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REGULAR ARTICLE

The US–Ireland–India in the catch-up cycles in IT services: MNCs, indigenous capabilities and the roles of macroeconomic variables

Tiago Couto Porto[1,2] · Keun Lee[3,4] · Sunil Mani[5]

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Abstract
This study attempts to explain successive changes in industrial leadership in IT services by employing the catch-up cycle theory developed by Lee and Malerba (Res Policy 46(2):338–351, 2017). A catch-up cycle was observed in which leadership have changed from the US to Ireland and subsequently to India. Currently, there is now a `coexistent leadership` in which both India and Ireland share the leadership position since Ireland has recently recovered some of its market shares. The research has two main contributions: First, it has introduced macroeconomic variables into the catch-up cycle framework and exposed that the over-reliance of Ireland on MNCs made their leadership less sustainable and more sensitive to macroeconomic variations, and thus, argued that wage rate, exchange rate and FDI were important explanatory variables to understand the rise, fall and re-rise of Irish IT service exports. Second, it is shown that India has been more effective in maintaining a leadership position by developing strong indigenous companies, a sectoral system of innovation and through better technological capabilities. Therefore, it brings an important contribution in terms of public policies and catch-up strategies.

Keywords IT services industry · Leadership · Catch-up · Window of opportunity · Sectoral system of innovation · Ireland · India

1 Introduction

Emerging countries and their firms are constantly aiming to catch up, or reduce the gap, with the more advanced economies and its leader firms in terms of per capita income or market shares. Recent studies have thus focused on cases with successive leadership changes, referred to as catch-up cycles. The catch-up cycles theory, developed by Lee and Malerba (2017), has been empirically tested in various

✉ Keun Lee
Kenneth@snu.ac.kr

Extended author information available on the last page of the article

sectors, such as mobile phone, memory chip, cameras, steel, mid-size jets and wine (Giachetti and Marchi 2017; Kang and Song 2017; Lee and Ki 2017; Morrison and Rabellotti 2017; Shin 2017; Vértesy 2017). Then, Lim et al. (2017) analyzed the case of the shipbuilding industry.

Whereas the preceding studies are mostly on manufacturing, this study extends the analysis to the case of service sectors, in particular, information technology (IT) services. This study uses the shares in world export market as a measurement of catch-up and leadership for the IT service sector. In this sector, a catch-up cycle is observed in which leadership has changed from the United States (US) to Ireland and subsequently to India. Currently, the IT service is characterized by a "coexistence of two leaders" in which both India and Ireland share the leadership since Ireland has recently recovered some of its market shares.

The catch-up cycle framework (Lee and Malerba 2017) asserts that catch-up cycles can be understood by a combination of windows of opportunity (WoO) and the responses and strategies taken by the incumbents and latecomers. The WoO was first proposed by Perez and Soete (1988) that detected a favorable environment to catch-up by the latecomer during a technological paradigm shift. Lee and Malerba (2017) considered more windows, such as that of institutions (including policy intervention by the government) and of changing market demand. However, WoO are necessary but not sufficient conditions for a catch-up to take place. In this regard, the framework introduces the concept of "responses", which refer to the strategies chosen by the different actors of a sectoral system to the opportunities emerged. While applying this framework, this study also follows a method of 'appreciative theorizing' (Nelson and Winter 1982, p. 46) which aims to provide 'casual explanations to observed patterns' of leadership changes across sectors.[1]

The first argument of the paper is that due to an over-reliance in Multinational Corporations (MNCs), macroeconomic variables such as wage rate, exchange rate and FDI are important explanatory variables to understand the rise, fall and re-rise of Irish IT service exports. The second is that the Indian case shows that capability building combined with local ownership and an effective sectoral system of innovation is important not only for the catch-up but also for long-run sustainability.

Following this introduction, Sect. 2 discusses the theoretical background and leadership changes in IT services. Section 3 analyzes the rise and fall of Ireland. Section 4 discusses the rise of India as the new leader. Section 5 contrasts India and Ireland in terms of the roles of indigenous capabilities, MNCs, and macroeconomic variables. Section 6 concludes the paper.

[1] An alternative approach is modeling, such as history friendly models (Capone et al. 2019; Malerba et al. 1999; Malerba et al. 2016).

2 Theoretical background and catch-up cycles in IT-services

Gerschenkron (1962) was one of the pioneers in the study of the development strategies in which the latecomer economies tried to catch-up with the forerunners. His early insight was that the interaction between technological imperatives and institutional responses would lead to the formulation of a catch-up strategy for latecomer countries. Recently, an important volume of the catch-up literature adopts the Schumpeterian concept of national innovation systems (NIS), which is comprised by firms, universities, and government agencies and, in a broad view, includes all parts of the economic structure affecting learning, searching and exploring – such as the marketing system and the system of finance (Nelson 1993). This concept is of extreme importance given the high degree of uncertainties involved in the innovation process, which call for effective communication and synergies among the parties involved (Lundvall 1992; Dosi et al. 2020).

In particular, to the extent that technologies are very heterogeneous in various dimensions, such as specificity vs. generality and explicitness vs. tacitness, and across sectors, different types of innovative search might be needed and a thus different set of institutional arrangements (Dosi 1988). So, the NIS concept can be captured at the sectoral level as SSI (sectoral systems of innovation) that understands innovation as a process involving systematic interactions among a variety of sector-level actors (Malerba 2005; Malerba and Adams 2014). Hence, SSI underlines the role played by the three main building blocks: a) the knowledge and technology; b) the actors and networks and c) the institutions. Those building blocks interact in various ways, thereby generating a variety of outcomes (Malerba 2002).

Lee and Malerba (2017) explain the catch-up process in the context of the SSI, noting that the building blocks are interconnected in various ways, evolving and changing over time. Some of these changes are radical and represent discontinuities with the past. The catch-up cycle theory refers to these discontinues as "windows of opportunities (WoO)." When the concept of WoO was first used by Perez and Soete (1988), it refers to the favorable environment for latecomers to rise or even leapfrog; a new advent of a paradigm shift generates and diffuses new types of knowledge, skills and experience, providing a favorable environment for easy entry by latecomers. Then, it was Mathews (2005) who first explores the role of changing demand to show how business cycles may pose strategic issues for both the latecomer and incumbent firm. Finally, Lee and Malerba (2017) considered the role of government or industrial policy as another window, observing that the government can intervene in a variety of ways creating an asymmetric environment where forerunners (often foreigners) are in a disadvantageous position, at least in the internal market, enabling latecomers to offset the initial entry disadvantages.

However, having WoO might be necessary but not sufficient for a catch-up to take place. So, the catch-up cycle framework considers the responses and strategies in the framework. Malerba (2002) highlights, following Nelson (1993), the importance of analyzing the ability to generate and exploit the opportunities by

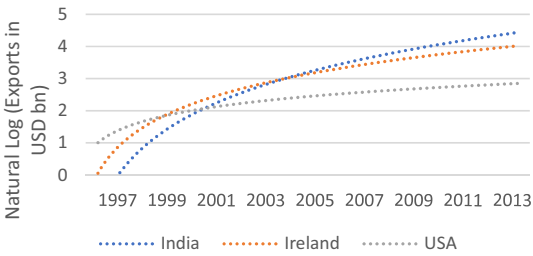

Fig. 1 Catch-up Cycles in IT Services (Logarithmic Trend Line). Source: Author elaboration based on International Trade in Services Database—IMF, link: https://data.imf.org/ITS. Accessed: 2018

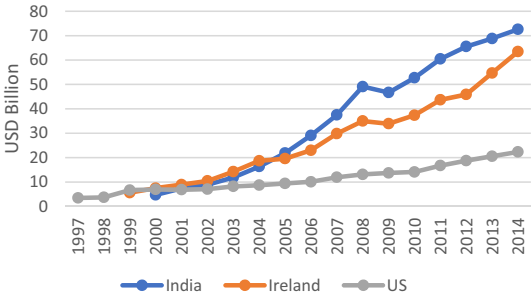

Fig. 2 IT Service Exports in Billions of USD. Source: Autor elaboration based on International Trade in Services Database—IMF, link: https://data.imf.org/ITS

different countries and actors, given their heterogeneity. Lee and Lim (2001) describe three important categories of strategies that latecomers may adopt in their process to catch-up. The first is the path-following strategy, in which latecomers opt to follow the same technological trajectories of the incumbent. The second is stage-skipping, in which latecomers follow the same path as the incumbent but skip some stages. Finally, the path-creating (leapfrogging) refers to the strategy of exploring its path of technological development.

Lee and Malerba (2017) propose a cycle that is characterized by having four stages; a) the entry-stage; b) the gradual catch-up; c) the forging ahead stage, and d) the falling behind the stage. Among these, the third stage – forging ahead – is a crucial step in the catch-up cycle since it represents the change in the global leadership from the incumbent to the latecomer. The fourth stage – falling behind – is when the newly emerged leader decline with the rise of a new challenger. However, this standard cycle is not definitive and can pass through variations. They refer to four variations, such as aborted catch-up, persistent leadership (supercycle), the coexistence of the new leaders with the old ones, and finally the return of the old leader in a new cycle.

Now, let us examine the actual catch-up cycles in the IT service sector. IT Service (called computer services) in the IMF database – International Trade In Services (ITS)—covers; customized software development and production, hardware and software installation, hardware and software consultancy and implementation

services, maintenance and repairs of computers and peripheral equipment; data recovery services, analysis, design, and programing of systems ready to use, and web page hosting services.[2] Using the IMF ITS database, this paper analyzes the leadership changes in the IT service trade, in particular the share of each country's export in total world exports.

Figures 1 and 2 indicate that there were 3 leader countries in the sector's history, and thus, three catch-up cycles. Until the mid-late 1990s, the US was the leader in the segment being the main exporter of IT services. However, in the mid 80ths, there was an outsourcing movement of US computer software companies, searching for localities with reduced costs. As Ireland had the good physical infrastructure, a copious supply of English-engineering speakers and government policies directed to attract FDI and MNCs, it accomplished to capture the subsidiaries and affiliates of the North American companies. Consequently, around the turn of the century, Ireland emerged as the new leader. However, the Irish success had led to a sharp increase in wage rates, which then impacted adversely the competitiveness of the sector. Also, at the beginning of 2000, the Euro exchange rate started to appreciate reverting the favorable environment for exporting and for inward FDI. In this context, together with strong indigenous companies, India had almost the same positive features of Ireland, but at a lower price. Between 2004 and 2005, India`s IT service leapfrogged and assumed leadership. India has maintained its leadership position for a cycle longer than ten years, exporting approximately 72 billion dollars in 2014 and having an average annual growth rate of more than 20 per cent between 2000 and 2014. However, in 2012 the gap between India and Ireland stopped to widen and is observable a new boost in Irish IT service exports the following years. Currently, we have ended up with coexistence of two leaders, in which both latecomer and forerunner shares the leadership position.

3 The rise and decline of Ireland

3.1 WoO and the initial advantage

The first and most important WoO opened for the Irish IT service sector was the outsourcing movement of USA MNCs. In the mid-and late 1980s, due to a significant increase in the cost of software engineers in the USA, there was a considerable movement of MNCs away from the country. Nonetheless, during the same period, there was a technological shift in hardware technology from mainframe to client–server computing. The already increasing trend of computerization in the USA and Europe gained a major boost. In that time, Ireland was the best-fit candidate to attract the MNCs movement and to provide supply for the increasing demand of computerization. This was because the country is located inside one of the biggest

[2] Refer to the information in https://data.imf.org/ITS. For a more detailed definition see International Monetary Fund (2009, p. 176).

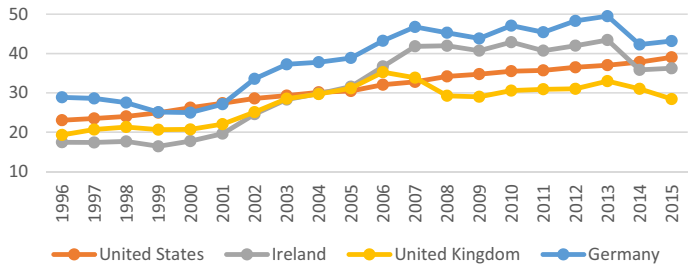

Fig. 3 Hourly Compensation Cost (US$). Source: The Conference Board, International Labor Comparisons program, February 2018

markets for IT service (Europe), had proactive government policies and the availability of English-speaking engineers at a low price (Moynihan 2008).

Ireland seized the opportunities opened since it had some entry advantages. Sands (2005) brings to our attention two other important factors that made Ireland the first choice for American MNCs. Firstly, the commonalities between the two countries related to the historical Irish immigration route to the USA. Secondly, due to the diaspora and international linkages. Indeed, in the same period of the outsourcing movement, there was a significant number of Irish students returning to their home country after having their studies in the USA.

As is observable in Fig. 3, until 2003 Ireland had all the advantages described above at a better price since the hourly compensation cost in the country was lower than other IT service leaders of Germany, USA and UK. Moreover, regarding the labor cost specific for the software industry, the trend is very similar. According to Athreye (2005), in the years of 1995 and 1999, the annual average rate of salaries paid of different software professionals was much lower in Ireland if compared with the US, being corresponding of US$50.000 and US$31.000 in the former year and US$ 60.775 and US$37.725 in the later.

3.2 Actors' responses and strategies

Despite the windows of opportunities opened in the sector and the entry advantages that the country presented, the catch-up process of Ireland IT service could not be explained without an analysis of the actor`s responses, especially the government and its agencies. In this sense, the public policies acted in three main branches; the education system, telecommunication infrastructure and industrial policy devoted to attracting MNCs. The former should be regarded in two different but complementary trends; the overall investment in higher education and the restructuring of the education system to meet the needs of the industry.

According to Breznitz (2012), after two generations, Ireland passed from having the less-educated to one of the most highly educated workforce in western Europe. Indeed, the larger amount of the funds received by the EU was spent in human capital rather than infrastructure, as many other countries did (Sands 2005). The education focus was also redirected to the needs of the industry, such that a great number

of degree programs in computer science and software engineering started during the time. The total number of student enrolments in technology-related disciplines consistently accounted for about 25 per cent of total new entrants into the higher education sector (Sands 2005). The second factor that brought a positive impact for the sector was the development of modern telecommunication infrastructure, ideal for the software industry. According to Sands (2005), this was only possible due to massive public investment.

Finally, a central characteristic of Ireland during many decades was an industrial policy directed to attract MNCs and FDI. Even though the high level of higher education and the telecom infrastructure were important for attracting MNCs, it would not have taken the same path if a direct and extremely favorable corporate tax policy was not implemented in the country. According to Riain (2000), there was a low-or no-tax environment until 1981 and, later, corporation tax became only 10 per cent for all manufacturing until 2000. This was extended to firms in the internationally traded services, including software and data processing, guaranteed until 2010. Recently a 12.5 per cent corporate tax rate has been guaranteed until 2025. Besides, the country also did not impose any restrictions on the repatriation of profits. If we compare with the other major player in the IT service market, Table 1 shows that the Irish corporate tax rate is the lowest, far below its competitors.

The MNCs had thus strong reasons to establish subsidiaries and affiliates in the country. Indeed, at this time, leading software companies had subsidiaries in the country, such as Microsoft, Dell, Oracle, Intel, Adobe, HP, SAP, IBM, and so on. Also, from 1999 to 2004 the country hand an outstanding exports growth rate of more than 27 per cent annual average.

3.3 Falling behind

The industrial strategy chosen by Ireland, on the one hand, provided the elements for the catch-up, on the other hand, compromised its long-run sustainability due to its over-reliance on MNCs. The share of MNCs in the total exports of computer software was around 90 per cent in the 1990s and around 95 per cent in the 2000s.[3] Besides, Fig. 3 indicates that wage rates also increased sharply during this time, and around 2004 the country became no more competitive.[4]

Moreover, the exchange rate (Euro Dollar and Euro Pound sterling) had moved to the direction of appreciating Euro since 2000 and impacted negatively the competitiveness of the Irish exports. In the words of the Irish Central Bank "The Competitiveness position of the Irish economy has deteriorated since the beginning of the current decade due to a combination of relatively high labor cost increases, generally muted productivity gains and adverse exchange rate movements" (Cassidy and O'Brien 2007). In this regard, India appeared as a more

[3] From Sands (2005: table 3.1) for the 1990s, and since 2000 from Annual Business Survey of Economic Impact 2016. https://dbei.gov.ie/en/Publications/ABSEI-2016.html. Accessed, 2018.

[4] In 2004, while in Ireland the IT employees were earning around twenty-five to thirty-five thousand dollars per year, in India the salary was less than half (Chandra 2006).

Table 1 Corporate tax rate by major IT service export countries

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ireland	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%
UK	30%	30%	30%	30%	30%	30%	28%	28%	26%	24%	23%	21%	20%
Israel	36%	35%	34%	31%	29%	27%	26%	25%	24%	25%	25%	26.5%	25%
China	33%	33%	33%	33%	33%	25%	25%	25%	25%	25%	25%	25%	25%
Germany	39.6%	38.3%	38.3%	38.3%	38.4%	29.5%	29.4%	29.4%	29.4%	29.5%	29.6%	29.6%	29.7%
Philippines	33%	33%	32%	35%	35%	35%	30%	30%	30%	30%	30%	30%	30%
India	36.8%	35.9%	36.6%	33.7%	34%	34%	34%	34%	32.4%	32.5%	34%	34%	34.6%

Source: KPMG. Link: https://home.kpmg.com/xx/en/home/services/tax/tax-tools-and-resources/tax-rates-online/corporate-tax-rates-table.html

competitive location. It had similar characteristics, such as infrastructure and English-speaking engineering in abundance, however, at a lower cost. Consequently, MNCs did not hesitate to move out of Ireland into India.

The over-reliance in the MNCs and its influence in the decline of the IT service in Ireland was already correctly observed by Moynihan (2008). The author also shows that lack of software graduates contributed to the Irish decline as well. At this point, two important factors already appear as detrimental for the IT service sector and its leadership. First, the availability of computer programers and its cost, the key factor input for providing this service. Second, the incentive of local and indigenous entrepreneurship together with the strategy to move up in the value chain to the higher-end level of services. Ireland chose a path-following strategy and depended far too much in the MNCs. Since the employment cost rose without upgrading to higher-end services, the MNCs did not hesitate to move to a cheaper location such as India.

4 The rise of India

4.1 Initial conditions

India had some entry advantages, that contributed to the process of catch-up in IT service. The main input in the software sector is computer programers and IT-related engineers, and indeed, India had it in copiousness. As showed by Arora (2006), between 1985 and 2004, the capacity of college graduate engineers had increased almost tenfold, from 45,000 in the former year to 440,000 in the later. Further, India has the 12 h' time zone difference within the US, which provided the opportunities for the companies to have a 24-h work cycle (Madhani 2008). Moreover, human capital formation in India had some characteristics that favored IT services development. First, it is offered in English. Second, the education system met the needs of the industry. Since around the 1990s, engineering education has expanded, most of them through privately run engineering colleges (Mani 2006). Finally, all the leading companies have their in-house training capability. Thereafter, India had a copious supply of the sectors` labor force during the years of boom in the market, as well as to sustain its sharp increase during the 1990s and 2000s.

Also, the large supply of qualified human capital was at a lower cost if compared with the competing countries such as Ireland, USA, UK, Israel and so on (Arora 2006; Krishnan and Vallabhaneni 2010; Nath and Goswami 2018). Further, one can mention the international linkages or the connection between India and the US through Indians in the US; Bhatnagar (2006, p. 64) highlights that "by the year 2000, Indians headed 972 Silicon Valley technology companies, accounting for 50 billion in sales and nearly 26,000 jobs. Indians headed about 3 per cent of technology companies started between 1980 and 1985; 10 years later, they headed up to 10 per cent of the companies". This connection showed importance later in the catching-up stage when firms started the outsource and offshore to different regions, being India one of the preferred destinations.

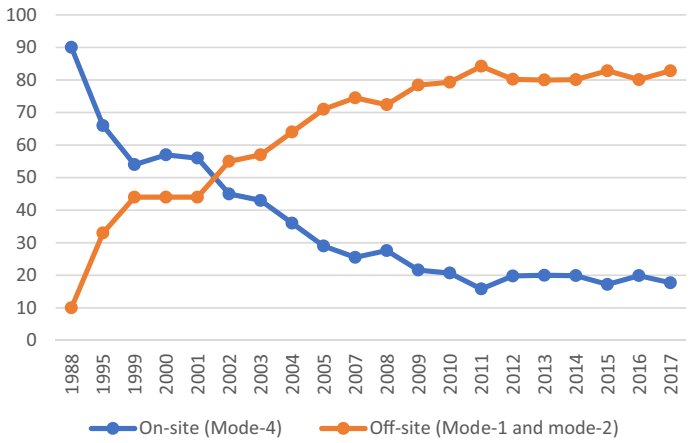

Fig. 4 Share of On-site and Off-site Exports (India). Source: Reserve Bank of India (2005 and various years), and Bhatnagar (2006:57)

4.2 Three windows of opportunities

The entry advantages mentioned above helped India to seize the windows of opportunities opened during the last four decades. The literature points to three different windows of opportunities for the IT service (Athreye, 2005; Krishnan and Vallabhaneni, 2010; Lee et al. 2014). Being in chronological order; a) the technological shift from mainframe to client–server computing; b) the demand shift, from the dot.com boom and YK2 problem to the dot.com recession, and c) the shift in the public policies in India. Those three WoO are consistent with the catch-up cycle literature. Specifically, the first two windows were important for the gradual catching-up stage and just the latter for the leapfrogging or forging ahead stage.

The first window of opportunity was the technological shift in the hardware technology from mainframe to client–server computing in the mid- and late 1980s. Across this shift, the already increasing trend of computerization in the USA and Europe gained a major boost. This technological shift not only represented a huge source of demand for customized software (Athreye 2005) but moreover, it created a significant new market (Lee et al. 2014). At this time, it was needed a considerable amount of consultants to help the American firms to make this transition. However, this labor force was not available in the USA. The Indian companies, like TCS, with the advantages explained above, were the natural candidates to provide this manpower. This window—even though created demand for low-value-added and higher labor-intensive services, such as coding, testing and maintenance, represented an important step for the Indian companies. This phase intensified the body-shopping stage in the development of the Indian indigenous firms, in which the Indian manpower was dispatched to the clients in the USA. As we can see in Fig. 4, during this time the great amount of the IT service exports were concentrated in the On-site, which represents the commercial presence and refers to the presence of natural persons. The body shop phase had its importance for the acquiring of knowledge and

experience, both emphasized by Malerba and Nelson (2011) as an important element for closing the gap.

The second window of opportunity was institutional. It is characterized by two different moments. Each period brought a diverse but complementary opportunity. The first, named by Lee et al. (2014) as the age of regulation, represents the period between Indian independence and the beginning of the 1990s. In 1973 the Indian state implemented the Foreign Exchange Regulation Act (FERA), that in search of pursuance self-resilience, required IBM to reduce its equity holding to 40 per cent. As a protest, IBM departure from the country. The exit of IBM provided indigenous firms with two opportunities. First, the foreign companies that substituted IBM depended upon programers in India to write software conversion (Athreye, 2005). Second, the government acquired and nationalized India-IBM. It resulted in the transfer of various capabilities, such as the mainframe support system, infrastructure, skills, and human resources, to many Indian firms during the nationalization period and, finally, in 2002 to TCS (Lee et al. 2014).

The second phase represented an institutional shift towards liberalization which involved the reduced barriers to FDI through a dramatic decrease in tariff rates, and curtailment of governmental intervention in the private sector. It is important to highlight that the timing of this institutional shift coincided with the boom in the international demand for IT services, in which the offshoring and outsourcing movement intensified. Looking back to the Fig. 4, it is evident that this shift matches with the beginning of the transition from on-site to off-site mode. Thereafter, the institutional window was not only important to favor the development of indigenous firms, but also foster the transition to the second stage of the IT service development in India, the offshoring.[5]

The third window of opportunity is represented by a business cycle window, which is characterized by two phases, a boom and a crisis. The boom phase was a result of the YK2 problem and the dot-com boom in the late 1990s. According to Krishnan and Vallabhaneni (2010, p.271) the "Y2K problem involved ensuring that the existing programs did not suffer glitches as the world entered the new millennium, and the internet boom represented the rush of the companies around the world to set up a web presence, conduct commerce over the internet, and use the power of the internet to improve their business effectiveness and efficiency". With that background, multinational companies used the Indian firms extensively (Lee et. al 2014).

The crisis represents the post-dot-com recession around 2001–2002. It is an extremely important moment in the IT service catch-up cycle since, while the recession represented a window of opportunity to India, it was a considerable obstacle for Ireland, therefore consisting the background moment for the Indian leapfrog. During the recession, major world companies were struggling to bring down costs, and the provision of high-quality software and related services at lower cost by Indian companies offered a useful and reliable way of doing this (Krishnan and Vallabhaneni 2010). Moreover, as offshoring is the best way of bringing down cost, during

[5] Subsidiary or captive developed center established overseas by multinational corporations.

the recession Ireland appeared not to be the preferred outsourcing location for USA firms anymore.[6]

The shift in preference to India was not only due to the lower cost but also because it coincided with the maturing of the indigenous firm's project of management capabilities. Here, the trend of offshoring to India can be also observable in Fig. 4. During the post-dot-com recession, it happened a shift of the exports revenue from on-site to off-site mode.

4.3 Responses and strategies by actors

The importance of the actors` responses to the growth of the IT services is still a matter of controversy. In one hand, the merit of the indigenous Indian firms is well accepted by the literature. In the other, the importance of the government is still fiercely debated. The argument defended in this paper is that a closed examination of the SSI indicates that a range of institutional support systems has coevolved with the success of the IT service exports. In this perspective, it is argued that the private indigenous firms first achieved some success and then the government stepped in, supporting the sector through a variety of mechanisms that manifested itself in terms of public policies such as tax incentives and infrastructure support. Nonetheless, the sector was also benefited by a third actor, the software industry association, NASSCOM.

4.3.1 Firms strategies

The development of Indian indigenous firms has been under the context of Global Value Chains (VGC). The report from UNCTAD (Sauvant 2005) shows that many forces that drove the internationalization of manufacturing were extended to some service functions and that global chains of service network became increasingly important to participate and access international market. The report also shows that despite the fact that the trend for outsourcing and offshoring started earlier, the GVC has reinforced this movement. This process helped indigenous firms to gain scale and scope. The IT service in India is a case in which indigenous firms interact and compete constantly with MNCs from advanced countries that were established in the country. While for some period it has served mainly for providing low value-added services, the development of the indigenous firms and its capabilities made them competitive to provide medium and high value-added services within the GVC. This is crucial since scaling up in the value chain is far from automatic and building technological capabilities are extremely important for creating the possibility to benefit from GVC (Fagerberg et al. 2018).

Table 2 provides an overview of the IT service firms in India, indicating the type of player according to its size, export revenue, employees, and work focus. It shows

[6] Also, the indigenous companies in Ireland were badly impacted. According to O'Callaghan et al. (2015), a significant amount of 115 indigenous firms were either closed or taken over between 2001 and 2003. For more information on the impact of the crisis in Ireland, indigenous firms see Breznitz (2012).

Table 2 Types of IT services players

Category	Number of players	Share in total export revenue	Share in total employees	Work focus
Large	11	47–50%	~35–38%	Indigenous and foreigner MNCs Fully integrated players offering complete range of services; Large scale operations and infrastructure; Presence in over 60 countries
Medium	120–150	32–35%	~28–30%	Mid-tier Indian and MNC firms offering services in multiple verticals; Dedicated captive centers; Near shore and offshore presence in more than 30–35 countries
Emerging	~1,000–1,200	9–10%	~15–20%	Players offering niche IT services; Dedicated captives offering niche services; Expanding focus towards sub Fortune 500/1,000 firms
Small	~15,000	9–10%	~15–18%	Small players focusing on specific niches in either services or verticals; Includes Indian providers and small niche captives

Source: Adapted from India Brand Equity Foundation, IT & ITeS report (March 2017): www.ibef.org

that a great part of the exports is done by indigenous and foreign big businesses. While emerging and small firms have focused on specific niches in IT services, medium firms offer services in multiple verticals and the large firms have been providing a complete range of services.

Differently from the case of Ireland, India developed strong indigenous firms that are currently active in global markets. The most prominent ones are TCS, Infosys, HCL and Wipro. Their development involved different strategies and responses to the WoO. Their evolution is characterized by three stages; a) the body shop; b) the offshoring and c) the global delivery model (GDM) which is India's reinvention after the offshore model (Lee et al. 2014).

The first stage of the Indian indigenous firm's development was the body shop model. It consists of dispatched Indian manpower to the client, normally for activities such as coding, and thus, representing a supply of low value-added services. It was already the trend in 1971, and as shown in Fig. 4 it was still very representative during the technological shift between mainframe to client service computing. This phase was important for indigenous development since it brought knowledge and experience mainly through learning by doing (Lee et al. 2014).

However, as mentioned earlier, due to economic difficulties of the multinationals on the 1980s, there was an outsourcing movement of the MNCs, especially from the US. As a strategy of lowering down cost, they started to establish offshores in other regions. One option was to establish subsidiaries abroad to realize services such as software development, as happened in India and as was intensively done in Ireland. However, despite the subsidiary model to be effective to reduce cost, it had some disadvantages. According to Lee et al. (2014), it could vary from a high level of initial investment, struggle with local regulation, culture differences and others. Realizing those difficulties, the Indian indigenous firms seized this opportunity and reinvented the existing offshoring. They appeared as a better choice compared to establish a subsidiary in India since they could supply the same services, but were better at managing software projects executed there (Arora, 2006). Simply put, it represented a change from foreign branches of multinationals to an independent business model for Indian IT services. This shift represented the second stage in the development of the Indian indigenous firms, named offshoring. It was relevant for the development of the indigenous firms since it contributed to the creation of scale and scope.

The third stage of indigenous development is called the Global Delivery Model (Mizuho Corporate Bank, 2008). It consists in effectively approximate to clients by combining different types of service models such as a) on-site model—that consists of offices permanently situated in the client's location (customer center); b) onshore model that consists of offices located where the client is based and in the client's region (usually country); c) offshore model that consists of low-cost offices located some distance apart from where the client is based and; d) with the near-shore model that consists in offices located in a region close to where the client is based (low-cost region).

All that combined to provide full range optimized IT services to clients at a better price and most effectively as possible. Also, the Global Delivery Model consists in offering a complete package of services to the client, from lower value-added to

Table 3 R&D expenditure and software patents by Infosys and TCS

Year	Infosys				TCS			
	patents	Patents per worker	R&D	R&D (% of Sales)	patents	Patents per worker	R&D	R&D (% of Sales)
2008	0	0,00%	201	1.3	4	0.004%	38.78	0.2
2009	1	0,00%	267	1.3	1	0.001%	43.92	0.2
2010	12	0.01%	440	2.1	4	0.003%	77.58	0.33
2011	14	0.01%	527	2.1	2	0.001%	525.96	1.38
2012	29	0.02%	660	2.1	4	0.002%	718.24	1.48
2013	59	0.04%	913	2.5	14	0.006%	913.76	1.12
2014	74	0.05%	873	2	38	0.014%	909.25	0.96
2015	74	0.05%	605	1.3	85	0.03%	1121.36	1.03
Average Growth Rate	225%	54%	21%	4%	117%	87%	108%	51%

Source: Authors elaboration based on USPTO. https://www.uspto.gov/web/offices/ac/ido/oeip/taf/stcasg/inx_stcorg.htm, and companies Annual reports from 2008 to 2016

Notes: R&D amounts are in millions of Indian currency. In the case of Infosys, for the years that there is no data available on Indian base employment, the table used global employment times the average percentage of employment outside India of available years

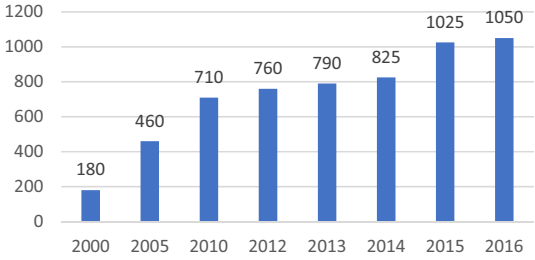

Fig. 5 Numbers of Global In-house IT centers in India. Source: Illustration based on IBEF, 2017. https://www.ibef.org/download/IT-and-ITeS-March-2017.pdf

high value-added, and thus, from programing and coding to consulting, market and design activities (Lee et al. 2014).

How was India able to create a new path, called the global delivery model? The main Indian firms enhanced the required capabilities largely by increasing sharply its R&D expenditure, developing its Global in-house centers (also based on Engineering R&D related activities and worker training) and combined this strategy with new external knowledge from M&A and alliances.

Regarding specific indigenous companies in India, Table 3 shows the patent grants and R&D expenditure for Indian most innovative companies, being them Infosys and TCS. We can see that both companies have been increasing sharply its innovative activities and technological capabilities in both absolute and relative terms.

The focus on the major firms is important since, as noted by Dosi (1988), the increase in complexity of technologies and search activities militates in favor of

this type of organization (together with government and university labs) instead of individual innovators, as the most conducive environments to the production of innovations.

Figure 5 shows the sharp evolution of Global In-house centers in India that increased around fivefold between 2000 and 2016. Global In-house centers are also known as capability centers since they focused on building high-skill capabilities and became a center for breakthrough innovation.

According to Rao and Balasubrahmanya (2017), those GICs are mainly serving as an Engineering R&D function and has placed software development at the helm of innovation in the ICT sector. For instance, Infosys in 2015 announced the creation of a US$500 million Innovation Fund earmarked for investments in disruptive new business models and technologies that centered in the investment in a leading Global In-house Center (ANSR Consulting) which helps global enterprises establish strategic service delivery and innovation capabilities.[7]

Finally, Lee et. al (2014) also emphasize the importance of M&A and alliances for acquiring capabilities. The author analyzed the three main companies in India (such as TCS, WIPRO and Infosys) and showed how they obtained specific knowledge by that strategy. Their strategy consisted basically of acquiring small firms rather than large ones, focusing on straitening their knowledge in specific services.

4.3.2 The Role of the Public Sector

While India IT services are characterized by firms having the primary role in the innovative process, the government policies (such as in education, infrastructure, export and tax incentives) and the software industry association (brand image, lobbying for finance access) co-evolved and interacted to form a favorable SIS.

Concerning the government, the protection of the indigenous companies in the earlier phase of the software development in India was already mentioned when analyzing the institutional WoO, as well as the role of the liberalization and deregulation. There are other important policies implemented by the government that were beneficial for the IT service development. They are twofold; a) tax incentives for export promotion; b) infrastructure investment. The first was characterized by tax holidays on company's profits derived from exports. Also, free trade zones, software-technological park (STP) and special economic zones benefited from full tax exemption. Secondly, the infrastructure investment can be well illustrated by the establishment of the STP that provided a full range of infrastructure directed to the sector. Indeed, in the STP firms were provided with office space and computer equipment, access to high-speed satellite links and uninterrupted supply of electricity (Athreye 2005).

The government were not the only actors that contributed to the catch-up of the IT service in India. The software industry association – NASSCOM- has acted assertively in the promotion and development of the sector, and indeed, it seems a point of concordance in the literature (Bhatnagar 2006; Mani 2014). Currently,

[7] https://www.infosys.com/newsroom/press-releases/Pages/innovation-fund-global-in-house-center.aspx.

Table 4 Software patent comparison

	Total software patents		Patent granted to domestic firms	
	(India)	(Ireland)	(India)	(Ireland)
2011	416	38	35	6
2012	567	59	54	3
2013	837	70	103	7
2014	1000	80	136	14
2015	1181	107	189	30

Source: Authors elaboration based on data from USPTO (2018). Links: https://www.uspto.gov/web/offices/ac/ido/oeip/taf/stcasg/inx_stcorg.htm, https://www.uspto.gov/web/offices/ac/ido/oeip/taf/stcasg/iex_stcorg.htm. Accessed in 2018

the member organization represents 95 per cent of the industry revenues (NASSCOM 2017). NASSCOM acted mainly in two fields: Lobbying for favorable-sector policies and building the brand image of the industry. The former comprises the influence towards policy reforms including rules that limit access to capital markets, issuance of stock options, easing rules on foreign-currency transactions, and improving telecom infrastructure (Bhatnagar 2006). The latter was achieved through the organization of events in India and participating in global trade fairs. Moreover, it helped the companies to get the best certificates in the world, such as the Capability Maturity Model (CMM))/Capability Maturity Model Integration (CMMI) level, ISO certification, and Six Sigma, among others.

5 Contrasting the two countries and return of Ireland

5.1 Indigenous firms vs. MNCs

The preceding discussion of the catch-up cycles in the IT service is already indicative of the contrast between Indian success in the development of the indigenous firms and Irish reliance on MNCs. While the low labor cost was important, especially in the entry stages, for both catch-up cycles, more sustained leadership in India seems to be associated with the development of higher-level capabilities combined with local ownership of both production and R&D and an SIS that is effective in sustaining innovation and growth (Lee and Malerba, 2017). In this regard, this section follows the standard way of analyzing the increasing technological capabilities, thus using innovation indicators.

First, the study of Mani (2014) is actualized. In this perspective, we use patent grants at USPTO as a proxy of the innovative capacity of the sector. Second, we extend the measurement of technological capabilities by also investigating the R&D investment by US MNCs in the countries. By doing so, both the inputs into and the output from the innovative process is considered.

Table 5 Software patents granted to selected domestic computer software companies in India

	Infosys	TCS	WIPRO	Ittiam Systems	Total	Growth Rate
2008	0	4	2	3	9	–
2009	1	1	1	7	10	11%
2010	12	4	6	16	38	280%
2011	14	2	7	3	26	– 32%
2012	29	4	8	3	44	69%
2013	59	14	9	3	85	93%
2014	74	38	10	6	128	51%
2015	74	85	22	5	186	45%

Source: Authors elaboration based on USPTO. https://www.uspto.gov/web/offices/ac/ido/oeip/taf/stcasg/inx_stcorg.htm, Accessed 2018

Table 6 MNCs expenditure in R&D in PST (millions of dollars)

	MNCS PST R&D—Ireland	PST/total (R&D)—Ireland	MNCS PST R&D—India	PST/total (R&D)—India
2009	96	9.2%	669	48.6%
2010	(D)	–	851	49.6%
2011	171	12.1%	1025	49.4%
2012	188	12.8%	1206	52.7%
2013	200	10.7%	1331	52.1%
2014	(D)	–	1337	46%
2015	(D)	–	1771	55.1%

Source: Based on Direct Investment and Multinational Enterprises: Comprehensive data (2018). https://www.bea.gov/international/direct_investment_multinational_companies_comprehensive_data.htm. Note: (D) indicates that the data in the cell have been suppressed to avoid disclosure of data of individual companies

Table 4 shows the number of patent grants at USPTO by domestic and foreign computer software companies from 2011 to 2015 in the two countries. The Indian software industry is more developed in terms of innovation and technological capability. Moreover, India accounts for much more patents by both, domestic and foreign companies. Irish domestic companies are responsible for an extremely small number of patents. Comparatively, the Indian domestic sector has become constantly innovative. Even though the MNCs are responsible for a greater amount of patent grants in both countries, the ratio between domestic and MNCs has been reducing since 2011 in India. If in 2011 the domestic companies were responsible for only 8.4 per cent of the total software patents, in 2015 they were responsible for 16.0 per cent in India. Table 5 shows who are the leading companies in terms of patenting in the US by India. They are Infosys and TCS, followed by WIPRO.

Yet, even regarding MNCs, India is more innovative than Ireland. Software MNCs in India have more than ten times patent grants compared with Ireland. And

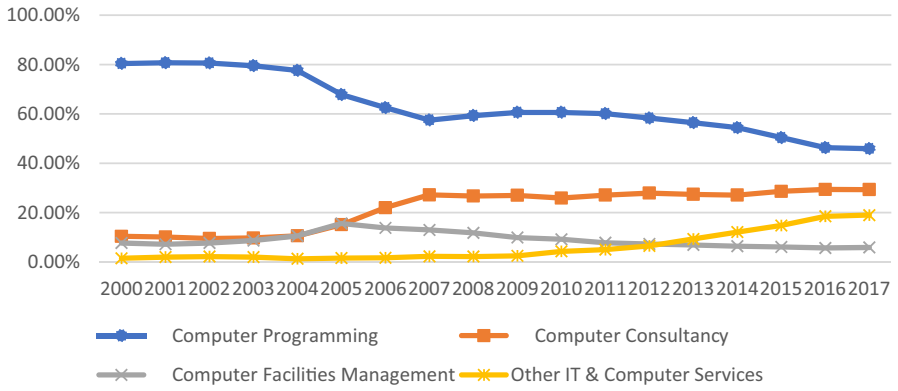

Fig. 6 Share of Exports by activity. Source: Author elaboration based on the Annual Business Survey of Economic Impact 2016. https://dbei.gov.ie/en/Publications/ABSEI-2016.html

this pattern has been constant during the years analyzed. The major software companies such as IBM, Microsoft, HONEYWELL, Oracle, for instance, do a greater amount of IT-related R&D in India. Thereafter, if one considers patent technology grants as a measurement of technological capability and higher value-added activities, the Indian IT service is increasingly moving towards more sophisticated activities. Moreover, even though MNCs are still the most relevant actors, the indigenous companies have been catching up in terms of patent technology as well.

Since MNCs are still the most prominent actors in terms of patent grants in both Ireland and India, the analysis that follows focus on R&D expenditure by MNCs, in particular those R&D expenditures in Professional, Scientific, and Technical Services (PST). PST consists mainly in computer system design and related activities. Table 6 indicates that US MNCs are spending much more R&D expenditure in India compared with Ireland. R&D expenditure in India grew at an annual average of 18.10 per cent from 2009 to 2015. More importantly, it also shows that in India, considerable or more than half of MNCs R&D expenditure is directed to PST activities while in Ireland it counts for about 10 per cent.

5.2 Macroeconomic variables in the return of Ireland

So far, it is shown that Ireland lost its leadership in 2004 and that India has been successfully maintaining its leadership position since then. However, after 2012 there is a strong rise in Ireland IT service exports. In only two years Ireland reduced the gap in IT service export from 19.9 billion dollars to 8.4 billion dollars with India. It seems that dynamic changes in wage rate and the exchange rate had particular influence in the rise, fall and re-rise of Ireland IT services. Such dynamic impact of macro variables during a phase of economic success is not new in the catch-up literature. Lee (2019) explains that the economic success of a country tends to bring changes in their macroeconomic variables (e.g. wage rate rises and currency appreciation), which may work adversely to the success of sectors and their firms.

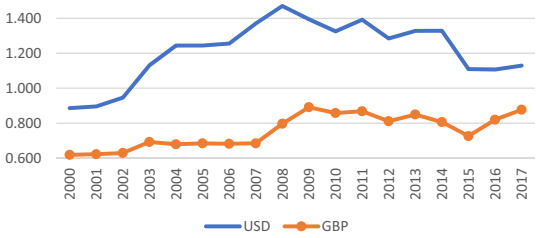

Fig. 7 Euro v Dollar & Sterling (Annual Average Exchange Rate). Source: Central Bank of Ireland. Link: https://www.centralbank.ie/statistics/interest-rates-exchange-rates/exchange-rates. Accessed 2018

The Irish export success in IT services during the 1990s and beginning of 2000 resulted in the rise of the wage rate. Moreover, the rising wages were not accompanied by a shift towards higher-end services until later times. As we can see in Fig. 6, from 2000 to 2004, 80% of the IT service exports were of computer programing, low value-added service in the IT service value chain. Since the rising wages were not followed by upgrading to higher-end services, Ireland lost competitiveness. Indeed, from 2000 to 2007, Irish labor costs have increased at a faster rate than their trading partners (Cassidy and O'Brien 2007). In this sense, it is argued that the "performance of the economy in terms of exports and foreign investment inflows confirms that the economy was, indeed, highly competitive in the late 1990s, but that there has subsequently been quite a significant deterioration" (p.110).

However, Fig. 6 illustrates that after 2004 there is an upgrading toward higher value-added services, such as computer consultancy. It increased from approximately 10% in 2004 to 30% of the total IT service exports in 2017. Overall, the IT service exports from Ireland remains low in the value chain. Computer programing and other IT & computer services (which consists mainly of installation services) count for almost 70% of Ireland IT service exports. Nevertheless, the increase in computer consulting is a sign in the right direction. This modification in the composition of IT service export activities could have contributed to the rise of exports in 2012 but it may not be the main explanatory variable because it happened before 2008. In fact, what seems to have boosted the exports were a new rise in inward FDI and a very favorable exchange rate.

Figure 7 illustrates the strong depreciation of the Euro after 2009 in relation to the Dollar (USD) and the Pound Sterling (GBP). The Euro depreciation is an important factor for Ireland competitiveness since the country exports considerably to countries outside the Eurozone. The exchange rate Euro Dollar and Euro Pound are extremely relevant since the UK and the US are Ireland's principal bilateral trading partners and together account for 36 per cent of Ireland exports.[8] A weak Euro results in exports from Ireland becoming more price-competitive on markets outside Eurozone, such as US and UK. Moreover, in the point of view of MNCs, a stronger dollar in relation with the Euro is favorable for doing investment into Euro region. Also, it means that wages in Ireland are lower in terms of the dollar.

[8] National Competitiveness Council Bulletin (2016:1).

The Euro depreciated 24.6 per cent from 2008 to 2015 in relation to the dollar and 18.5 per cent from 2009 to 2015 to the Pound Sterling. Yet, the favorable exchange rate not only directly boosted exports by improving competitiveness but also influenced indirectly by attracting more FDI. The weaker Euro summed to the lowest corporate tax rate compared with all the competing countries in IT service, became a very promising factor for doing business and investment in the country. Such reasoning can be confirmed by the trend of FDI by US MNCs in Ireland, which started to rise again in 2010; it increased from 8.4 billion dollars in 2010 to 13.82 billion dollars in 2014.[9] Such FDI had its peak in 2014, which is again associated with the fact that Euro has appreciated after 2015 slightly in relation to the Dollar and the Pound Sterling. This way, this favorable macroeconomic environmental was somewhat temporary. We are thus not sure how long the strong rise in Irish exports might not be sustained for longer, which may depend on its speed of upgrading into higher-end segments. For now, there is a coexistent leadership in terms of IT service Exports in the world market, with India as the leader and Ireland slightly behind.

6 Conclusion

This study analyzed the changing leadership in IT service. The paper applied the catch-up cycle theory developed by Lee and Malerba (2017) for a service sector rather than manufacturing. Catch-up cycles have been observed in which leadership had changed from the US to Ireland and subsequently to India. Currently, there is now a `coexistent leadership` in which both India and Ireland share the leadership position since Ireland has recently recovered some of its market shares.

While there were some similarities between Ireland and India in terms of conditional elements for a catch-up in the IT service sector, we find that there are also great discrepancies in these two country's strategies. The most important difference is the relation between indigenous firms and MNCs. Both countries implemented policies to attract MNCs. Yet, Ireland has kept relying on MNCs, while India also developed strong indigenous firms. In the Irish case, the continuing reliance on MNCs made the sector more sensitive to variables such as wage rate and tax rate, but also somewhat exogenous variables such as exchange rate and FDI. In the Indian case, government policies co-evolved with the success of the exports of the sector and built a favorable SIS that enabled developing technologic capabilities and made India the location of R&D activities by MNCs.

The paper makes some contribution to the literature on catch-up by latecomers. First, it has elaborated the role of macroeconomic variables as a new 'window of opportunity' (or trouble) variable into the catch-up cycle framework. Among such variables, the role of exchange rates or appreciation/depreciation of currencies is consistent with the story of leadership changes from Japan to Korea in electronics sector due to the sharp appreciation of Japanese Yen since the Plaza Accord in

[9] The sources are Direct Investment and Multinational Enterprises: Comprehensive data (2018). https://www.bea.gov/international/direct_investment_multinational_companies_comprehensive_data.htm.

1985 (Lee 2019). In the meantime, the roles of wage rates change is interesting in the sense that it is not just exogenous factor but partly endogenous factor driven by the very success of the sectors and countries in economic growth; Ireland experienced the IT workers' wage rate rise owing to its success in IT services. Second, the paper shows some interesting contrast between the MNC vs. indigenous firm-driven catch-up. As a policy implication, the contrast implies that the continued reliance on MNCs may not be a viable strategy of sustaining leadership as they are more subject to changes in cost conditions and macroeconomic variables. Maintaining a longer-term leadership position may require developing strong indigenous technological capabilities and sound SIS. Also, a new window of opportunity may open anytime unexpectedly, and those who are ready in terms of building such capabilities would be able to take advantage of such opportunity to fly out of the open window or to leapfrog.

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Authors and Affiliations

Tiago Couto Porto[1,2] · Keun Lee[3,4] · Sunil Mani[5]

Tiago Couto Porto
tiago.porto@fgv.edu.br

Sunil Mani
mani@cds.edu

[1] Public Administration and Governance at Getulio Vargas Foundation of São Paulo, São Paulo, Brazil

[2] Center for Studies on New Developmentalism, São Paulo, Brazil

[3] Department of Economics, Seoul National University, Seoul, South Korea

[4] CIFAR Fellow, IEP Program, Seoul, South Korea

[5] Centre for Development Studies, Thiruvananthapuram, Kerala, India