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# DOES INSTITUTIONAL QUALITY STRENGTHEN THE POSITIVE INFLUENCE OF OFFSHORE R&D STRATEGY ON THE FIRM PRODUCTIVITY?

**Wen-Bin Chuang[1†] --- Hui-lin Lin[2] --- Chien-Wei Wu[3]**

[1]*Department of International Business Studies, National Chi-Nan University, Taiwan*

[2]*Department of Economics, National Taiwan University, Taiwan*

[3]*Department of Economics, National Chi-Nan University, Taiwan*

## ABSTRACT

*The purpose of this study is to examine whether the host country's institutional quality has a significant moderating effect on the relationship between the offshore R&D strategy in the local environment and firm productivity. In addition, due to the firm's operating mode in the host country being distinguished as either exploitation-oriented or exploration-oriented, we further examine whether the moderating effects of institutional quality is influenced by the different types of operating mode in the host country. This analysis takes advantage of a longitudinal dataset of Taiwan-based firms and their most prominent subsidiary as well as the institutional quality indices developed by the World Economic Forum (WEF) over the 2006-2009 period. The empirical results show that there are different moderating role of institutional quality between the exploitation-oriented and exploration-oriented mode in terms of the relationship between offshore R&D and firm productivity, which indicates that the institutional quality in the host countries does not necessarily strengthen the positive influence of the offshore R&D strategy on firm productivity as do the extant studies in the previous literature.*



**Keywords:** Offshore R&D strategy, Firm productivity, Institutional quality, Operation mode, Taiwan MNE, Panel data.
**JEL Classification:** F63, F23, F55.

## Contribution/ Originality

This paper's primary contribution is finding that institutional quality in the host country play a significant moderating role when Taiwan-based firms develop offshore R&D to enhance

† Corresponding author
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performance. Moreover, we also find that the moderating role is influenced by the different kind of operational mode.

## 1. INTRODUCTION

With the rapid technological innovations in information and communication, firms have been increasingly disintegrating their production processes and becoming more vertically specialized along with the trend toward increased globalization (Ambos and Ambos, 2011; Jensen and Pedersen, 2012). Through relocating their production processes to foreign countries, firms can not only achieve higher growth in terms of productivity, reap economies of scale or engage in new business activities but they can also can source new organizational capabilities, and increase their organizational flexibility and local absorptive capacity in order to quickly and effectively respond to global market needs (Lewin *et al.*, 2009; Roza *et al.*, 2011). Moreover, an increasing number of studies have also found that the global trend towards offshore research and development (R&D) around the world and its patterns have changed quite considerably in recent years (Gersbach and Schmutzler, 2011; Rilla and Squicciarini, 2011; Jensen and Pedersen, 2012). [1]

At the same time, it is claimed that the quality of collaborative relationships plays a crucial role in firms' strategic resources and specific capability building as they develop their overseas activities in the host country (Almeida and Phene, 2004; Hallin *et al.*, 2011; Chang *et al.*, 2012). Firms have tried to obtain collaborative advantages in the host country by utilizing inter-organizational relationships in cases where synergistic benefits could not have been achieved by acting independently, which in turn will significantly affect their technological capabilities and productivity (Oke *et al.*, 2008; Cao and Zhang, 2010) The collaborative relationships can also serve as an important channel for interorganizational learning, which helps firms to share risks and information, to access complementary resources, and to enhance capacity, which in turn will enhance their firm productivity (Cantwell and Mudambi, 2005; Choi and Ko, 2012).

Similarly, the effects of R&D offshoring/outsourcing on firm productivity are also heavily shaped by their inter-organizational relationships and operating mode in the local environment (Belderbos *et al.*, 2010; Chang *et al.*, 2012). Through the utilization of an offshore R&D strategy based on the collaborative relationships, firms can not only upgrade and improve their existing technologic and knowledge assets, products and processes to satisfy the local environment, but they can also search for and acquire new technology learning opportunities from the local environment to augment their technological knowledge or capabilities, thereby enhancing their productivity (Belderbos *et al.*, 2010; Cantwell *et al.*, 2010; Hallin *et al.*, 2011; Chang *et al.*, 2012).

However, the host country's environment, especially its institutional quality, challenges the collaborative relationships in the local market, thereby changing the effects of strategic decisions in

[1] OECD (2007). defined offshoring as the relocation of processes to foreign countries without distinguishing whether the production is external or internal to the firm, while outsourcing is defined as a process whereby an activity that was previously undertaken in-house is contracted to another providers regardless of whether a provider's location is within the home country or in a host country Görg, Aoife and Strobl (2008). Offshoring, therefore, includes international outsourcing and international insourcing. In addition, related terms are 'international outsourcing', 'international insourcing', the 'fragmentation of global value chains', 'slicing up the value chain', 'global production sharing', or 'trade in tasks' which all describe the location of different stages of the production process in different locations.

the host country (Antràs, 2005; Nunn, 2007; Du *et al.*, 2012).[2] The concept of an institutional environment refers to a wide range of social factors, rules, beliefs, values and organizations that jointly motivate regularity in individual and social behavior, which affect the efficiency of the responses to the investment of relationship-specific assets in the collaborative relationships (Antràs, 2005; Aeberhardt *et al.*, 2014). Recent studies have also found that the differences in the institutional environment could be a source of competitive advantages in North-South trade (Levchenko, 2007; Antràs and Helpman, 2008; Chor, 2010; Levchenko, 2013). Moreover, the institutional environment in the host countries has a greater impact on the effects of strategic decisions that are more susceptible to relationship-specific investments and the commitment of corresponding collaborative relationships (Defever and Toubal, 2007). Thus, it is an interesting issue in addressing the moderating role of institutional quality in the host countries when the firms develop an offshore R&D strategy based on their local collaborative relationships in order to raise firm productivity.

Despite an increasing number of studies that have been conducted to examine the effect of the differences in the institutional environment on North-South trade (Nunn, 2007; Du *et al.*, 2012), for example, Ranjan and Lee (2007) show that bilateral trade volumes are more affected by institutional quality across countries,[3] few studies have examined the moderating role of institutional quality in the different kinds of operating mode in the host country when firms develop an offshore R&D strategy to raise firm productivity. More importantly, the effects of instructional quality are different for different kinds of firms' operating modes in the local environment and for the specific characteristics of technological assets.[4] We expect to provide significantly different results and significant contributions on the moderating roles of institutional quality in the host country for different kinds of operating mode, with particular emphasis on the effects on the relationship between offshore R&D and firm productivity.[5]

Taiwan is a significant emerging economy in the world and its overseas exploitative and explorative activities have recently grown (Chen and Chen, 2002; Chen and Chen, 2003; Chuang and Lin, 2011). Taiwan-based firms usually confront more liability of foreignness (or smallness)

[2] For example, Bernard, Jensen, Redding and Schott (2010a). Bernard, Jensen, Redding and Schott (2010b). estimate the effect of product contractibility and countries' institutions on the choice of intra-firm trade. Antràs and Foley (2011). examine how the choice of financial terms in international transactions depends on the institutional quality in the importing and exporting countries.

[3] Most empirical studies focus on the relationships between trade/FDI and institutional quality. For example, Depken and Sonora (2005). find that US exports are positively related with economic freedom in the rest of the world. Ranjan and Lee (2007). show that the institutional quality in the south affect bilateral trade flows. Turrini and Ypersele (2010). show that differences among legal systems affect trade flows. Aeberhardt, Buono and Fadinger (2014)., Araujo, Mion and Ornelas (2012). and Söderlund and Tingvall Gustavsson (2014) find that improved institutional quality in the host country will raise the survival rate of exporter and trade flows. In addition, the theoretical framework regarding firms' offshore decisions in relation to institutions is derived from the Grossman-Hart-Moore property rights models developed by Grossman and Hart (1985). Hart and Moore (1990). Grossman and Helpman (2003). Grossman and Helpman (2005). show that a good contracting environment increases a firm's propensity to offshore its activities. Antràs and Helpman (2008). show that the firms must choose not only between producing in-house and producing outside the firm (outsourcing) but also between producing at home and producing abroad. Grossman and Rossi-Hansberg (2012). suggest that tasks that are easily codified will tend to be offshored to countries with the lowest factor costs, whereas advanced tasks will be offshored to high-wage countries.

[4] March (1991). argues about the duality in inter-organizational activities: exploitation and exploration. Exploitative activities refer to the leveraging of existing capabilities, while explorative activities refer to the creation of new knowledge capabilities ibid., Levinthal and March (1993). Belderbos, Faems, Leten and Van Looy (2010). Cantwell, Dunning and Lundan (2010). Levchenko (2013). Similarly, Cantwell and Mudambi (2005). distinguish between different types of capabilities based on the firms' competence terminology. The competence-exploiting mode refers to the adaptability of products and processes to local conditions, while the mode to undertake product development, or some responsibility for international strategy development, is referred to as a competence-creating mode. Thus, the operating modes in this study are distinguished as being either exploitation-oriented or exploration-oriented.

[5] To examine the moderating role of institutional quality in this study, the term "offshore R&D" here refers to the relocation or transfer of R&D services in local R&D networks, while the subsidiary R&D is included in the control variables.

than those from developed economies, which results in their being more likely to utilize inter-organizational collaboration in foreign locations in order to benefit from the collaborative advantages in the host countries. The offshore R&D strategy in this study is thus considered as the sourcing of R&D services through inter-firms activities in the local R&D networks rather than simply contracting-out to other independent legal entities based on explicit contracts specifying outsourced tasks. Finally, our study benefits from the longitudinal dataset information for Taiwan-based firms covering the 2006-2009 period.

Following on from this introduction, the remainder of this paper is organized as follows. Section 2 provides an introduction to the research methodology adopted, including the empirical model, the data sources and the variable selection employed in the estimations. The empirical results of the estimations are presented and interpreted in the penultimate section, Section 3, before the paper concludes with some remarks on the findings in Section 4.

## 2. METHODOLOGY

### 2.1. Data Sources

A longitudinal dataset is compiled by the Department of Statistics of the Ministry of Economic Affairs, Taiwan for 2006-2009. The Report on Foreign Investment Strategies of the Manufactures provides information on the basic characteristics of the firms in Taiwan's manufacturing industry and their most prominent subsidiaries based on the amount of investment from a list of 18 countries and regions. To examine the different kinds of operating mode in the local environment and the specific characteristics of technological assets, the sample is classified into two categories based on their operating mode in the host countries. A firm is considered to be exploration-oriented when the operating mode in the host country is 'product design and innovation', or 'ODM for brand marketers'. On the other hand, when the operating mode is only 'manufacture and sale for the local market' or 'OEM for brand marketers', it is considered to be exploitation-oriented.

While the USA and the Association of Southeast Asian Nations (ASEAN) countries were previously the major destinations for Taiwan-based firms until the 1990s, China, in particular, has become the most popular destination for Taiwan-based firms. China is a very attractive and highly preferred destination for most Taiwan-based firms owing to cultural and language similarities along with lower labor costs and huge market size, even though the investment risk in China is very high. Table 1 shows the distribution of offshore R&D and institution al quality in the host country for the periods 2006-2009. China, on average, is found to have the largest number of observations among the host countries, followed by the U.S. and Hong Kong. Interestingly, the share of engaging in an offshore R&D strategy in DCs is larger than that in LDCs.[6] At the same time, the U.S. (19) accounts for the largest number of firms developing an offshore R&D strategy among developed countries, while China (225) accounts for the largest number of firms developing an offshore R&D strategy among developing countries. Moreover, the larger share in terms of the number of Taiwan-

[6] The terms DCs and LDCs represent developed countries and less developed countries, respectively. Following Makino, Lau and Yeh (2002)., we place countries in North America (U.S. and Canada) and Western Europe, as well as Hong Kong, Singapore and Japan in the DCs group, while we place Central/South American, African and other ASEAN countries into the LDCs group.

based firms developing an offshore R&D strategy firms is found in those host countries with a higher level of institutional quality. We can thus see the important role played by the Taiwan-based firms in offshore R&D and the influence of institutional quality in the host countries.

**Table-1.** The Distribution of Offshore R&D and Institutional Quality by Country

| | Number of Firms (1) | Firm's Engaging in an Offshore R&D Strategy | | Institutional Quality (4) |
|---|---|---|---|---|
| | | Number (2) | % of Firms (3)=(2)/(1) | |
| DCs | 91 | 32 | 35.16 | 6.93 |
| United States | 52 | | 36.53 | 7.56 |
| Hong Kong | 23 | | 30.43 | 7.38 |
| Japan | 6 | | 50.00 | 6.40 |
| Singapore | 6 | | 50.00 | 8.54 |
| Canada | 4 | | 0 | 4.80 |
| Taiwan | | | | 5.50 |
| LDCs | 961 | 242 | 25.18 | 4.57 |
| China | 905 | | 24.86 | 6.85 |
| Thailand | 19 | | 36.84 | 6.26 |
| Malaysia | 19 | | 26.31 | 5.16 |
| Indonesia | 12 | | 25.00 | 1.20 |
| Philippines | 6 | | 33.33 | 3.40 |
| Total | 1,052 | 274 | 26.04 | |

**Notes:** 1.Source: Statistical Dept. of the Ministry of Economic Affairs, 2006-2009, Survey Data.
2. When a firm has experience buying or cooperating with the following local counterparts: (1) business partners, (2) firms in joint research projects, and (3) rivals in the same industry in terms of R&D services, the firm is considered to be an offshore R&D firm.
3. The institutional quality index used in this study is a measure of the legal enforcement of contracts developed by the World Economic Forum (WEF). This index is constructed based on two main components of the time cost and the money cost of the debt. The institutional quality index ranges from 0 to 10 with higher numbers reflecting better levels of institutional quality.
4. The terms DCs and LDCs represent developed countries and less developed countries, respectively.
5. The numbers in the table are mean value over the 2006-2009 period.

Table 2 shows the operating modes in the host country for Taiwan-based firms for the periods 2006-2009. First of all, 'manufacture and sale for the local market' is found to account for more than 60% of the cases, reaching 69.96% in 2007, followed by 'OEM for brand marketers' (more than 31%) and 'ODM for brand marketers' (more than 10%), 'Product design and innovation' is in fourth place. We can thus see that the main operating modes in the host country by Taiwan-based firms are still focused on exploitation-oriented activities based on existing knowledge such as 'manufacturing and sale' and 'OEM for brand marketers'. Interestingly, the proportion of exploration-oriented activities to augment firm's capabilities such as 'ODM for brand marketers' and 'product design and innovation' are found to exhibit an increasing trend over time. The statistics indicate that the case of Taiwan-based firms will provide more evidences from the emerging economies perspective. As a result, it is worth examining the heterogeneities on the influence of offshore R&D on firm productivity for different kinds of firm operating mode in the host country.

**Table-2.** Taiwan-based Firm's Operating Modes in the Host Country Unit: %

| | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| - Manufacture and Sale | 61.21 | 69.96 | 68.86 | 67.72 |
| - OEM for Brand Marketers | 31.55 | 38.40 | 40.30 | 40.06 |
| - ODM for Brand Marketers | 6.08 | 13.30 | 11.40 | 14.44 |
| - Product Design and Innovation | 4.94 | 5.70 | 6.84 | 7.04 |
| - Others | 6.78 | 4.57 | 5.57 | 7.66 |

**Note** 1.Source: Statistical Dept. of the Ministry of Economic Affairs, 2006-2009, Survey Data.
2. Others mode includes 'distribution and wholesale in the local market' and other options.

### 2.2. Econometric Model

Based on the discussion regarding the effect of offshore R&D on firm productivity and the moderating role of institutional quality in the host country, the augmented Cobb-Douglas knowledge stock model can be parameterized as:

$$Y_t = Af(K, L, D) = AK_t^{\alpha_1} L_t^{\alpha_2} D_t^{\gamma} e^{\mu t} \quad (1)$$

where $Y, K, L, D, A$ are output, capital, labor, the knowledge stock and the efficiency of production, respectively; $\mu$ is a vector of other influences. The firm productivity is measured as:

$$\ln TFP_t = \ln Y_t - \alpha_1 \ln K_t - \alpha_2 \ln L_t \quad (2)$$

To obtain an estimable equation, we specify the empirical model and add control variables as follows:

$$\ln TFP_{it} = \beta_0 + \beta_1 \ln firm_{it} + \beta_2 \ln host_{it} + \beta_3 Indu_{it} + \varepsilon_i + \mu_{it} \quad (3)$$

where firm, host, and Indu are the vectors of firm-specific factor host country factors, and industry dummies, respectively, the $\beta_s$ are parameters to be estimated, the $\varepsilon_i$ are the unobservable individual specific factors and $\mu_{it}$ is a stochastic term. Finally, the subscripts i and t denote observation and year, respectively. We specify two types of panel date estimators, fixed effects (FE) and random effects (RE), to explore the moderating role of institutional quality in the host country in terms of the effects of offshore R&D on the firm productivity and compare the role of institutional quality in the host country between exploration-oriented and exploitation-oriented modes after disentangling the time invariance firm-specific effects and unmeasured heterogeneity.[7] Since the key consideration is the orthogonality of $\varepsilon_i$ and the independent variables, we compare the fixed-effects model with the random-effects model using the Hausman test in order to evaluate the more appropriate model. [8]

### 2.3. Variable Selection

The variables used in the empirical analysis are defined as follows. The dependent variable in this study is proxied by total factor productivity.[9] To avoid the confounding effect of related

[7] The panel data model has several advantages over cross-sectional or time-series data Hsiao (2003). First of all, the panel data model provides more accurate inferences regarding the model's parameters because the panel data model contains more degrees of freedom and more sample variability than cross-sectional data. Secondly, the panel data model has greater power to cope with the complexity of individual behavior than a model based only on cross-sectional or time series data. Thirdly, the panel data contain more information on individual behavior that allows us to control for the missing or unobserved variable effects.

[8] It is a standard estimation method for the panel data model, such as the fixed-effects (FE) or random-effects (RE) techniques, and is used to eliminate the individual effect. If $\varepsilon_i$ is uncorrelated with the independent variables, then the random effects are appropriate estimators. Otherwise, the fixed effects should be selected. The Hausman test is thus provided to evaluate the more appropriate model.

[9] Many empirical studies adopt a firm's productivity such as total factor productivity (TFP) and labor productivity to assess the contributions of technological knowledge Cantwell, Dunning and Lundan (2010), Huang, Hou and Yang (2012). In particular, TFP is a better index for examining the firm's productivity than labor productivity. The details for computing TFP in this study are provided in Appendix B.

variables, three types of explanatory variables are employed in the empirical analysis. The first one comprises the firm-specific factors that include the market importance, firm size, overseas experience, parent R&D, subsidiary R&D, and offshore R&D strategy. The second one consists of the host countries characteristics, which account for the local environment faced by the firms. The factors include local demand growth, local technological capacity, and institutional quality in the host countries (LIQ). Finally, two industry dummies (hi-tech industry and basic industry) are included that control for the difference in technological opportunity in different kinds of industry.[10]

The offshore R&D strategy is thus here operationalized as the amount of local counterparts, which provide the R&D services through inter-firm activities, which includes pure arm's length transactions and technological collaborations in terms of joint scientific projects. Three Yes-No items are used according to whether a firm has experience of buying or cooperating in terms of R&D services with the following local counterparts: (1) business partners, (2) firms in joint research projects, and (3) rivals in the same industry in the local market.[11] We use the sum of the three items and an index ranging from 0 to 3, so that the higher the value is, the greater the extent to which an offshore R&D strategy is employed by a firm in this analysis. In addition, Indexes for the degree of institutional quality in the host countries are obtained from the World Economic Forum (WEF). The institutional quality index used in this study is a measure of the legal enforcement of contracts developed by the World Economic Forum (WEF). This index is constructed based on two main components of the time cost and the money cost of the debt. The institutional quality index ranges from 0 to 10 with higher numbers reflecting better levels of institutional quality.

Table 3 summarizes the average basic statistics, definitions and measurement of the main variables based on operating mode. Some interesting points are worth mentioning. Firms are found on average to have similar firm size and overseas experience regardless of the different operating modes. Secondly, exploitation-oriented firms are found to exhibit superior productivity and to face greater parent R&D and higher market importance, while exploration-oriented firms are found to have greater subsidiary R&D and to engage in more offshore R&D strategy in local R&D networks. The statistics lead us to again conclude that exploration-oriented are significantly different in terms of the basic characteristics from those exploitation-oriented firms. As a result, it is worth re-examining the role of institutional quality in the host country in terms of the influence of offshore R&D strategy on their productivity for different kinds of operating mode.

[10] The hi-tech industry dummy includes the electrical and electronic machinery industries and machinery industries, while the basic industry dummy consists of the chemical and chemical product industries, rubber and plastic product industries, and primary metal and metal product industries, respectively.

[11] The word "cooperation" in Chinese indicates that a long-term and stable relationship has been formed and that can create new market values together with mutual trust rather than pure transactions Chiao, Yang and Yu (2006). In addition, the term business partners includes the important suppliers, customers and other business partners.

**Table-3.** Descriptive Statistics for Main Variables (2006-2009 Period)

| Variable | Full Sample | Firm's Operating Mode in the Host Country | |
|---|---|---|---|
| | | Exploration -Oriented | Exploitation -Oriented |
| Firm Productivity<br>Total Factor Productivity | 8.35<br>(1.83) | 8.15<br>(1.79) | 8.67<br>(2.01) |
| Market Importance<br>Subsidiary sale/ firm sale | 0.48<br>(0.26) | 0.46<br>(0.29) | 0.53<br>(0.27) |
| Operating Mode<br>1 for Exploration, 0 for Exploitation | 0.29<br>(0.45) | – | – |
| Firm Size<br>Log (Firm sale) | 12.36<br>(1.86) | 12.51<br>(1.85) | 12.33<br>(1.86) |
| Overseas Experience<br>Years of overseas operation | 10.50<br>(3.92) | 10.79<br>(4.04) | 10.38<br>(3.86) |
| Parent R&D<br>Log (Domestic R&D stock/ Firm labor) | 4.38<br>(2.55) | 4.16<br>(2.34) | 4.89<br>(3.61) |
| Subsidiary R&D<br>Log (Subsidiary R&D stock/ Subsidiary labor) | 1.73<br>(3.01) | 2.10<br>(2.17) | 1.31<br>(3.08) |
| Offshore R&D | 0.31<br>(0.57) | 0.35<br>(0.64) | 0.29<br>(0.55) |
| Local Market Growth<br>Log (Subsidiaries' sales growth*100) | 0.72<br>(2.48) | 0.74<br>(2.44) | 0.71<br>(2.51) |
| Local Technological Capacity<br>Log (Average number of patents applied for) | 7.03<br>(1.04) | 7.19<br>(1.06) | 6.96<br>(1.03) |
| Institutional Quality in Host Country | 6.78<br>(0.79) | 6.70<br>(0.83) | 6.84<br>(0.76) |
| Observations | 1,052 | 308 | 744 |

**Notes:** 1. Source: Statistical Dept. of the Ministry of Economic Affairs, Survey Data, 2006-2009.
2. The exploration-oriented firms refer to those whose operating mode in the host countries is "product design and innovation", or "ODM for brand marketers"; when their operating mode in the host countries is only "manufacturing and sales for the local market" or "OEM for brand marketers", in which they are considered to be exploitation-oriented.
3. Local technological capacity is defined as the average number of patents applied by the host country to U.S. patents in the past three years.
4. The offshore R&D is operational defined as the sum of the three yes-no questions according to a firm's experience to buy or to "cooperate" with the following counterparts: (1) business partners, (2) firms in joint research projects, and (3) rivals in the same industry in the local market in terms of R&D services.
5. According to the perpetual inventory method (Mairesse and Hall, 1996; Chuang and Lin, 2010; Chuang and Lin, 2011), the R&D stock is constructed from past R&D flows with a depreciation rate of 15% per year.
6. The descriptive statistics in Table 3 are mainly the mean value and standard deviation, respectively.
7. The institutional quality index used in this study is obtained from the World Economic Forum (WEF).
8. All variables are deflated by the corresponding price deflator.

## 3. EMPIRICAL RESULTS

Given the above methodology and dataset as well as the selection of variables, the empirical results are presented in Table 4 using the panel data model. The statistics obtained from the Hausman tests and F-tests as shown in Table 4 are significant at the 1% statistical level indicating that the fixed effects model is more appropriate.[12] There are two parts to the empirical results. First of all, columns (1)–(2) examine our hypothesis for the full sample to evaluate the moderating effect of institutional quality in the host countries. The first model contains all the variables with the exception of institutional quality and the offshore R&D strategy. The second model includes both the main and control variables. Next, to compare the effects of the firm's operating modes in this analysis, columns (3)-(6) provide the empirical results for the exploration-oriented and

[12] The F tests indicate that the unobserved effects are relatively important and the fixed effect model is more appropriate than the pooled OLS model. Moreover, the empirical results of using the Pooled OLS approach show that only a few estimated coefficients such as firm size, the offshore R&D .etc. are significant, and most estimates of the estimated coefficients are found to have unexpected signs. So the estimator for the Pooled OLS model is likely to be poorly behaved.

exploitation-oriented modes, and columns (5) and (6) represent the full model, which includes the main variables as well as the interaction variable of institutional quality and offshore R&D strategy.

**Table-4.** Results of the Panel data Model over 2006-2009 Period

| Variable | Full Sample | | Firm's Engaging in Offshore R&D Based on Operating Mode | | | |
|---|---|---|---|---|---|---|
| | Model (1) | Model (2) | Model (3) Exploration -Oriented | Model (4) Exploitation -Oriented | Model (5) Exploration -Oriented | Model (6) Exploitation -Oriented |
| Constant | 3.793*** | 2.942** | 5.834*** | -7.573* | 4.646** | -7.943* |
| | (2.88) | (2.02) | (2.92) | (-1.92) | (2.25) | (-1.95) |
| Firm Size | 0.242*** | 0.230*** | 0.185* | 0.574*** | 0.186* | 0.587*** |
| | (2.79) | (2.65) | (1.79) | (2.64) | (1.81) | (2.70) |
| Overseas Experience | -0.018* | -0.020* | 0.038 | -0.037* | 0.038 | -0.040* |
| | (-1.73) | (1.89) | (1.42) | (-1.82) | (1.45) | (-1.90) |
| Operating Mode | -0.011* | -0.013* | - | - | - | - |
| | (-1.95) | (-1.71) | | | | |
| Market Importance | 0.218** | 0.185* | 0.234** | 0.186** | 0.147** | 0.188** |
| | (2.52) | (1.94) | (2.40) | (2.51) | (2.37) | (2.48) |
| Parent R&D | 0.060** | 0.062** | 0.128* | 0.669*** | 0.120* | 0.667*** |
| | (2.09) | (1.99) | (1.78) | (3.35) | (1.93) | (3.17) |
| Subsidiary R&D | 0.204*** | 0.201*** | 0.299*** | 0.505** | 0.291*** | 0.578*** |
| | (3.76) | (3.76) | (4.24) | (2.51) | (4.12) | (3.84) |
| Offshore R&D (ORD) | 0.397*** | 0.373** | 0.473** | 0.664*** | 0.485** | 0.578** |
| | (3.20) | (2.21) | (2.29) | (3.21) | (2.37) | (2.17) |
| Local Tech Capacity | -0.017 | 0.015* | -0.018 | 0.261* | -0.011* | 0.317** |
| | (-1.21) | (1.66) | (-1.15) | (1.74) | (-1.08) | (2.02) |
| Local Market Growth | -0.001 | 0.002* | 0.005 | 0.001** | 0.008 | 0.001** |
| | (-0.58) | (1.78) | (1.05) | (2.24) | (1.03) | (2.36) |
| Institutional Quality (LIQ) | 0.054* | 0.078* | 0.013 | 0.612* | 0.008 | 0.546** |
| | (1.81) | (1.70) | (1.62) | (1.64) | (1.53) | (2.07) |
| LIQ*ORD | - | 0.482** | - | - | -0.645** | 0.946*** |
| | | (1.98) | | | (-2.19) | (2.87) |
| Hi-Tech Industry | 0.394* | 0.414* | 0.567* | 0.571** | 0.578* | 0.402** |
| | (1.88) | (1.65) | (1.79) | (1.99) | (1.86) | (1.98) |
| Basic Industry | 0.491* | 0.473* | 0.087 | 0.253* | 0.080 | 0.233* |
| | (1.88) | (1.85) | (1.15) | (1.91) | (1.14) | (1.88) |
| Adjusted R2 | 0.512 | 0.529 | 0.488 | 0.524 | 0.493 | 0.535 |
| F- Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hausman Test | 46.35 | 46.31 | 34.68 | 22.75 | 32.90 | 25.34 |
| Observations | 1,052 | 1,052 | 308 | 744 | 308 | 744 |

**Notes:** 1. The dependent variable is the firm productivity.
2. The numbers in the parentheses are t statistics except those for the F-test that are p-values.
3. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

First of all, the empirical results regarding the control variables are consistent with the previous empirical studies. The estimated coefficients of firm size in columns (1)-(6) are both positive and significant which indicates that larger firms, regardless of whether they are exploration-oriented or exploitation-oriented, will have better resources and skills to gain a better

firm productivity than smaller ones. Since a large-scale operation can benefit from economies of scale both in production and distribution activities in host countries, firm productivity can thereby be raised. The positive and significant estimated coefficient in columns (1) - (6) provide evidence that a higher degree of market importance will be more likely to have the organizational resources, skills and opportunities for local market penetration (Motohashi, 2006), thereby raising firm productivity. On the contrary, the significant and negative coefficients for overseas experience in columns (4) and (6) indicate that only the exploitation–oriented firms with more overseas experience may be liable to experiencing some form of inertia, thereby reducing firm productivity, while there is no direct effect on exploration-oriented firms.

Turning to the technology-specific factors, the estimated coefficients of parent R&D in column (1) –(6) indicate that a increase in R&D at home often help firms to exploit their firm-specific advantage in global markets (Siler *et al.*, 2003) and/or to enhance their absorptive capacity for technology learning from local counterparts (Cantwell and Mudambi, 2005), which in turn will raise firm productivity. The significant estimated coefficients of subsidiary R&D indicate that firms that engage in more R&D activities in their foreign location indeed create the opportunities to access the desired technological capabilities and markets, which in turn will raise firm productivity (Marin and Sasidharan, 2008). These empirical results for the offshore R&D strategy in column (1) –(6) are consistent with the previous empirical studies (Hallin *et al.*, 2011) and indicate that the firms should seek the complementary resources and market opportunities through the utilization of an offshore R&D strategy in local R&D networks to enhance firm productivity.

As for the host country's environment, the positive and significant coefficient of institutional quality only in columns (4) and (6) implies that better institutional quality in the host countries will provide opportunities for firms to exploit their current capability, thereby enhancing their productivity. Moreover, the significant local market growth that appears only in columns (5) and (7) provides evidence that local demand growth in the host countries plays a crucial role in exploiting their current capability and resources, thereby enhancing their firm productivity, while there is no direct effect on exploration-oriented firms. Finally, the significant coefficients in columns (4)- (6) indicate that the firms in hi-tech industries and the exploitation-oriented firms in basic industries often have better firm productivity.

Our main concern in this empirical analysis is to assess whether the moderating effects of institutional quality in the host countries are sensitive to the different kinds of operating mode in the host countries when firms develop offshore R&D based on local collaborative relationships to raise their firm productivity. The significant coefficients of the moderating role of institutional quality in columns (5) and (6) support our hypothesis which indicates that there are different moderating effects of institutional quality in the host countries between the exploration-oriented and exploitation-oriented modes in the host country. On the one hand, the positive and significant coefficients in column (6) imply that when firms customize their existing products, production methods and technological capabilities for the local market by developing an offshore R&D strategy based on local collaborative relationships, the doubts over the ex post opportunistic

behavior due to the poor institutional quality in the host countries will reduce the influences of offshoring an R&D strategy on their firm productivity (Nunn, 2007; Du *et al*., 2012). In this case, if the host governments raise the institutional quality in their local environment, more substantial relationship-specific investments and the commitment of corresponding collaborative relationships will result, which in turn will result in(exploitation-oriented) firms being attracted and will enable them to raise the efficiency of their existing products and technological capability in the host country. On the other hand, the negative and significant estimated coefficient in columns (5) provides evidence that when firms wish to augment their technological knowledge or capabilities from the corresponding local firms with complementary capabilities by developing an offshore R&D strategy based on local collaborative relationships, the institutional quality in the host countries will have a negatively moderating effect on the offshore R&D strategy–/firm productivity relationships. To reduce the frictions and foster a mutually beneficial environment when parties with competing interests enter into a collaborative relationship, the host government should lower their institutional quality to some extent so that (exploration-oriented) firms will face less rivalry and greater opportunities for technology learning, thereby enhancing the effect of utilizing an offshoring R&D strategy on firm productivity.

To sum up, these empirical results lead to an interesting conclusion in that institutional quality in the host country indeed significantly moderates the effect of offshore R&D based on collaborative relationships on firm productivity. Of particular note, the moderating role is found to have totally different influences on the exploitation-oriented and exploration-oriented operating modes.

## 4. CONCLUSION

This study has presented a comprehensive empirical framework to examine whether there are different moderating effects of institutional quality in the host countries for different kinds of firm operating modes in the host country. Two important implications arise from the above findings. First of all, when (exploitation-oriented) firms customize their existing products, production methods and technological capabilities for the local market, the level of familiarity with the local environment shapes their success in developing an offshore R&D strategy based on their collaborative relationships in the host countries. To avoid doubts over contract enforcement and ex post opportunistic behavior, a higher level of institutional quality in host countries will encourage firms to develop an offshore R&D strategy, which in turn will raise the efficiency of their existing products, productions and firm productivity.

Secondly, when (exploration-oriented) firms wish to augment their technological knowledge or capabilities from the corresponding local firms with complementary capabilities, the institutional quality in the host countries has a negatively moderating effect on the offshore R&D strategy–firm productivity relationships. This result is different from those of extant studies in the previous literature. To reduce the friction and foster a mutually beneficial environment, if the host governments can lower their institutional quality to some extent, (exploration-oriented) firms will

face less rivalry and have greater opportunities for learning technology, thereby enhancing the effect of the offshore R&D on firm productivity.

The empirical analysis in this study has some limitations and there are several directions for future research that are also worth mentioning. First of all, although the sample in this study consists of a longitudinal dataset (2006-2009), the limited time series cannot fully explain the time-dimensional difference in terms of the basic characteristics across firms and their most prominent subsidiary. Secondly, only a dataset consisting of Taiwan-based firms has been employed in this empirical analysis. Thus, the findings of our study should be interpreted with caution. Despite there being some limitations, this empirical analysis does, however, still provide some interesting results that should be of value in the field of developing an offshore R&D strategy with local counterparts that face different kinds of firm operating mode in the host countries.

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## Appendix

The firm productivity index is calculated separately for each firm of the three-digit industries in the manufacturing sector. The multilateral TFP index has been adopted by Aw *et al.* (2001) and is constructed by the industry mean level of log output, log input, and input cost shares in this study. The TFP index for firm $i$ in year $t$ is thus calculated as follows:

$$\ln TFP_{it} = \left(\ln VA_{it} - \overline{\ln Q_t}\right) + \sum_{s=2}^{t}\left(\overline{\ln VA_s} - \overline{\ln VA_{s-1}}\right) - \left[\sum_j \frac{1}{2}\left(\alpha_{ijt} + \overline{\alpha_{jt}}\right)\left(\ln X_{ijt} - \overline{\ln X_{jt}}\right)\right] + \left[\sum_{s=2}^{t}\sum_j \frac{1}{2}\left(\overline{\alpha_{js}} + \overline{\alpha_{j(s-1)}}\right)\left(\overline{\ln X_{js}} - \overline{\ln X_{j(s-1)}}\right)\right]$$

where $\ln VA_{it}$, $\ln X_{ijt}$, and $\alpha_{ijt}$ are the log value added, input j, and the cost share of input $j$ for firm $i$ in year $t$. $\overline{lnVA_t}$, $\overline{lnX_{jt}}$, and $\overline{\alpha_{jt}}$ are the mean of the corresponding variable for all firms in the industry in year $t$. The first term is the deviation of firm $i$'s value added from the industry mean level in year $t$, and the second term captures the growth of industry value added relative to the initial year. The last two terms are the same operations for the deviation of input usage weighted by

the corresponding cost shares of inputs. Firm value added is defined as the production value deflated by a wholesale price index defined at the three-digit industry level. We use two inputs in the production to construct the TFP: labor and capital. The labor input is measured by the number of employees. Labor expenditures are measured as total salaries paid by the firm. We use the book value of the capital stock of the firm as the measure of capital input. In addition, we deflate the change in each firm's book value by a price index for new capital goods. The cost shares for labor and capital are measured as the input expenses divided by the value of firm output.