The Degree of Internationalization and Firm Productivity: Empirical evidence from the large multinationals

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Abstract

The paper examines whether the S-shaped and the M-shaped hypotheses explain the internalization-firm's productivity relationship. The internationalization –performance (I-P) literature is using accounting-based performance indicators in order to examine such a relationship. In contrast to the mainstream literature, productivity and its components (efficiency and technical change) are used as firm's performance measures. Utilizing a semi-parametric model based on artificial neural network techniques, accounting for potential heterogeneity, firm's productivity efficiency and technical change levels are estimated. The innovative methodological framework is applied in a sample of large experienced non-financial firms over the period 1992-2019. The empirical evidence suggests that firms' internationalization in relation to their productivity and efficiency levels exhibits an inverted U-shaped relationship. This finding corresponds to the last two stages of the S-shaped and the M-shaped hypotheses. Furthermore, the evidence suggest that internationalization has a positive non-linear effect on firms' innovation capacity (technical change). Overall, the empirical evidence from data driven techniques applied, support the view that the effect of internationalization on firms' productivity levels is asymmetric.

Keywords: Internationalization; Productivity; S-shaped Hypothesis; M-shaped Hypothesis; Artificial Neural Network.

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Introduction

The international business (IB) literature recognizes that there are two main categories of firms' strategic behavior under which the firms adopt in order to enter new markets and expand their operations. These two strategic categories determine how firms internationalize their operations and directly affect their performance. According to Pan and Tse (2002), these are the non-equity strategies involving exports and contractual agreements, and the equity strategies involving firms' expansion through equity joint ventures and wholly owned subsidiaries. As a result the internationalization-performance (I-P) relationship is at the core of strategic management and the IB agenda (Pisani *et al*., 2020).

The entry into markets using non-equity modes and its impact on firm performance has been known in the IB literature as the "learning by exporting" perceptive (Clerides *et al*., 1998). Salomon and Shaver (2005) argues that exporting strategies enhance firms' innovation capacity, whereas, Wagner (2007) and Martins and Yang (2009) suggest that exporting is linked firms' productivity levels. Similar to Salomon and Shaver (2005), Silva *et al*., (2012) suggest that firms engaging on exporting strategies become more efficient and innovative. In addition, Almodóvar *et al*., (2014) utilizing a sample of Spanish firms over the period 2000 to 2008 enhance the "exporting-learning" relationship by providing empirical evidence of a positive impact of exports on firm's innovative learning.

In contrast to the "learning by exporting" stream of research, the second line of research investigates the impact of equity strategies on firms' performance levels. This line of research recognizes that when firms internationalize their operations, possess some specific assets which provide them with competitive advantages (Dunning, 1980, 1988). According to Porter (1996,

2008) firms' global competitive advantage, which is derived from such strategic choices, is related to firm's ability to coordinate and configure its value chain across foreign market activities.

In addition, firms' strategic focus from international explanation relates to their competence of penetrating new markets, developing new products, and be able to diversify and expand their capacity in order to meet global demand (Ansoff , 1965; Grauman, 1994; Schoppe e*t al*., 1995). Mainly the firms internationalize their operations seeking for strategic assets, efficiency, resources and profit maximization (Glaum, 1996; Dunning, 1998). This paper is based on the second line of research, contributing to the investigation of the I-P relationship. According, to Hennart (2007) and Nguyen (2017) the I-P relationship has been investigated from different theoretical backgrounds such as the resource-based view, the organization learning theory and the finance theory, suggesting that the relationship is positive, monotonic and nonlinear (Kim and Lin, 1986; Kim *et al*., 1993; Kotabe *et al*., 2002; Ruigrok and Wagner, 2003).

The conflicting results of the I-P relationship have engaged the development of the three-stage sigmoid hypothesis (Contractor *et al*. 2003; Lu and Beamish, 2004; Contractor, 2007), which provides the theoretical framework under which the different results of the I-P relationship can be explained and analyzed. Given the importance of such a theoretical framework, throughout the years, the IB literature has tried to provide empirical evidence based on the three-stage sigmoid hypothesis but again with conflicting results (Hitt *et al*., 2006a; Glaum and Oesterle, 2007; Nguyen, 2017). More recently, Oh and Contractor (2012, 2014) provided evidence supporting the three-stage sigmoid hypothesis, whereas, Berry and Kaul (2016) could not verify the S-shape relationship reported by Contractor *et al*. (2003) and Lu and Beamish (2004). In addition to the three-stage theoretical framework there is another stream of research under which the I-P

relationship exhibits four phases resulting in a M-shaped relationship (Lee, 2010; Lee, 2013; Almodóvar, 2012; Almodóvar and Rugman, 2014).

However, the empirical evidence provides conflicting findings, which are heavily based on the sample characteristics, the different methodological frameworks, alongside with the various variables used as proxies of firms' performance and internationalization levels. In fact the majority of the studies examine the I-P relationship, utilize different accounting-based measures as a proxy of firm's performance. Given that firms' main motive is the maximization of their profits (Glaum, 1996), accounting-based measures appear as appropriate proxies of firm performance. However, from the early years Fisher and McGowan (1983) highlighted the weaknesses of the accounting-based measures. They argue that accounting rates of returns in many cases are inconsistent among firms and among industries and provide no information of economic rates of return. Fisher and McGowan (1983) emphasize that if we can exclude the measurement related problems of accounting-based metrics, ignoring economic rates of return is a major drawback of firms' performance measurement. In fact, firm's economic rates of return enable them to equalize with long-run industry's competitive equilibrium. Kaplan (1983) argues that performance related decisions need to be based less on simple, short-term accounting-related measures, and move towards performance metrics which influence firm's long-run competitive advantage and profitability. According to Kaplan (1983) such a metric is firm's productivity which is a long run performance measure, is based on firm's production function and accounts for physical operations. Moreover, in contrast to the accounting–based measures, productivity is not depended on variations of the relative prices of firm's input factors (Kaplan, 1983). Smith and Reece (1999) assert that firm's productivity is a mediating factor between business strategy and firm's overall performance. Along the same lines Hitt *et al*. (2006a, p.836) asserts that the I-P relationship must

be examined in a mediator firm's stage, which involves firm's process and organizational outcomes (i.e. innovation, operating efficiency, productivity, etc.). According to Hitt *et al*., (2006a) the effect of internationalization on productivity precedes the effect on firms' profit performance. This paper contributes to the I-P literature by investigating the effect of internationalization on firms' productivity and its components. In contrast to the majority of the I-P studies we examine the influence of internationalization on firms' performance mediators. Therefore, this study contributes to the existing literature by analyzing the effect of internationalization on (i) firms' productivity, on (ii) firms' technical catch-up (efficiency) and (iii) on firms' technical change (innovation) levels (Grant *et al*., 2017; Broadstock *et al*., 2020).

Moreover, several authors support the view that the mixed findings of the I-P relationship are attributed to methodological related issues such as: identification and specification problems in relation to heterogeneity and endogeneity (Kotabe et al., 2002; Hennart, 2011; Verbeke and Forootan, 2012; Wiersema and Bowen, 2011; Abdi and Aulakh, 2018). This study contributes to the relative literature by investigating for the first time the I-P relationship utilizing Monte Carlo methods. Specifically, firms' performance is modeled in a production function framework, by utilizing a semi-parametric model using artificial neural network (ANN) techniques based on particle filtering (Godsill *et al*., 2004; Andrieu *et al*., 2010; Creal and Tsay, 2015). The approach applied provide us with several methodological advantages. First, the methodological framework applied enable us to account for endogeneity when estimating firms' production function (Ackerberg *et al*., 2015). Second, it allows the accountability of heterogeneity avoiding traditional specification problems (Kotabe *et al*., 2002; Hennart, 2011; Verbeke and Forootan, 2012; Wiersema and Bowen, 2011; Abdi and Aulakh, 2018). Third, given that ANN is a data driven technique, it can easily accommodate flexible relationships among the variables in hand, allowing

the properties of the data to reveal any nonlinear I-P relationships without any predetermination. Hashai (2015) emphasizes that future research on I-P relationship should adopt different methodological frameworks, which will reveal possible nonlinear relationships and move away from simple linear explanations.

Finally, in respect to the sample of the analysis, we contribute to the relative literature by examining the I-P relationship using a sample of large experienced (non-financial) multinationals. Our sample contains large multinationals (based on the volumes of their foreign assets) like: Royal Dutch Shell plc, Toyota Motor Corporation, BP plc, Nestlé SA, Total SA, Volkswagen Group, Exxon Mobil Corporation, Vodafone Group Plc, Unilever PLC, Procter & Gamble Co (among others). These firms are experienced multinationals, with high degree of internationalization, operating at different sectors. Our sample contains firms from twenty six different countries (home of origin), with a degree of internationalization far in excess of most companies. Based on the two theoretical backgrounds hypothesizing an S-shape and W-shape for the I-P relationship, our sample covers the period 1992-2019, investigating dynamically the effect of internationalization on firms' productivity, efficiency and innovation capacity (technical change) levels. According to Almodóvar and Rugman (2014), such a long period of time, enables the investigation of the long-run effects of I-P on firms' performance levels. Moreover, due to the fact that our sample consists of experienced multinationals, there are a priori reasons to assume that, in a sample of this sort, the first stage(s) of the S-shaped and W-shaped hypotheses, would not be statistically seen in our empirical findings. This is attributed due to the fact that our sample consists of multinationals that have expanded beyond the optimal inflection point.

In the next section, we present the two main theoretical frameworks describing a non-linear form of the I-P relationship. Then we present in detail our sample and we analyze the variables

used in our model. In addition, we present our methodological framework which enables to tackle endogeneity and heterogeneity in our estimation. Furthermore, our empirical findings in relation to other studies are analyzed. Finally, we draw different implications (theoretical, managerial and policy related) alongside with caveats and a description of future research directions.

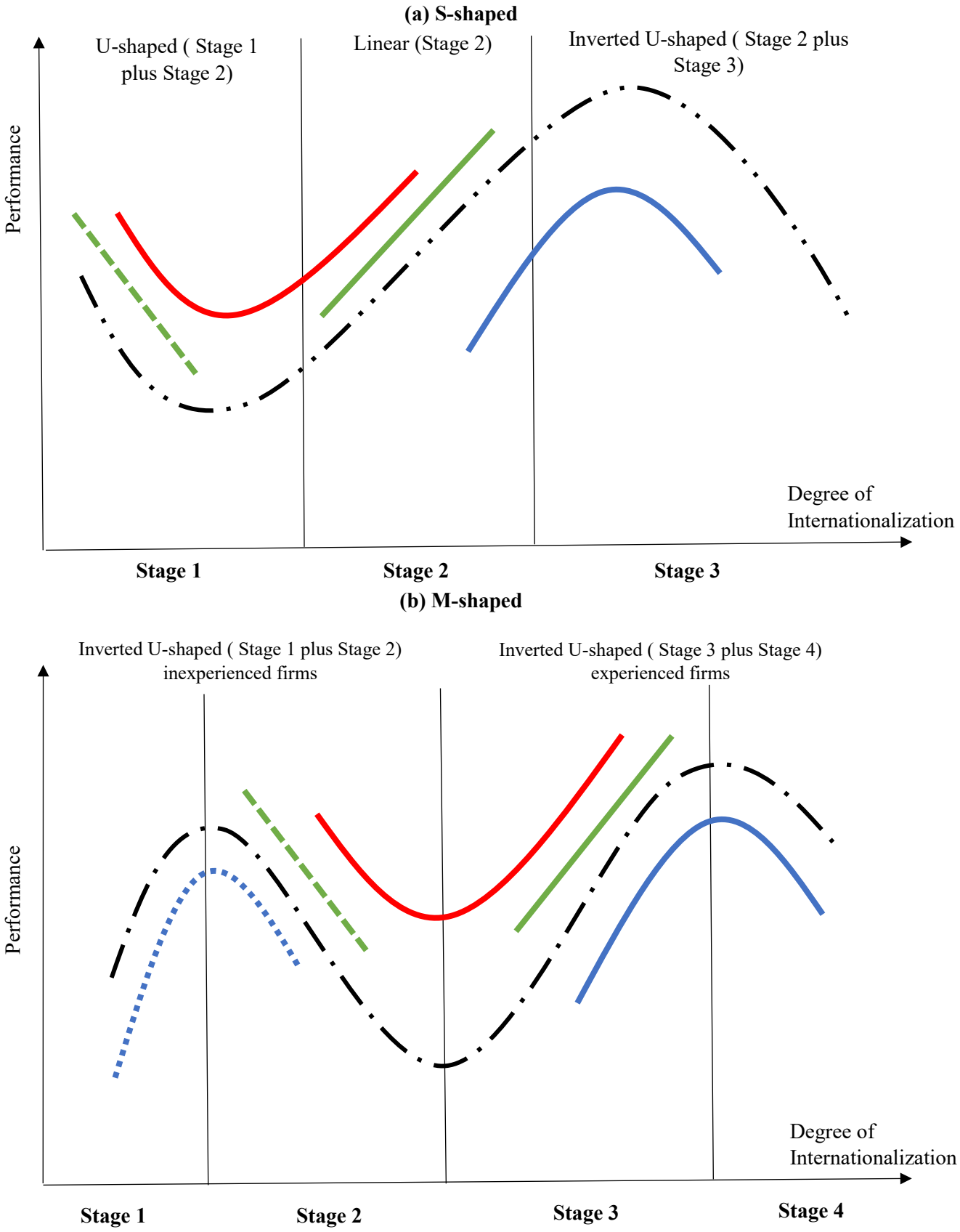
Theoretical background and hypotheses

One part of the I-P literature suggests a monotonic relationship among internationalization and firm performance. However, the majority of the studies point towards a different direction. Specifically, there is a vast amount of empirical evidence suggesting that the relationship is non-monotonic, being either U-shaped, inverted U-shaped, S-shaped or M-shaped (Contractor *et al*. 2003; Lu and Beamish 2004; Hitt *et al*. 2006a; Hennart 2007; Lee 2010, 2013; Nguyen, 2017). Our study evaluates the internationalization- productivity relationship based on two theoretical frameworks. The first hypothesizes an S-shaped (Contractor *et al*. 2003; Lu and Beamish 2004; Oh and Contractor, 2014), whereas, the second hypothesizes an M-Shaped (Lee 2010, 2013; Almodóvar and Rugman, 2014) relationship among internationalization and firm's performance levels.

Figure 1a presents the three-stage (S-shaped) I-P relationship, indicating in a graphical manner three distinct stages (dashed-dotted black line). According to Contractor *et al*., (2003, p.7) the first stage refers to the early internationalizers, which can result to negative returns on firms' performance due to learning costs and the inability of the firm to fully exploit economies of scale. The second stage, however, results mainly to increasing returns since firms' fully exploit economies of scale and economies of scope. Moreover, they are able to extend the life cycle of their products and services and be able to minimize their productions costs since they have access to cost efficient resources. In contrast, the third stage is associated with negative returns to the

firm. This is mainly due to all the problems associated with over-internationalization and with increased costs in relation to production activity coordination and managerial deficiencies of overextended organizational structures. On the other hand the theoretical framework of the M-shaped hypothesis (Almodóvar and Rugman, 2014) implies the existence of four-stages. Figure 1b presents the four phases of the M-shaped I-P relationship. The main difference in relation to the S-shaped hypothesis is the first initial stage, which according to Almodóvar and Rugman (2014) is created due to the effect of the "born global illusion". This effect arises when inexperienced firms in their early international careers respond to opportunistic sales from export orders without any prior strategic assessment. Therefore the potential gains in this initial stage tend to increase firms' performance levels. However, during the second stage, inexperienced firms' engaged on international new ventures, experiencing negative returns on their performance due to rising costs, inability to achieve optimal scale operations, due to coordination costs and so on (Contractor *et al*., 2003; Oh and Contractor, 2014). Moreover, it must be mentioned that the third and the fourth stages of the M-shaped hypothesis, are identical to the second and the third stages of the S-shaped hypothesis. In fact these two common stages are referring to experienced firms, which achieve positive returns (positive slope) due to gains derived from economies of scale, marketing skills and then they face negative returns (negative slope) due to over-internationalization related problems. Empirical research finds difficulties to provide supporting evidence for all the phases of the two theoretical frameworks since the samples applied may refer either to experienced or inexperienced firms. Therefore, the empirical findings of the I-P studies are heavily based on sample characteristics. Specifically in Figure 1, the colored slopes and curves verify that when empirically an inverted U-shaped I-P relationship is found, can be referred to either the second and third or the third and fourth stages of the S-shaped and the M-shaped hypotheses.

Figure 1: A graphical representation of the S-shaped and M-shaped models



Contractor (2007, pp. 466-467) suggests that studies revealing and inverted U-shaped relationship have a better statistical fit between the second and the third stage (blue curve, Figure 1a), whereas, a better statistical fit among the first and the second stage reveals a U-shaped relationship (red curve, Figure 1a). Note that the inverted U-shaped relationship is only true when we are talking for experienced internationalizers. However, a similar schematic relationship (blue dotted curve, Figure 1b) can be also found for the first and second stages supported by the M-shaped hypothesis referring to early internationalizers. Looking at the relative literature, Lu and Beamish (2001) using a sample of 164 Japanese small and medium-sized enterprises (SMEs) provide evidence of a U-shaped relationship among the number of firms' foreign investments and firms' return on assets and return on sales. Similarly, Qian (2002) provides evidence of an inverted U-shaped relationship between SMEs' returns on sales (ROS) and their internationalization levels, which is measured by the ratio of firm's foreign sales to its total sales. Moreover, Ruigrok and Wagner (2003) based on a sample of 84 German manufacturing companies over the period 1993-1997, provide evidence of a U-shaped relationship among internationalization and firms' performance. ROA has been used as a measure of performance, whereas, the ratio of foreign sales to total sales has been used as a proxy of firms' internationalization levels. On the other hand, Contractor *et al*. (2003) using a sample of 103 large service firms provide evidence of a cubic (S-shaped) relationship between firms' performance and internationalization levels. As a measure of performance, they have used two measures, viz. ROS and return on assets (ROA). As a degree of firms' internationalization levels they have followed the approach by Sullivan (1994). They have utilized a composite index constructed by the eigenvector-weighted sum of: foreign sales to total sales, the number of foreign employees to the number of total employees and of the number of foreign offices to the number of total offices. Lee (2010) using a sample of 2236 Korean SMEs

(new ventures) verify the existence of an M-shaped relationship among internationalization and firm performance. In order to verify the M-shaped hypothesis, return on equity (ROE) and ROS have been used as performance measures, whereas, the ratio of foreign export sales to total sales has been used as a proxy of internationalization. Similarly, Lee (2013) using a sample of Korean international new ventures (INVs), provide evidence of the M-shaped hypothesis. Lee (2013) has used several financial ratios (ROE, ROS and ROA) as INVs' performance measures. In addition, the ratio of foreign exports to total sales, alongside with other export-based measures are used as a proxy of internationalization. Almodóvar and Rugman (2014) was the first study to provide a solid theoretical support regarding the M-shaped hypothesis. Specifically, using a sample of Spanish INVs utilize ROS as firms' performance measures and the ratio of exports over total sales as a measure of INVs' degree of internationalization. Almodóvar and Rugman (2014) provide empirical evidence and a theoretical support of the M-shaped hypothesis. The common characteristic of the pre-mentioned studies verifying the M-shaped hypothesis, is the empirical investigation of the I-P relationship on export oriented INVs. When such sample characteristics exist the M-shaped hypothesis can be verified due to the existence of the "born global illusion" effect (Almodóvar and Rugman, 2014). However, when firms' are experienced internationalizers engaging equity mode strategies (Pan and Tse, 2002), the first stage of the M-shaped hypothesis is difficult to be verified.

Furthermore, Lu and Beamish (2004) provide empirical validation of an S-shaped relationship between internationalization and firm performance. Specifically, they utilize a sample of 1,059 Japanese firms over the period 1986-1997, having ROA as firms' performance measure. As a proxy of firms' internationalization they constructed a composite index consisting by firms' number of overseas subsidiaries and the number of countries in which the firms owned those

subsidiaries. Thomas and Eden (2004) provide evidence both for a linear and a U-Shaped relationship for a sample of 151 firms over the period 1990-1994. They utilize two performance indicators ROA and ROE, whereas, as a measure of firms' internationalization employed Principal Components analysis having a composite index of the ratios of foreign sales to total sales, foreign assets total assets and the number of foreign countries in which the firms are operating. Additionally, Hitt *et al*., (2006b) using a sample of 72 large U.S. law firms provide evidence of a curvilinear (inverted U-shaped) effect of internationalization on firm performance. As a proxy of firms' internationalization, they have used an entropy measure of the number of foreign offices and the number of lawyers of every office. More recently, Shin *et al*. (2017) using a sample of 1082 Spanish service micro multinational firms, provide evidence of an inverted U-shaped I-P relationship for knowledge-intensive service, whereas, a U-shaped I-P relationship is revealed for capital-intensive service firms. As a measure of internationalization Shin *et al*., (2017) used an index composed by the number of foreign affiliates and the number of countries in which these affiliates operate. They have applied ROA and ROE as proxies of firms' performance levels. Abdi and Aulakh (2018) examined the I-P relationship using a sample of 2,620 US manufacturing firms over the period 1976–2008. Their findings suggest a negative sigmoid curve for the I-P relationship providing supportive evidence for the three-stage hypothesis only for the long-run. Abdi and Aulakh (2018) have used ROA as a measure of firms' performance, whereas, the ratio of foreign to total sales have been applied as a proxy of firms' degree of internationalization.

Finally, based on the two theoretical frameworks of the I-P relationship, we can derive to the following separate but related hypothesis for the large (experienced) firms.

H1a: Productivity levels of large firms that have expanded more to foreign regions compared to their home region, will show an inverted U-shaped relationship, which corresponds to the last two stages of the S-shaped and M-shaped hypotheses.

H1b: Efficiency levels of large firms that have expanded more to foreign regions compared to their home region, will show an inverted U-shaped relationship, which corresponds to the last two stages of the S-shaped and M-shaped hypotheses.

H1c: Technical change (innovation capacity) levels of large firms that have expanded more to foreign regions compared to their home region, will show an inverted U-shaped relationship, which corresponds to the last two stages of the S-shaped and M-shaped hypotheses.

Sample characteristics and variable description

The existing literature (Atkinson *et al*., 2018; Tsionas and Mallick, 2019; Kumbhakar and Tsionas, 2020) suggests that in our setting firms' productivity can be measured by specifying a production function, utilizing at least three main variables (i.e., capital, labor and production output). Therefore, as inputs we utilize total[1] assets (measured in million US dollars) and total number of employees. Total sales (measured in million US dollars) represent firms' output. Our sample consists of an unbalanced panel of global, world leading multinationals over the period 1992-2019. The data have been manually extracted from various World Investment Reports (WIR) which are issued by the United Nations Conference on Trade and Development (UNCTAD).[2] The data are collected and distributed by UNCTAD through the various WIR reports as: "the world's top 100 non-financial firms, ranked by their foreign assets". The unique sample contains non-financial firms from sixty one different industries and from twenty six different countries.

[1] In all variables used the term "total" refers to the sum of domestic and foreign quantities.
[2] WIR reports can be downloaded from: https://unctad.org/topic/investment/world-investment-report

According to Contractor (2007), when we examine the I-P relationship among firms from different countries operating in different sectors, we minimize the bias generated from 'local' properties (i.e., investigating the I-P relationship for a single sector/single country). As a result, according to Contractor (2007) the properties of our sample enable to investigate the global properties of the I-P relationship. Furthermore, as a proxy of the degree of internationalization (DOI) we have followed the literature (Kim and Lyn, 1986; Sullivan, 1994; Contractor *et al*., 2003) and applied a composite index of firms' internationalization index known as the Transnationality Index (TNI) which is calculated and provided by UNCTAD. The TNI index is expressed as a percentage and is based on the average value of the foreign assets to total assets ratio; the foreign sales to total sales ratio and the foreign employment to total employment ratio. The index assigns equal weights to all three variables, since our sample contains firms from different industries (labor intensive and capital intensive industries).

Some missing data and the lag structure applied resulted in a sample of a total 2576 firm-year observations having 92 firms per year. Table 1 shows the sample statistics in year-by-year basis, whereas, Figure 2 presents the distribution of the variables used. The descriptive statistics suggest that throughout the examined period firms' total assets have increased. Similarly, the density plots show that the mean values (vertical lines) of firms' foreign assets are higher compared to home assets. The expansion of foreign assets suggest that firms' over the years are exploiting their specific advantages at foreign markets providing them with distinctive competences which in turn reflect on their performances (Caves, 1996). Also, it is evident that on average terms, firms' internationalization levels (as expressed by the TNI measure) is 60% indicating that the firms in our sample are experienced firms. The descriptive statistics also project a similar picture indicated by firms' TNI mean values. Therefore, our sample contains only large,

experienced firms that in many cases have over-internationalized beyond their optimal stage. Therefore, we assume that the first stage from the S-shaped hypothesis (Contractor *et al*., 2003; Contractor 2007a, 2007b; Oh and Contractor, 2014) and the first two stages of the M-Stage hypothesis (Lee 2010, 2013; Rugman and Almodóvar, 2011; Almodóvar and Rugman, 2014) would not be statistically seen in our findings. In addition to the primal variables defining firms' production function and firms' degree of internationalization (DOI), we use several other country of origin specific variables as control factors of our model. Given the importance of countries cultural characteristics on firms' performance (Teerikangas and Very, 2006; Maseland *et al*., 2018), we use Hofstede dimensions as a proxy of firms' home region cultural values. Table 1 presents the descriptive statistics of Hofstede's four indices namely: power distance (PDI), individualism (IDV), Masculinity (MAS) and uncertainty avoidance (UAI). According to Wan and Hoskisson (2003), home country environment alongside with home regional characteristics (Oh, 2010; Rugman and Oh, 2013) play an important role and influence firms' performance. Therefore in order to account for home country specific economic environment, we use six additional (to the Hofstede's four indices) variables. Specifically, we have extracted from Penn World Table-PWT v10.0 (Feenstra *et al*., 2015): (1) home country's foreign direct investment inflows measured in millions of dollars (FDI_{in}); (2) home country's foreign direct investment outflows measured in millions of dollars (FDI_{out}); (3) home country's population size measured in millions (POP); (4) home country's gross domestic product measured in million dollars (GDP); (5) home country's share of merchandise exports at current PPPs (EXPSH) ; (6) home countries' share of merchandise imports at current PPPs (IMPSH). Table 1 presents the descriptive statistics of those variables which according to the relative literature influence firms' performance levels (Wan and Hoskisson, 2003; Contractor *et al*., 2003; Contractor, 2007a; Nguyen, 2017). Finally,

as our model has a complicated posterior which depends on latent productivity ω_{it} we use Sequential Monte Carlo (SMC) methods also known as Particle Filtering (PF) to draw samples from the posterior distribution. We use 150,000 iterations, omitting the first 50,000 in the burn-in phase to mitigate the possible impact of start-up effects. We choose the ANN order G using marginal likelihoods and it turns out that the best model has $G = 2$ with posterior model probability close to 92% among models where G ranges from 1 to 5. Details on estimation are available in the online Appendix.

Figure 2 : Density plots of the variables

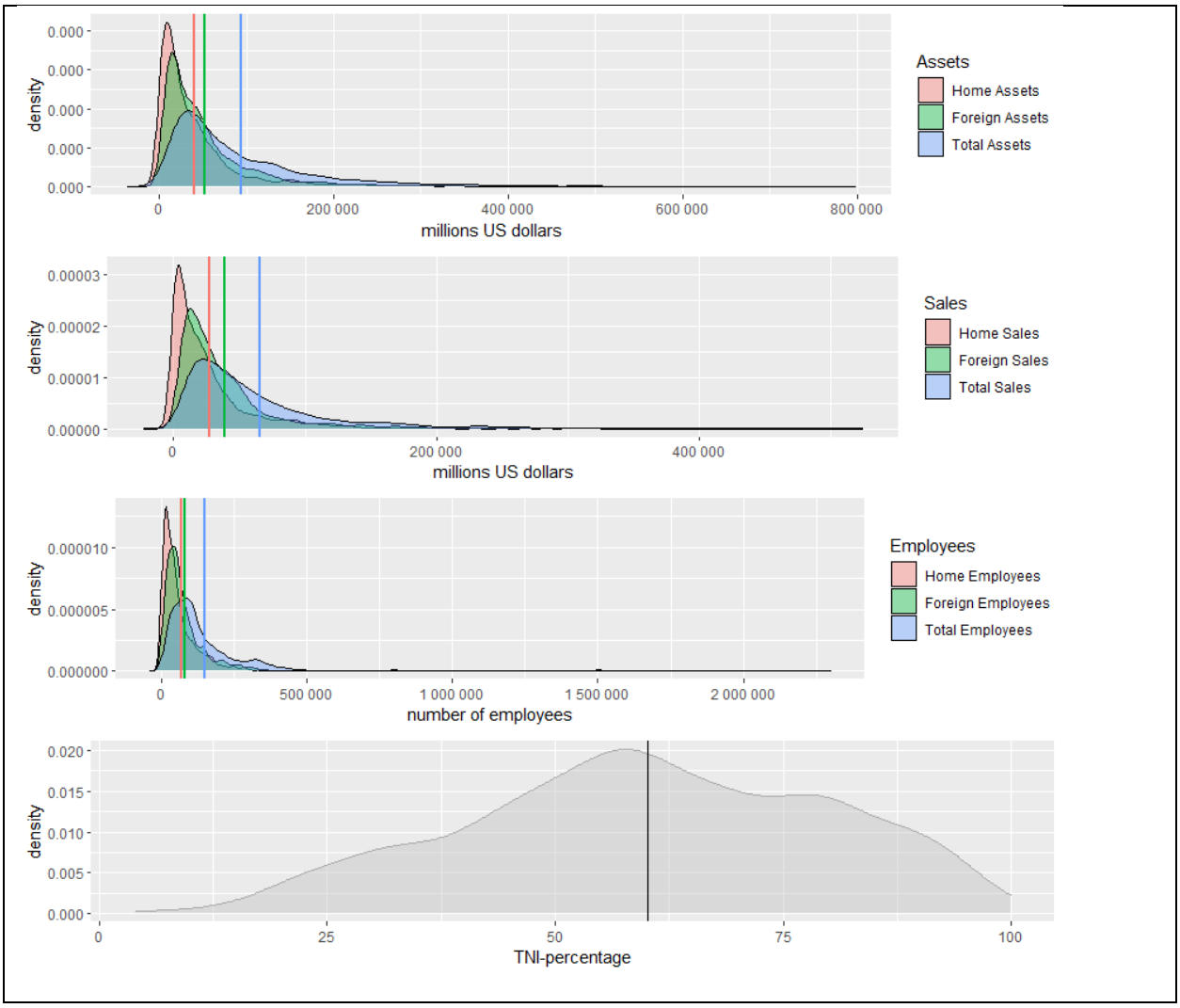


Table 1: Descriptive statistics

Year	Statistic	Assets		Sales		Employment		TNI (Per cent)
		Foreign	*Total*	*Foreign*	*Total*	*Foreign*	*Total*	
2019	*Mean*	98703.057	160558.812	60989.600	92324.786	97439	169836	65.946
	Stdev	64665.105	103991.343	53458.045	84797.593	129586	263484	19.050
2018	*Mean*	96158.838	160524.121	60517.774	91667.753	101436	170254	66.446
	Stdev	64852.010	109020.785	53067.368	83658.134	132535	269138	19.931
2017	*Mean*	94947.631	155458.571	57141.964	86994.192	100386	170971	66.208
	Stdev	61335.252	100613.704	47879.335	78624.896	126312	268519	19.009
2016	*Mean*	88565.792	142548.570	52444.149	81321.638	98537	172981	66.328
	Stdev	59137.175	91385.198	41522.403	71591.103	119643	273981	18.210
2015	*Mean*	85984.263	138966.706	54529.943	84138.222	98974	173723	66.286
	Stdev	56360.212	91055.825	44433.939	74099.270	119105	273237	18.218
2014	*Mean*	86871.007	143159.291	54311.354	82959.466	98206	175743	65.030
	Stdev	61733.180	100360.870	47480.609	74984.631	114978	274751	19.208
2013	*Mean*	80690.134	128295.475	49437.738	77705.254	88533	155541	66.163
	Stdev	55683.224	89161.569	41289.431	71562.264	95654	245662	15.914
2012	*Mean*	83060.191	134508.005	60381.566	94049.304	91361	159417	65.712
	Stdev	61492.714	101476.675	53698.894	90291.165	103723	245527	15.359
2011	*Mean*	83169.229	132648.937	58500.562	90018.686	93744	159634	66.426
	Stdev	74135.716	115790.658	56404.800	89418.130	103429	238925	16.669
2010	*Mean*	79244.170	123286.583	58777.042	91086.233	94008	160527	67.106
	Stdev	71542.872	99669.084	56147.882	90292.214	103002	229952	15.875
2009	*Mean*	76721.479	122063.635	51785.837	81235.299	91174	158337	65.789
	Stdev	62565.164	103119.292	46253.457	74890.464	100430	239166	15.963
2008	*Mean*	63340.061	109293.627	53891.622	87588.577	93521	162448	63.502
	Stdev	57395.375	100235.007	54687.938	88646.132	93540	232411	15.842
2007	*Mean*	60815.729	102412.271	47517.750	78397.052	82544	145479	64.101
	Stdev	58431.486	94000.178	47046.650	77859.008	88021	223797	15.254
2006	*Mean*	52831.904	93280.638	41273.085	72484.213	90115	161891	62.076
	Stdev	52758.015	89118.356	41138.650	73070.395	85472	215625	15.170
2005	*Mean*	49390.295	90756.737	38114.253	68128.779	82510	156575	59.138
	Stdev	56205.646	98993.477	40345.407	69564.108	81421	204505	17.313
2004	*Mean*	46067.179	89319.653	34666.663	62243.505	74810	151852	56.573
	Stdev	46530.421	93546.938	38062.986	61474.626	65990	192096	17.881
2003	*Mean*	38432.168	77780.589	29843.611	55730.284	75718	153069	56.916
	Stdev	42637.102	86341.740	30710.926	52783.316	64613	175255	19.310
2002	*Mean*	34055.792	70776.573	25340.281	50020.135	72283	147694	56.067
	Stdev	35048.332	74239.579	25210.300	47197.159	62604	164944	21.183
2001	*Mean*	28979.463	60361.695	23531.305	45724.463	73740	145063	57.962
	Stdev	30595.677	67461.967	23645.648	45345.067	66952	166981	20.193
2000	*Mean*	24553.957	58443.685	23961.804	47797.163	68934	132390	57.890
	Stdev	26482.059	70670.207	22976.552	46996.251	67726	156642	22.876

1999	*Mean*	21739.258	51627.957	22212.688	44879.570	66771	134343	54.974
	Stdev	20946.497	58442.330	20107.284	39574.150	63541	147980	21.228
1998	*Mean*	22805.978	53909.783	23089.130	46430.435	75267	153151	54.106
	Stdev	20049.465	58822.265	19149.100	38455.185	63109	136925	20.295
1997	*Mean*	18496.289	42315.556	21577.778	40423.333	63260	118175	56.706
	Stdev	15415.424	46235.022	16853.405	34189.505	58214	102414	20.644
1996	*Mean*	18555.913	43218.478	20623.913	43295.978	62401	124671	54.151
	Stdev	14985.344	43457.421	14598.129	36252.004	55225	113534	20.645
1995	*Mean*	15824.468	35754.255	19381.915	37602.128	56345	107163	54.836
	Stdev	13203.883	30968.207	17351.291	37224.922	50533	87816	20.712
1994	*Mean*	15693.109	42768.478	18552.174	41569.565	56754	126915	50.877
	Stdev	12711.423	42802.685	15333.462	41641.069	51477	108784	22.704
1993	*Mean*	13709.891	38649.674	16668.478	38259.783	61168	141794	49.612
	Stdev	10430.447	41465.848	14910.811	37912.476	53542	119476	21.876
1992	*Mean*	13102.353	32205.882	16964.941	36508.235	59183	128558	50.171
	Stdev	10664.851	27170.924	14887.441	31385.731	56786	107291	20.995

	PDI	**IDV**	**MAS**	**UAI**	**FDI_{in}**	**FDI_{out}**	**POP**	**GDP**
Mean	45	74	60	61	68428.221	90928.784	32.407	742788.711
Stdev	13	16	20	21	90387.612	92360.402	59.916	2527504.195
Min	11	17	5	23	41.038	408.668	0.007	16.936
Max	104	91	95	94	471792.000	396569.000	294.994	16070041.000

	EXPSH	**IMPSH**
Mean	0.128	-0.167
Stdev	0.083	0.477
Min	0.000	-23.238
Max	1.121	0.009

Notes: Assets and Sales are measured in millions U.S. dollars; PDI: power distance; IDV: individualism; MAS: masculinity; UAI: uncertainty avoidance; FDI_{in}: foreign direct investment inflows measured in millions of dollars; FDI_{out}: foreign direct investment outflows measured in millions of dollars; POP: population size measured in millions; GDP: gross domestic product measured in million dollars; EXPSH: share of merchandise exports at current PPPs; IMPSH: share of merchandise imports at current PPPs.

Methodological Framework

We consider the following production function:

$$y_{it} = \alpha_i + \beta_{l,i} l_{it} + \beta_{k,i} k_{it} + \beta_{\tau,i} \tau_{it+} v_{i,t,1} + \omega_{it}, i = 1, \dots, n, t = 1, \dots, T \quad (1)$$

where $y_{it},, l_{it}, k_{it}$ denote logs of output, labor and capital, respectively, $v_{it,1}$ is an error term, τ_{it} is a time trend to measure technical change, and ω_{it} denotes productivity. Moreover, α_is are fixed effects, and $\beta_{l,i}, \beta_{k,i}$ are unknown firm-specific parameters. We model productivity semi-parametrically using an artificial neural network (ANN):

$$\omega_{it} = \sum_{g=1}^{G} \delta_{i,g,1}\, \varphi\left(M_{it}\delta_{i,g,2} + \omega_{i,t-1}\delta_{i,g,3} + z'_{it}\Gamma_{i,g}\right) + v_{it,2}, \tag{2}$$

where G is the number of terms in the ANN, $v_{it,2}$ is an error term, $\delta_{ig,1}, \delta_{ig,2}, \delta_{ig,3}$ are firm-specific unknown coefficients, M_{it} is the (log) index of industrialization, z_{it} is a vector of control variables with coefficients $\Gamma_{i,g}$, and $\varphi(z)$ is the so-called activation function which, in this instance, we take to be $\varphi(z) = \tanh(z)$. It is well known that ANNs can approximate any functional form provided G is large enough (White, 1989, 1990). In the ANN we also condition into lagged productivity.

If we consider capital as quasi-fixed then, since Marschak and Andrews (1944) the literature on estimating production functions suggests that variable inputs are not independent of productivity (Ackerberg *et al*., 2015, Gandhi *et al*., 2020, Levinsohn and Petrin, 2003, Olley and Pakes, 1996, *inter alia*). Therefore, we augment (1) with the following equation:

$$l_{it} = \gamma_i + \zeta_i \omega_{i,t-1} + v_{it,3}, \tag{3}$$

where $v_{it,3}$ is an error term, γ_i are fixed effects, and ζ_is are unknown firm-specific coefficients. Including the lagged productivity term, means that labor decisions are made at the "beginning of the period" without having observed the current productivity level and is common in the literature (e.g. Ackerberg *et al*., 2015). Moreover, in order to account of the heterogeneity of our sample, we collect our firm-specific coefficients

$$\boldsymbol{\beta}_i = \left[\alpha_i, \beta_{l,i}, \beta_{k,i}, \delta_{i,g,1}, \delta_{i,g,2}, \delta_{i,g,3}, \gamma_i, \zeta_i, \Gamma_{g,i}\right], i = 1, \dots, n, \tag{4}$$

and we assume

$$\boldsymbol{\beta}_i \sim \mathcal{N}_d(\bar{\boldsymbol{\beta}}, \Sigma_{\boldsymbol{\beta}}), i = 1, \dots, n, \tag{5}$$

where $\bar{\boldsymbol{\beta}}, \Sigma_{\boldsymbol{\beta}}$ represent, respectively, the mean and covariance matrix of the random coefficients, and the dimensionality $d = 8$. For the error terms we assume

$$\boldsymbol{v}_{it} = [v_{it,1}, v_{it,2}, v_{it,3}]' \sim \mathcal{N}_3(\mathbf{0}, \Sigma_{\boldsymbol{v}}), \tag{6}$$

independently of all other error components and regressors. Our priors are flat:

$$p(\bar{\boldsymbol{\beta}}, \Sigma_{\boldsymbol{\beta}}, \Sigma_{\boldsymbol{v}}) \propto |\Sigma_{\boldsymbol{\beta}}|^{-(d+1)/2} |\Sigma_{\boldsymbol{v}}|^{-2} \mathbb{I}(\beta_{l,i}, \beta_{k,i} > 0), \tag{7}$$

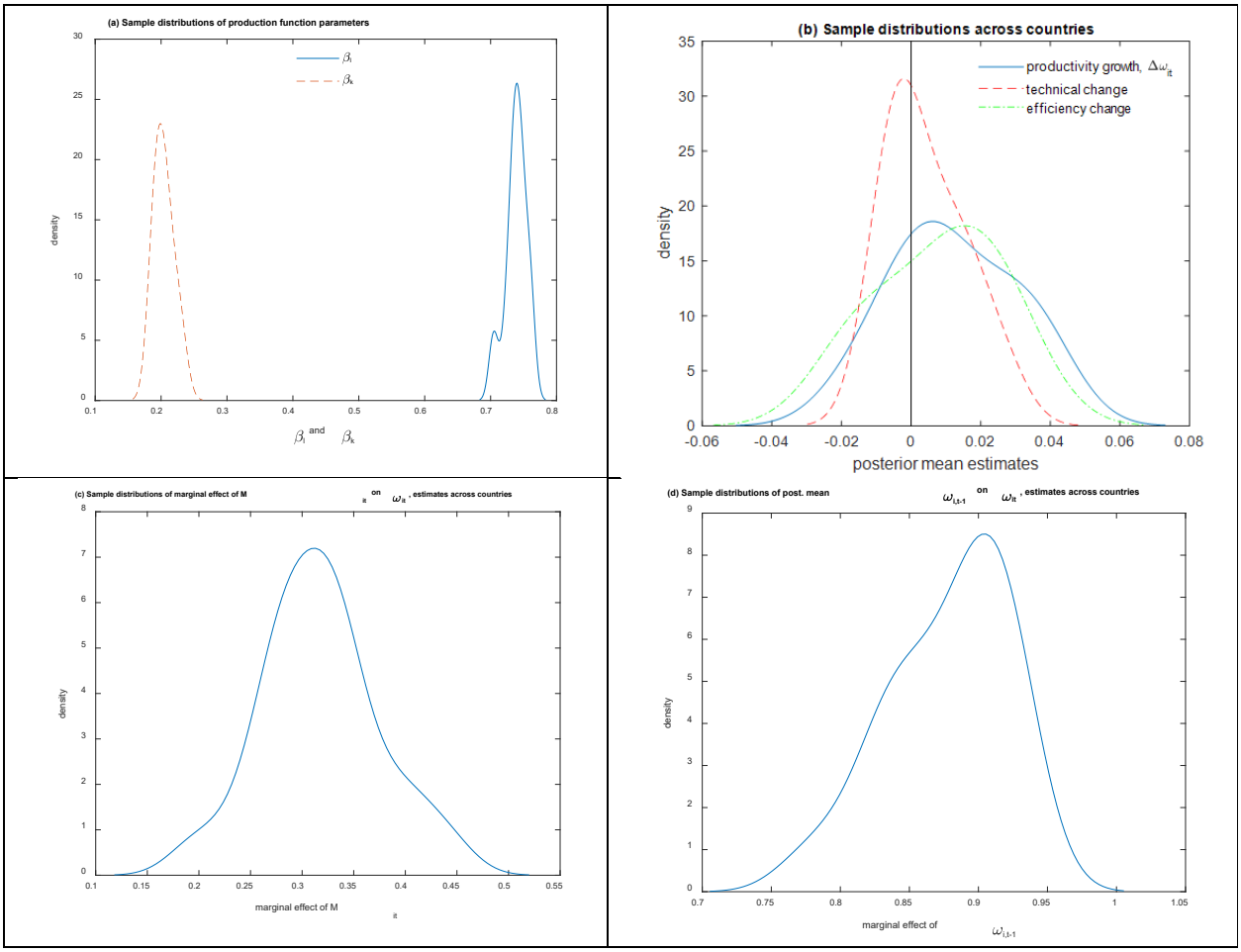
where $\mathbb{I}(\cdot,\cdot)$ denotes the indicator function. In our model, technical change is measured by the parameter $\beta_{\tau,i}$, i.e., the coefficient of the time trend. Technical inefficiency is estimated from the residuals of (1) as $u_{i,t} = -(v_{i,t,1} - \max v_{i,t,1})$ where the maximum is taken across all observations. Finally, we define efficiency as $r_{i,t} = e^{-(u_{i,t})}$ and efficiency change as $EC = r_{i,t} - r_{i,t-1}$. Our method of obtaining inefficiency is also known in the literature as "corrected least squares" although, here, the method of estimation is not least squares.

Results

The analysis starts by presenting the elements of our model calculating firms' productivity ($\omega_{i,t}$) and its components (efficiency and innovation) using an artificial neural network (ANN). Specifically, in panel (a) of Figure 3, we present marginal posterior densities of the unknown firm-specific parameters associated with firms' labor β_l and capital β_k displayed in equation (1). The posterior densities are derived from our model taking into account the control variables (i.e. home

country environment). The evidence suggests that the distribution of β_l is bimodal, whereas, for β_k is unimodal. In addition to Figure 3, Table 2 presents the posterior means both for $\bar{\beta}_l$ and $\bar{\beta}_k$, with and without the inclusion of the control variables. When we include the control variables into our model the estimated values are for $\bar{\beta}_l$=0.738 and for $\bar{\beta}_k = 0.204$. In panel (b) in Figure 3 we provide firms' productivity change distribution and its components (i.e. efficiency and technical change). It is evident that during the examined period productivity change was positive having the majority of productivity's distribution on the right side of the black vertical line. In addition, we provide evidence that firms' productivity during the examined period was driven both by firms' ability to innovate (technical change-red dashed line), and by their ability to catch-up (efficiency change-green dashed line). This is evident since a large amount both of both distributions are on the right side of the black vertical line. Moreover, in panels (c) and (d) in Figure 3 we present the sample distribution of the marginal effect of internationalization (M_{it}) on firm productivity ($\omega_{i,t}$), and the marginal effect of lagged firm's productivity ($\omega_{i,t-1}$) on foremost firm productivity ($\omega_{i,t}$). The literature highlights the importance for tackling causal inference when examine the I-P relationship (Capar and Kotabe 2003; Lu and Beamish, 2004; Abdi and Aulakh, 2018). As a result, our approach accounts both for heterogeneity and facilitates causal inference in the examination of firms' productivity- internationalization relationship. The findings presented in Table 2 suggest that on average internationalization and lagged productivity have both a positive effect on firms' productivity levels. These findings are robust since they are also verified by our baseline modeling which excludes the control variables. Therefore, we provide support for the studies that find a positive effect of internationalization on firms' performance levels (Kim and Lyn, 1986; Grant, 1987; Geringer *et al*., 1989; Lu and Beamish, 2001, 2004).

Figure 3: Aspects of the model



	post. mean	post. s.d.
$\bar{\beta}_l$	0.738 *(0.717)*	0.014 *(0.023)*
$\bar{\beta}_k$	0.204 *(0.255)*	0.014 *(0.017)*
average marginal effect of M_{it} *on productivity*	0.203 *(0.563)*	0.017 *(0.081)*
average marginal effect of $\omega_{i,t-1}$ *on productivity*	0.878 *(0.527)*	0.043 *(0.071)*

Table 2: Posterior means and standard deviations

Notes: Numbers in parenthesis are from the model excluding control variables.

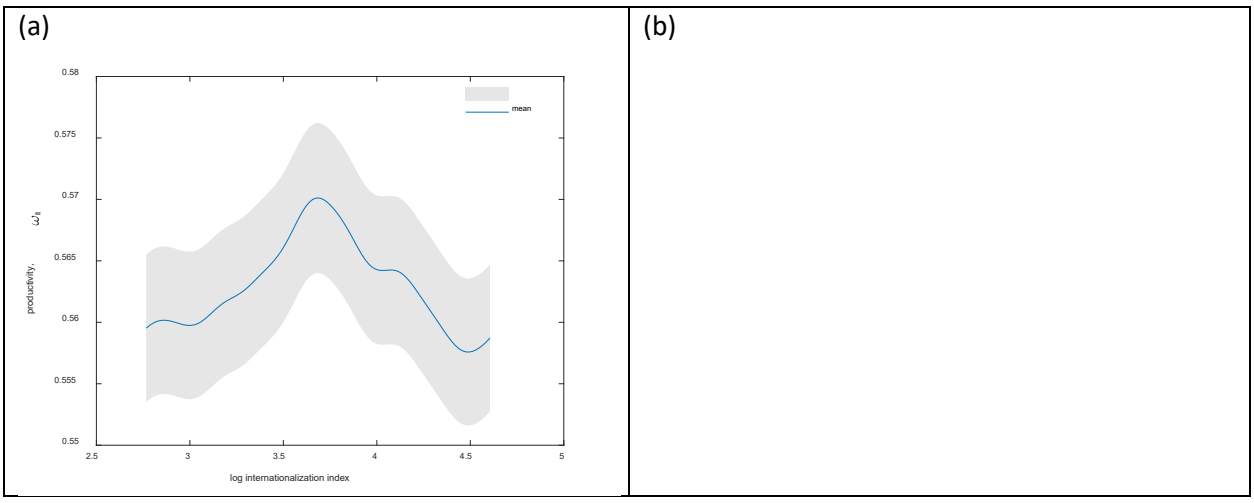
Moreover, Figure 4 shows the effect of internationalization (presented in logarithmic form) on firms' productivity ($\omega_{i,t}$), efficiency and technical change levels. Our estimation includes the control variables, accounting for home country environment. In addition it accounts both for different settings of the effect of the marginal effect of lagged productivity ($\omega_{i,t-1}$) on firm's ($\omega_{i,t}$) levels, but also it accounts for the heterogeneity in our sample. Similarly, the effect of lagged efficiency and technical change components are incorporated in our estimation.

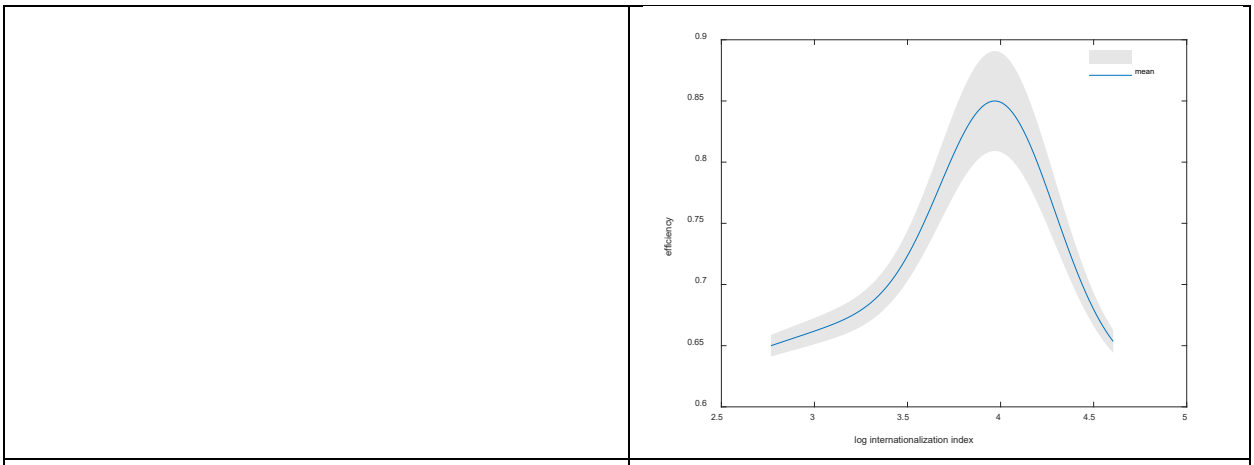
Overall, the results presented in panel (a) report the existence of two distinctive stages in relation to the effect of internationalization on firms' productivity. Specifically, we provide evidence that when experienced (large) firms' internationalize their operations between the range of 14.8% to 40.4%, are able to experience a positive effect on their productivity levels due to the exploitation of economies of scope and economies of scale. As it is presented in panel (a) this range is between 2.7 and 3.7 in our logged internationalization index and corresponds to Contractor *et al.*'s (2003) description of the second stage of the three-stage sigmoid hypothesis. Moreover, this finding represents the third stage of the M-shaped hypothesis (Almodóvar and Rugman, 2014). After the highest point (3.7) the effect on firms' productivity turn to negative, which corresponds to the third and fourth stages of the S-shaped and the M-shaped hypotheses. As a result an inverted U-shaped relationship among firms internationalization and productivity levels is verified, providing supporting evidence for Hypothesis 1a. In a similar manner, panel (b) presents the effect of internationalization on firms' efficiency levels (catch-up). Therefore, it represents the effect of internationalization on firms' ability to catch-up. The results again reveal an inverted U-shaped relationship, which corresponds to the last two stages of the S-shaped and M-shaped hypotheses. We provide evidence that during the range between 15% and 55%, firms' experience a positive effect of internationalization on their efficiency levels. This range is between 2.7 and 4 in our logged internationalization index represented graphically by an increasing trend. However, after the highest point (4) the effect of internationalization turns negative on firms' efficiency levels. As a result, we provide supporting evidence for Hypothesis 1b. According to Contractor *et al*. (2003) due to high internationalization after a certain point, firms are facing increasing costs derived from the coordination and governance of their over internationalized operations. As a result, these costs exceed the benefits gained from the internationalization, reflecting upon their performances in a

negative manner. According to Hitt *et al*., (2006a) such fluctuations may occur due to eventual discontinuance of operations between home and foreign countries' operations. Even though the associated costs in the initial stages of internationalization can be overcame, productivity fluctuations can occur due to influences from host country environmental conditions (Wan and Hoskisson, 2003).

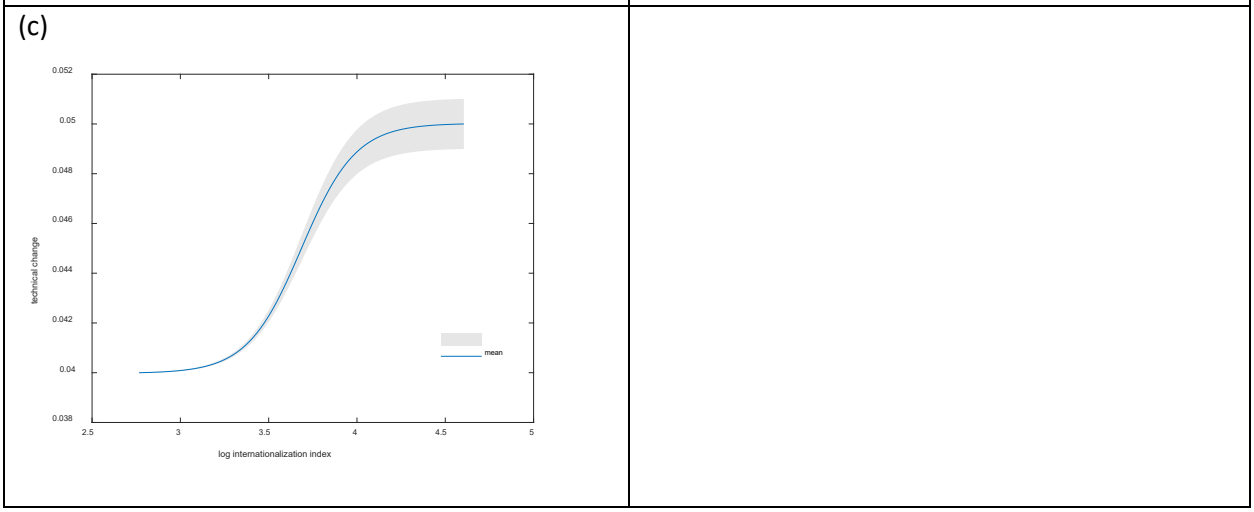
Moreover, panel (c) in Figure 4 presents the effect of internationalization on firms' ability to innovative (technical change). Our findings suggests a positive effect of internationalization on firms' technical change levels during the range of 14.8% to 54.5%, which corresponds to the range from 2.7 to 4 in our logged internationalization index. After that point the effect on firms' technical change levels continues to be positive but in decreasing rate. Since a negative effect is not verified from our findings, hypothesis H1c cannot be verified. However, this finding is not new to the IB literature. Hitt *et al*., (1997) on the grounds of the resource based view (Wernerfelt 1984; Conner, 1991), suggests that firms' international diversification strategies can have a positive effect on firms' innovation capacity. In a global competitive market, innovation (i.e. technical change) is strongly related to firms' competitive advantage (Bettis and Hitt, 1995)

Figure 4: Productivity, efficiency and technical change, as a function of log internationalization





(c)



Notes: Mean value is indicated by the solid blue line, whereas the grey area represents 95% confindence intervals

Concluding remarks and Discussion

The paper highlights some theoretical and methodological implications. Specifically, the empirical findings verify the existence of the last two stages of the S-shaped and the M-shaped hypotheses. The empirical evidence suggest that for large experienced firms, the productivity – internationalization relationship exhibits an inverted U-shape. Specifically, this finding supports the existence of the second and third stage of international expansion as described in the three-stage sigmoid hypothesis (Contractor *et al*., 2003; Lu and Beamish, 2004; Contractor, 2007). Also it verifies the third and fourth stage of the M-shaped hypothesis (Lee, 2010; Lee, 2013; Almodóvar, 2012; Almodóvar and Rugman, 2014). A similar finding is also provided when examine the firms'

efficiency-internationalization relationship. Again, the study verifies an inverted U-shaped relationship which corresponds to the last two stages of the S-shaped and the M-shaped hypotheses. Firms realize a positive effect on their productivity levels between the range of 14.8% to 40.4%, whereas, for their efficiency levels the positive effect is realized between the range 14.8% to 54.5%. After these two threshold points (40.4% and 54.5%), the effect turns negative both for firms' productivity and efficiency change levels. It must be emphasized that in contrast to the studies using financial based indicators as a performance measure, this paper adopts operational performance measures. Hitt *et al*., (2006a) asserts that measures like productivity and efficiency are operational related performance measures acting as mediators and therefore predetermine the I-P relationship. Moreover, the evidence suggest that when experienced firms internationalize their operations increase their innovation capacity. The empirical evidence shows a non-linear positive effect of internationalization on firms' technical change. The findings could not verify negative returns of internationalization on firms' technical change levels. According to Hitt *et al*., (1997) firms' diversify their operations abroad in order to enhance their innovation capacity. This in turn will allow them to enhance their competitive advantage and compete globally (Bettis and Hitt, 1995).

Implications

The applied innovative methodological framework allows for flexible functional forms and accounts both for lagged effects of productivity and heterogeneity effects. However, this study brings forward several methodological issues that need to be considered when the I-P analysis is empirically examined. The research highlights that different model specifications can have a major influence on the outcome of the I-P analysis. In addition, sample characteristics are of great importance. In this study, the first stage from the S-shaped hypothesis, and the first and second

stages from the M-Shaped hypothesis couldn't be empirically verified. This was attributed to the properties of our sample, which contains large firms with past experience of international operations. In addition, several authors have asserted that multicollinearity can influence the verification of the I-P relationship (Elango and Sethi, 2007; Banalieva and Sarathy, 2011). As a result, innovative methodological tools (i.e. data driven methods) are needed, allowing flexible functional forms and the ability to overcome traditional measurement problems which can create deficiencies in the estimation. On the other hand, the majority of the studies adopt accounting-based measures in order to evaluate the I-P relationship. The problems of such performance measures have been well highlighted in the literature (Fisher and McGowan, 1983; Kaplan, 1983). However, as Hitt *et al*. (2006a) assert the effect of internationalization is directly linked with the firms' process and organizational outcomes, whereas, in a latter phase it is reflected upon firms' financial outcomes. As a result, there is a necessity for the I-P literature to investigate further the internationalization effect on firms' process and organizational aspects like productivity, performance, operational efficiency, innovation capacity and organizational formations.

The managerial implications of our work suggest that overall internationalization can increase firms' performance. However, managers and decision makers must be aware that the effect is nonlinear having negative returns on firms' performance. This is evident for firms' productivity and efficiency change levels. However, it is also evident that through international expansion firms enhance their global competitive position by enhancing their innovation capacity. Firms by adopting international diversification strategies invest on deferent resources which enable to build new capabilities which enable them to maintain and increase their innovation capacity. Another crucial managerial implication of our study is that the effect of internationalization according can be revealed first on firms' operational structure and then in a latter phase on firms'

financial performance. As a result, managers alongside with the accounting performance measures, should evaluate operational related performance measures, which are strongly linked to organizational changes during firms' internationalization process. Therefore, they will be able to evaluate in time potential asymmetric effects of firms' internationalization process and act accordingly. Moreover, our study brings forward some useful policy implications. As has been emphasized by the relative literature (Contractor *et al.* 2003; Contractor, 2007; Almodóvar and Rugman, 2014) the negative returns on firms' productivity and efficiency change levels (attributed to increasing costs), are derived both from firms' endogenous and exogenous factors. Buckley *et al*., (2020) assert that host country's political and institutional environment can mitigate or magnify the exogenous risk which firms are facing when they expand their operations into foreign markets. Given the fact that firms' regional aggregation and integration of their foreign operations is of great importance (Arregle *et al*., 2018), governments should apply specific policies which will enable firms to have a better control over their diversified operations. Therefore, governments should adopt policies which minimize regulatory failures (such as entry and exit regulations), minimize high taxation (Gande *et al*., 2020; Contractor *et al*., 2020) and engage on institutional reforms of intellectual property rights (Khoury and Peng, 2011).

Limitations and future research

Finally, the estimated effects of internationalization on firms' productivity, efficiency and technical change levels are influenced by our sample characteristics. Specifically, our sample contains large non-financial firms, which have been previously engaged on international expansion of their operations. As a result, the negative returns of over-internationalization arise at the point above 40.4% for the case of productivity and above 54.5% for the case of efficiency. These two threshold levels of internationalization can vary if the firms are small in size, or if they are new

companies with no past internationalization experience, or if their financial firms. Studies have pointed out that the path and the effect of internationalization on accounting-based performance measures can vary based on firms' characteristics (Inkpen and Beamish, 1997; Lu and Beamish, 2001; Zhou *et al*., 2007; Ruigrok *et al*., 2007; Lee, 2010; Lee, 2013; Almodóvar, 2012; Almodóvar and Rugman, 2014). As a result, future research must adopt the new methodological advances in order to further investigative the effect of internationalization on firms' process performance measures for export-oriented SMEs and INVs. This study provides clear empirical evidence that, in principle, the S-shaped (Contractor *et al*. 2003) and the M-shaped hypothesis (Almodóvar and Rugman, 2014) provide to the decision maker solid theoretical frameworks enhancing the understanding of the asymmetric effects of internationalization on firms' productivity levels.

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