THE EFFECT OF ECONOMIC CRISES ON PATENTING ACTIVITY ACROSS COUNTRIES

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ABSTRACT

This article offers a conceptual and empirical contribution regarding the effect of economic crises on patenting activity across countries. It does so in the midst of the predominant general view that economic crises flatly chill patenting activity for all countries alike.

Financial crisis literature commonly assumes that, during global financial crises, private enterprises consequently tend to retreat to the safety of their domestic markets. These enterprises presumably react this way because of the lesser familiarity of foreign markets, the currency risks involved in international investment, and the uncertainties regarding the issue of how states will treat foreign assets.

This article acknowledges the idiosyncrasies underlying advanced and emerging economies abridging the archetypical North-South divide while rendering separate patenting patterns in particular. It offers a quantitative statistical methodology for the evaluation of the influence of economic crises on patenting activity. The article's main finding shows that when analyzing patent application rates by proxy of applicants' national origin (or shortly, 'by origin') applications, the influence of economic crises modeled through independent economic variables is much weaker over emerging economies than over advanced economies. Consequently, when the economic variables' values rise, the probability of the negative change in patent applications count falls. Surely this decline is much steeper for advanced economies than for emerging ones.

The analysis possibly corroborates that in emerging economies, where innovation is predominantly promoted by overseas multinational corporations (MNEs) and foreign direct investments (FDI), patenting activity-related decisions come from outside the country and relatively less as a response to economic developments within the country.

INTRODUCTION

Economic crises have acutely disturbed normal functions of financial and monetary systems all throughout history. While economists diverge over the role of the financial sector in economic growth,[1] there is general agreement that economic crises diminish short-term growth.[2] An economic crisis surely is marked by the often unexpected failure of banks, the sharp decrease in credit and trade, or the collapse of an exchange rate regime that diminishes the efficiency of a given economy.[3] Less is understood, however, about the exact impact of eco-

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** Dr. Michael Gishboliner is a research student at the M.A (in Patent law) program in cooperation with the World Intellectual Property Organization (WIPO) at the University of Haifa Faculty of Law.1. Economists have found a positive connection between the financial sector and growth since England's' post-industrialized revolution throughout the twentieth century, beginning with the work of economist Walter Bagehot in his 1873 manuscript, *Lombard Street*, WALTER BAEGHOT, LOMBARD STREET: A DESCRIPTION OF THE MONEY MARKET, (1873) (Homewood, IL, Richard D. Irwin (1962 Edition)), followed in 1969 by John Hicks in his seminal book, A Theory of Economic History, JOHN HICKS, A THEORY OF ECONOMIC HISTORY (1969) (Oxford: Clarendon Press, 1969). *But see,* Robert E. Lucas Jr., *On the Mechanics of Economic Development*, 22 J. OF MONETARY ECON., 3, 3 (1988); Pioneers in Development (Gerald M. Meier & Dudley Seers eds., Oxford University Press, 1984). Ross Levine offers a thorough literature review of this theoretical disparity. *See,* Ross Levine, *Financial Development and Economic Growth: Views and Agenda*, 35 J. OF ECON. LITERATURE, 688, 688 (1997); Ross Levine, Finance and Growth: Theory and Evidence, 1(A) HANDBOOK OF ECON. GROWTH, 865, 867 (Philippe Aghion & Steven N. Durlauf eds. 2005).

2. The biggest decline in growth of world output since the 1930s was in the 2008 crisis. It decreased from a historic peak of 5.2% in 2007. The recession triggered by the burst of the "dot-com" crisis in 2001, in comparison, led to a growth decline of global output from 4.8% in 2000 to 2.3% in 2001. *See,* Press Release, World Trade Organization, Trade to Expand by 9.5% After a Dismal 2009, WTO Reports—Press/598 (Mar. 26, 2010) (on file at https://www.wto.org/english/news_e/pres10_e/pr598_e.pdf).

For a literature review of corporate conduct leading amidst economic crises, *see, e.g.*, Claire A. Hill & Brett H. McDonnell, *Reconsidering Board Oversight Duties After the Financial Crisis*, 2013 U. ILL. L. REV. 859, 860 (2013). *See also*, Christopher M. Bruner, *Corporate Governance Reform in a Time of Crisis*, 36 J. CORP. L. 309, 313 (2011); Nicholas Calcina Howson, *When "Good" Corporate Governance Makes "Bad" (Financial) Firms: The Global Crisis and the Limits of Private Law*, 108 MICH. L. REV. FIRST IMPRESSIONS 44, 44 (2009); Aleksandar Nikolic, *Securitization of Patents and its Continued Viability in Light of the Current Economic Conditions*, 19 ALB. L.J. SCI. & TECH. 393, n.140 citing Emily Chasan, *Wall Street's Estoric Assets May Be Trouble*, REUTERS (Nov. 8, 2007, 9:17 PM), http://www.reuters.com/article/2007/11/09/businesspro-column-lifting-dc-idUSN0254788320071109). The "current inability of investors, issuers and rating agencies to accurately value the underlying assets . . . has worked to chill investor exuberance in asset backed securities investment, leading to a virtual trading freeze." *Id.* at 412. *See also,* discussion herein.

3. *See,* Itay Goldstein & Assaf Razin, *Three Branches of Theories of Financial Crises* 2 (NBER Working Paper No. 18670, 2013), *available at* http://www.nber.org/papers/w18670.pdf (adding that the recent 2008 global financial crisis exhibits characteristics from essentially three types of financial crises in recent history, namely: banking crises, credit and market freezes, and currency

nomic crises at large, as well as the 2001 dot-com and 2008 subprime crises, on economic growth. Arguably less is known about the exact relation between economic crises and patenting activity, and their measure as a proxy of such economic growth, regardless whether or not the measured economic growth is innovation-based.

Given the traditional flow of economic crisis theory, surely any comparison between the advanced and emerging economies abridging the North-South divide may seem to indistinctly connote a decline in patenting activity due to economic crises. A closer look, however, reveals a more subtle reality across the development divide. While the 2008 crisis might be telling on how emerging economies similarly stand for a lesser decline on growth or possibly funneled through patent activity rates, a more principled analysis of the effect of economic crises on patenting activity is judicious.

Part I presents the topic's theoretical setting. It accounts for both economic crisis theory and patent law-related literature, which frame the discussion. Part II presents the article's empirical analysis for 1997–2012 with emphasis on the two global crisis years of 2001 and 2008. These two years refer to the dot-com and the subprime crises, respectively, which will be analyzed as to their effect on patenting filling trends across developed and advanced countries. This part offers a quantitative statistical methodology of the potential North-South discrepancies thereof. It is a logistic regression (logit) model for dichotomous outcome variables.[4] This model connects a probability of the negative change in patent applications count (outcome or dependent variable) with a linear combination of income or independent variables, including country type, and economic variables and their interac-

crises). The authors add however that "different people have different views on what constitutes a financial crisis." *Id.* at 3. *See also,* FINANCIAL CRISES: THEORY, HISTORY, AND POLICY (Charles P. Kindleberger & Jean-Pierre Laffargue eds., Cambridge University Press 1982) (offering articles on financial crises presented at a conference held in 1979).

As for the unpredictability of financial crises from the early 1960s, see the breakthrough work of Nobel prize winners Milton Friedman and Anna Schwartz, and later Charles Kindleberger, which confirmed that financial crises tend to be hard to predict ex ante, and may seem sudden and unexpected as they occur. *See,* MILTON FRIEDMAN & ANNA JACOBSON SCHWARTZ, A MONETARY HISTORY OF THE UNITED STATES, 1867-1960, (1963). *See also,* CHARLES P. KINDLEBERGER & ROBERT Z. ALIBER, MANIAS, PANICS, AND CRASHES: A HISTORY OF FINANCIAL CRISES (1978). Similarly for the recent global economic crisis, see Ben Bernanke & Mark Gertler, *Agency Costs, Net Worth, and Business Fluctuations*, 7 THE AM. ECON. REV., 14, 14 (1989) ("[c]rises are triggered by shocks, defined as unpredictable events affecting economy"). *See also,* the seminal book by Gary Gorton, GARY B. GORTON, SLAPPED BY THE INVISIBLE HAND: THE PANIC OF 2007 (2010).

4. Logistic regression accounts for the link between an independent variable and a categorical dependent variable. It is usually continuous, by using probability scores as the predicted values of the dependent variable. *See,* Glossary of Statistical Terms, STATISTICS.COM, http://www.statistics.com/index.php?page=glossary&term_Id.=391.

tions. The analysis first accounts for an annual time series of 1997–2012 at large, but then corroborates its main findings per the global crisis years of 2001 and 2008. Finally, Part III offers numerous theoretical ramifications, relating to the connection between patenting and R&D policy, as well as the connection between expenditures by multinational enterprises (MNEs) from advanced countries on both patenting and foreign direct investment (FDI) in emerging economies.

I. THE NORMATIVE FRAMEWORK

A. Economic Crises across the North-South Divide

Economic crises have been traditionally modeled as cyclical, periodically appearing and at times erupting in downturned markets. Economic crisis theory originally evolved along the clash between the two theoretical traditions of liberal economic theories of Hayek, inspired by the Austrian School led by Ludwig von Mises and the Keynesian post-1930s Great Depression state interventionist economics.[5] That also explains why theories of economic crises are often assumed to intertwine with business-cycle taxonomies modeling of periodic economic crises,[6] originated by Norwegian Economics Nobel Prize winner Ragnar Frisch,[7] followed by Austrian-American economist Gottfried Haberler[8] and leading business cycles scholar Victor Zarnowitz.[9] Notwithstanding the theoretical intricacies between financial crises and business cycle theories, financial crises clearly erupt *within* countries but also oftentimes *across* countries.[10]

5. For a seminal depiction of these two theoretical traditions, see NICHOLAS WAPSHOTT, KEYNES HAYEK: THE CLASH THAT DEFINED MODERN ECONOMICS (2011). Wapshott argues that while state interventionist theories of Keynes appeared to be correct so as to delay the Second World War in Europe, the liberal theories of Hayek appear to be gaining favor nowadays. *See also,* BERNANKE & GERTLER, *supra* note 3, at 3 (Economic crises occur periodically in different countries, constituting a downturn phase of real business cycle.).

6. Professors Brenda Spotton and Robin Rowley add: "This tentative connection may offer a means of deriving sensible bases for taxonomies of financial crises, fragility, and volatility." *See*, Brenda Spotton & Robin Rowley, *Efficient Markets, Fundamentals, and Crashes: American Theories of Financial Crises and Market Volatility*, 57 AM. J. OF ECON. AND SOCIOLOGY, 663, 675 (1998).

7. Ragnar Frisch, *Propagation Problems and Impulse Problems in Dynamic Equations*, *in* ECONOMIC ESSAYS IN HONOUR OF GUSTAV CASSEL, OCTOBER 20TH, 1933, 171, 171 (1933).

8. GOTTFRIED HABERLER, PROSPERITY AND DEPRESSION: A THEORETICAL ANALYSIS OF CYCLICAL MOVEMENTS (1937).

9. Victor Zarnowitz, *Recent Work on Business Cycles in Historical Perspective: A Review of Theories and Evidence*, 23 J. OF ECON. LITERATURE, 523, 523 (1985).

10. SPOTTON & ROWLEY, *supra* note 6 ("We are compelled to settle for much less than a comprehensive taxonomy, offering some distinctive strands of comparison of alternative theories . . . .").

Although economic crisis theory traditionally modeled the western hemisphere economies, surely not all major crises erupt in these countries. All six major international economic crises during the 1990s started in developing countries. These began in Mexico in 1995; Thailand, Indonesia, and South Korea in 1997–1998; Russia in 1998; and Brazil in 1998–1999.[11] The economic crises later occurring in International Monetary Fund (IMF)-labeled thirty-two advanced economies represent a broad range of events with Japan's 1992 national crisis starting an emblem "lost decade." It being yet another developing country's economic crisis, it ultimately expanded into a developed country, namely the U.S. mid-1980s crisis.[12]

Since the 1960s, global political economy of private capital has grown to a volume where they now dwarf international trade flows,[13] periodically leading to global economic crises.[14] Thus, even aside from archetypal local national crises associated with major declines in economic performance,[15] global crises can often erupt. The two chief global crises starting in developed or advanced economies are the 2001–2002 dot-com global crisis[16] and the 2008 subprime crisis, each of

11. Lawrence H. Summers, *International Financial Crises: Causes, Prevention, and Cures*, 90 AM. ECON. REV.: PAPERS AND PROCEEDINGS, 1, 5 (2000).

12. These crisis episodes include the "Big Five" crises of Spain in 1977, Norway in 1987, Finland in 1991, Sweden in 1991, and Japan in 1992. *See,* Carmen M. Reinhart & Kenneth S. Rogoff, *Is the 2007 U.S. Sub-Prime Financial Crisis So Different? An International Historical Comparison*, 98AM. ECON. REV.: PAPERS AND PROCEEDINGS, 339, 340 (2008).

13. Eric Helleiner, *Explaining the Globalization of Financial Markets: Bringing States Back In*, 2 REV. OF INT'L POL. ECON., 315, 315 (1995).

14. *See,* THE FIN. CRISIS INQUIRY COMM'N, THE FINANCIAL CRISIS INQUIRY REPORT: FINAL REPORT OF THE NATIONAL COMMISSION ON THE CAUSES OF THE FINANCIAL AND ECONOMIC CRISIS IN THE UNITED STATES, xvi–xvii (2011) (hereinafter, "The U.S. Financial Crisis Report") ("The changes in the past three decades alone have been remarkable. . . . Technology has transformed the efficiency, speed, and complexity of financial instruments and transactions. There is broader access to and lower costs of financing than ever before."). *See also,* HELLEINER, *supra* note 13, at 331 (detailing key political developments to explain the reemergence of current global finance). Helleiner further emphasizes that "the key role of states was that of either liberalizing capital controls or refraining from tightening them." *Id.*

15. REINHART & ROGOFF, *supra* note 12.

For a thorough analysis of major national financial crises worldwide, see also the seminal book by Gerard Caprio, Jr., Daniela Klingebiel, Luc Laeven, and Guillermo Noguera, Gerard Caprio, Jr. et al, *Banking Crises Database*, *in* SYSTEMIC FINANCIAL CRISES 341 (Patrick Honohan & Luc Laeven eds., Cambridge University Press 2005). *See also,* Graciela L. Kaminsky & Carmen M. Reinhart, *The Twin Crises: The Causes of Banking and Balance-of-Payments Problems*, 89 AM. ECON. REV. 473, 473 (1999).

16. *See, e.g.*, Walden Bello, *The Capitalist Conjuncture: Over-Accumulation, Financial Crises, and the Retreat from Globalisation*, 2 THIRD WORLD QUARTERLY 1345, 1351 (2006) (depicting the global nature of the 2001–2001 dot-com financial crisis by stating that "[s]peculative crises marked the deregulation of finance capital in different parts of the world, and one crisis in one market touched off another in another market in an increasingly unified global market.").

which equally serve as a case in point.[17] Regardless of each crisis' intricacies, the historical record surely finds striking qualitative and quantitative equivalents across a number of standard financial indicators.[18]

In continuation, the relation between economic crises and patenting activity works essentially twofold. At a start, optimal patenting activity accelerates economic growth. In a prominent book titled *Innovation and Its Discontents: How Our Broken Patent System is Endangering Innovation and Progress, and What to Do About It*, economists Adam Jaffe and Josh Lerner argue that suboptimal patenting activity may ultimately reduce economic growth altogether.[19] In balance, given economic crisis conditions, the value of patents as competitive assets may increase the likelihood of firm survival.[20] As a whole, suboptimal patenting activity presumably catalyzes economic crises.[21]

The relation between economic crises and patenting activity has a second highly significant effect. The latter, which is also the focal point of this article, is that economic crises may reduce patenting activity while at times reducing innovation-based growth altogether. This line of thought indeed may seem to flow naturally at first sight; financial crisis literature has conventionally assumed that during international financial crises international market players consequently tend to retreat to the safety of domestic markets. The explanations herein are

17. *See,* The U.S. Financial Crisis Report. The report was prepared by the Financial Crisis Inquiry Commission (FCIC), which is a ten-member commission appointed by the United States government for investigating the causes of the financial crisis of 2007–2010.
The U.S. Financial Crisis Report, confirms "it was the collapse of the housing bubble—fueled by low interest rates, easy and available credit, scant regulation, and toxic mortgages—that was the spark that ignited a string of events, which led to a full-blown crisis in the fall of 2008." *Id.* at xvi. The U.S. Financial Crisis Report confirms "[t]his happened not just in the United States but around the world." *Id.* To be sure, Section 5 of the Fraud Enforcement and Recovery Act of 2009, signed into law by President Barack Obama on May 20, 2009, established the FCIC "to examine the causes, domestic and global, of the current financial and economic crisis in the United States." *Id.* at xi.

18. *See, e.g.,* REINHART & ROGOFF, *supra* note 12. Reinhart and Rogoff further add: "Starting in the summer of 2007, the United States experienced a striking contraction in wealth, increase in risk spreads, and deterioration in credit market functioning."

19. *See, e.g.,* ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS: HOW OUR BROKEN PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT 149–50 (2004).

20. *See,* Iain M. Cockburn & Stefan Wagner, *Patents and the Survival of Internet-Related IPOs* (NBER Working Paper No. 13146, 2007), *available at* http://www.nber.org/papers/w13146.pdf (analyzing a sample of 356 newly-listed firms at NASDAQ while concluding that firms were unable or unwilling to seek patent protection were much less likely to survive the collapse of the dot-com bubble after 2001). Cockburn and Wagner further conclude that firms with no patent applications had a much higher hazard of exiting the sample. *Id.* at 22.

21. Jaffe & Lerner, *supra* note 19, at 150 ("[t]here is a 'crisis in the quality of issued patents' and further extrapolates this crisis to also be a 'potential economic crisis' as intellectual property has increased in economic significance."). *But see,* William L. LaFuze, *Keeping Current with the Chair*, 2 INTELL. PROP. L. NEWSL. 2, 4 (2005) (criticizing Jaffe & Lerner's conclusion, whereby: "The logic employed by the authors in reaching such a dramatic end point appears to be a giant leap without substantial foundation.").

again intuitive, given the familiarity of such financial operators or multinational enterprises operating in foreign markets, the currency risks involved in international investment, or uncertainties regarding the issue of how states will treat foreign assets.[22] A similar account is found also within business cycle scholarship. Economist Antonio Fatás noticeably has argued that economic output fluctuations constituting business cycles, such as economic crises, may affect long-term growth, noting that this influence is expected to be stronger for less-developed countries.[23] There is respectively also increasing theoretical literature that places capital market imperfections at the core of national or regional crises in emerging market.[24] The impact of such economic crises on the twenty-five IMF's-labeled emerging economies is said to be similarly stronger in comparison with crises hitting advanced economies at first.[25]

Given the traditional flow of economic crisis theory, surely any comparison between advanced and emerging economies abridging the North-South divide may seem to indistinctly connote a decline in patenting activity due to economic crises. The World Intellectual Property Indicators report for 2010 published by the World Intellectual Property organization (WIPO) reveals that most reviewed countries indeed experienced a slowdown in patent applications in the 2008 crisis.[26] Countries worldwide similarly witnessed a decrease in the numbers of patent applications filed in 2009.[27] These transformations were measured by both national and regional patent application

22. *See, e.g.,* Mark Aguiar & Gita Gopinath, *Fire-Sale Foreign Direct Investment and Liquidity Crises*, 87 THE REV. OF ECON. AND STATISTICS, 439, 439 (2005) (associating liquidity crises with low foreign investment and an exit of investors from crisis economies); HELLEINER, *supra* note 13, at 331 (using the case of the 1930 international financial crisis as a case in point).

23. Antonio Fatás, *The Effects of Business Cycles on Growth*, INSEAD AND CERP, at 17 (2011), *available at* http://faculty.insead.edu/fatas/Recoveries%20Fatas%20Mihov.pdf.

24. Economists have separately modeled financial crises also for emerging economies. These primarily focus on bank and currency crashes. *See,* Roberto Chang & Andrés Velasco, *A Model of Financial Crises in Emerging Markets*, 116 Q. J. OF ECON., 489, 499, n.17 (2001) (citing Jeffrey Sachs, Aaaron Tornell & Andrés Valasco, *The Collapse of the Mexican Peso: What Have We Learned?*, 11 ECON. POL'Y, 13, 14 (1996) (providing evidence that the Mexican 1994–95 collapse was not anticipated by investors); Steven Radelet & Jeffrey Sachs, *The Onset of the Asian Financial Crisis*, HARVARD INST. FOR INT'L DEV. (1998), *available at* http://www.cid.harvard.edu/archive/hiid/papers/eaonset2.pdf (arguing that, like the Mexican 1994–95 collapse, the Asian 1997 collapse was also not anticipated by investors).

25. For theoretical literature, see, e.g., CHANG & VELASCO, *supra* note 24; Ricardo J. Caballero & Arvind Krishnamurthy, *International and Domestic Collateral Constraints in a Model of Emerging Market Crises*, 48 J. OF MONETARY ECON. 513, 513 (2001); Philippe Aghion, Philippe Bacchetta & Abhijit Banerjee, *A Simple Model of Monetary Policy and Currency Crises*, 44 EUR. ECON. REV. 728, 728 (2000).

26. *See, World Intellectual Property Indicators 2010 Report*, WIPO, at 21 (2010), *available at* http://www.wipo.int/edocs/pubdocs/en/intproperty/941/wipo_pub_941_2010.pdf.

27. *Id*.

rates.[28] They were particularly witnessed by Patent Cooperation Treaty (PCT) agreement application rates,[29] where for the first recorded time the number of applications filed through the PCT System dramatically declined compared to the previous year.[30]

A closer look however reveals a more complex and subtle reality across countries. The 2008 crisis in fact bears witness to the fact that the advanced economies saw actual declines in growth output in 2009 of an average of 3.2%.[31] In an intriguing comparison, however, the emerging economies were substantively less affected.[32] Their growth output in fact grew in 2009, yet at a much slower pace compared to previous years. Their growth rate was on average 2.5% in 2009 compared to 6.1% in 2008 and 8.3% in 2007.[33] While the 2008 crisis might be telling on how emerging economies similarly stand for a lesser decline on growth or possibly funneled through patent activity rates, a more principled analysis of effect of economic crises on patenting activity became timely.

B. Patenting Activity and Economic Crises

Economic crises largely affect patenting prosecution and litigation fivefold. Economic crises surely carry such effect notwithstanding the discrepancies over the decline rates in patenting activity across the archetypical development divide when economic crises occur.

First and foremost, the decline in patent application rates due to the 2008 crisis presumably increased relative patenting litigation costs. This was funneled by a surge in the willingness to sue competitors.[34] In such conditions, a consolidation of patent portfolios may take

28. *Id.*

29. *Id.* at 8. ("At the height of the economic crisis in 2009, applications filed through the Patent Cooperation Treaty (PCT) dropped by 4.5%, the first drop since the inception of the PCT System"). The WIPO report adds that PCT applications from the United States who is the largest user of the PCT System, dropped by 10.8% in 2009. *Id.* at 51.

30. *Id.*, at 51.

31. *Id.* at 14. (explaining that the actual declines in output in IP systems in Advanced economies in 2009 were most pronounced for European countries (for example, around -5% for Germany and the United Kingdom) and for Japan (around -5%)).

32. *Id.* (adding that "This was mainly due to continued growth in developing Asia (notably China, India and Indonesia), but also growth in Africa that compensated for declines elsewhere").

33. *See*, *World Intellectual Property Indicators 2010*, *supra* note 26, at 14.

34. For the European context, *see, e.g.*, EMMANUEL BAUD ANDREAS, EBERT-WEIDENFELLER DOROTHÉE, WEBER-BRULS, STEFANO MACCHI DI CELLERE, ALASTAIR MCCULLOCH, IP CLIENT STRATEGIES IN EUROPE, 2010 EDITION LEADING LAWYERS ON ANALYZING EMERGING IP TRENDS, BUILDING CLIENT RELATIONSHIPS, AND NAVIGATING EUROPEAN IP LAWS AND LEGAL SYSTEMS IP STRATEGY IN A PAN-EUROPEAN ENVIRONMENT, 2010 WL 3628954 at *1 (2010) (indicating that in the backdrop of the 2008 economic crisis companies operating in Europe are now checking their intellectual property as the willingness to sue competitors has grown).

place.[35] This on the one hand, leads to fewer patent applications being filed, and conversely to more legal disputes on patent applications already filled.[36]

The European context serves a first prime illustration. For Europe, the 2008 global economic crisis has apparently led numerous industries to reduce their R&D budgets and expenditures for the application and maintenance of intellectual property rights (IPRs).[37] That is, as the number of both patent and trademark applications decreased.[38] Similarly, within the South-East Asian context, as in the case of Thailand, evidence shows that litigants further seem to signal high rates of selectiveness as they become increasingly mindful about obtaining the most cost-effective IPR strategies including patenting-related ones.[39] In Taiwan, moreover, there were 78,425 patent applications in 2009, while there were 83,613 in the global crisis year of 2008.[40] The growth rate for patent applications in 2009 thus decreased about 6.2 percent from 2008, which is the first negative growth rate since 2002.[41] Lastly, in the case of China's State Intellectual Property Office (SIPO), the global economic crisis has similarly decreased patent applications at large.[42] Importantly, further investigation per the South-East Asian case possibly

35. *Id.*

36. *Id.*; For the U.S. and European contexts, see e.g., Philip P. Soo, *Enforcing a Unitary Patent in Europe: What the U.S. Federal Courts and Community Design Courts Teach Us*, 35 LOY. L.A. INT'L & COMP. L. REV. 55, 96 (2012) (adding that the recent global economic crisis underscores the need for reducing litigation costs and further justifies a unified European patent system).

37. *Id.*; *See, also*, MANUEL LOBATO, NAVIGATING INTELLECTUAL PROPERTY LAW IN EUROPE LEADING LAYERS ON COMPLYING WITH REGIONAL LAWS, LEVERAGING NEW TECHNOLOGY, AND AVOIDING INFRINGEMENT ISSUES RECENT CASES IN SPAIN: A GENERAL FRAMEWORK OF IP LITIGATION, 2011 WL 5618008 at *4 (2011) (Focusing on the Spanish case: "[t]he decrease in patent applications (a notable feature of the Spanish economic crisis) is due to lack of research, but not to decisions to avoid patent expenditure").

38. *Id.*

39. For the South-East Asian context, *see*, PETER J. DERNBACH, IP CLIENT LAWYERS ON DEVELOPING A DEFENSE STRATEGY, NAVIGATING RECENT CHANGES IN IP PROTECTION, AND UNDERSTANDING THE IMPACT OF THE ECONOMIC CRISIS ON IP CLIENTS IP TRENDS AND NEEDS IN TAIWAN, 2010 WL 2511572 at *3 (2010) (emphasizing that there certain types of demand inelasticity over relevant IPRs i.e., filings of patents before there is public disclosure of an invention; ongoing trademark and copyright issues and lawsuits regardless of the overall economic crisis). Dernbach broadly concludes that in due to the economic crisis: "all of our clients have become very selective and mindful about obtaining the most cost-effective IP strategies." *Id.*

40. *See*, EDGAR CHEN, IP CLIENT STRATEGIES IN ASIA, 2010 EDITION LEADING LAWYERS ON DEVELOPING A DEFENSE STRATEGY, NAVIGATING RECENT CHANGES IN IP PROTECTION, AND UNDERSTANDING THE IMPACT OF THE ECONOMIC CRISIS ON IP CLIENTS CHALLENGES AND SOLUTIONS FOR IP ATTORNEYS IN TAIWAN, 2010 WL 2511574 at *2 (2010).

41. *Id.*

42. *See*, Peter K. Yu, *Five Oft-Repeated Questions About China's Recent Rise as a Patent Power*, 2013 CARDOZO L. REV. DE NOVO 78, 85–86 (2013).

reveals that this trend was mainly caused by the decline of applications filed by foreign entities.[43]

Surely, the drop in patent applications is said to be temporary in reflection of the crisis' phase.[44] In fact, as of early 2010, the IMF and the Organization for Economic Co-operation and Development (OECD) officially adjusted their growth estimates upwards.[45] Patent filings worldwide rebounded in 2010 while growing by 7.2% in 2010, after having fallen by 3.6% in 2009.[46] It is presently unclear what explains the decrease in patent applications, whether it either lack of research,[47] or the overall avoidance of patent expenditure consistently world-

43. EDGAR CHEN, IP CLIENT STRATEGIES IN ASIA, 2010 EDITION LEADING LAWYERS ON DEVELOPING A DEFENSE STRATEGY, NAVIGATING RECENT CHANGES IN IP PROTECTION, AND UNDERSTANDING THE IMPACT OF THE ECONOMIC CRISIS ON IP CLIENTS CHALLENGES AND SOLUTIONS FOR IP ATTORNEYS IN TAIWAN, 2010 WL 2511574 at *2 (2010) (revealing that this trend was mainly caused by the decline of applications filed by foreign entities).

44. *See, World Intellectual Property Indicators 2010 Report*, *supra* note 26, at 14. (confirms that "While economic recovery after the 2008 global crisis has set in, the crisis has invariably affected patent, trademark and industrial design filing activity and is likely to have a lingering effect in 2010 and 2011.").

See, e.g., Bratislav Stankovic and Mirjana Stankovic, *The Selfish Patent*, 3 CASE W. RESERVE J.L. TECH. & INTERNET 195, 195–196 (2012) (adding that notwithstanding the recent temporary drop due to the economic crisis, the global number of patent applications has been steadily increasing); Peter K. Yu, *Five Oft-Repeated Questions About China's Recent Rise as a Patent Power*, 2013 CARDOZO L. REV. DE NOVO 78, 85 (2013). Professor Yu explains however that post-2008 China's patent application growth rate has well recovered: "If the projected growth rate for all patents combined is a meager 5.2%, China will have reached two million patent applications by 2015. With a growth rate of about 34% in 2011". *Id.* at 86. He further foresees that "If the projected growth rate for all patents combined is a meager 5.2%, China will have reached two million patent applications by 2015". *Id.* at 86.

45. *See*, *World Intellectual Property Indicators 2010*, *supra* note 26 at 14–15 (adding that "This was mainly due to continued growth in developing Asia (notably China, India and Indonesia), but also growth in Africa that compensated for declines elsewhere").

46. See, *World Intellectual Property Indicators 2011*, WIPO, at 5 (2011), *available at* http://www.wipo.int/edocs/pubdocs/en/intproperty/941/wipo_pub_941_2011.pdf ("That growth was driven by a steep filing increase in China and the US, which accounted for four-fifths of worldwide growth. An all time high of 1.98 million applications were filed globally, consisting of 1.23 million resident applications and 0.75 million non-resident applications."). Similarly, the WIPO report adds that trademark filings worldwide grew by 11.8% in 2010 compared to a 5.1% increase in global gross domestic product (GDP). *Id.*

47. *See*, WORLD BANK, *Global Economic Prospects 2010: Crisis, Finance and Growth* (2010), *available at* http://siteresources.worldbank.org/INTGEP2010/Resources/GEP2010-Full-Report.pdf (for evidence foretells the effect of the 2008 global economic crisis on R&D performers). For business cycle literature offering empirical work Business sector R&D expenditures correlate with gross domestic product, *see* D. Comin and M. Gertler, *Medium-Term Business Cycles*, 96 AMERICAN ECONOMIC REVIEW, AMERICAN ECONOMIC ASSOCIATION 523 (2006); G. Barlevy, *On the Cyclicality of Research and Development*, 97 AMERICAN ECONOMIC REVIEW, AMERICAN ECONOMIC ASSOCIATION 1131 (2007).

There is however no empirical proof of a linear relationship between R&D expenditure and patent filing activity or innovation. *See*, *World Intellectual Property Indicators 2010*, supra note 26, at 21 ("In other words, a certain number of firms with relatively low R&D expenditure still file a large number of patents").

wide.[48] The empirical data on this account in still overly general and incomplete.

Moreover, for some developing countries the 2008 global economic crisis seemingly did not take down domestic patent applications counts.[49] On the other hand, foreign patent and trademark applications have experienced decreases as shown during the same period.[50]

Economic crises impact patenting activity in a second way. Economic crises may reduce patent filling expenditures while hindering quality patenting.[51] There are numerous accounts of a demand increase for patent prosecution discounts over patent filing fees.[52] Similarly, there is worldwide evidence of savings over cheaper patent drafters.[53]

Such changes raise new concerns about the quality of the patent protection, especially in terms of patent registrations.[54] To illustrate, in the context of the 2008 crisis, the European Union (EU) accordingly urged its member states to reduce fees for patent applications and maintenance by up to 75%.[55] Furthermore, the European Commission adopted in 2009 a recommendation to the Council that would provide the Commission with negotiating directives for the conclusion of an agreement creating a Unified Patent Litigation System (UPLS).[56] Such a reduction in legal costs could permit many Small and Medium Enterprises (SMEs) to enforce their patent rights in all EU and European Patent Convention (EPC) countries.[57] In the same vein, in an output of

48. MANUEL LOBATO, NAVIGATING INTELLECTUAL PROPERTY LAW IN EUROPE LEADING LAWYERS ON COMPLYING WITH REGIONAL LAWS, LEVERAGING NEW TECHNOLOGY, AND AVOIDING INFRINGEMENT ISSUES RECENT CASES IN SPAIN: A GENERAL FRAMEWORK OF IP LITIGATION, 2011 WL 5618008 at *4 (2011).

49. *See, e.g.*, YEAP LIN, IP CLIENT STRATEGIES IN ASIA, 2010 EDITION LEADING LAWYERS ON DEVELOPING A DEFENSE STRATEGY, NAVIGATING RECENT CHANGES IN IP PROTECTION, AND UNDERSTANDING THE IMPACT OF THE ECONOMIC CRISIS ON IP CLIENT MEETING IP CHALLENGES IN MALAYSIA, 2010 WL 2511569 at *2 (2010) (adding that the number of domestic patent and trademark applications have in fact increased over the year 2009).

50. *Id.*

51. *See, e.g.*, JAY YOUNG-JUNE YANG, *IP Client Strategies in Asia*, 2010 EDITION LEADING LAWYERS ON DEVELOPING DEFENSE STRATEGY, NAVIGATING RECENT CHANGES IN IP PROTECTION, AND UNDERSTANDING THE IMPACT OF THE ECONOMIC CRISIS N IP CLIENTS NEW IP PROTECTION CHALLENGES IN KOREA AND THE ASIA-PACIFIC REGION, 2010 WL 2511568 at *2 (2010) (for the case of the Asia-Pacific region including South Korea).

52. *Id.* ("After the economic crisis, we noticed that many of our clients tried to reduce their patent filing costs. Many clients now demand very strong discounts for filing fees, or they try to change their IP counselors in order to hire cheaper agents.").

53. *Id.*

54. *Id.*

55. *See*, OECD, *OECD Science, Technology and Industry Outlook 2010*, at 126 (2010), *available at* http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/oecd-science-technology-and-industry-outlook-2010_sti_outlook-2010-en#page1

56. *Id.*

57. *Id.*

invited readers by the IP Review magazine in 2009, titled *State of the IP Industry Survey 2009*,[58] most American law firms said clients were similarly reporting a reduction in budgets for acquiring and developing intellectual property.[59] Patent attorneys were consequently said to process fewer foreign filings and clients focused more on selling or licensing intellectual property than on acquiring or litigating intellectual property.[60] More than a third of the companies surveyed stated that they would spend less specifically in patent and trademark protection.[61] In the backdrop of the 2008 crisis, clients significantly have said to put work 'on hold' or to prioritize out-licensing or divestiture over acquisition.[62] European and American evidence of an overall reduction in patent filling expenditures still fall short in accounting for the more subtle and complex trends abridging the north-south divide.

Third, the effect of economic crises over patenting activity embeds an institutional corollary. It possibly underscores the need for patent courts to encourage innovation and reduce litigation costs.[63] The current economic crisis thus possibly may accentuate the need for a unitary patent and an integrated patent court to encourage innovation and investment.[64] Fourth and in continuation, economic crises allegedly increases suboptimal patent settlements and reduce court case decision-making accordingly. Due to the 2008 crisis, presumably more settlements over intellectual property occurred.[65] This is particularly so given the high litigation costs over IPRs and particularly litigation over patents.[66] Fifth and lastly, economic crisis reduces the bargaining power of developing countries over intellectual property-related goods.[67] To illustrate, in view of major national economic crises devel-

58. *See*, CPA GLOBAL IN ASSOCIATION WITH IP REVIEW, *State of the IP Industry Survey 2009* (April-May 2009), *available at* https://ipcloseup.files.wordpress.com/2010/04/ip_industry_survey_final111.pdf (In an output of invited readers of IP Review magazine of whom around half were based in corporate legal departments and the other half in law firms).

59. *Id*. at 4-5.

60. *Id.*

61. *Id.*

62. *Id.*

63. See, Philip P. Soo, *Enforcing a Unitary Patent in Europe: What the U.S. Federal Courts and Community Design Courts Teach Us*, 35 LOY. L.A. INT'L & COMP. L. REV. 55, 96 (2012).

64. *Id.*

65. STANLEY M. GIBSON, LITIGATION STRATEGIES FOR INTELLECTUAL PROPERTY CASES LEADING LAWYERS ON ADAPTING TO NEW TRENDS, IMPROVING COURTROOM TACTICS, AND UNDERSTANDING THE IMPACT OF RECENT DECISIONS FROM THE TRENCHES OF IP LITIGATION, 2010 WL 1535345 at 4*(2010) ("I think we are seeing more settlements in the IP area because of the current global economic crisis, primarily because IP litigation is very expensive, particularly patent litigation.").

66. *Id.*

67. Daniel Benoliel & Bruno M. Salama, *Towards an Intellectual Property Bargaining Theory: The Post-WTO Era* (with Prof. Bruno M. Salama), 32 U. PA. J. INT'L L. 265, 274 (2010) In what are

oping country leaders such as India,[68] Argentina,[69] or Thailand,[70] finally succumbed to U.S.-led pressure and signed the WTO-led 1994 Trade Related Aspect of Intellectual Property (TRIPS) agreement. Professor Samuel Oddi elegantly labeled it a "*polite form of economic imperialism*".[71] Instead of introducing rule of law in the transnational space we are told, the WTO has repeatedly become an instrument of U.S.-led unilateralism.[72]

II. THE MODEL

A. Overview

This part offers a quantitative statistical methodology of the potential north-south discrepancies over the impact of economic crises over patenting activity. It is a logistic regression (logit) model for dichotomous outcome variables.[73] This model connects a probability of

Tier-1 sanctions, such developing countries may be sanctioned by the governments of developed countries; and in what are Tier-2 sanctions, they may be sanctioned by the industry as well. This dual sanction cost structure is in reality the main way in which the post-WTO intellectual property framework may be said to have generally reduced the bargaining power of developing countries); Samuel Oddi, *Nature and Scope of the Agreement TRIPS - Natural Rights and a "Polite Form of Economic Imperialism"*, 29 VAND. J. TRANSNATL. L. 415, 426 (1996).

68. For the seminal case of India, *see* A. Dutta, and S. Sharma, *Intellectual Property Rights in Developing Countries: Evidence from India*, WORLD BANK WORKING PAPER 47524 at 5 (2008). Dutta, and S. Sharma explain that due to the 1989 economic crisis in India, this country which during the first three years of the Uruguay round of trade negotiations led the opposition to the inclusion of patent and intellectual property rights in a GATT accord succumbed U.S.-led pressure to sign the 1994 of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)." *Id. See also*, C. O'Neal Taylor, *Linkage and Rule-Making: Observations on Trade and Investment and Trade and Labor*, 19 U. PA. J. INT'L ECON. L. 639, 668 n.114 (1998); George K. Foster, *Opposing Forces in a Revolution in International Patent Protection: The U.S. and India in the Uruguay Round and its Aftermath*, 3 UCLA J. INT'L & FOREIGN AFF. 283, 315 (1998). Argentina's analogous economic crisis serves as yet another case in point.

69. For the case of Argentina, *see also*, Daya Shanker, *Argentina-US Mutually Agreed Solution, Economic Crisis in Argentina and Failure of the WTO Dispute Settlement System*, 44 ID.EA 565, 615 (2004) (explaining how the Argentinean economic crisis and subsequent development have led to Argentina accepting terms in violation of the TRIPS Agreement after resisting even minor adjustments in its patent law for years).

70. *See*, Rosemary Sweeney, *The U.S. Push for Worldwide Patent Protection for Drugs Meets the AID.S Crisis in Thailand: A Devastating Collision*, 9 PAC. RIM L. & POL'Y J. 445, 462 (2000) ("In 1997, Thailand suffered a severe economic crisis that placed it in a weak position to resist U.S. attempts to dictate changes in its intellectual property laws. . .Thai government officials expressed hopes during this period that Thailand could finally be removed from the USTR watch list so that more of its exports could enjoy the benefits of the GSP."). ("U.S. pressure has resulted in amendments to the Thai Patent Act that have cut off the possibility of parallel importing to obtain less-expensive, generic versions of these drugs and narrowed the situations in which compulsory licenses can be issued to produce generic versions of AID.S drugs locally") *Id.* at 463.

71. See, Samuel Oddi, TRIPS-Natural Rights and a "Polite Form of Economic Imperialism," 29 VAND. J. TRANSNATL. L. 415 (1996).

72. *Id.*

73. Logistic regression measures the relationship between a categorical dependent variable and one or more independent variables, which are usually (but not necessarily) continuous, by

the negative change in patent applications count (outcome or dependent variable) with a linear combination of income or independent variables, including country type, economic variables and their interac-interactions. The analysis first accounts for an annual time series of 1997-2012 at large, but then corroborates its main findings per the global crisis years of 2001 and 2008.

B. Methodology

The empirical analysis herein examines the effect of different independent variables as proxy of economic crises on dependent patent application procedures across countries. There are three such independent variables. Firstly, these are countries by country group classification, namely countries belonging to the thirty-two advanced economies or twenty-four emerging economies. Secondly, the article's independent variables include a set of three economic variables, namely Gross Domestic Product (GDP)[74], Gross national Income[75] (GNI-PPP), both at Purchasing Power Parity (PPP) and Gross Domestic Expenditure on Research and Development (GERD)[76] GDP and GNI-PPP annual change data are available at World Bank,[77] whereas GERD annual time series are available by the OECD.[78] It further examines the statistical interaction between economic variables and country group.[79] Concretely, the effect of these independent economic variables is examined

using probability scores as the predicted values of the dependent variable. Logistic regression is used with binary data when you want to model the probability that a specified outcome will occur. STATISTICS.COM, http://www.statistics.com/index.php?page=glossary&term_Id.=391.

74. Gross domestic product is an aggregate measure of production equal to the sum of the gross values added of all resId.ent institutional units engaged in production. *See*, BUSINESSDICTIONARY.COM, *GDP*, http://www.businessdictionary.com/definition/gross-domestic-product-GDP.html.

75. Gross national income equals the total domestic and foreign output claimed by residents of a country. It consists of gross domestic product (GDP) and factor incomes earned by foreign residents, minus income earned in the domestic economy by non- residents. *See*, BUSINESSDICTIONARY.COM, *Gross National Income*, http://www.businessdictionary.com/definition/Gross-National-Income.html.

76. Gross domestic expenditure on R&D includes expenditure on research and development by business enterprises, higher education institutions, as well as government and private non-profit organizations. *See*, EUROPEAN COMMISSION, *Eurostat*, http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Gross_domestic_expenditure_on_R_%26_D_(GERD). This economic variable was chosen, since patenting is usually seen as an output of R&D.

77. *See*, THE WORLD BANK, http://data.worldbank.org/.

78. *See*, OECD, *Research and Development Statistics*, http://www.oecd.org/innovation/inno/researchanddevelopmentstatisticsrds.htm

79. In statistics, an interaction occurs given the relationship among three or more variables, and describing a situation in which the simultaneous influence of two variables on a third is not additive**. *See*,** Y. DODGE, THE OXFORD DICTIONARY OF STATISTICAL TERMS (Oxford University Press, 2003).

by means of comparing the probability of the negative annual change,[80] in different dependent patent application procedures for both advanced and emerging economies.[81]

The first patenting procedure examined is that of counting patent applications by proxy of "Applicants' Origin" (or shortly, *by origin*) applications. This procedure shows worldwide patenting activity of applicants originated from any given country. It is important, since patenting activity of residents may be primarily affected by economic crisis conditions in a country of residence. The second patenting procedure examined is that of counting patent applications by proxy of "Filing Office" applications (or shortly, *by office*). It counts patent applications filed in the national patent office by all applicants. This procedure was chosen, since that target of patenting in the specific country is promoting sales and suppressing competitors in this country, therefore economic crisis conditions in the country targeted for patenting may affect patenting activity of potential applicants, independently of their origin. The third patenting procedure examined is that of counting patent applications by proxy of "Non-Residents" patent applications (or shortly, *non-resident*).[82] This procedure also counts patent applications filed in the national patent office, but only those filed by foreigners. This procedure was chosen, since country residents are more prone to file applications in local patent office than abroad. Economic crisis conditions thus differently affect residents and non-residents. Statistical data for all three patenting activity procedures are available in annual time series format at WIPO.[83] In order to base the analysis on the reliable data, time series over the 16-years period of 1997-2012 have been chosen for all variables.

For each patent applications count three logistic statistical models have been fitted. Each model examines the effect of the three inde-

80. The choice of probability of negative change as a dependent variable converts this variable from quantitative to categorical. In our opinion, this is more suitable to the target of the study, since one of the independent variables, namely, country group, is also categorical. Moreover, economic crisis, related to negative change in economic output, has a categorical sense as well.

81. The dependent variable represents the output or effect. The independent variables represent the inputs or causes, In our case variables were chosen with intention to examine the effect of economic crises on patenting activity, and not vice versa.

82. The non-resident patent applications count covers all patent applications filed in the countries' Patent Office by non-residents (foreigners).

83. *See*, WIPO, *Statistics*, http://www.wipo.int/ipstats/en/.

pendent economic variables, namely GDP, GNI-PPP and GERD.[84] The three types of models are analyzed henceforth.

C. Findings

For each model the following hypotheses have been checked per every single independent variable. In relation, null hypothesis, *H*0, represents the article's main counter argument whereby for each independent variable it is assumed that no statistical difference is accounted for between the two country group classifications. That is, over the influence of each of the three economic variables on the probability of negative change for each patent applications procedure.[85] Consecutively, each *H1* hypothesis assumes the existence of such differing influence of economic crises on patenting procedures in comparing advanced and emerging economies.

From the results represented below, it follows that the influence of the explanatory variables on the negative change probability of different patent application procedures differ per each of the three patent application procedures reviewed.

1. The Emerging Economies Patent Applications Bent

At a start, when the patent application procedure *by origin* is forecasted, all modeled results shown below demonstrate significant interactions between economic variable and country group type.[86] Models 1.1 – 1.3 presented in equivalent tables below followed by Figure 1 visualizing the regression equations obtained from these models for each of the three economic variables, namely GDP, GNI-PPP and GERD show the results. From models 1.1 – 1.3 the noticeable influence of each economic variable on the probability of the negative change of the patent applications count *by origin* can be easily seen. That is while the influence of economic crises on patent application *by origin* count modeled through independent economic variables is much weaker over emerging economies than over advanced economies.

Consequently, when the economic variables' values rise, the probability of the negative change in patent applications count *by origin*

84. For all three accounts, to forecast the probability of negative change in patent applications count logistic models have been chosen, including random factor of country and fixed effects of country type, specific economic variable and their interaction.

85. This null hypothesis sets the default assumption thereof, either because it is believed to be true or because it is to be used as a basis for argument, but has not been proved.

86. This is accounted for when p-value less than 0.01. Accordingly, the influence of the main effects is explained via this interaction.

falls. Surely this decline is much steeper for advanced economies than for emerging ones.

Model 1.1 Forecasting probability of negative annual change in patent applications count by origin v. country (random effect), GDP and their interaction (fixed effects)

Solutions for Fixed Effects

Effect	Category	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		-0.5736	0.1764	85.16	-3.25	0.0016
GDP		-4.3319	2.6095	844	-1.66	0.0973
Category	Advanced	0.04615	0.2372	84.56	0.19	0.8462
GDP*Category	Advanced	-21.9933	4.8672	843.8	-4.52	<.0001

Model 1.2 Forecasting probability of negative annual change in patent applications count by origin v. country (random effect), GNI-PPP and their interaction (fixed effects)

Solutions for Fixed Effects

Effect	Category	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		-0.3725	0.2001	164.1	-1.86	0.0644
GNIPPP		-5.7748	2.2697	836.6	-2.54	0.0111
Category	Advanced	0.02777	0.2684	164.5	0.10	0.9177
GNIPPP*Category	Advanced	-10.5767	3.7438	828.5	-2.83	0.0048

Model 1.3 Forecasting probability of negative annual change in patent applications count by origin v. country (random effect), GERD and their interaction (fixed effects)

Solutions for Fixed Effects

Effect	Category	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		-0.8082	0.1781	34.41	-4.54	<.0001
GERD		-0.3765	0.5015	571	-0.75	0.4531

Category	Advanced	-0.09183	0.2373	39.03	-0.39	0.7009
GERD*Category	Advanced	-5.6998	2.0529	569.5	-2.78	0.0057

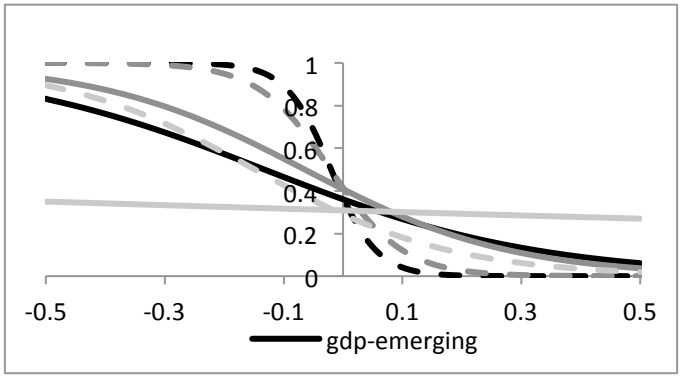

Fig.1 Probability of negative annual change in patent applications by origin count (vertical axis) v. annual change in economic variables (horizontal axis)

Model 1.1 demonstrates that the only significant independent variable is the combination (interaction) of GDP with country category, while either GDP itself or country category alone have been found insignificant. The influence of this interaction is strongly negative. This means that for advanced economies negative values of GDP annual change would increase a probability of the negative change in patent applications count by origin. For emerging economies on the other hand the influence of GDP annual change on the probability of annual decrease in patent applications count by origin would be much weaker.

This kind of behavior can be clearly seen from Fig.1, which visualizes the dependence of negative change in patent applications count by origin probability on annual change in GDP. While for advanced economies sharp failure in the probability with GDP annual change switch from negative to positive is observed, for emerging economies the probability change is smooth (with values around 0.3-0.5 over the wide range of GDP annual change).

In the case of GNI-PPP economic variable (Model 1.2), both this variable and its interaction with country category demonstrate significant and negative effect, while the influence of the interaction is

stronger. The effect, as can be seen from Fig.1, is similar to GDP, but the difference between advanced and emerging economies is somewhat weaker. As for the third economic variable (GERD) influence, Model 1.3 shows that only the interaction of GERD with country category is significant. Also in this case the effect is negative, but much weaker than that of two previous economic variables. This means that only a strong negative annual change in GERD would provide a negative change in patent applications by origin with high probability for advanced economies. On the other hand, for emerging economies patent applications count by origin is totally insensitive to annual changes of GERD.

As a whole, when patent applications are counted by proxy of applicants' national origin applications (or shortly, 'by origin'), the influence of economic crises modeled through independent economic variables is much weaker over emerging economies. That is in comparison with the effect of economic crises over advanced economies across the north-south divide. Put differently, when the values of economic variables consequently rise, the probability of the negative change in patent applications by origin count falls. Surely this decline is much steeper for advanced economies than for emerging ones.

But what might explain these findings? At first sight one recalls that in emerging economies where innovation is predominantly promoted by multinational corporations (MNEs) and by foreign direct investments (FDI) - decisions relating to patenting activity come from outside the country to a large extent.[87] Such investments are thus done less as a response to economic developments within given emerging economies, but as part of an international or at least multinational enterprise.

On that account, one should recall the marginal number of MNEs originating from the developing world with emphasis on emerging economies. The United Nations Conference on Trade and Development's (UNCTAD) seminal 2005 World Investment Report comes to mind. UNCTAD's 2005 investment report was pivotal as of 2005 in

87. On the role of MNEs in patenting activity and innovation in developing countries, *see*, *generally*, Shih-Fen S. Chen, *Extending Internalization Theory: A New Perspective on International Technology Transfer and its Generalization*, 36 J. INT'L BUS. STUD. 231, 232 (2005) (assessing the high degree of control that MNEs have over their technology in developing countries); Xavier Martin & Robert Salomon, *Tacitness, Learning, and International Expansion: A Study of Foreign Direct Investment in a Knowledge-Intensive Industry*, 14 ORG. SCI. 297, 298 (2003) (focusing on the knowledge based assets, such as technological intelligence which MNEs from overseas bring to developing countries); Nicholas C. Georgantzas, *MNE Competitiveness: A Scenario-Driven Technology Transfer Construct*, 12 MANAGERIAL & DECISION ECON. 281, 282-83 (1991) (depicting the dominant role of MNEs in developing countries in introducing new technologies and the competition between MNEs thereof).

explaining how over eighty percent of the seven hundred largest R&D spending firms come from only five advanced economies, namely the United States, Japan, Germany, the United Kingdom and France, in descending order.[88] Only one percent of the top seven hundred are based in developing countries or South-East Europe and the former Soviet Bloc's Commonwealth of Independent States (CIS).[89] Within the list of MNEs from developing countries almost all these firms are concentrated in East Asia, notably from the Republic of Korea and Taiwan Province of China.[90]

This remarkably highly centralized nature of MNEs then helps to understand the WIPO 2010 Indicators report which further illustrates how in 2010, resident applications accounted for 57.4% of total applications in high-income and 52.3% in middle-income economies. The report's main finding however was that by means of comparison, the resident share of middle-income economies largely incorporating emerging economies (yet excluding China's State Intellectual Property Office (SIPO)), is only 30.8%.[91] Moreover, in certain adherence with UNCTAD' 2005 earlier findings, the WIPO report shows that only a fifth of all applications in low-income economies are again resident applications.[92] Likewise, another 2010 survey involving 300 of the largest U.S. companies engaged in outsourcing reveals how a remarkable share of 77% of their outsourcing activity is again international.[93] Outsourcing is thus less affected by economic crises per their impact on emerging economies.[94]

88. See, UNCTAD, *World Investment Report*, NEW YORK AND GENEVA, UNITED NATIONS at 121 (2005), available at http://unctad.org/en/Docs/wir2005_en.pdf (Table IV.2). The IMF's Balance of Payments Manual (fifth edition, 1993) and the OECD Benchmark Definition of Foreign Direct Investment (third edition, 1995) provide agreed guidelines for compiling FDI flows. *See also*, *Id.* at 16-17.

89. *Id*. at 120. (Table IV.1.) Several countries have moved up the ranks since the late 1990s. *Id*.

90. *Id*. at 121 (Table IV.2.) In balance, only one MNC comes from Africa and two are from Latin America. *Id*.

91. *See*, *World Intellectual Property Indicators 2010*, *supra* note 26, at 40.

92. *Id*.

93. These findings concerning outsourcing rates corroborate the concentration of MNEs operating in emerging economies, while presiding in developed countries. See, Capgemini, Latin America is the third most popular outsourcing destination (2010), at: http://apps.us.capgemini.com/DownloadLibrary/files/factsheets/Capgemini_BPO_LatAmOSdest_fs0610.pdf (The most important outsourcing destination is India used by 60% of the surveyed companies. It is followed by China with 27% and Latin America (excl. Mexico) with 25%. Other Asian countries are less important with 16% just like Western Europe with 14%, Canada (12%) and Mexico (9%)). Two caveats apply. Firstly, the survey does not connote outsourcing with innovative activity such as patenting. Secondly, the survey does not relate the proportion of outsourcers to the total number of MNEs as opposed to smaller companies. *Id*.

94. *Id*.

In continuation, firms of different sizes also differ substantially in terms of the effect of financial crises on their partly related innovation performance.[95] Surely, not all patenting activity directly connotes innovation, yet the relation is outsized. In such cases, larger firms more readily accommodate shocks to sales given both their internal financial resources as well as larger access to external financial resources.[96] By the same token, a 2011 OECD survey of manufacturing companies in Austria, France, Germany, Hungary, Italy, Spain and the United Kingdom shows how innovative companies witnessed a smaller decrease in sales.[97] Multinational enterprises continuously are archetypal transferors of technology and innovation across borders.[98] That is, as they engage in FDI and other forms of cross-border value-adding activity including patent prosecution.[99]

Beyond the distinctive financial endurance of MNEs, there stands an explanation as to why patent application rated *by origin* decreased less in emerging economies inflicted by economic crises. As numerous economic crises literature studies further observe, global shocks predominantly affect advanced economies.[100] Less-developed and emerging economies on the other hand, depend exclusively on idiosyncratic shocks, and thus are less vulnerable to crisis spread.[101] World renowned Chilean Economist Ricardo Ffench-Davis further explains that the major source of economic fluctuations in emerging economies indeed are external shocks, which are essentially exogenous, and generally independent of economic policies in these countries. So much so, as emerging economies may still be affected by some domestic factors.[102] During the 2008 global crisis to illustrate, emerging economies

95. *See*, OCED, *OCED Science, Technology and Industry Outlook 2012*, at 31-32, *available at* http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/oecd-science-technology-and-industry-outlook-2012_sti_outlook-2012-en#page1 (concerning the 2008 global economic crisis).

96. *Id*. ("Large firms used internal financial resources to make fewer cuts to innovation investments during the downturn and thus smooth their innovation investments over time").

97. *See*, *Id.* at 33 (referring to G. Békés, L. Halpern, M. Koren and B. Muraközy, Still standing: how European firms weathered the crisis, The third EFIGE policy report, Bruegel, 22 December 2011 (2011)).

98. P. J. BUCKLEY AND M. C. CASSON, THE FUTURE OF THE MULTINATIONAL ENTERPRISE, (London: Macmillan) (1976).

99. *Id*.

100. Troy Matheson, *The Global Financial Crisis: An Anatomy of Global Growth*, IMF WORKING PAPER WP13/76 (2013), *available at* http://www.imf.org/external/pubs/ft/wp/2013/wp1376.pdf.

101. *Id*.

102. RICARDO FFENCH-DAVIS, *Reforming Macroeconomic Policies in Emerging Economies: from Procyclical to Countercyclical Approaches*, THE FINANCIAL AND ECONOMIC CRISIS OF 2008-2009 AND DEVELOPING COUNTRIES, UNITED NATIONS REPORT, 256–279 (2010), *available at* http://unctad.org/en/Docs/gdsmdp20101_en.pdf.

were surely less affected by the global decline in growth in comparison with advanced economies.[103] Advanced economies saw actual declines in output in 2009 of an average of 3.2%.[104] The output of emerging economies, on the other hand grew in 2009, albeit at a more measured pace in contrast to previous years. Their output moderately grew on average 2.5% in 2009 in comparison with 6.1% in 2008 and 8.3% in 2007.[105]

Be that as it may, MNEs patenting in emerging economies nevertheless patent overseas while focusing mostly on profit maximization internationally.[106] In a recent study analyzing the effect of the location of headquarters on investment decisions of approximately 5,000 subsidiaries worldwide, the authors find that foreign ownership encourages a focus on profitability when taking investment decisions.[107] The

103. *Id*. (adding that "This was mainly due to continued growth in developing Asia (notably China, India and Indonesia), but also growth in Africa that compensated for declines elsewhere"). *But see,* D. M. PRATES AND M. A. M. CINTRA, *The emerging-market economies in the face of the Global financial crisis*, THE FINANCIAL AND ECONOMIC CRISIS OF 2008-2009 AND DEVELOPING COUNTRIES, UNITED NATIONS REPORT 54-70 (2010) ("When this crisis spread and turned into recession, emerging economies were affected, mainly through trade channels, and the consequences of these indirect effects in many countries were as severe as the direct effects in the developed countries."), *available at* http://unctad.org/en/Docs/gdsmdp20101_en.pdf.

104. *Id*. (explaining that the actual declines in output in IP systems in Advanced economies in 2009 were most pronounced for European countries (for example, around -5% for Germany and the United Kingdom) and for Japan (around -5%)).

105. *See*, *World Intellectual Property Indicators 2010*, *supra* note 26, at 14.

106. This argument makes part of growing theoretical literature on the internationalization of MNEs. *See generally*, Peter J. Buckley and Mark C. Casson, *The internalization theory of the multinational enterprise: A review of the progress of a research agenda after 30 years*, 40 J. INT'L BUS STUD. 1563, 1563 (2009) (providing the most inclusive internalization theory analysis across 30 years focusing mainly on the emergence and functioning of MNEs); Shih-Fen S. Chen, *Extending Internalization Theory: A New Perspective on International Technology Transfer and its Generalization*, 36 J. INT'L BUS STUD. 231, 232 (2005) (attempted to clarify the continued importance of the market. It extends internalization theory by adding hitherto neglected market institutions to the investment versus licensing trade-off in governing the developer-manufacturer cooperation: arm's length co-marketing, contractual co-marketing, and Original equipment manufacturers (OEM)); J. A. Cantwell and L. Piscitello, *Accumulating technological competence: Its changing impact on corporate diversification and internationalization*, 9 INDUSTRIAL AND CORPORATE CHANGE 21, 21-51 (2000) (identifying three historical phases in the growth of firms in terms of their patterns of diversification and internationalization). Nicholas C. Georgantzas, *MNE Competitiveness: A Scenario-Driven Technology Transfer Construct*, 12 MANAGERIAL & DECISION ECON. 281, 282-83 (1991) (depicting the nature of the competition between MNEs operating in developing countries); Satya Das, *Externalities, and technology transfer through multinational corporations: a theoretical analysis*, 22 J. OF INT'L ECONS. 171, 171 (1987) (analyzing the behavior of a multinational firm's subsidiary in a host country when learning of its production techniques by its native rivals occurs).

107. *See, e.g.*, W. CARLIN, A. CHARLTON AND C. MAYER, MULTINATIONAL OWNERSHIP AND SUBSIDIARY INVESTMENT, OXFORD FINANCIAL RESEARCH CENTRE ECONOMICS SERIES 32 (2007), *available at* http://www.hnb.hr/dub-konf/15-konferencija/paper-carlin-charlton-mayer.pdf ; Capgemini, Latin America is the third most popular outsourcing destination (2010), at: http://apps.us.capgemini.com/DownloadLibrary/files/factsheets/Capgemini_BPO_LatAmOSdest_fs0610.pdf2; Grant Thornton LLP, International Sourcing: Offshore or near shore?, Supply Chain

MNEs barrier of efficiency in fact is even more powerful than in case of independent firms.[108] This is all the more visible during a host country crisis when MNEs often times withdraw capital and invest elsewhere more easily than domestic firms.[109]

2. Patent Applications by Office Indifference

Secondly, when the probability of negative change of the patent application procedure counted *by office* is forecasted, this article's logistic models provide very different results. Counting patent applications by office, to recall, account for fillings in the national patent office by all applicants. This procedure was chosen, since that target of patenting in the specific country is promoting sales and suppressing competitors in this country, therefore economic crisis conditions in the country targeted for patenting may affect patenting activity of potential applicants, independently of their origin.

The dissimilar results here are threefold referring to the effects of GDP, GNI-PPP and GERD as follows. To begin with, model 2.1, representing GDP as an explanatory variable is the only significant variable.[110] This means that the influence of GDP on the probability of annual decrease in the patent applications count by office is not different for both advanced and emerging economies.

Accordingly, chart model 2.2 below, representing GNI-PPP as an explanatory variable, witnesses no significance in influencing the probability of the patent application procedure by office. The probability declines instead (with p-value less than 0.0001). More specifically, the influence of GNI-PPP on the probability of patent application by office is not significantly different for either advanced or emerging economies. In balance, lastly, when the probability of negative change of the patent application procedure *by office* is forecasted using GERD, model 2.3 demonstrates significant influence of GERD interaction with country type (p-value 0.0002). This means that the influence of GERD on the decrease in patent applications count by office is different for advanced and emerging economies. More specifically, there is no such influence for emerging economies, while for advanced economies GERD influence is evidenced. The results of the models 2.1-2.3 for pa-

Solutions, 1:3 (2009) (adding that although the main reason for outsourcing is identified as labour cost reduction, the total cost of outsourcing also matters when companies make a decision).

108. W. Carlin, A. Charlton and C. Mayer, *supra* note 107, at 32.

109. *Id*.

110. The p-value function of the observed sample results is 0.008.

tent applications count by office are summarized and visualized also on Figure 2.

In conclusion, when the probability of negative change of the patent application procedure *by office* is forecasted the overall influence of the three independent variables examined is non significant and thus offer no different effect on emerging economies in comparison with advanced ones.

Model 2.1 Forecasting probability of negative annual change in patent applications count by office v. country (random effect), GDP and their interaction (fixed effects)

Solutions for Fixed Effects

Effect	Category	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		-0.2555	0.1790	98.04	-1.43	0.1567
GDP		-7.0085	2.6372	839.6	-2.66	0.0080
Category	Advanced	0.3535	0.2370	91.14	1.49	0.1392
GDP*Category	Advanced	-8.4292	4.3667	839.6	-1.93	0.0539

Model 2.2 Forecasting probability of negative annual change in patent applications count by office v. country (random effect), GNI-PPP and their interaction (fixed effects)

Solutions for Fixed Effects

Effect	Category	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		0.08930	0.2146	174	0.42	0.6779
GNIPPP		-9.7217	2.3924	826.7	-4.06	<.0001
Category	Advanced	0.1758	0.2820	159.9	0.62	0.5338
GNIPPP*Category	Advanced	-1.4321	3.5306	826.2	-0.41	0.6851

Model 2.3 Forecasting probability of negative annual change in patent applications count by office v. country (random effect), GERD and their interaction (fixed effects)

Solutions for Fixed Effects

Effect	Category	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		-0.5571	0.1844	39.98	-3.02	0.0044
GERD		-0.1280	0.4618	553.5	-0.28	0.7817
Category	Advanced	0.6448	0.2437	43.7	2.65	0.0113
GERD*Category	Advanced	-7.2895	1.9604	569	-3.72	0.0002

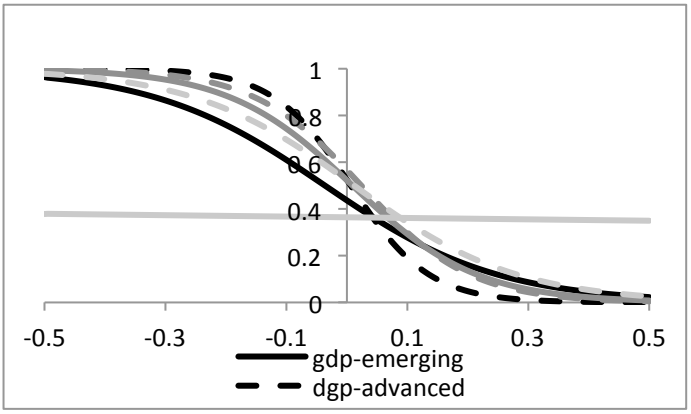

Fig. 2 Probability of negative annual change in patent applications by office count (vertical axis) v. annual change in economic variables (horizontal axis)

When patent applications count by office is taken as a dependent variable, the picture is significantly different. In such case, for GDP itself influence (Model 2.1) was found significant.[111] A similar observations were found for the GNI-PPP economic variable (Model 2.2).[112] In both cases the effect is negative, but for GNI-PPP its absolute value is much lower than for GDP. GERD, oppositely, shows rather strong, negative and significant interaction effect (Model 2.3), while pure GERD effect is insignificant. Fig. 2 summarizes and visualizes these effects. It can be seen that the difference between advanced and emerging economies for GDP as an economic variable is much less pronounced than in the case of patent applications by origin as a dependent variable (Fig.1), for GNI-PPP this difference is negligible, and for GERD, again, patenting activity in emerging economies is totally insensitive to

111. The interaction was not significant as the p-value was found to be above 0.05.

112. In this case interaction shows p-value as high as 0.6851, indicating negligible significance.

changes in this variable. The fact that *by office* patent applications do not account for the separate contribution of MNEs operating from overseas, may explain these dissimilar results in comparison with the previous *by origin* patent application count.

3. Non-Resident Patent Applications Insignificance

So far we have examined two of three patent application procedures, namely *by origin* and *by office*. A third patent application procedure follows. It is as said the application procedure by *non-resident*.

Such patent procedure to recall counts patent applications filed in the national patent office, but only those filed by foreigners. This procedure was chosen, since country residents are more prone to file applications in local patent office than abroad.

When the probability of the negative change in *non-resident* patent applications is forecasted, the overall non significant results are similar to those for patent applications *by office*. Model 3.1, similar to model 2.1 demonstrates that the only significant explanatory economic variable is GDP (p-value 0.0078). The influence of GDP on the probability of annual decrease in *non-resident* patent applications is thus not different for advanced and emerging economies. Also model 3.2 shows similar influence of GNI-PPP on the probability of the negative annual change in *non-residents* application for both types of country groups (p-value in this case is 0.0063). As for the influence of GERD, model 3.3 demonstrates no influence of this explanatory variable on the probability of negative change in *non-resident* patent applications for both types of country groups. The probability of the patent count decrease in this case is in the range 40-50%, as can be seen in almost parallel lines in Figure 3 below.

Model 3.1 Forecasting probability of negative annual change in non-resident patent applications count v. country (random effect), GDP and their interaction (fixed effects)

Solutions for Fixed Effects

Effect	Category	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		0.02330	0.1769	117.6	0.13	0.8954
GDP		-7.1249	2.6710	822.3	-2.67	0.0078
Category	Advanced	0.2178	0.2329	105.3	0.94	0.3518
GDP*Category	Advanced	-0.7927	4.1867	821.8	-0.19	0.8499

Model 3.2 Forecasting probability of negative annual change in non-resident patent applications count v. country (random effect), GNI-PPP and their interaction (fixed effects)

Solutions for Fixed Effects

Effect	Category	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		0.1074	0.2046	182.1	0.52	0.6003
GNIPPP		-6.0444	2.2067	816.9	-2.74	0.0063
Category	Advanced	0.2882	0.2724	170.7	1.06	0.2916
GNIPPP*Category	Advanced	-1.0752	3.3108	815.1	-0.32	0.7455

Model 3.3 Forecasting probability of negative annual change in non-resident patent applications count v. country (random effect), GERD and their interaction (fixed effects)

Solutions for Fixed Effects

Effect	Category	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		-0.2610	0.1993	38.2	-1.31	0.1981
GERD		-0.1661	0.4484	533.9	-0.37	0.7113
Category	Advanced	0.3937	0.2642	40.96	1.49	0.1439
GERD*Category	Advanced	-0.1020	1.6980	553.1	-0.06	0.9521

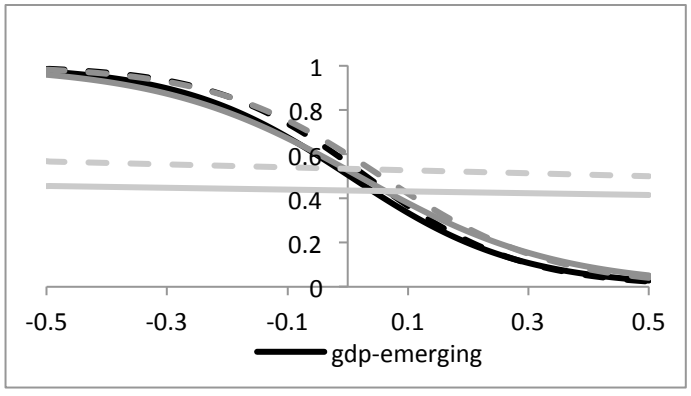

Fig. 3 Probability of negative annual change in non-resident patent applications count (vertical axis) v. annual change in economic variables (horizontal axis)

Finally, when the non-resident patent applications count is considered as a dependent value, two of the economic variables were found significant separately (GDP in Model 3.1 and GNI-PPP in Model 3.2), while their combinations with country category were found essentially insignificant. As for GERD influence, Model 3.3 demonstrated insignificance of all the independent variables included. No difference between advanced and emerging economies in influence of separate economic variables on this kind of patenting activities has been observed, as Fig. 3 illustrates.

4. Verification of Irregularities for Crisis Years 2001, 2008

Three additional models labeled as models 1.1Y - 1.3Y were fitted referring to the global crisis years of 2001 and 2008 as a fixed factor. The former, also known as "Early 2000s Recession", affected the European Union, the United States, Turkey, Argentina and other countries and was triggered by the "Dot-com Bubble" collapse in 2000. This recession was relatively short and mild.[113] Alternatively, the latter economic crisis caused the 2008 recession, triggered by housing bubble collapse in the USA, was spread worldwide and hit many countries with different degree of severity.[114] The purpose of this section is to corroborate this article's findings with data concerning the two global crises years which fell within the article's annual time series of 1997-2012. The three models herein are complementary to the three economic variables described above, namely GDP, GNI-PPP and GERD. As models 1.1Y- 1.3Y forecast below, the annual negative change in patent applications count *by origin*, in all three cases demonstrate significance

113. The 2001 recession is regarded short and mild on average in comparison to other post-World War II recessions. *See*, Kevin L. Kliesen, *The 2001 Recession: How Was It Different and What Developments May Have Caused It?*, THE FEDERAL RESERVE BANK OF ST. LOUIS 23 (2003), *available at* https://research.stlouisfed.org/publications/review/03/09/Kliesen.pdf.

114. The crisis started in the United States as of 2007. It later spread to numerous financial institutions in other OECD countries. Only when it became a global economic recession that developing and emerging-market economies were affected. See, SEBASTIAN DULLIEN, DETLEF J. KOTTE, ALEJANDRO MÁRQUEZ AND JAN PRIEWE, FINANCIAL AND ECONOMIC CRISIS OF 2008-2009 AND DEVELOPING COUNTRIES, UNITED NATIONS REPORT 1 (2010), *available at* http://unctad.org/en/Docs/gdsmdp20101_en.pdf.

of year and interactions over patenting application procedures in the two country groups (p-values less than 0.05).[115]

In analogy, as models 1.1-1.3 above have demonstrated, there is a significant influence of each economic variable reviewed on the probability of negative change in patent applications count *by origin*. That is, as this influence is much milder for emerging economies than for advanced ones per the two crisis years reviewed. In any case, decrease in the value of the economic variables significantly increases the probability of negative change in patent applications count *by origin*, and. Thus, if Figure 1 above represent general dependence of said probability on the annual change in economic variables, positive or negative, Figures 4-6 below demonstrate such dependence for specific years with predominantly negative change in economic factors for most advanced economies. It further shows significant slowdown for most emerging economies. It can be seen that the difference between advanced and emerging economies is much more pronounced for the crises wrecked years of 2001 and 2008 in comparison with the overall patent application *by origin* examination per Figure 1 above, as follows.

Model 1.1Y Forecasting probability of negative change in patent applications count by origin by means of the following explanatory variables: country (random effect), GDP, category and their interaction (fixed effects) and year (fixed factor)

Solutions for Fixed Effects

	Category	Year	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept			-0.3116	0.3306	527.8	-0.94	0.3464
GDP			-1.2902	3.0350	822.5	-0.43	0.6709
Category	Advanced		0.04762	0.2500	85.51	0.19	0.8494
GDP* Category	Advanced		-20.3347	5.1092	829	-43.98	<.0001
Year		1997	0.02819	0.4137	780	0.07	0.9457
Year		1998	-1.3148	0.4811	779.2	-2.73	0.0064
Year		1999	0.09868	0.4101	779	0.24	0.8099
Year		2000	-0.8407	0.4708	781.2	-1.79	0.0745
Year		2001	-0.1324	0.4045	775.7	-0.33	0.7436
Year		2002	0.05813	0.4007	776.6	0.15	0.8847

115. Since interactions have been found significant, the influence of the main effects can be explained via these interactions as represented on Figures 4-6 below for years 2001 and 2008 only. That is since the representation of the year as an additional variable will complicate visualization.

Year		2003	-0.3688	0.4167	778.1	-0.88	0.3765
Year		2004	-1.0255	0.4834	782.6	-2.12	0.0342
Year		2005	-0.6869	0.4463	781.7	-1.54	0.1242
Year		2006	-0.6019	0.4525	784.6	-1.33	0.1839
Year		2007	-0.7201	0.4611	784.8	-1.56	0.1187
Year		2008	-0.4412	0.4090	774.9	-1.08	0.2809
Year		2009	0.3228	0.4222	790.1	0.76	0.4447
	Category	Year	Estimate	Standard Error	DF	t Value	Pr > |t|
Year		2010	-1.1987	0.4759	778.4	-2.52	0.0120
Year		2011	-0.07861	0.4033	776.2	-0.19	0.8455

Type III Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
GDP	1	815	14.27	0.0002
Category	1	85.51	0.04	0.8494
GDP*Category	1	829	15.84	<.0001
Year	15	779.4	2.06	0.0102

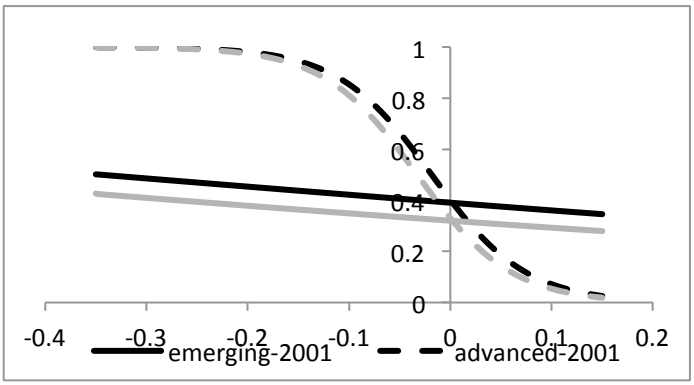

Fig.4 Probability of negative change in patent applications count by origin (vertical axis) v. annual changes in GDP (horizontal axis)

Model 1.2Y Forecasting probability of negative change in patent applications count by origin by means of the following explanatory variables: country (random effect), GNI-PPP, category and their interaction (fixed effects) and year (fixed factor)

Solutions for Fixed Effects

	Category	Year	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept			-0.03142	0.3466	559.5	0.09	0.9278
GNIPP			-3.9551	2.6293	822.5	-1.50	0.1329
Category	Advanced		0.01618	0.2882	164	0.06	0.9553
GNIPPP* Category	Advanced		-9.7950	3.9628	815.5	-2.47	0.0136
Year		1997	-0.1822	0.4050	772.5	-0.45	0.6529
Year		1998	-1.5509	0.4765	774.8	-3.25	0.0012
Year		1999	-0.2354	0.4024	771.7	-0.58	0.5588
Year		2000	-0.9705	0.4655	775.6	-2.08	0.0374
Year		2001	-0.2600	0.4015	771.6	-0.65	0.5174
Year		2002	-0.1090	0.3972	771.2	-0.27	0.7839
Year		2003	-0.5859	0.4120	772.2	-1.42	0.1554
Year		2004	-1.1722	0.4760	774.8	-2.46	0.0140
Year		2005	-0.8259	0.4409	775.6	-1.87	0.0615
Year		2006	-0.5488	0.4579	782.2	-1.20	0.2311
Year		2007	-0.9896	0.4630	774.4	-2.14	0.0329
Year		2008	-0.5120	0.4130	771.3	-1.24	0.2154
Year		2009	0.2706	0.4145	777.3	0.65	0.5141
Year		2010	-1.4293	0.4724	772.8	-3.03	0.0026
Year		2011	-0.1259	0.4014	770.8	-0.31	0.7538

Type III Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F

GNIPPP	1	823	14.49	0.0002
Category	1	164	0.00	0.9553
GNIPP*Category	1	815.5	6.11	0.0136
Year	15	774	2.43	0.0018

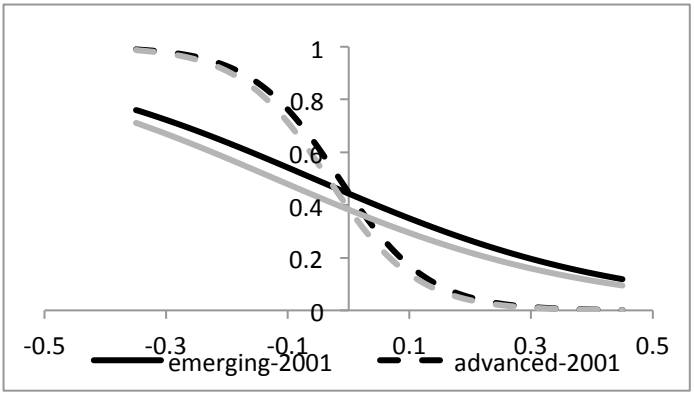

Fig. 5 Probability of negative change in patent applications count by origin (vertical axis) v. annual changes in GNI-PPP (horizontal axis)

Model 1.3Y Forecasting probability of negative change in patent applications count by origin by means of the following explanatory variables: country (random effect), GERD, category and their interaction (fixed effects) and year (fixed factor)

Solutions for Fixed Effects

	Category	Year	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept			-0.5513	0.4069	367.8	-1.35	0.1763
GERD			0.06267	0.4914	547.9	0.13	0.8985
Category	Advanced		-0.1391	0.2579	38.9	-0.54	0.5926
GERD* Category	Advanced		-4.5098	2.1313	557	-2.12	0.0348

Year	1997	0.04680	0.5074	523.8	0.09	0.9265
Year	1998	-1.2248	0.5984	522.7	-2.05	0.0412
Year	1999	-0.02881	0.5049	523.8	-0.06	0.9545
Year	2000	-0.9000	0.5739	523.8	-1.57	0.1174
Year	2001	0.01533	0.4961	523.1	0.03	0.9754
Year	2002	0.3544	0.4831	524.1	0.73	0.4636
Year	2003	-0.06289	0.4949	523.3	-0.13	0.8989
Year	2004	-1.2767	0.5935	520.5	-2.15	0.0319

	Category	Year	Estimate	Standard Error	DF	t Value	Pr > |t|
Year		2005	-0.5106	0.5228	522.3	-0.98	0.3291
Year		2006	-0.6515	0.5353	522.5	-1.22	0.2241
Year		2007	-1.1973	0.5955	520.2	-2.01	0.0449
Year		2008	-0.2801	0.5169	521.2	-0.54	0.5582
Year		2009	1.1554	0.4983	523.5	2.32	0.0208
Year		2010	-0.7985	0.5506	520	-1.45	0.1476
Intercept			-0.5513	0.4069	367.8	-1.35	0.1763

Type III Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
GERD	1	557	4.11	0.0430
Category	1	38.9	0.29	0.5926
Gerd*Category	1	557	4.48	0.0348
Year	14	519.6	2.97	0.0002

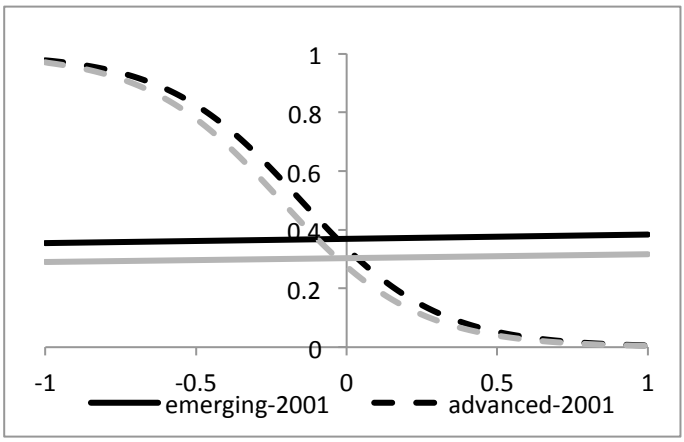

Fig. 6 Probability of negative change in patent applications count by origin (vertical axis) v. annual changes in GERD (horizontal axis)

Additional Models 1.1Y-1.3Y were applied to check the relevance of the above mentioned findings for years of global or, at least, widespread economic crisis. Two years—2001 and 2008 were chosen, the former is associated with so-called "Early 2000-s Recession", and the latter with the global recession following the 2007 financial crisis. The three models include one dependent variable—patent applications count by origin, and independent variables according to Models 1.1—1.3 respectively. They include also years as a fixed factor. The results for Model 1.1Y, including GDP as an economic variable, show significance of GDP, its interaction with country category, and of year. This is different from Model 1.1, in which only the interaction significance was established.

Fig.4 shows a strong influence of GDP change on the probability of negative change in patent applications count by origin for advanced economies, whereas for emerging economies an essential indifference could be observed. Similar picture can be observed on Fig. 5 for Model 1.2Y, which includes GNI-PPP as an economic explanatory variable. Also in this case economic variable, its interaction with country category, and year were found significant. One can see the noticeable difference in advanced and emerging economies patenting activity behavior: the latter demonstrates essential indifference to economic variable changes even in the crisis years. Fig. 6 illustrates the results of the Model 1.3Y, including GERD as an explanatory economic variable. Also in this case the difference between advanced economies (strong dependence of patenting activity on GERD changes) and emerging economies (essential indifference of patenting activity to GERD changes) could be observed.

These observations show first that the response of the patenting activity to change in the economic variables is year sensitive. These observations further shows that the type of this response, different for advanced and emerging economies, is essentially the same for diverse and concrete crisis years. Models 1.1-1.3 describe patenting activity response to economic development along the years, when annual changes of economic variables for different countries could be positive

or negative, according to the business cycle phase. However, for two chosen years, included in Models 1.1Y-1.3Y, changes of economic variables were strongly biased to negative values for a wide range of countries, due to the spread of the economic crisis. The obtained results show that, even in this case, the probability of negative change in patent applications count by origin for emerging economies remained much less sensitive to economic development.

The results described above should not be understood as a lack of response of the patenting activity to economic developments, and, specifically, to economic crises for emerging economies. They solely demonstrate that the real decrease in patent applications count by origin is much less probable for emerging economies than for advanced ones altogether. Notwithstanding these findings, a certain slowdown in the rate of annual change of patent applications count by origin (yet remaining positive) has been observed for most emerging economies in 2008-2009. These findings may help finding policies to protect innovation or at least patenting filling activity from the influence of business cycle downturns, recessions and other crisis effects. The reasons being it, that successful innovation and more so patenting activity could possibly be perceived a key factor for recovery from crises while overcoming their negative consequences.

D. Conclusions

The analysis of all nine models described shows how different patenting filing procedures separately convert as economic crisis conditions come about. GDP changes affect all of the three analyzed types of patenting activities. That is so, as economic crisis conditions significantly increase the probability of negative change in patent applications count with decrease in economic variable value. What is more is that crisis conditions influence patenting activity in advanced and emerging economies distinctively. For patent applications by origin where MNEs take central stage this difference is very pronounced. In such case, annual negative change in GDP in advanced economies is followed by negative change in the count of patent applications, originated from the same country, with high probability. Then again, in emerging economies patent applications by origin are essentially indifferent to changes of GDP. This may indicate that in emerging economies, where innovation is predominantly promoted by multinational corporations and FDI as said, patenting activity-related decisions come from outside the country. In such cases patenting is substantively less

of reactive to economic developments within emerging economies themselves.

Furthermore, when the count of patent applications by office is considered as a dependent variable, the difference in its response to economic changes is much less pronounced for advanced and emerging economies. This count includes either domestic or foreign patent applications. Foreign patenting is aimed predominantly to increase market shares and suppress competitors, while the motives for domestic patenting could be different, such as primary filing for priority. In this case a much closer behavior of patenting activity in advanced and emerging economies vis-à-vis annual changes of GDP is observed.

Turning to the non-resident patent applications count as a dependent variable, one can observe an almost identical behavior of this kind of patenting activity in advanced and emerging economies. That is, with regard to annual changes in GDP. Since non-resident patent applications represent foreign patenting in the country's Patent Office, it may mean that the response of foreign patent applications filing to the domestic economic development is similar for different groups of countries. So much so, at least for emerging and advanced economies. This makes sense in the assumption that advanced and emerging economies constitute important markets for innovative technologies and products. They similarly offer a mix of players present in non-resident patent applications filing activity in each country, excluding domestic applicants. These domestic applicants may make difference between applications by office and non-resident applications behavior.

Switching to GNI-PPP as an independent economic variable, similar behavior of three types of patent applications counts are observed. The effect here is nevertheless significantly less pronounced. The difference between GDP and GNI-PPP is in that the former measures domestic economic output, including gross values added by foreign producers functioning in the country, and excluding those added by residents functioning outside the country. The latter on the other hand measures gross national income, including domestic and foreign output claimed by residents, but excluding that of foreign producers functioning within the country. These foreign producers, originating mainly from advanced economies, are responsible for the lion's share of innovation and R&D thereof in emerging countries. Residents of emerging economies presiding overseas on the other hand thus seem much less influential for patenting and possibly innovative activity in these countries. Conversely, residents of advanced economies presiding overseas are substantively more influential.

The analysis observed differently when GERD was chosen as an explanatory independent economic variable. For emerging economies in this case a totally indifferent behavior of all three kinds of patenting activities to annual change of GERD was established. In the case of non-resident applications such indifference was observed also for advanced economies. For patent application counts by origin and by office the difference in patenting activity behavior between advanced and emerging economies in response to GERD changes could be explained similarly to the above explanation of GNI-PPP influence. It could be expected that innovation activity in emerging countries, predominantly led by foreign and multinational corporations would not depend on changes of domestic GERD that is predominantly financed by the public sector. That should not be the case in the advanced economies, where significant influence of business R&D investments on domestic patenting activity could be expected.

As for non-resident patent applications count, this variable presents merely foreign patenting activity that naturally is not expected to depend on the domestic R&D expenditures. Therefore total indifference could be observed for both advanced and emerging economies.

III. THEORETICAL RAMIFICATIONS

Extreme disruption of financial and monetary systems seemingly affects patenting activity. Labeled as economic crises, they do so whether patenting activity is measured by patent application rates proxied *by origin*, *by office* or *by non-residents*.

That said, four conceptual and methodological constraints still entail further research. To start with, given the loose causality between patenting application rates and innovation-based growth, also the connection between economic crises on innovation-based growth remains unsettled. Up to now, no linear connection linking R&D expenditure as proxy of innovation and patent filing activity has been accurately established.[116] This relation necessitates further analysis. That is notwithstanding empirical evidence showing that R&D as a chief proxy of innovation is predominantly pro-cyclical, concentrated in the boom phases of business cycles and thinned out in crises.[117]

At first sight, one could draw parallel between R&D propensity rates and patent filling rated *by origin*, across the north-south divide.

116. *See*, *World Intellectual Property Indicators 2010*, *supra* note 26, at 21.

117. G. Barlevy, *On the Cyclicality of Research and Development*, 97 AMERICAN ECONOMIC REVIEW 1131, 1131–1164 (2007).

The impact of the 2008 economic crisis indeed indicates such comparable gap herein. Estimates by the 2009 Battelle and R&D Magazine suggests in fact that per total world R&D investments for 2009 would of almost 1% lower than in 2008, an overall figure masks substantial differences amid countries. A notable 3.7% increase in R&D spending in 2009 was perceived per Asia. China most notably increased by 20% and India by an increasing rate of 5%. The United States and other Americas economies, Japan and Europe on the other hand were estimated to drop by more than 2%, 5.5% and 4%, respectively.[118] Similar findings are found for Europe. A 2009 cross-country survey of European firms, finds that in response to the 2008 global economic crisis firms were two to three times more likely to save on innovation cost spending.[119] Overall, evidence from 2009 seems to confirm that the 2008 crisis and economic downturn have had a chilling effect over firms' expenditures on innovation, similar to the one witnessed with patent filling rates as said.

Yet, not all R&D activity connotes patenting prosecution or patent filling.[120] WIPO's 2010 Indicators report confirms that per a series of top 100 PCT applicants and their R&D expenditure finds a positive and considerable correlation between R&D investment and PCT applications across the top PCT applicants.[121] R&D expenditure however explains less than 10% of the variation in patent applications.[122] Put differently, a certain number of firms with relatively low R&D expenditure still file a large number of patents. Patent filing intensity is influenced by a large number of factors which still embed further examination. These surely are the level of R&D and business R&D in particular, institutional incentives to patent, and education and science and technology policies and more.[123]

The effect of economic crises on patenting activity embeds further theoretical adjustment. It relates to a second parallel that possibly exists between the effects of economic crises on patenting filing rates on the one hand, and FDI inflows on the other. Interestingly enough, FDI

118. *See*, *OECD Science, Technology and Industry Outlook 2010*, *supra* note 55, at 35 (referring to Battelle and R&D Magazine, 2010 Global Funding Forecast, December, United States (2009)).

119. *See*, *OECD Science, Technology and Industry Outlook 2010*, *supra* note 55, at 34 (referring to See, EC, Innobarometer Policy Measures for Gender Equality in Science, EUR 23314, Luxemburg. Adding that "overall 200% of firms had decreased their innovation expenditures in the previous six months as a direct result of the economic downturn, while 9% had increased their innovation budget.").

120. *See*, *World Intellectual Property Indicators 2010*, *supra* note 26, at 21.

121. *Id*.

122. *Id*.

123. *Id*.

inflow rates into emerging economies during economic crises offer surprising stability, a sizable component of which are mergers and acquisitions by MNEs operating in emerging economies.[124] There is in fact a stable record showing that FDI flows are less volatile as compared with other foreign capital flows in the form of portfolio investment and debt how economic crises.[125] Research on this phenomena still needs to account for the intriguing resemblance with the effect of economic crises on patent filling rates across the development divide. Surely, the role of MNEs per the case of FDI inflows is similarly pivotal. In an influential article titled *Fire-Sale Foreign Direct Investment and Liquidity Crises* economist professors Mark Aguiar and Gita Gopinath provide decisive evidence that a component of the stability of the FDI flows in the 1997-1998 Asian crisis relates to the merger and acquisition activity of MNEs. So much so, as MNEs were able to purchase domestic firms at exemplary 'fire-sale' prices.[126]

Amidst these conceptual theoretical considerations, certain other methodological issues remain outside the scope of this article. To recall, a high probability was found for decrease in patent applications count by origin under crisis conditions in the case of advanced economies. A question remain however as to whether there is causality or coincidence between this probability and economic crisis? A separate Granger causality study could clarify this issue. Neighboring research herein is telling. One important contribution is worth mentioning. That is the work of Lee, Lin, Chuanfg and Lee who estimated the existence of dual Granger causality between research output and economic output (measured through GDP) for Asian countries, including Taiwan, South Korea and Singapore.[127] For some developed countries one-way causality was estimated, namely for Norway, the United States, Spain and Israel, where economic output changes cause change in research output. For the group of developing countries, including China, India, Japan and Poland, no causality between research and economic output was nevertheless found. As their article measures scientific publications but not patent filling counts as a measure of the research output, further adaptation to patent counts could be illustrative.

124. Mark Aguiar and Gita Gopinath, *supra* note 22, at 439 (Fig 1 showing capital inflows into East Asia between 1986-1999; "This stability in FDI contrasts with the sharp reversals in portfolio flows and bank lending").

125. W. Carlin, A. Charlton and C. Mayer, *supra* note 107, at 32.

126. Aguiar and Gopinath uphold that M&A activity is consistent with the tightening of liquidity constraints for domestically owned firms. *See*, Mark Aguiar and Gita Gopinath, *supra* note 22, at 439.

127. Ling Chu-Lee, Pin Hua-Lin, Yun Weng-Chuang and Yi Yang-Lee, Research Output and Economic Output: a Granger causality Test, Scientometrics, 89 (2011), 465–478.

Lastly, further research should account for mitigating economic variables measuring the effects of economic crisis conditions on patenting activity. It could target not only economic outputs, such as GDP or GNI, but also crisis conditions inputs, including monetary and credit variables and interest rates. More particularly, such measurements could include imports and exports of goods and services, current account balance, domestic credit provided by financial sector and as abovementioned also foreign direct investments. Studying the influence of these factors on patenting activity could help to locate the critical link responsible for patent activity and suggest the respective counter-cyclical policy to protect innovation against economic crisis consequences.

CONCLUSION

Crisis conditions influence patenting activity in advanced and emerging economies differently. For patent applications by origin where MNEs take central stage this difference is presumably evident. In such case, annual negative change in GDP in advanced economies is followed by negative change in the count of patent applications, originated from the same country, with high probability. Then again, in emerging economies patent applications by origin are essentially indifferent to changes of GDP. This may indicate that in emerging economies, where innovation is predominantly promoted by multinational corporations and at times funneled by FDI as said, patenting activity-related decisions come from outside the country. In such cases patenting is substantively less reactive to economic developments within emerging economies themselves.

As a whole, for patent applications count by origin the probability of negative annual change strongly and negatively depends on annual change of GDP, GNI-PPP and GERD respectively for advanced economies. In balance, for emerging economies this dependence is much weaker and in the case of GERD it is negligible. For advanced economies the strongest response was observed on GDP annual change and the weakest - on GERD.

For patent applications by office where the numerical significance of MNEs is unclear the probability of negative change was rather similar for advanced and emerging economies as a response to annual change of the economic variables. For non-resident patent applications the difference between advanced and emerging economies with regard to their response to annual change in economic variables was negligible.

The obtained results may indicate the different sources of patenting activity and maybe even innovation at large, in two categories of economies. In emerging economies patenting activity is led predominantly by foreign and multinational corporations, functioning within the country that are less influenced by domestic economic developments. Business decisions by MNEs in emerging economies are arguably done less as a response to economic developments within given emerging economies. Such decisions, and particularly over patenting abroad possibly are part of a less dependent business strategy on local crisis conditions in such target countries.

These findings were verified for two specific years of global economic crises, when annual change in economic variables were strongly biased to negative values, and it was demonstrated that even in this case patent applications by origin in emerging economies show very low probability of negative annual change as a response to economic development. These findings may alternatively indicate either higher resistance or suspended response by emerging economies to economic crises. This and other alternative explanations also entail future examination.