Analysis of Industrial Linkages of Macau Gaming Industry

Xinke Chen¹ and Yu Song²
¹National University of Singapore, Department of Economics, 21 Lower Kent Ridge RD, Singapore
²Macau University of Science and Technology, School of Business, Avenida Wai Long, Macau
*ysong@must.edu.mo

Abstract. The issue of Macau's moderate economic diversification has drawn much attention from the SAR government and scholars. Gaming is the most important industry of Macau, with great influence to Macau's economy. It is of great significance to study the effect of the industrial linkages in Macau for the promotion of moderate diversification of economy. The study attempted to complete the Input-Output Tables of Macau firstly, then based on the Input-Output analyzed the industry-correlation effects of the gaming industry in Macau. The conclusion is that the industry-correlation effects of gaming industry is very low, has weak pulling and pushing effects to other industries. It does not make any contribution it should make as a pillar industry. However, the gaming industry has a great impact on the growth of the total economy of Macau. Therefore, it is necessary to continue the modest development of the gaming industry, increase the policies and funds supports to the other industries to promote the development of other industries and speed up the process of moderate economic diversification.

1. Introduction
Gaming industry is the pillar industry of Macau. With the sovereignty of Macau return to China, the government make Gaming industry market-oriented, with the increasing of the tourists from mainland China, Gaming industry was promoted and made huge profit. Gaming industry contributed huge financial revenues, substantial employment opportunities and almost half of GDP. However, due to the unbalanced economic development caused by the excessive unilateral growth of the gaming industry, Macau's economy faced great risks. With the purpose of reducing these risks, the issues related to promoting a moderate diversification economic development in Macau are increasingly subject to the concerns of both scholars and the SAR government. The meaning of "moderate diversification" is that the industrial structure of Macau should have other several pillar industries in addition to the gaming industry, and the industries should be linked and coordinated with each other. Therefore, studying the moderate diversification of Macau's economy should focus on the inter-linkages between industries of Macau firstly, the inter-linkages is the pulling and pushing effects of the industries to each other. As the most important pillar industry of Macau at present, Macau’s economic growth is highly dependent on Gaming industry. Analyzing the pulling and pushing effects of Gaming industry to other industries in the industrial structure is conducive to providing some theoretical and empirical support for studying of the moderate diversification development of Macau's economy.

In 2009, Guo used the gray relational model and the VAR model to analyze the driving ability of the development of Gaming industry on economic factors such as related industries and economic growth. It concludes that Gaming industry is highly concentrated with low industrial correlation. Chen (2012) used the gray relational model to compare the economic driving effects of the Macau gaming industry
with Event industry in Macau and tried to provide theoretical and policy suggestions to Macau's economic restructuring and diversification. However, these two documents do not specifically analyze the pulling and pushing effect of Gaming industry to other industries. The Input-Output Model is an economic model created by Wassily Leontief (1936), the 1973 American Nobel list economist and a professor at Harvard University. The theoretical basis of the model is the general equilibrium theory of Walras, which uses the form of a checkerboard balance table to reflect the mutual quantitative relationship between input and output of various sectors of the national economy. It is a quantitative method that can be used to analyze the inter-related effects of each sectors in the economic system and industrial structure. Using I-O model can study the pulling and pushing effects of each industry. At present, there is no Input-Output Table in Macau, no scholars have used the I-O model to analyze the industrial relations in Macau. To fill this gap, this study first attempts to prepare I-O table of Macau from 2006 to 2015 based on the data released by the DESC Macau and using I-O model analyzed the pulling and pushing effects of Macau's gaming industry to other industries.

2. Preparation of Macau Input – Output Table

According to the characteristics of the industrial structure of Macau and the data released by DSEC of Macau, after combine the Banking Industry with Insurance and Pensions into the Financial Services, the industries in the input-output table are divided into the following 16 industries: 1. Mining, 2. Manufacturing, 3. Gas Supply, 4. Construction, 5. Wholesale & Retail, 6. Hospitality, 7. Catering, 8. Transportation, Storage and Communications, 9. Financial Services, 10. Real Estate, 11. Leasing and Business Services, 12. Public Administration, 13. Education, 14. Health Care and Social Welfare, 15. Gaming and Gaming Intermediaries and 16. Others.

2.1 Structure of Macau Input-Output Table

The preliminary Input-Output Table of Macau for this study was mainly based on Method of Preparing China's Input-Output Table (2012) edited by the National Accounts Division of the National Bureau of Statistics of the People’s Republic of China and Gross Domestic Product issued by DSEC, then adjusted according to the actual economic situation in Macau and statistical information, prepared the preliminary Input-Output Table of Macau from 2006 to 2015. The preliminary Input-Output Table of Macau prepared in this study includes the Total Output: the value of all goods and services produced by all resident in a country within a certain period of time, including newly created value and intermediate consumption of goods and services and the value of fixed assets transfer; Intermediate investment: also known as intermediate consumption, refers to the value of all non-fixed assets and services used by resident in the production process; Value-added: Including employee compensation, operating surplus, tax on production, reflecting the added value created during the production process and the value of the fixed asset transfer; Intermediate demand: refers to the value of all non-fixed-asset goods and services of a resident sectors used in the production process of other sectors; Final demand, which includes the final consumption expenditure, Total capital formation (gross fixed capital formation + changes in inventories), exports and imports. Input-Output Table has a certain balance of relations, respectively, line balance, column balance and the relationship between the total balance. End-use = final consumption + total capital formation; final consumption = resident consumption + total government consumption and capital formation = total fixed capital formation + increase in inventories. Column balance is the total intermediate input + value added = total investment. The aggregate balance includes total input = total output; total investment by sector = total output by sector; total input by all sectors = total intermediate use by all sectors.

2.2 Data Source of the Preliminary Input – Output Table of Macau

Data for the preliminary Input-Output Table of Macau are all collected from the statistics released by DSEC of Macau SAR. Data of the total output, intermediate inputs and value-added of each industry in the preliminary I-O Tables are collected from GROSS DOMESTIC PRODUCT 2016 (p94) released by the DSEC. Data for the current year's consumption expenditures, capital formation, exports and imports in the preliminary table are sourced from GROSS DOMESTIC PRODUCT 2016 (p40). Data in
the preliminary table of total capital formation of each industry (fixed capital formation + inventory changes) are based on *Surveys of Gaming Industry* published by DSEC. The data for exports and imports in the table are derived from *GROSS DOMESTIC PRODUCT 2016* (p40) and *BALANCE OF PAYMENT*. The intermediate input is calculated according to the equilibrium relationship.

### 3. Direct Industry Correlation Index

Industrial relations refer to the driving effects of an industry on its upstream and downstream industries in the industrial chain, respectively, the pulling effect on the upstream industries and the pushing effect on the downstream industries.

#### 3.1 Direct Pulling Effect Index:

Pulling effect refers to the production technology linkage of an industry or sector with the other industries and sectors which provide the production elements to it, revealing the industry's intermediate investment structure. Direct pulling effect index is an industry acting as a demand side through consuming other industries' products or services to reflect its role in the industry chain. In the I-O Table, Direct Pulling Effect Index is the proportion of the j\textsuperscript{th} industry’s total intermediate input in the first quadrant covers the j\textsuperscript{th} industry’s total output value.

The formula is:

\[
L_{B(j)} = \frac{\sum_{i=1}^{n} x_{ij}}{X_j} \quad (j = 1, 2, ..., n)
\]

Where: \(x_{ij}\): the direct consumption of the j\textsuperscript{th} industry to the i\textsuperscript{th} industry; \(X_j\): the total output of the j\textsuperscript{th} industry; \(L_{B(j)}\): Direct Pulling Effect Index of the j\textsuperscript{th} industry.

#### 3.2 Direct Pushing Effect Index:

Pushing effect refers to the production technology linkage of an industry or sector with the other industries and sectors which demand for the production elements provided by it, revealing the industry's intermediate consumption structure. Direct pushing effect index is an industry acting as a supply side through providing products or services to other industries to reflect its role in the industry chain. In the I-O Table, Direct Pushing Effect Index is the proportion of the i\textsuperscript{th} industry’s total intermediate input in the first quadrant covers the i\textsuperscript{th} industry’s total output value.

The formula is:

\[
L_{P(i)} = \frac{\sum_{j=1}^{n} x_{ij}}{X_i} \quad (i = 1, 2, ..., n)
\]

Where: \(x_{ij}\): the direct consumption of the j\textsuperscript{th} industry to the i\textsuperscript{th} industry; \(X_i\): the total output of the i\textsuperscript{th} industry; \(L_{P(i)}\): Direct Pushing Effect Index of the i\textsuperscript{th} industry.

The formula of Direct Pulling Effect Index is the same as that the formula of the Intermediate Input Rate. The formula of Direct Pushing Effect Index is the same as that of the Intermediate Demand Rate.

### 4. The Empirical Results and Analysis

The Pulling Effect is the demand sides or called the downstream industries consume the input of their upstream industries, causing the demand of raw material supplying. The Pushing Effect is that the suppliers or called the upstream industries invest their own economic output into other industries and stimulates the utilization of their output. The higher the Direct Pushing Effect Index or the Direct Pulling Effect Index, the greater the pulling or pushing effect on other industries.

#### 4.1 Linkage Analysis of Gaming Industry:

#### 4.1.1 Analysis of Gaming Industry’s Direct Pulling Effect

The Direct Pulling Effect Index of the Gaming industry is relatively low, with an average of only 18.56% over the 10 years. This shows that the Gaming industry is not closely linked with its upstream industries and has low pulling effect to its upstream industries. And the Direct Pulling Effect Index of the gaming industry showed a downward
trend from 2006 to 2015, that is, the pulling effect of the gaming industry to its upstream industries is showing a declining trend year by year.

4.1.2 Analysis of Gaming Industry’s Direct Pushing Effect. The Direct Pulling Effect Index of the Gaming industry is also low, with an average of only 14.22% for 10 years. This shows that the Gaming industry is also not closely related to its downstream industries and has low pushing effect to its downstream industries. And the Direct Pulling Effect Index of the Gaming industry showed a downward trend from 2006 to 2015, that is, the pulling effect of the gaming industry on its downstream industries showed a declining trend year by year.

4.1.3 Comparison of Gaming Industry’s Forward and Backward Linkage. Both the pulling and the pushing effect of Gambling industry to others are low, means that the Gaming industry has a very low degree of linkage with both its downstream and upstream industries, and has a very low pulling and pushing effect on the other industries. It is a relatively independent industry and has low impact on the other industry. The Direct Pulling Effect Index is slightly higher than The Direct Pushing Effect Index, the pulling effect of Gaming industry on other industries is slightly higher than the pushing effect. From the perspective of time change, both the Direct Pulling Effect Index of The Direct Pushing Effect Index are showing a downward trend, and the downward trend of the Pushing Effect Index is more obvious, it also has larger fluctuation during the ten years.

Table 1. Direct Linkage Index of Gaming Industry

| Year | Direct Pulling Effect Index | Direct Pushing Effect Index |
|------|-----------------------------|-----------------------------|
| 2006 | 0.2170                      | 0.2011                      |
| 2007 | 0.1810                      | 0.1328                      |
| 2008 | 0.1740                      | 0.1714                      |
| 2009 | 0.2190                      | 0.1435                      |
| 2010 | 0.1900                      | 0.1533                      |
| 2011 | 0.1800                      | 0.1402                      |
| 2012 | 0.1820                      | 0.1381                      |
| 2013 | 0.1710                      | 0.1299                      |
| 2014 | 0.1680                      | 0.1193                      |
| 2015 | 0.1740                      | 0.0926                      |
| Mean | 0.1856                      | 0.1422                      |
| SD   | 0.0173                      | 0.0277                      |

Both the pulling and pushing effect of Gaming industry to other industries in Macau is very low, but it is sure the most important pillar industry of Macau at present, where is the contribution of Gaming industry? The input-output table has some balance relations. The total Intermediate Consumption + Final Consumption = Total Output, Total Intermediate Input + Value-Added = Total Input, Total Output = Total Input. Gaming industry has low pulling and pushing effect to the other industries, that is, the intermediate demand rate and the intermediate input rate are low. From the perspective of the balance relationship, the intermediate demand rate and intermediate investment rate are low, on the contrary, the proportion of final demand and value-added to the total output is high. The following will analyze the contribution of Gaming industry to the economy of Macau under the perspective of value-added.

4.2 Value – Added of Gaming Industry:
From the perspective of value-added, Gaming industry's intermediate input is the lowest among all industries in Macau. Therefore, its value-added represents the highest proportion of total output among all industries, with the highest proportion of value-added indicating the added value of gaming industry was the highest. The value-added of the gaming industry maintained its rapid growth until
2014, making an important contribution to the growth of Macau's economy. The value-added of Gaming industry in Macau in 2013 was more than five times of that in 2006. And the Gaming industry has made a very high contribution to GDP of the region, increased from 40% in 2002 to 63% in 2013, accounting for more than half of Macau's GDP. As the value-added of Gaming industry has covered a large proportion of GDP, from that we can recognize the growth of Gaming industry had an important impact on the growth of Macau's GDP. These two economic indicators show that the gaming industry as a pillar industry played a very important role in the economic development of Macau and its importance was constantly on rising.

Since 2014, due to the increasing strength of fight of corruption from the central government of China, the performance of Gaming industry reduced sharply. The sharp decline in the value-added of the Gaming industry has caused the first negative growth of Macau's economy in the past decade. Therefore, the Gaming industry had a huge impact on the growth of Macau's economy.

Table 2. Value – Added of Gaming Industry

| Year | Value-added of GI | GDP of Macau | (1)/(2) |
|------|------------------|--------------|---------|
| 2006 | 44,899           | 110,006      | 0.4082  |
| 2007 | 63,695           | 143,438      | 0.4441  |
| 2008 | 77,127           | 163,498      | 0.4717  |
| 2009 | 83,226           | 166,672      | 0.4993  |
| 2010 | 132,090          | 223,514      | 0.5910  |
| 2011 | 186,661          | 296,647      | 0.6292  |
| 2012 | 216,329          | 344,262      | 0.6284  |
| 2013 | 258,966          | 410,874      | 0.6303  |
| 2014 | 254,051          | 434,973      | 0.5841  |
| 2015 | 171,094          | 356,725      | 0.4796  |

5. Conclusion
This study first attempts to prepare a preliminary table of Input-Output Tables of Macau, using the I-O model to analyze the industry-related effects of the gaming industry. The gaming industry's Direct Pull Effect Index and Direct Push Effect Index were both low, the linkages with both its upstream and downstream were very low. It was relatively an independent industry with little impact on other industries.

Both the Pulling and Pushing Effect Index of Gaming industry to others stated a trend of decreasing, and the downward trend of The Pushing Effect Index was more obvious. However, the value-added of the gaming industry shows a trend of rapid growth and occupies a very high proportion of Macau's GDP. This has contributed significantly to the rapid growth of total amount of Macau's economy.

Although the Gaming industry acted as a pillar industry having significant impact on the growth and development of the total economy of Macau, but the Gaming industry has a very low degree of industrial linkage and a weak pulling and pushing effect on other industries. It is a relatively independent industry. According to previous studies, in addition to the rapid growth and the high proportion of the pillar industries in the industrial structure, they generally have large linkage to other industries. The pillar industries will pass its high level of productivity to its related industries, then passing through the interlink of industrial sectors to the whole industries. Obviously, in the industrial structure of Macau, Gaming industry has contributed a lot to the total amount of economy, but the characteristics of its low industrial linkage had not yet fulfilled the economic contribution it should have as a pillar industry. The one-side over-development of the pillar industry Gambling industry had led to a high imbalance industrial structure in Macau. Such an industrial structure was easily being exposed to the external macro-economic changes, which had posed a serious threat to the long-term
steady development of the economy. Therefore, Macau should promote the development of moderate economic diversification.

Macau should maintain a moderate development in Gaming industry. Although Gaming industry only contributed little to the development of other industries, the impact of Gaming industry on the total amount of economic growth of Macau was very large, a short period of significant decline in the Gaming industry would likely cause shock in Macau economy. At the same time, we should increase policy and financial support to other industries to promote the rapid development of other industries and accelerate the process of economic and industrial diversification. Then moderately invest in some emerging industries that are suitable with Macau's economic, social and geographical aspects to further promote industrial diversification.

After the completion of this study, we will continue to work on compiling a more complete input-output table for Macau. Using the input-output model. In addition to the direct coefficient analysis in this study, we will further calculate the full factor and analyze the impact and sensitivity and other full industry correlation coefficient to study the driving effect of the gaming industry on each industry in the industrial structure of Macau more detailly, that is, the industry-related effect of the gaming industry, to find a more reliable way to study and promote the development of Macau's economic diversification.

6. References

[1] L. Yin, World Vision, 8, (2010)
[2] Z. Jian, Z. Min, J of Shenzhen University (Humanities & Social Science), 22, (2005)
[3] Y. Chiping, Z. Yuqing, Studies on Hongkong and Macau, 1, (2010)
[4] L. Yifei, SHANGHAI & HONGKONG ECONOMY, 2, (2010)
[5] X. Yamin, Social Science In Guangdong, 6, (2009)
[6] C. Shian, (2009), from http://hm.people.com.cn/GB/42273/10614978.html
[7] CHINANEWS, (2009), from http://hm.people.com.cn/GB/42280/174360/174859/10450629.html
[8] G. Xiaodong, L. Changsheng, International Economics and Trade Research, 25, (2009)
[9] C. Zhangxi, Jinan Journal(Philosophy & Social Science Edition), 161, (2012)
[10] T. Yan, Y. Junlong, Q. Meidong, Academics, 167, (2012)
[11] R. Zeping, Methods and Empiric (in Chinese), (2012)
[12] China’s 2012 Input-Outout Table Preparation Method (in Chinese), (2014)
[13] X. Xianchun, Seeking Truth, 41, (2014)
[14] L. Shuixing, Research on the Correlation and DrivingEffect of Real Estate (in Chinese), pp32-33, (2006)
[15] DSEC, Research of Gaming Industry, (2007-2015)
[16] DSEC, GROSS DOMESTIC PRODUCT, (2016, 2017)
[17] L. Yue, Industrial Economics (2nd ed) (in Chinese), p416, (2004)