sectoral differences in terms of the technological complexity of their products, product life cycle, and the ways in which they cope with imitation risks (Ivus et al, 2016). We identify sectors by four-digit NAICS codes (2002 version). For example, the pharmaceutical sector is coded 3254. The chemicals sector are those firms with NAICS classification codes 3251, 3252, 3253, and 3255 – 3259 inclusive. The ICT sector consists of firms essentially in technology hardware and software, with NAICS codes 3241 – 3246 inclusive and 5111 (software publishers).

We provide sample statistics on market concentration based on the *Herfindahl-Hirshman Index (HHI)*, which is obtained by squaring the market share of each firm in a defined market and summing the squares; that is:

⁷ Another approach might be to focus on those foreign companies operating in Brazil, India, or China, based on the country risk assessment of Thomson Eikon. This measure, however, gauges only the risk exposure that firms have in local markets but does not allow us to estimate their sales in the local markets.

$$(1) \text{ HHI} = \sum_{i=1}^N s_i^2$$

We also calculate the concentration of patent ownership and patent citations using the HHI method. The HHI for sales, patent grants, and patent citations are computed for specific groups of firms, for example by industry (at the 4-digit NAICS level) and year.

As another perspective on market concentration, we examine measures of sales inequality among firms using the Gini coefficient⁸ and the ratio of the mean sales of the top quintile of firms to that of the middle quintile of firms, which we label as T20/M20.⁹ That is, we ranked firms (in a particular industry and year) in descending order of sales, and formed quintiles. From these quintiles, we can observe the percentage of sales that each quintile accounts for and the mean sales per quintile.

To examine how the sales of foreign affiliates of U.S. MNCs have trended in a host country, we examine the normalized path of the *median* affiliate sales per worker:

$$(2) \sigma_t = \frac{\text{Sales}_t}{\text{Employees}_t}$$

where again s_t is the median firm's sales per worker at some time t . The normalized value of the median firm sales is obtained by dividing s_t by some base (initial) year's median sales per worker s_0 :

$$(3) \text{ Norm } \sigma_t = \frac{\sigma_t}{\sigma_0}$$

The normalized affiliate sales per worker series is computed for each host country and industry pair (i.e., chemicals and pharmaceuticals, and ICT). The normalized sales measure is then compared to the trend in patent protection in the host country, using the updated index of patent rights in Park (2008). Sales were also converted to real 2009 dollars using the GDP deflator.

As a measure of profitability, we examine the rate of return, defined as the ratio of net income to assets:

$$(4) \text{ ROR} = \frac{\text{NetIncome}}{\text{Assets}}$$

The ROR here is the *mean* rate of return for each industry and host country pair for a given year.

⁸ For this, we compare the cumulative share of firm sales to the cumulative population of firms, the way the Gini coefficient is calculated for income distribution. The Gini varies from zero (perfect equality, where all firms have equal sales) to one (perfect inequality, where one firm accounts for all the sales).

⁹ We did not compute the conventional ratio of the top 20% to the bottom 20% because the data for (and the number of firms in) the bottom quintile fluctuated heavily over time. We thought the top 20% to middle 20% therefore provided a steadier, more reliable, comparison.

The ROR fluctuates over time due to business cycles. To smooth the series out, we applied exponential smoothing (with a dampening factor of 0.5):

$$(5) \text{ROR}_t^{\text{ES}} = 0.5\text{ROR}_{t-1} + 0.5\text{ROR}_{t-1}^{\text{ES}}$$

We compare the ROR of the affiliates to that of the local indigenous companies.

Lastly, we perform some regression analyses. Using the sample of firms in the U.S., we examine the effects of patenting on market concentration, and the effects of market concentration on firm profitability. Using the sample of foreign affiliates of U.S. parent companies in Brazil, India, and China, we examine the effects of patent reforms on firm profitability and on incentives to engage in R&D.

For the U.S. sample of firms, our model of industrial market concentration is:

$$(6) \text{HHI}_{it} = \alpha_0 + \alpha_p \text{PAT}_{it-l} + \alpha_{pc} \text{PAT}_{it-l} \times \text{CHEM}_i + \alpha_{pp} \text{PAT}_{it-l} \times \text{PHARM}_i + \alpha_{pi} \text{PAT}_{it-l} \times \text{ICT}_i + \alpha_t + \beta_{it} + \varepsilon_{it}$$

where the unit of analysis is industry (i) by year (t). The dependent variable is the HHI of concentration in industry i at time t. The key explanatory factor is PAT_{it-l} , where PAT could take one of four variables: the level of patent grants, the HHI of patent grants (measuring the concentration of patent ownership), the level of patent citations, and the HHI of patent citations (measuring the concentration of quality patents). Note that the patent variables are all lagged by l years. In our regressions, $l = 5$ years.¹⁰ It is important to lag the patent grants since a third factor (say, firm size) may be driving both the concentration of sales and patent ownership, which can confound the effects of patenting on market concentration. In addition, the correlation between patenting and firm size is mitigated by the use of citations, which need not vary with firm size; that is, patent quality is not necessarily a function of the size of firms. CHEM, PHARM, and ICT are dummy variables which equal one if the particular four-digit NAICS coded industry sector correspond to one of the meta-sectors. α_t and β_{it} refer to the year fixed effects and industry x year fixed effects, respectively. In this and the following regression equations, all the variables (except the dummies) are in natural logs. The coefficients therefore have the interpretation of an elasticity.

We next relate the industry rate of return to market concentration measures:

$$(7) \text{ROR}_{it} = \alpha_0 + \alpha_s \text{HHI}_{it} + \alpha_{sc} \text{HHI}_{it} \times \text{CHEM}_i + \alpha_{sp} \text{HHI}_{it} \times \text{PHARM}_i + \alpha_{si} \text{HHI}_{it} \times \text{ICT}_i \\ + \beta_p \text{HHI-PAT}_{it} + \beta_{pc} \text{HHI-PAT}_{it} \times \text{CHEM}_i + \beta_{pp} \text{HHI-PAT}_{it} \times \text{PHARM}_i + \beta_{pi} \text{HHI-PAT}_{it} \times \text{ICT}_i + \alpha_t + \beta_{it} + \varepsilon_{it}$$

The rate of return is regressed on both the HHI of sales as well as the HHI of patents, where we examine the concentration of either patent grants or patent citations.

In the sample of foreign affiliates of U.S. multinational companies, we estimate a model of the rate of return (ROR) as well as R&D to sales (all in natural logs):

¹⁰ The lag length was primarily dictated by the availability of the patent data.

$$(8) \text{ ROR}_{jnt} = \alpha_0 + \alpha_p \text{IPR}_{nt} + \alpha_v \left(\frac{\text{VA}}{\text{L}} \right)_{jnt} + \alpha_M \frac{\text{Sales}_{jnt}}{\text{HQ}_{nt}} + \alpha_{Mn} + \alpha_{Mi} \\ + \alpha_n + \alpha_t + \alpha_j + \alpha_i + \alpha_{it} + \alpha_{in} + \alpha_{pn} + \alpha_{pi} + \varepsilon_{jnt}$$

where IPR denotes the index of patent rights, VA value added, and L employees. The ratio VA/L is a measure of firm productivity (output per worker). Sales refers to affiliate sales and HQ the sales of all the local headquarter companies. The ratio Sales/HQ is a measure of the market advantage of the affiliate firm vis-à-vis the local indigenous companies (or roughly market share). In equation (8), the unit of analysis is the firm j in country n at time t . The number of countries is three (consisting of Brazil, India, and China). We control for a myriad of fixed effects and interaction effects: year (a_t), country (a_n), industry (a_i), industry \times year (a_{it}), industry \times country (a_{in}), IPR interacted with industry (a_{pi}) and with country (a_{pn}), and market share (Sales/HQ) interacted with industry (a_{Mi}) and with country (a_{Mn}). Equation (9) is estimated by the method of least squares dummy variables (LSDV) and absorbs firm fixed effects. In this case, we have both firm and industry fixed effects because some affiliates are in two or more industries.

We test the extent to which local patent reforms stimulate affiliate R&D by estimating the following model:

$$(9) \left(\frac{\text{R\&D}}{\text{Sales}} \right)_{jnt} = \alpha_0 + \alpha_p \text{IPR}_{nt} + \alpha_R \text{ROR}_{jnt} + \alpha_M \frac{\text{Sales}_{jnt}}{\text{HQ}_{nt}} + \alpha_{pR} + \alpha_{pM} + \alpha_{RM} \\ + \alpha_n + \alpha_t + \alpha_j + \alpha_i + \alpha_{it} + \alpha_{in} + \alpha_{Ri} + \alpha_{Rn} + \alpha_{pi} + \alpha_{pn} + \alpha_{Mi} + \alpha_{Mn} + \varepsilon_{jnt}$$

where, in addition to the variables already defined, ROR is the (natural log) of the rate of return, a_{pR} the interaction between IPR and ROR, a_{pM} the interaction between IPR and market share, and a_{RM} the interaction between ROR and market share. a_{Ri} and a_{Rn} are the interactions between ROR and industry fixed effects and between ROR and country fixed effects, respectively. The coefficient estimates from equations (8) and (9) can be used to find the differentiated effects of patent rights by country and industry (e.g., pharmaceutical, chemicals, and ICT).

5. Analysis

There are two parts to the empirical analysis. In the first part, we study companies in the U.S. market; specifically, we examine both U.S. parent companies operating in their home market and U.S. affiliates of foreign multinational companies (MNCs). We utilize this relatively large sample of firms to study levels of market concentration in three industries of interest: chemicals, pharmaceuticals, and ICT. We then examine how market concentration in the U.S. has been affected by patenting activity, and how market concentration has affected firm profitability, as measured by the rate of return (or net income-to-assets ratio). In the second part, we turn to three large developing nations that are of key interest (and concern) to U.S. intellectual property owners: Brazil, India, and China. We focus on the local sales, rate of return, and the R&D intensity of foreign affiliates of U.S. multinational companies operating in those markets. We are specifically interested in how patent reforms in the host countries affected the sales and return to those companies, and how much more those reforms benefited U.S. companies relative to local, headquarter companies in Brazil, India, and China.

(A) U.S. Sample

Table 1 presents three perspectives on market concentration and inequality for the three key industries of interest – the pharmaceutical industry, non-pharm chemicals industry, and the information and communications technology (ICT) industry. We examine three cuts of the sample: A) the full sample of companies – both the U.S. multinational parent companies’ domestic operations and the U.S. affiliates of foreign multinational companies; B) the U.S. multinational parent companies’ domestic operations separately (which we refer to as a *domestic* sample); and C) the U.S. affiliates of foreign multinational companies separately (*foreign* sample). We show two periods: 1995 – 1999 and 2009 – 2014. The five-year pooling helps to smooth out the cyclical fluctuations in these measures of concentration and inequality.

Table 1. Market Concentration Measures in the U.S. Sample

A. Full Sample:	Industry	Period	HHI	T20/M20	Gini:
<i>Companies in the U.S. (U.S. Parent MNCs and U.S. Affiliates of Foreign MNCs)</i>	<u>Chem</u>	1995-1999	187	74.5	0.87
	<u>Chem</u>	2009-2014	202	66.6	0.87
	Pharm	1995-1999	420	144.8	0.88
	Pharm	2009-2014	313	170.2	0.87
	ICT	1995-1999	194	106.9	0.92
	ICT	2009-2014	275	151.8	0.93
B. Domestic Sample:	Industry	Period	HHI	T20/M20	Gini:
<i>U.S. Parent Companies operating in the U.S.</i>	<u>Chem</u>	1995-1999	351	19.1	0.78
	<u>Chem</u>	2009-2014	386	34.7	0.83
	Pharm	1995-1999	672	41.3	0.78
	Pharm	2009-2014	546	84.9	0.83
	ICT	1995-1999	343	65.2	0.88
	ICT	2009-2014	443	77.9	0.91
C. Foreign Sample:	Industry	Period	HHI	T20/M20	Gini:
<i>U.S. Affiliates of Foreign MNCs operating in the U.S.</i>	<u>Chem</u>	1995-1999	258	77.2	0.88
	<u>Chem</u>	2009-2014	404	76.2	0.89
	Pharm	1995-1999	764	116.6	0.89
	Pharm	2009-2014	678	264.0	0.89
	ICT	1995-1999	382	99.1	0.95
	ICT	2009-2014	238	305.6	0.92

Notes:

HHI - Herfindahl-Hirschman Index

T20/M20 - Ratio of mean sales of top quintile to mean sales of middle quintile

GINI - Gini coefficient of firm sales

CHEM - chemicals; PHARM - pharmaceuticals; ICT - information and communication technologies

The HHI measures the concentration of sales in the U.S. market. Relatively speaking, concentration is highest in the pharmaceutical industry across the samples, followed by the ICT. However, over time, market concentration (as measured by the HHI) falls for the pharmaceutical sector, while it rises for the ICT and non-pharm chemicals sectors. If we compare the *domestic* sample and *foreign* sample, we observe relatively less market concentration among U.S. pharmaceutical parent companies than among U.S. pharmaceutical

affiliates of foreign multinationals, in an evolving trend. That is, initially, during 1995 – 1999, U.S. parent companies in the chemical industry had greater market concentration amongst one another than the U.S. affiliates of foreign companies in the same industry had amongst themselves. However, by 2009 – 2014, we observe a reversal: the foreign companies' chemical affiliates in the U.S. have gotten more concentrated than the U.S. chemical parent companies have. In the ICT sector, we observe the opposite shift. Market concentration among U.S. parent companies is lower than among U.S. affiliates of foreign companies during the late 1990s. By 2009 – 2014, increased entry and greater competitiveness among foreign ICT companies have helped reduce their within-group market concentration. Thus, these trends demonstrate some heterogeneity among industries within the U.S. and between the domestic sample and foreign sample.

Nevertheless, on balance, we observe increased market concentration in the chemical and ICT sectors in the U.S. Accompanying this development is greater sales inequality among firms in the pharmaceutical and ICT industries. According to the ratio of the top quintile's mean sales to the middle quintile's mean sales (T20/M20), the firms in the top 20% of sales have widened their lead over the competition. For example, in the pharmaceutical industry (with all firms, domestic and foreign), the mean sales of the top 20% is about 170 times the mean sales of the middle 20% during 2009 – 2014. In the ICT sector for all firms, the ratio is over 150 times. Only in the chemical sector has this gap between the top 20% and middle 20% not changed very much. This is particularly the case among foreign companies' affiliates; among U.S. parent companies in the chemical sector, sales inequality has expanded. The average sales of the top 20% of firms compared to the middle 20% of firms has almost doubled in the 2009 – 2014 period compared to the late 1990s. These trends in inequality are confirmed by the Gini index. The coefficients are relatively large and in general have increased over time. The Gini focuses on the relative shares of firm sales across groups. The rise in the Gini is driven, for example, by the greater share of industry sales obtained by the top 20% and the next top 20% of firms (results not shown) over time, a trend which has been observed by others (see Council of Economic Advisors, 2016, and Economist 2016).

Figures 1 and 2 provide further perspectives on market competition by examining the number of companies in the chemicals, pharmaceuticals, and ICT sectors.¹¹ Figure 1 shows the trend in the number of U.S. parent companies operating in the domestic (U.S.) market and Figure 2 shows the same for U.S. affiliates of foreign multinational companies. It is quite clear that there are many more producers of information and communications technology goods and services than there are in the other two sectors. The ICT includes, as mentioned earlier, both hardware and software. Among U.S. parent companies, a rising trend in net entry into the domestic ICT industry can be seen. However, Table 1 indicates that industry sales are concentrated among the top 20 – 40% of firms. Among U.S. affiliates of foreign MNCs, there were waves of entry between 1994 and 1999 and between 2004 and 2009, before the number of firms' levels down to about 700 companies. The top 20% of companies has very high mean sales compared to the middle 20%, yet among the top companies, their market share seems fairly similar, given that the HHI has fallen over a 15-year period, according to Table 1.

As for the chemicals industry, there has a modest net exit of domestic firms during most of the 2000s, with a small rise in numbers in 2014. Among affiliates of foreign companies, we observe just half the number of firms in 2014 that we did in 1999, consistent with the increased market concentration among foreign firms in the U.S. that we found in Table 1. Pharmaceutical

¹¹ We plot these trends for the BEA benchmark years, which are the most complete survey years.

companies are relatively the fewest in the sample. Overall, there have been increased net entry among both domestic and foreign companies since the mid-1990s, which have contributed to a reduction in market concentration in the pharmaceutical sector, but among U.S. parent drug companies, the rise in net entry occurs in more recent years (post-2009).

A key issue we address in this paper is the extent to which changes in market concentration and firm inequality in sales are attributable to patenting activities in the U.S. We next show, therefore, the state of patenting and concentration in patenting across the key sectors of interest. Table 2 shows that the average firm in the pharmaceutical sector, particularly a U.S. parent company, receives the most U.S. patent grants. The average foreign firm in the ICT industry receives the lowest; this is partly due to the sheer numbers of firms in the ICT sector compared to the chemicals and pharmaceutical sectors, as we saw in Figures 1 and 2. U.S. parent companies on average tend to obtain more patent grants per year than the U.S. affiliates of foreign companies. In terms of patent quality-adjustment, the average firm in the pharmaceutical sector receives the most patent citations, followed by that in the ICT industry. This is seen in the full sample and in the sample of U.S. parent companies. However, the average foreign firm in the ICT sector receives the least citations. Their technological innovations appear to lag the breakthrough quality of American ICT innovations.

Table 2. U.S. Patents Granted and Citations

Average Annual Grants and Citations per firm, and industrial concentration of patents and citations

A. Full Sample	Counts		HHI	
	Grants	Citations	Grants	Citations
CHEM	17	134	955	802
PHARM	27	230	3204	1367
ICT	17	205	1047	398
B. Domestic Sample	Grants	Citations	Grants	Citations
CHEM	18	139	968	883
PHARM	28	236	3032	1403
ICT	18	217	1099	407
C. Foreign Sample	Grants	Citations	Grants	Citations
CHEM	12	75	7216	7451
PHARM	13	75	3558	3622
ICT	4	48	3549	3505

Notes: Domestic sample refers to U.S. parent companies operating in the U.S. Foreign sample refers to U.S. affiliates of foreign companies. See also notes to Table 1.

Among U.S. parent companies, pharmaceutical patent grants from the U.S. patent office are heavily concentrated, as are the pharmaceutical patent citations, as shown by the HHI of patent grants and citations. This indicates that patent ownership is very heavily concentrated among American drug companies, including over the high-quality drugs (as measured by the citations the drug patents get). Next most concentrated are ICT patent grants among U.S. parent companies, but the citations to patent grants that the U.S. ICT industry receives is not heavily skewed. Among foreign companies, it is the chemical industry where patent grants and

citations are most concentrated. The other two sectors are also heavily concentrated in terms of patents and citations. Thus, U.S. affiliates of foreign companies not only receive fewer U.S. patent grants on average, but just a small number of them have acquired most of the patents granted to foreign companies, including the relatively high-quality patents.

Table 3 presents some findings on the impact of patents on market concentration in the U.S. The dependent variable is the HHI of local sales; that is, sales in the United States. The unit of analysis is industry (four-digit NAICS) by year. Column 1 shows that, in general, the quantity of patent grants does not contribute to market concentration. Patent grants can have two opposing effects on concentration. On the one hand, they can enable the patentee to exercise greater market power and exclude rivals. On the other hand, they can also enable new firms to enter a market or existing firms to strengthen their market position against leading incumbents. The insignificant coefficient on patent grants suggests either that grants do not determine HHI levels or that the opposing effects cancel each other. However, for the chemicals industry, the quantity of patent grants is positively associated on balance with increased product market concentration.¹²

Table 3. Impact of Patenting on Market Concentration in the U.S. Market

	Full Smp1	Full Smp1	Full Smp1	Full Smp1	Domestic	Foreign
	(1)	(2)	(3)	(4)	(5)	(6)
	HHI Sales	HHI Sales	HHI Sales	HHI Sales	HHI Sales	HHI Sales
Patent Grants	-0.022 (0.020)					
HHI Patents		0.108** (0.042)				
Patent Citations			-0.019 (0.017)			
HHI Citations				0.123** (0.049)	0.151*** (0.037)	0.038 (0.134)
Grants x Pharm	Yes					
Grants x Chem	Yes***					
Grants x ICT	Yes					
HHI Patents x Pharm		Yes				
HHI Patents x Chem		Yes				
HHI Patents x ICT		Yes**(-)				
Citations x Pharm			Yes***			
Citations x Chem			Yes			
Citations x ICT			Yes			
HHI Citations x Pharm				Yes***	Yes	Yes
HHI Citations x Chem				Yes	Yes	Yes
HHI Citations x ICT				Yes	Yes	Yes
Year effects	Included	Included	Included	Included	Included	Included
Year x industry	Included	Included	Included	Included	Included	Included
Constant	Included	Included	Included	Included	Included	Included
Adjusted R-squared	0.763	0.764	0.765	0.766	0.828	0.773

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Variables are in natural logs. 'Yes' indicates that the variable is controlled for, along with significance level.

¹² The Chem dummy variable refers to those four-digit NAICS industry codes representing chemicals producers.

Column 2 of Table 3 provides an alternative perspective and shows that the concentration of patent ownership does contribute to product market concentration.¹³ This arises if the intellectual property rights to exclude rivals or competitors are concentrated among the market leading firms. This produces an outcome in which the leaders can gain sturdier control over the market for the sales of their protected products, or products produced with protected technologies. The positive coefficient on HHI Patents signifies that those sectors where patents were heavily concentrated were those sectors where market sales were heavily concentrated. In the ICT sector, the concentration of patent ownership appears to be *negatively* associated with market concentration. This indicates that among ICT sub-sectors (such as electronics, software publishers, semiconductors, and so forth), the concentration of sales occurs where patent rights are not concentrated. The ICT is a sector where much of the patenting is strategic. Patents are acquired for purposes of, say, enhancing bargaining power in cross-licensing negotiations. This sector tends to be characterized by short product life cycles, where technological obsolescence can occur before imitation and where new entrants are not beholden to catching up to the incumbents' core technologies since the technologies will eventually become superseded more quickly by new innovations and standards. Market sales may therefore be more concentrated among groups of firms where more rapid innovation and greater turnover of technological leaders arises; and hence, where patent rights are more dispersed and fragmented.

The next two columns of Table 3 investigate the robustness of the results thus far by employing patent citations and the HHI of citations in place of patent grants and the HHI of grants. Column 3 shows that in general patent citations are not a contributing factor to market concentration; but for the pharmaceutical sector, possession of high-quality rights (in terms of citations) is positively associated with sales concentration. Having exclusive rights to blockbuster drugs or medicines that are transformative certainly contributes to the ability of firms to capture sales. Column 4 confirms that it is the ownership of patent rights, particularly rights to highly cited patents, that drives market concentration. Moreover, this effect is boosted for the pharmaceutical industry.

Columns 5 and 6 re-estimate the model in column 4 for the domestic sample and foreign sample respectively. Among U.S. parent companies operating in the domestic market, again the concentration of high-quality patent ownership is positively associated with market concentration, controlling for other factors. The model is weak for the sample of U.S. affiliates of foreign multinationals. The concentration of patent ownership is not detected to be a significant factor in the concentration of foreign sales in the U.S. market; nor is there a sector-specific effect among the three industries of interest: ICT, pharmaceuticals, and chemicals.

Table 4 examines the extent to which market concentration translates into higher rates of return (net income to assets). The results show that market concentration in the ICT sector in the U.S. does not statistically significantly relate to profitability. However, for pharmaceuticals, the results indicate that market concentration does positively relate to the rate of return (columns 1 and 2). The results also indicate a significant positive association between market concentration and the rate of return in the chemicals industry (see columns 1 – 4). The concentration of patent grants only raises the profitability of the pharmaceutical industry (column 2) and the concentration of patent citations is associated with lower rates of return in the chemical industry (columns 3 and 4). Relaxing the concentration of ownership of quality

¹³ To reiterate, the patent variables in Table 3 are all lagged five years, so that there should be no contemporaneous effect of large firms having both large sales and large ownership of patent rights.

patents helps to raise returns in the chemical industry perhaps by easing licensing costs and increasing access to technological inputs. In contrast, for U.S. affiliates of foreign MNCs, the concentration of HHI citations – or ownership of critical, high-quality patents – appears to enhance their ability to compete in the U.S. market and earn higher returns (column 5).

Table 4. Impact of Concentration on Return in the U.S. Market

	Full Smpl (1)	Full Smpl (2)	Full Smpl (3)	Domestic (4)	Foreign (5)
	Rate of Return	Rate of Return	Rate of Return	Rate of Return	Rate of Return
HHI Sales	0.009 (0.078)	-0.0002 (0.106)	0.015 (0.112)	-0.026 (0.122)	0.049 (0.292)
HHI Patents		0.016 (0.088)			
HHI Citations			0.075 (0.106)	0.035 (0.115)	-0.212 (0.174)
Pharm x HHI Patents		Yes***			
Chem x HHI Patents		Yes***(-)			
ICT x HHI Patents		Yes			
Pharm x HHI Citations			Yes	Yes	Yes
Chem x HHI Citations			Yes*(-)	Yes***(-)	Yes***
ICT x HHI Citations			Yes	Yes	Yes
Pharm x HHI Sales	Yes***	Yes***	Yes	Yes	Yes
Chem x HHI Sales	Yes**	Yes***	Yes***	Yes***	Yes
ICT x HHI Sales	Yes	Yes	Yes	Yes	Yes
Year effects	Included	Included	Included	Included	Included
Year x industry	Included	Included	Included	Included	Included
Constant	Included	Included	Included	Included	Included
Adjusted R-squared	0.338	0.262	0.326	0.322	0.287

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Variables are in natural logs. 'Yes' indicates that the variable is controlled for, along with significance level.

(B) Brazil, India, and China

Up to now, we have shown results for global companies in the U.S. market; that is, for U.S. parent companies and affiliates of foreign multinational companies operating in the U.S. The following analyses turn to U.S. foreign affiliate activity in Brazil, India, and China. The performance of these firms is also compared to Brazilian, Indian, and Chinese companies, headquartered in Brazil, India, and China respectively. Thus, we combine the BEA data with the Thomson Reuters Eikon data. We turn now to the impact of patent reforms on the sales and rates of return to affiliates in the developing world, with the goal of gauging the degree to which patent protection facilitates market power and rents.

Interestingly, there is an asymmetry: Patent protection has a positive association with the rate of return of U.S. foreign affiliates (Table 5). In detail, Table 5 shows that the affiliates' rate of return (ROR) has a highly elastic response to a strengthening of patent rights. A 1% increase in the index of patent protection is associated with at least a 1.141% change in the ROR (see

column 1). The elasticity could be as high as 2.114 if we control for firm productivity, or value added per worker (see column 2). In columns 3 and 4, the latter effect (value added per worker) is tempered if we control for market share. This variable represents the ratio of the affiliates' sales to the domestic sales of the local headquarter companies. It is intended to capture, albeit in a limited way, the contribution of the firm's market power on its rate of return. As discussed earlier, we do not have measures of local market concentration. We therefore use a proxy by examining the sales of the affiliate relative to those of the host country firms; for instance, the sales of Brazilian HQ companies in Brazil or Indian HQ companies in India. The Mkt Share variable in Table 5 therefore helps measure the slice of the local market captured by the affiliate relative to the local firms (but excluding other foreign companies, such as from Japan, the EU, and so forth). In column 4, we allow the 'Mkt Share' variable to vary by country and by sector through its interaction with country fixed effects and industry fixed effects. The market 'share' of the affiliate positively influences its ROR at conventional significance levels.

At the bottom of Table 5, we show the net effects of a 1% change in the patent rights index by country and sector by evaluating the coefficient estimates of the various dummies and interaction terms. We especially observe a highly elastic response of the rate of return to a strengthening of patent rights in the ICT sector in all three countries. The response is especially highest in the Indian ICT market. A strengthening of patent rights has a positive effect in the chemicals and pharmaceutical industry but the response is less elastic, except in India, where a 1% rise in the patent index is associated with a 1.116% rise in the ROR to chemical affiliates. In Brazil, the response is smallest in the chemicals industry, including pharmaceuticals. A 1% strengthening of patent rights raises the ROR to U.S. drug company affiliates by only 0.093%. Pharmaceutical firms here may have the benefits of entry barriers, other than patent rights, to help protect market returns in Brazil. In contrast, in India and China, where there is formidable competition from generics and other local firms, a rise in patent protection does more to protect pharmaceutical returns. A 1% rise in patent strength in India and China helps raise pharmaceutical ROR by 0.922% and 0.558% respectively.

Table 5. Impact of Patent Rights on Affiliate Return in Brazil, India, and China

VARIABLES	(1) Rate of Return	(2) Rate of Return	(3) Rate of Return	(4) Rate of Return
Patent Rights Index	1.141** (0.495)	2.114*** (0.509)	1.687*** (0.540)	1.863*** (0.537)
Value Added/Labor		Yes***	Yes***	Yes***
Mkt Ratio			Yes*	Yes**(-)
Country x Mkt Ratio				Incl.
Industry x Mkt Ratio				Incl.
Year effects	Incl.	Incl.	Incl.	Incl.
Country effects	Incl.	Incl.	Incl.	Incl.
Industry effects	Incl.	Incl.	Incl.	Incl.
Industry x Year	Incl.	Incl.	Incl.	Incl.
Industry x patent index	Incl.	Incl.	Incl.	Incl.
Country x patent index	Incl.	Incl.	Incl.	Incl.
Industry x country	Incl.	Incl.	Incl.	Incl.
Constant	Incl.	Incl.	Incl.	Incl.
Adjusted R-squared	0.297	0.388	0.442	0.457

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Variables are in natural logs. Regressions absorb firm fixed effects.

Yes' indicates that the variable is controlled for, along with significance level.

Rate of Return = Net Income/Assets, Mkt Ratio = Ratio of Affiliate Sales to Local Headquarter Sales

Evaluated Impact of Patent Rights on ROR by country and industry

	Brazil	India	China
Pharmaceuticals	0.093	0.922	0.558
Chemicals	0.287	1.116	0.752
ICT	1.251	2.080	1.716

*(Estimates based on column 4)***Evaluated Impact of Market Ratio on ROR by industry**

	Pharm	Chem	ICT
All Countries	0.243	1.209	0.608

(Estimates based on column 4)

These results are mapped graphically in figures 3-5, which show the normalized sales growth of foreign affiliates of U.S. MNCs in Brazil, India and China respectively. The measure of sales is the median sales per worker in real 2009 U.S. dollars. This measure is normalized so that it equals one in the initial year. Given the relatively small number of U.S. pharmaceutical companies' affiliates in the developing world, we pool the pharmaceutical firms with the non-pharm chemical firms. In Figure 3, in the secondary axis, we also show movements in patent rights in Brazil; for example, a modest reform occurred in 1994, followed by a major one in 1999. As the figure shows, the growth in the median affiliate sales per worker began rising in the mid-1990s. For firms in the ICT sector, we observe rapid growth around the time of the major reform (1999). For chemical firms, there is a more gradual rise. By 2011, in both sectors, the median real sales per worker of U.S. companies' affiliates is about triple what it was in 1989. Similar rises can be observed in India and China as well, in figures 4 and 5.

Figures 6 – 11 turn to the rates of return earned by U.S. foreign affiliates relative to the local, indigenous companies; specifically, the *headquarter (HQ) companies* of the developing country concerned. For example, Figures 6 – 7, for example, show plots of the rate of return to U.S. foreign affiliates and the rate of return to Brazilian (HQ) firms for each industry group – chemicals (including pharmaceuticals) and ICT, respectively. Due to the cyclical volatility in the series, the rate of return series has been exponentially smoothed.¹⁴ The figures shows that the rate of return of U.S. companies compared to local companies fell from the mid-1990s to the early 2000s; this may be due to the increased innovative potential of local Brazilian companies and their own emergent growth. However, it is still the case that for most of the period, U.S. companies enjoyed higher mean rates of return than their local headquarter counterparts. Figures 8-9 and Figures 10-11 depict similarly for India and China.

But the higher rate of return does not appear to have a significantly positive association with the R&D of those same foreign affiliates (Table 6). This is troubling because an ostensible purpose of strengthening patent rights is to motivate innovation, as also emphasized as one of the benefits for developing countries from implementing stronger IPRs. In theory, the increased rents that patent holders enjoy “should” in return stimulate R&D, but instead, foreign affiliates appear to enjoy higher rates of return due to stronger patent protection, but the latter does not significantly affect their R&D in the local market. This may be due to the fact that patent protection is stronger than optimal, because if the results are true, that would mean that a

¹⁴ Note that exponential smoothing was not used in Figures 3 – 5 since we wanted to show how the path of normalized sales shifted as patent reforms occurred. Smoothing out cyclical fluctuations would prevent us from observing turning points in the data in response to policy shifts.

decrease in patent protection would lower the profits of U.S. foreign affiliates but do no harm to – or have no effect on – the local R&D done by those companies.

Table 6 indicates that patent protection has a statistically insignificant association with affiliate R&D intensity. As for the control variables, the ROR does positively influence incentives to invest in R&D (see column 1). The rest of the table allows the ROR to be interacted with patent rights, with country and industry effects, and introduces the market share variable again. Although the share of R&D abroad conducted by foreign affiliates of US companies is not quantitatively small (in Brazil, the R&D of the foreign affiliates of U.S. companies is about 2 – 3% of their sales in recent years, whereas in India and China, it is higher at around 5%), there may be some reasons for their lack of focus on R&D in these countries. It is useful to note that the coefficient of the interaction between market share and rate of return is negative (columns 3 and 4). This indicates that a higher rate of return and lower market power combine to stimulate R&D intensity. This result is more favorable to the view that competitiveness helps to stimulate R&D rather than market power. Had the interaction term had a positive coefficient, this would have suggested that greater market power combined with higher returns stimulates innovation incentives. The intuition for why competitiveness matters is that greater market power (or greater sales relative to the competition) puts less pressure on the affiliate firm to innovate, as it can enjoy rents on existing technologies for a longer period. In contrast, firms faced with greater competitive pressures would have a greater incentive to innovate in order to escape the competition and gain a lead over rivals (see Aghion and Griffith, 2005).

Table 6. Impact of Patent Rights on Affiliate R&D in Brazil, India, and China

VARIABLES	(1) R&D/Sales	(2) R&D/Sales	(3) R&D/Sales	(4) R&D/Sales
Patent Rights Index	0.248 (1.241)	0.362 (1.242)	0.808 (1.373)	0.437 (1.374)
Rate of Return (ROR)	Yes***	Yes	Yes	Yes
Patent Index x ROR			Yes	Yes
Mkt Share			Yes	Yes
Mkt Share x ROR			Yes***(-)	Yes***(-)
Mkt Share x Patent Index			Yes	Yes
Country x Rate of Return		Incl.	Incl.	Incl.
Industry x Rate of Return		Incl.	Incl.	Incl.
Country x Mkt Share				Incl.
Industry x Mkt Share				Incl.
Year effects	Incl.	Incl.	Incl.	Incl.
Country effects	Incl.	Incl.	Incl.	Incl.
Industry effects	Incl.	Incl.	Incl.	Incl.
Industry x year	Incl.	Incl.	Incl.	Incl.
Country x Patent Index	Incl.	Incl.	Incl.	Incl.
Industry x Patent Index	Incl.	Incl.	Incl.	Incl.
Industry x country	Incl.	Incl.	Incl.	Incl.
Constant	Incl.	Incl.	Incl.	Incl.
Adjusted R-squared	0.549	0.553	0.638	0.647

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Variables are in natural logs. Regressions absorb firm fixed effects.

Yes' indicates that the variable is controlled for, along with significance level.

Rate of Return = Net Income/Assets, Mkt Share = Ratio of Affiliate Sales to Local Headquarter Sales

6. Concluding Remarks

IPRs are legal rights for exclusive use, which depending on certain market and other circumstances, can lead to situations where IP owners can earn returns in excess of their opportunity cost. Much contention exists on what the amount of rent is that could be assumed productive, and how much is 'fair reward' for the inventor. While this *rent* is often regarded as a key factor that motivates knowledge investment and commercialization, critics of ever-expanding IPR regimes claim that the rents often cover excessive ground, going far beyond what is needed for the inventor to recoup the costs of R&D and earn a reasonable rate of return (to cover certain other opportunity costs). It has been argued that IPRs, in such instances, are being used as instruments of market power, often resulting in excess rents to the IP holder, in the sense of *more* than needed to bring about the innovation. It is true that in the absence of a clear *benchmark rent* that shows what the optimal amount of reward could be, it is hard to discuss or assess excess payments. It also seems intuitive to argue that such a benchmark rent will be different for different sectors and industries.

Our paper has commenced research on these challenging conceptual and measurement issues, and brings to light three important results. Firstly, the relationship between the concentration of patent ownership and market concentration in the USA is statistically significant. Thus, while patents on their own do not lead to market concentration, we find that the concentration of patent ownership is statistically significant for increased market concentration. In the developing countries that we considered in the paper, namely, Brazil, India, and China, a strengthening of patent protection has a significant quantitative impact on their rates of return and confer increased market power to the incumbents (recall Table 5).

In the ICT sector, rapid technological innovations suggest relatively short product cycles, whereas pharmaceutical innovation can have short (in the sense of generics and evergreening efforts) and long product cycles. In ICT, technologies and products are also relatively complex, consisting of multiple complementary inputs, which make imitation relatively more difficult. In theory, this makes patent protection relatively less important in ICT, yet this is a sector which patents heavily.¹⁵ An explanation for this paradox has been that firms in this industry patent not so much for purposes of appropriating their returns but for averting patent holdups. Firms amass patent portfolios as bargaining chips in cross-licensing negotiations. In light of this, the ICT industry would be a sector where we might observe a correlation between patenting and economic rents, since technologies have a short product cycle and long imitation lags, yet can be protected by patents for up to 20 years. Similarly, patent thickets and fencing-off of large areas of research, often upstream to prevent downstream innovations, have been observed to be a hallmark of the global pharmaceutical industry, particularly in the past two decades, not to mention the new surge in patent trolls (see Watkins 2013). The highly differentiated product market in the pharmaceuticals sector is one another reason for this result (Bessen, 2016).

Secondly, our results indicate several undesired outcomes of patent protection. We find that although increased patent protection in developing countries is associated with greater rates of return of foreign affiliates and higher market power, there is no increase in their R&D intensity

¹⁵ The OECD (2014) estimated that already between 2009 and 2011, ICT-patents filed under the Patent Cooperation Treaty were over 38% of the total number of all patents filed.

(recall Table 6). In fact, our results show that a higher rate of return and lower market power combine to stimulate R&D intensity, due to the competitive dynamics of the market. In contrast, the current scenario with high rates of return and high market power put less pressure on the affiliate firm to innovate, as it can enjoy rents on existing technologies for a longer period. Our results are confirmed by other studies, such as Jeanjean and Houngbonon (2017) who note similarly in the case of the mobile telephony sector that the relationship between competition intensity among operators and the level of investment is non-linear. This brings us to the question: What is the benefit to developing economies of raising their IP standards, if it impedes competition in the local market and does not stimulate local R&D for the benefit of the local population? What would this imply for technology transfer, learning and local innovation? The recent study by Cunningham et al. (2018), show that successful incumbent pharmaceutical firms acquire potential rivals with competing drugs and terminate the target's drug development, supporting our findings that stronger patents do confer significant market power and easily lend themselves to anti-competitive practices subject to misuse especially in a global setting. Although some of these issues have been in debate since the onset of the TRIPS Agreement, the evidence in our paper seems to point that they need a revisit with new evidence of the kind presented in this paper.

Thirdly, our analysis focusing on ICTs, pharmaceuticals and chemicals, also shows that the role of IPRs as a rent-securing mechanism is expanding in several high technology industries. This is corroborated by several other studies that find that superstar firms share greater investment in intangible assets and greater skills inputs (Mckinsey Global Institute, 2018) or that firms (including start-ups) are increasing their emphasis on IPRs right from the start of business (De Vries et al, 2017). Thus, not only does this result confirm the changing nature of IP-sensitivity in industries, it points to the need to expand the role of antitrust from several perspectives – price and product competition, inequality, economic development and catch-up, given the public welfare relevance of some of these industries in question, especially pharmaceuticals and ICTs. More research on these aspects is also needed.

Our study's aim has been to explore whether IP rights confer any excess rents and related market power across different sectors and regions. Further work could test for the robustness of the findings using alternative approaches to measuring rents, market power, and market concentration. The next step would be to study how concentration affects industry dynamics, innovation, and global technology transfer. Other extensions to this paper include investigating other developing economies, as well as taking into account the R&D of indigenous firms. For the U.S. market, it would be useful to compare companies by their levels of R&D intensity.

7. References

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