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**Determination of Optimal Location in Fragmented Production System:  
A comparison of the 80 Provinces in the Philippines.**

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**Abstract**

Globalization has further intensified competition which compel the firms to lower their productions cost by fragmenting the production processes and transferring them to appropriate locations. Identification of optimal locations is very significant in this system of production. This paper presents the steps undertaken in establishing prospective locations and analyzes the influence of transfer price and corporate taxation system in the determination of locations. With the assumption that the Philippines is within the prospective area, the paper conducts a comparison of economic and social conditions among the 80 provinces in the Philippines. This study elucidates the two-steps in determining prospective location: first, across countries, and second, among regions or provinces of the selected country. During the first-step, chaotic phenomenon has occurred which showed several potential locations that can guarantee in achieving the target profits. On the second-step, based on the comparison of the provinces, Metro Manila and the neighboring provinces have the highest provincial dynamism scores which denote the favorability of both economic and social conditions those provinces. On the other hand, provinces in Mindanao, particularly in the Autonomous Region of Muslim Mindanao (ARMM) have relatively adverse economic and social conditions.

Keywords: Factory's location, Chaotic phenomenon, Location targeted area, Regional development, Spatial disparity

JEL: R.12, R.30, O.18, O.53.

## 1. Introduction

In order to complete expanding their businesses, firms lower their production costs by cutting the production processes into different parts and assigning them to appropriate locations. Fragmentation of the production processes ranges from highly-complex process to simple production processes. In the identification of the potential location of these production processes, the candidate location's presence of production factors and quality of living are taken into account. For example, simple production processes are oftentimes dispersed to many developing countries where there are abundant supplies of cheap unskilled labor. This relocation of the factories entails a huge cost. However, savings from the low labor costs offset this cost and allow profit-maximization. Therefore, fragmentation of production processes facilitates further expansion of the factories which have become widespread in the late 20<sup>th</sup> century.

Choosing a potential location is therefore an utmost important in this system of production. There are some location factors to be considered when choosing potential locations in a large geographical space including several countries: characteristics of economic activity, corporate taxation system and social conditions in each country. The determination of the potential locations sites is first decided at a country-level and then at regional or provincial-level.

Selection of potential location at the country-level takes into account each country's economic and social conditions as well as the taxation system. Accordingly, firms will only consider transferring to potential sites with good economic and social conditions and relatively wide production base<sup>1</sup>. Moreover, the country's tax system should be considered because all profits made by the factories are subject to taxes imposed by the country's national or local government. On the other hand, the government also needs to understand the firm's profit management to establish appropriate taxes and transfer prices. Firms compare the different countries' taxation system and estimate transfer price when choosing the potential location<sup>2</sup>.

Determination of the prospective locations at the specific region or provinces considers attributes such as infrastructure, education, culture, housing, safety, and welfare. This is due to the fact that these factors play decisive roles in firms' production, sales, and research and development. Furthermore, the decision to reside in a particular place is influence by the natural environment, educational institutions, culture, housing, safety and welfare support. Given the fact that the citizen's activities might have an impact on production efficiency as well as quality improvement, it is necessary to evaluate the region's economic and social features.

This paper has three main objectives. First, the analysis introduces the two-step decision process of the establishing prospective locations. Secondly, the analysis incorporates transfer price system and corporation system in the analysis of prospective locations. Third, assuming that the Philippines

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<sup>1</sup> For more information about the potential location, see Ishikawa (2010).

<sup>2</sup> This area is extensively studied by Hirshleifer (1956), Bond (1980) and Eden (1985).

is one of the prospective locations, this paper compares the economic and social conditions of 80 provinces.

The paper is organized as follows: Section 2 explains the framework for analyzing the location decision of the firms and derivation of optimal transfer prices and prospective area. Section 3 analyzes the impact of country's taxation system on the transfer price, location decision, and company's profit. Section 4 evaluates the economic and social conditions of 80 provinces in the Philippines. Section 5 concludes the paper.

## 2. Location decision-making and optimal transfer price

### 2.1 Derivation of the profit function of a firm

The following assumptions are placed and the framework for the analysis is formed in this section. A transnational firm produces goods by using two production processes, the first process, and the second process. The factory 1 which is assigned to the first process manufactures intermediate goods,  $m_4$ , in home country. The intermediate goods produced at factory 1 are transported to the factory 2 by the transfer price  $m_{q4}$ , which locates at a city in a foreign country. The factory 2 uses one unit of the intermediate goods to produce one unit of the final goods. And the factory sells the finished goods by the price  $p$  to the market which is at the same city in the foreign country. The tax rates of home and foreign country are represented by  $t$  and  $t^*$ , respectively.

The profits of the factory 1 is given by equation (1)

$$Y_1 = (1 - t)[mp_4 \cdot m_q - C(m_q) - F_1] \quad (1)$$

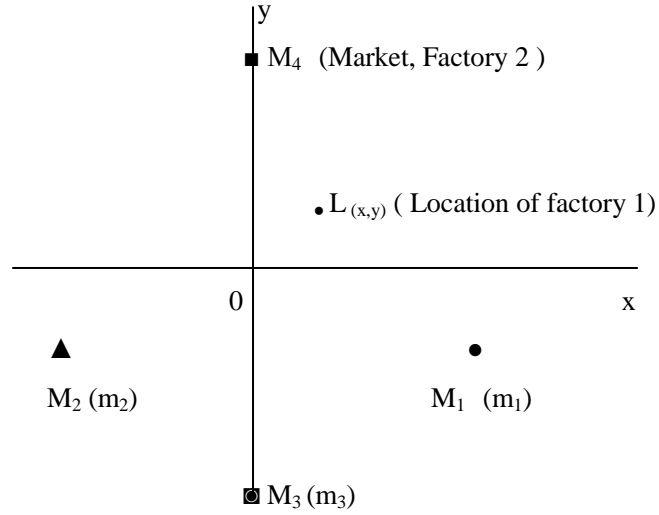
where  $m_q$  is quantity of the finished goods,  $C(m_q)$  is the cost function and  $F_1$  is fixed costs. The cost function  $C(m_q)$  of the factory 1 is derived on the basis of the following assumptions: The factory 1 uses two different kinds of materials  $m_1$ ,  $m_2$  to produce the final goods  $m_q$ . And the factory uses lubricating oil  $m_3$  to operate machines. The materials  $m_1$ ,  $m_2$  and oil  $m_3$  are produced at points  $M_1$ ,  $M_2$  and  $M_3$  which are identified by coordinates  $(x_1, y_1)$ ,  $(x_2, y_2)$ ,  $(x_3, y_3)$ , respectively, on a large plain space. These materials are transported to the factory 1 at point L indicated by  $(x, y)$ . Freight rates of the materials  $m_1$ ,  $m_2$  are denoted by  $t_m$ , and the rate of the oil  $m_3$  is given by  $t_e$ . Mill prices of these are shown by  $p_1$ ,  $p_2$ , and  $p_3$ , and these prices are given. The intermediate goods are transported from the factory 1 to the factory 2 which locates at the market at point  $M_4$   $(x_4, y_4)$ . The freight rate of the intermediate goods  $m_q$  is  $t_g$ . Figure 1 illustrates the geographical relationship between the factory 1, the factory 2, the market and the points of the three materials.

The production function of the factory 1 is represented by equation (2):

$$m_q = Am_1^a m_2^b \quad (2)$$

where  $A$ ,  $\alpha$  and  $\beta$  are parameters and they are defined as  $A > 0$ ,  $0 < (\alpha + \beta) < 1$ .

**Figure 1 Location figure of the factory 1**



The distances between the material places,  $M_i$  ( $i=1, 2,3$ ) and the factory1,  $L(x,y)$  are represented by  $d_1$ ,  $d_2$   $d_3$ , respectively:

$$d_1 = ((x - x_1)^2 + (y + y_1)^2)^{0.5}, \quad (3a)$$

$$d_2 = ((x+x_2)^2 + (y +y_2)^2)^{0.5}, \quad (3b)$$

$$d_3 = (x^2 + (y + y_3)^2)^{0.5}. \quad (3c)$$

The distance between the factory1 and the factory 2 which locates at the finished market  $M_4$  is given by  $d_4$ :

$$d_4 = (x^2 + (y-y_4)^2)^{0.5}. \quad (3d)$$

If the profits of the factory 1,  $Y_1$ , is given by equation (4),

$$Y_1 = (1-t)[ m_q((mp_4 - t_g d_4) - (p_3 + t_e d_3)) - (p_1 + t_m d_1) m_1 - (p_2 + t_m d_2) m_2 - F_1]. \quad (4)$$

Making use of the law of equi-marginal productivity, that is, the ratio between the productivities

of the two intermediate goods should be equal to the ratio between the delivered prices of them, quantities of these goods are derived as equations (5a) and (5b): (For simplicity,  $\alpha$  and  $\beta$  are assumed  $\alpha=\beta=0.4$ ):

$$m_1 = A^{-1.25} m_q^{1.25} ((p_2+t_m d_2) / (p_1+t_m d_1))^{0.5}, \quad (5a)$$

$$m_2 = A^{-1.25} m_q^{1.25} ((p_1+t_m d_1) / (p_2+t_m d_2))^{0.5}. \quad (5b)$$

Since quantity of oil  $m_3$  is assumed to be a linear function of amount of the final goods, it is simply given by (5c),

$$m_3 = m_q. \quad (5c)$$

From the above equations, the cost  $C(m_q)$  of the factory 1 is obtained as equation (6),

$$C(m_q)=2A^{-1.25} m_q^{1.25} (p_1+t_m d_1)^{0.5} (p_2+t_m d_2)^{0.5} +x((p_3+t_e d_3)+F_1). \quad (6)$$

Thus, the profit function of the factory 1 is rewritten as equation (7):

$$Y_1=(1-t)[m_q((mp_4-t_g d_4)-(p_3+t_e d_3))-2m_q^{1.25} A^{-1.25} (p_1+t_m d_1)^{0.5} (p_2+t_m d_2)^{0.5} -F_1]. \quad (7)$$

The factory 1 determines the transfer price and its location in order to maximize the firm's total profits by using equation (7).

Then, let us derive the profits of the factory 2,  $Y_2$ . The profits are obtained under the following assumptions: The factory 2 uses one unite of intermediate goods to produce one final goods, thus, the quantity of the final goods  $Q$  is equal to the intermediate goods  $m_q$ , (that is,  $Q=m_q$ ). The market price of the finished goods is shown by  $p$  which is determined by the market demand function given by equation (9).

$$Y_2 = (1-t^*)[(p - mp_4)Q - C(Q)-F_2] \quad (8)$$

$$p=600 - Q \quad (9)$$

where  $F_2$  is the fixed cost, and  $C(Q)$  is the costs of assembling the intermediate goods to the finished goods,  $C(Q)$  is given by equation (10).

$$C(Q) = 1.5Q(2+Q)^2/B \quad (10)$$

Since the factory 2 determines the quantity supplied at the market to maximize its profits, the quantity supplied to the market is derived by using equation (8), (9), and (10), it is shown by equation (11) where parameter B is assumed 200 for simplicity,

$$Q=0.22(-206 + (582409 - 900mp_4)^{0.5}) \quad (11)$$

Since the supply quantity Q is a function of the transfer price mp<sub>4</sub>, the total profits of the firm can be rewritten as a function of the transfer price as equation (12),

$$\begin{aligned} Y = & (1-t)[(0.22(-206 + (582409 - 900mp_4)^{0.5}))(mp_4 - t_g d_4) - (p_3 + t_e d_3)] - \\ & -2(0.22(-206 + (582409 - 900mp_4)^{0.5}))^{1.25} A^{-1.25} (p_1 + t_m d_1)^{0.5} (p_2 + t_m d_2)^{0.5} - F_1] \\ & + (1-t^*) [(600 - (0.22(-206 + (582409 - 900mp_4)^{0.5})) - mp_4)(0.22(-206 + \\ & (582409 - 900mp_4)^{0.5})) - F_2]. \end{aligned} \quad (12)$$

## (2) Derivation of the optimal transfer price and the factory's location

The optimal transfer price mp<sub>4</sub> and the location (X,Y) of the factory1 are derived by using equation (12). To derive the optimal values of the transfer price and the location of the factory 1, the Gradient dynamics is used. The essence of this method is that first, an initial value set is given to x<sub>n</sub>, y<sub>n</sub>, and p<sub>4n</sub> in the following equations (13a,b, and c) as a temporal solution, and obtain the values of x<sub>n+1</sub>, y<sub>n+1</sub>, and p<sub>4n+1</sub> by calculations indicated by the three equations (13a,b, and c). And then, the same calculation is iterated until a given tentative solution can be approximately judged as the solution. If the values of (x<sub>n+1</sub>, y<sub>n+1</sub>, mp<sub>4n+1</sub>) in equations (13a,b, and c) become approximately the same as those of (x<sub>n</sub>, y<sub>n</sub>, mp<sub>4n</sub>), the values can be admitted as the solution.

$$x_{n+1} = x_n + j * \partial Y / \partial x, \quad (13a)$$

$$y_{n+1} = y_n + j * \partial Y / \partial y, \quad (13b)$$

$$mp_{4n+1} = mp_{4n} + j * \partial Y / \partial mp_4, \quad (13c)$$

where j is the width of a step and n shows the number of the calculation. And  $\partial Y / \partial x$ ,  $\partial Y / \partial y$ , and  $\partial Y / \partial mp_4$  are given by equations (14a, b, and c). In addition, In addition, the tax rates are assumed to be the same in home and foreign country, t=t\*=0.82. Other parameters' value are assumed as follows:

$(x_1=3, y_1=-0.5), (x_2=-3^{0.5}, y_2=-0.5), (x_3=0, y_3=-1.5), (x_4=0, y_4=1), A=1, p_1=0.25, p_2=2, p_3=0.2, t_m=0.11, t_e=0.01, t_g=0.225, F_1=5000, F_2=2500,$

$$\begin{aligned} \partial Y/\partial x = & 0.18[-A^{-1.25}Q^{1.25} t_m [ \{(p_2+t_m d_2)^{0.5}/(p_1+t_m d_1)^{0.5}\} (x - x_1)/d_1 + \\ & + \{(p_1+t_m d_1)^{0.5}/(p_2+t_m d_2)^{0.5}\} (x + x_2)/d_2 - t_g x Q/d_4 + \\ & + Q (-t_g(x/d_4) - t_e(x/d_3))] = 0 \end{aligned} \quad (14a)$$

$$\begin{aligned} \partial Y/\partial y = & 0.18[-A^{-1.25}Q^{1.25} t_m [ \{(p_2+t_m d_2)^{0.5}/(p_1+t_m d_1)^{0.5}\} (y + y_1)/d_1 + \\ & + \{(p_1+t_m d_1)^{0.5}/(p_2+t_m d_2)^{0.5}\} (y + y_2)/d_2 - t_g(y-1)Q/d_4 + \\ & + Q (-t_g((y - y_4)/d_4) - t_e((y - y_3)/d_3))] = 0 \end{aligned} \quad (14b)$$

$$\begin{aligned} \partial Y/\partial mp_4 = & 0.18[(Q - 99mp_4/(582409-900mp_4)^{0.5}) + (99mp_4/(582409-900*mp_4)^{0.5})t_g(x/d_4) + \\ & + (99mp_4/(582409-900mp_4)^{0.5})t_e(x/d_3)] + \\ & + 2.5*0.5A^{-1.25}(p_2+t_m d_2)^{0.5}(p_1+t_m d_1)^{0.5}Q^{0.25}) - \\ & 0.18[-Q-99(600-Q)/(582409-900*mp_4)^{0.5} + \\ & + (0.7425(2+Q)^2)/(582409-900*mp_4)^{0.5} \\ & + (21.78Q)/(582409-900*mp_4)^{0.5} + \\ & + (0.3267(2+Q)*(-206+(582409-900*mp_4)^{0.5})/(582409-900*mp_4)^{0.5} + \\ & + 99mp_4/(582409-900mp_4)^{0.5}] = 0. \end{aligned} \quad (14c)$$

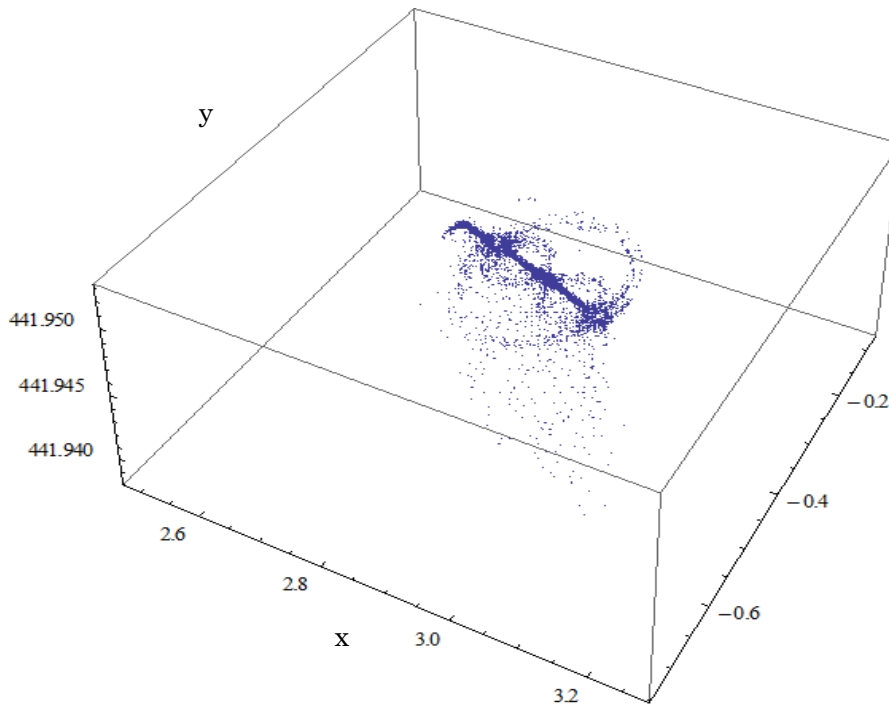
The calculation result derived from the Gradient dynamics using equation (14a, b, and c) shows the figure illustrated in Figure 2. Figure 2 indicates that the optimal transfer price is approximately 442, and although the optimal location of the factory 1 is not clearly specified, the best location is can be found in the area where a chaotic phenomenon appears.

The graph shows that chaotic phenomenon appears along the area of  $M_1$ , the source of raw materials. It can be established that the optimal transfer price is at 442. However, it is difficult to determine the optimal location of factory 1 which produces intermediate goods. Nevertheless, the optimal location is proximate to the area of  $M_1$  or the source of raw materials. If the factory 1 chooses to locate within that particular area, the profit will be almost at the same level. Total profits will be  $Y=3308^3$ .

<sup>3</sup> Graph 2 shows that chaotic phenomenon occurred in the derivation of optimal location and price or the Cauchy Convergence. This Cauchy Convergence needs further analysis but this will not be discussed in this study. However, Puu (1998) explained that chaotic phenomenon appears when the derivation of optimal location does not include



**Figure 2 Optimal transfer price and location expected area**



### 3. Effects on factory's production of corporate tax rate and agglomeration economy

#### 3.1 Coexistence of the factories at a market place

It is assumed that when factory 1 and factory 2 locate at the market, agglomeration economies generate. It is supposed in this subsection that the influence is represented in the reduction of costs in the factories; the reduction of fixed cost ( $F_1$ ) in the assembly factory 1. Given this kind of agglomeration economies, to what level this fixed cost can occur the co-existence of the two factories at the market place. As shown in the Figure 1, when intermediate goods producing factory 1 locates within (3, -0.5) are of the sources of raw materials  $m_1$ , transfer price, level of price, production level will be the same. If the factory 1 locates to the market (0, 1), the total profits is shown in the right-most column of Table 1. The corporate tax rate is set at  $t=t^*=0.82$  for each location points, and taking into account the influence of agglomeration economy, fixed cost ( $F_1$ ) will be reduced from 5000 to 4936 and this can result to co-existence of intermediate goods producing factory 1 and assembly factory 2 at the market location. On the other hand, in the case the fixed cost reduction will not drop by 64, these two factories will have to be diffused to the two countries.<sup>4</sup>

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price in the two-dimensional space.

<sup>4</sup> For concise discussion about co-existence and dispersion of production processes, refer to Stigler (1956).

**Table 1 Location of factories and changes in volume of production and profit**

	$t=t^*=0.82$	$t=t^*=0.82$
location point	(3,-05)	(0,1)
transfer price	442	442
product price	551	551
volume of production	49	49
profit(Y)	3307	3296
factory( $Y_1$ )	2968	2957
factory( $Y_2$ )	339	339

Source: Authors' calculations

### 3.2 Reduction in corporate tax rate and the changes in location and transfer price

Since factory 1 is located in a country with a lower corporate tax rate of 0.70, and factory 2 is located abroad with tax rate equivalent to  $t^*=0.82$ . The transfer price for intermediate goods will drop to 417. While, the prospective area will be within the about same area that was shown in Figure 2. The firm's profit and production volume will be similar to the first column of Table 2.

If the factory 1 will be relocated abroad, what will happen to the co-existence of intermediate goods factory and assembly factory 2? Transfer price, product price, and production volume will remain the same as shown in the right-most column of Table 2. The optimal location of intermediate goods factory is in a country where there is a source of raw materials  $M_1$  and where the corporate tax rate is comparatively low as illustrated in Table 2. Thus, in this case, it is not reasonable to put the intermediate goods factory and assembly factory in the same location.

**Table 2: Location of factories and the changes in volume of production and profit (different tax rate)**

	$t=0.70$ $t^*=0.82$	$t=0.70$ , $t^*=0.82$
location point	(3,-05)	(0,1)
transfer price	417	417
product price	545	545
volume of production	55	55
profit(Y)	5844	3723
factory( $Y_1$ )	5268	3147
factory( $Y_2$ )	576	576

Source: Authors' calculations

It is however possible to locate these two factories within the market if the reduction of cost based on agglomeration economy is big or when there is a support from the government. Assuming that agglomeration-based fixed cost reduction  $F_1$  of the factory 1, if the firm's profit exceeds 5844, it is possible to put the factory 1 in the same location. As reflected in the values in Table 2, even though agglomeration-based fixed cost reduction drops to zero, the target profit of 5844 will not be achieved. Therefore, given the two country's different tax rate,  $t=0.70$ ,  $t^*=0.82$ , the firm will not move their intermediate goods factory 1 to the location of the market. Thus, in this case, if the firm would not receive any support from the government, spatial dispersal of the firm's factories will happen<sup>5</sup>.

### 3.3 Significance of a prospective area and new location factors

Chaotic phenomenon shown in Figure 2 can be interpreted as follow: If the firm decides the location of the factory 1 and price of the intermediate goods in the range of the chaotic phenomenon, the firm's profits may not so decrease from the maximum level because the optimal solution is contained in this sphere. It can be, therefore, considered that the range indicates a *prospective area* for a possible factory's location. The firm can determine the search area in a large location space into a small range for the factory's location; they can reduce significantly the searching costs. Chaotic phenomena may provide the firm with useful information, especially in the case firms do not have adequate information about many regions in a large space.

It is also considered that even if the firm could identify the optimal site for the factory, it may not establish a factory at that site by some reasons. For instance, the place has been occupied by another firm, or land is too weak to build a factory. In this case, the firm has to search the second best sites around the optimal place. In this searching, chaotic phenomenon can be used for squeezing the spatial range to be searched. The firm can easily find out the second best sites around the best point in a relatively short period. Chaotic phenomena could be useful for alleviating the firms' location problem.

The prospective area generates new location factors to firms: When a firm decides the factory's location in the prospective area, the firm becomes to consider the location issue in a broader perspective. Besides profit level, the firm can incorporate many location factors such as education, culture, housing, safety, and welfare in the area into its decision-making. Considering of the locational effects of these new location factors, the firm decides the location of factory in the prospective area. That is, new location factors such as education, culture, housing, safety, and welfare play important role in the determination of factory's site in the prospective area.

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<sup>5</sup> On the other hand, if tax rates are  $t=0.82$ ,  $t^*=0.70$ , even without the benefits of agglomeration economies, the intermediate goods factory can co-locate with the market location. In such case, considering the fragmentation of factory 1 and 2, the amount of diseconomies of scale will be huge.

#### **4. Comparison of the provinces in the Philippines**

This section assumes that Philippines is within the prospective area and examines each provinces economy and social condition. Based on the provinces characteristics, the firms can have an idea where to possibly locate.

##### **4.1 The Philippines**

The Philippines is an archipelago located in the Southeast Asia. It is composed of 7, 107 islands which totals to 300,000 square kilometers, the second biggest archipelagic country in the world. The topography of these islands varies, from mountains, hills, and plains.

The Philippines is one of the fastest growing economies in the East Asia with 6-7% growth rate in recent years. The services sector, fuelled by the recent growth in BPO businesses, contributes more than half of the economic output. The manufacturing sector accounts for 30% of the national output.

The Philippines is a republic with presidential form of government. The Philippines is divided into

three main islands; Luzon, Visayas, Mindanao. The country is divided further into 17 regions, 80 provinces, 138 cities, 1,496 municipalities, and 42,025 barangays<sup>6</sup>. These local government units (provinces, cities, municipalities, and barangays) are responsible for the delivery of basic services such as health, social welfare, natural resources and environment, agricultural extension, and public works. Majority of the income of the local governments comes from central government in the form of internal revenue allotment (IRA) or the share from national tax collections.

##### **4.2 Data**

The primary sources of data in this study are the National Statistical Coordination Board (NSCB) and National Statistical Office (NSO). The study used the latest data for each indicator. Reference year, however, is not uniform, from 2000 to 2013.

##### **Table 3 List of Indicators**

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###### **Indicators**

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###### **Demography**

Land Area,  
Population  
Population density

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<sup>6</sup> Barangay, the smallest administrative unit, is derived from the Malay word, *Balangay*, which means sailboat. Early inhabitants are said to have reached the islands through these sailboats.

**Economy**

Real per capita income  
Wage Rate Non-Agriculture  
Wage Rate Agriculture  
Total number of banks  
Total bank deposits (millions)  
No of MSME  
Employment in MSME  
Poverty Incidence among Families (%)

**Education**

Mean Years of Schooling  
Literacy rate (simple literacy)  
Net Enrolment Ratio (NER) in Primary Education  
Completion Rate in Primary Education  
Net Enrolment Rate (NER) in Secondary Education  
Completion Rate in Secondary Education  
Number of Higher Education Institution(HEI)  
Enrollment in HEI(SUC)  
Graduates in HEI(SUC)

**Security**

Crime Incidence(Crime per Population)  
Traffic Accident (Traffic Accident Per Population  
Total Terrorists/Insurgency Incidences  
Magnitude of Terror Attacks(No of Casualties)  
Weather and Climate-related risks  
Geophysical risk

**Infrastructure**

Paved Road Length KMs(Road Density)  
Permanents Bridges Linear Meters(Bridge Density)  
Total Number of Airports  
Total Number of Ports  
Energized Barangays (%)  
Number of Special Economic Zones

**Health**

Life expectancy at birth (years)  
Safe Water Supply per Population  
Sanitary Toilet per Population  
Total Health Works per Population

**Governance**

Good Governance Index  
State of Performance  
Internal Revenue Allotment  
Local Sources

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**4.3 Estimation of provincial dynamism scores**

Provincial Dynamism Score is computed using various variables that falls into six categories:

economic condition, education, security, infrastructure, health, and governance. These variables are standardized using equation 815),

$$S_{IvP} = \frac{(X_{Iv} - AVE_{Iv})}{ST_{Iv}} \quad (15)$$

(I=a, b, e; V=1, 2, 3, 4...n; P=P1, P2, P3...P80)

Where  $X_{Iv}$  is the value of the indicator of I of a province P;  $AVE_{Iv}$  is the mean value; and  $ST_{Iv}$

is the standard deviation of the indicator I of variable E.

Score of the indicator I was obtained using equation (16),

$$S_{Iv} = (1/n) \sum_{I=vP}^{I_n} S_{IvP} \quad (16)$$

The provincial dynamism index was computed based on equation (17),

$$PD_p = (1/6) \sum_{I=a}^e S_{Iv} \quad (17)$$

Principal Component Analysis (PCA) is then used to discern the similarities or difference in the set of variables and plot these variables into two-dimensional space. This representation could identify characteristics of each province.

#### 4.4 Provincial dynamism scores

High provincial dynamism index would mean vibrant local economy, good local governance, presence of infrastructure, educated citizens, presence of health-support, and high-level of safety. In the Figure 3, provinces with high provincial dynamism index are shaded in black color and the low provincial dynamism index is shaded in grey or white.

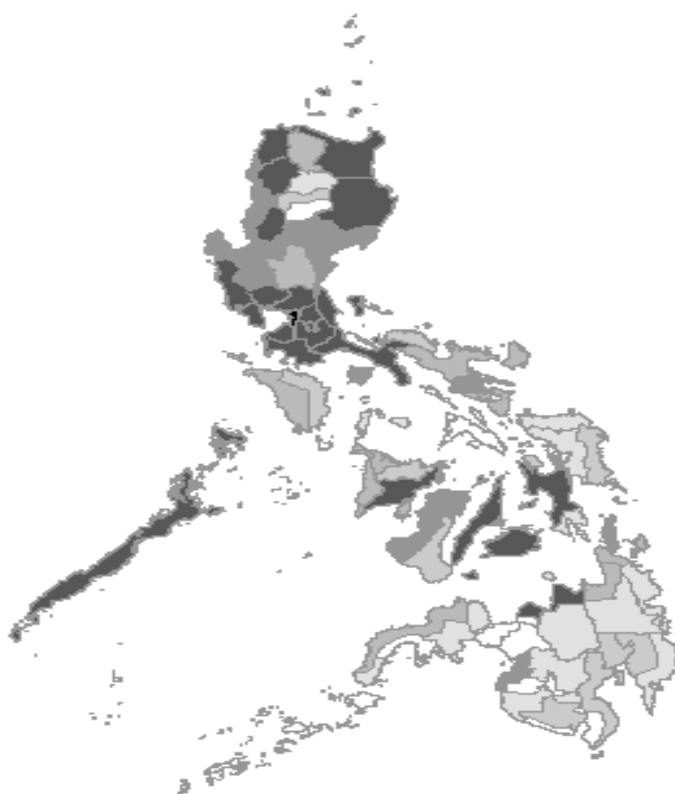
The top provinces that have the highest computed provincial dynamism scores are the following: Metro Manila<sup>7</sup>(3.040), Batanes(0.786), Cavite(0.539), Bulacan(0.420), Laguna(0.411), Rizal(0.330), Batangas(0.306), Cebu(0.299), Ilocos Norte(0.292), and Palawan(0.283). Except for Batanes, Cebu, Ilocos Norte, and Palawan, the rest of the provinces are located within regions that adjacent to Metro

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<sup>7</sup> For comparison purpose, Metro Manila is considered as a province in this study.

Manila. On the lowest end of the ranking are the following provinces: Maguindanao(-1.200), Sulu(-0.994), Basilan(-0.919), Lanao del Sur(-0.639), Tawi-tawi(-0.617), Masbate(-0.527), Sarangani(-0.489), Ifugao(0.-429),Lanao del Norte(-0.418), and Zamboanga Sibugay(-0.413). Except for Ifugao and Masbate, these provinces are located in Mindanao, primarily in ARMM.

**Figure 3: Map of provincial dynamism scores**



Source: Authors' calculations

In terms of economic scores, except for Cebu, the provinces which rank the highest are located within the peripheries of Metro Manila: Laguna, Cavite, Rizal, Batangas, Bulacan, Pampanga, Bataan and Quezon. In this aspect, neighborhood definitely seems to matter. In terms of education, except for Pangasinan and Batanes, the provinces with the highest scores are again located near the capital: Cavite, Rizal, Laguna, Bulacan, Batangas, Pampanga, and Bataan. Notice that in both economic and education scores, no provinces from Mindanao have made it on the top. In terms of security, the provinces that are considered to be the safest are the following: Apayao, Isabela, Ilocos Norte, Negros Occidental, Palawan, Iloilo, Zamboanga del Norte, Batanes, and Tawi-Tawi. Metro Manila is at the top of the rankings most of the time except for this component as it has the lowest

score in security. In terms of infrastructure, the provinces which have the highest score are the following: Metro Manila, Leyte, Cebu, Palawan, Negros Occidental, Pangasinan, Batangas, Bohol, and Occidental Mindoro. In terms of health, provinces with relatively good health support are the following: Batanes, Palawan, Guimaras, Ilocos Norte, Aurora, Benguet, Abra, La Union, and Siquijor. In terms of governance score, the provinces which rank the highest are the following: Metro Manila, Bulacan, Laguna, Rizal, Camiguin, Cavite, Compostela Valley, Benguet, Siquijor, and Kalinga.

#### **4.5 Results of principal component analysis (PCA)**

For the sample of 80 provinces, the first principal component(PC) accounts for 54.91 percent of the total variance with Eigen value higher than 1, and the second principal component accounts for 22.33 percent of the total variance, with Eigen value higher than 1. The first two principal components explain 76.23 percent of the total variance. The first component puts higher weight on economic, education, governance, and infrastructure indicators. The second component emphasizes security, and health indicators.

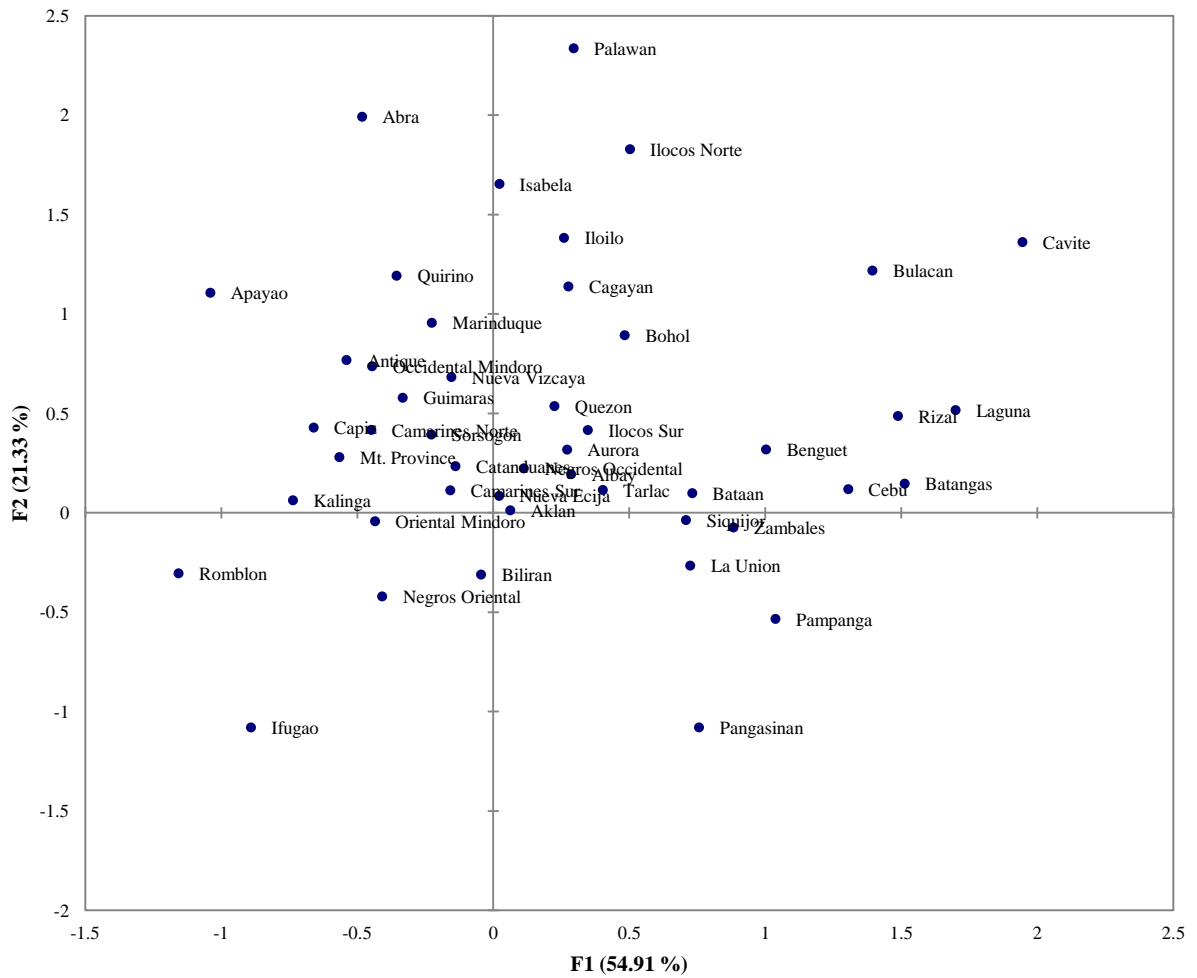
It is shown in Figure 4 that the higher the score in economic, education, governance, and infrastructure, the higher the score of the first PC on the x-axis and the provinces which exhibited these features are found the right portion of the graph. Meanwhile, the higher the score in security and health indicators, the higher the score of the second PC on the y-axis and provinces with such characteristics are found on the upper portion of the graph.

Metro Manila is no longer shown by graph in Figure 4 because it is located on the far right but lower portion of the graph. This implies that Metro Manila has a good economic situation, high level of education, presence of infrastructure, and high-quality of governance but it is still found lacking in terms of security and health. Batanes is also no longer shown because it is located in the upper-right portion of the graph. Batanes is the only provinces that have favorable economic condition and relatively high-level of security. The provinces that have the highest computed provincial dynamism scores are located in the upper right portion of graph. Most provinces tend to cluster near the center which means that these provinces have either relatively good economic conditions but needs improvement in security and health.

This representation allows easy identification the characteristics of the provinces in the Philippines. This is particularly useful for the firms who are planning to locate in the Philippines. For instance, firms that conduct high-technology processes as well as research and development (R&D) can select the provinces with high education-level. Or firms that handles assembly or logistics can chose to locate in the provinces with relatively well-built infrastructure. Furthermore, this representation can also be helpful to policymakers and local administrators who are aiming to revitalize local economy and improve social conditions.



**Figure 4: Principal component analysis of the provinces in the Philippines**



Source: Authors' calculations

**5. Concluding Remarks**

It is elucidated in this paper that the steps in establishing prospective location and effects to firm's location decision-making of transfer price system and corporate taxation system which are closely related to the economic situation and economic policy of a country. There are two steps in the determination of prospective location: cross-country comparison and within country (regional or provincial level). At the first step, countries' economic and social conditions are evaluated. Consequently, firms are likely to locate in countries with relatively good economic and social conditions. As the profits made by firms are subject to taxation, the system of taxation is also considered as one of the deciding factors, particularly as these production processes tend to disperse across borders. At this first step of determination of optimal location, chaotic phenomenon occurred which implied presence of several optimal locations. The analysis found out that as long as the firms locate within the prospective area, firms can still achieve target profits. In the second step, regions or

provinces economic and social characteristics are analyzed. In this paper, it is assumed that the Philippines are within the prospective area so comparison among provinces was performed. Using various indicators that are available at the provincial-level, this study constructed a provincial dynamism score of 80 provinces. The study has found out that among the ten provinces which have the highest computed scores, there are four provinces which are not located near the primary economic center of Metro Manila: Batanes, Cebu, Ilocos Norte, and Palawan. However, provinces in Mindanao, particularly those within the ARMM are found to have the lowest provincial dynamism scores.

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