UNIVERSITY OF MACAU

Tears behind the Diamond

A study on income inequality in Macau

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Introduction

1.1 Executive Summary

The large gap of wealth has been a serious problem from 1990s' in Macau. In the new century, the economy of Macau recovered its energy with many casinos constructed and operated. However, the wealth gap did not narrow down. The problem tends to be more serious and leads to many other social conflicts.

Based upon thorough analysis, the economic development, industry structure, percentage of people under poverty line, and education are four most significant factors which influence the income inequality in Macau. Economic development directly optimizes the primary distribution of wealth. A good economy leads to lower unemployment rate and higher income. The shift of industry structure from secondary sector to tertiary sector caused a huge gap between the income of manufacture industry and that of gambling-related industries, which hence enlarge the wealth gap. Education level is a determinant of income level. People with higher education can earn more than others. A monolithic increasing in education level can mitigate the wealth gap problem. Proved by the close relationship between percentage of people under poverty line and the wealth gap, poverty is also a major factor causing large gap of wealth.

In addition to above four factors, the social welfare system, tax structure, and unemployment also impose effects on the income inequality. A good social welfare system can help low income group and improve their life standards. Besides, tax structure is the determinant of available capital to be used on social welfare system. Unemployment is a reflection of the economy situation. High unemployment rate can result in a deteriorating income inequality.

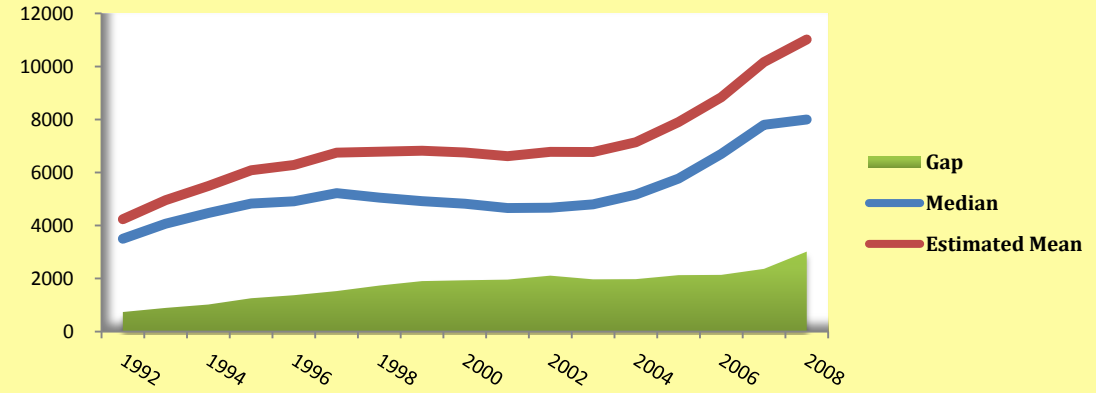
To address the income inequality, the government should put efforts to three aspects. First, the government should keep encouraging the development of gambling-related industries and transfer its profit in order to help those inferior industries like manufacturing. Second, the government should improve the current social welfare system and put a larger proportion of budget on it. By developing the overall education level, the government can achieve a narrower wealth gap in the long run.

1.2 Background

Contrasts always exist: peace against war, love against hatred, or affluence against poverty. The contemporary public appreciates the contribution of the rich to the society and easily ignores the concern how many people are still starved in the same city. As time moves on, the income inequality appears to a black hole that can never be filled up with. Some supported the existence of such inequality believing such distinction inspire the poor to struggle. However, the superiority of the rich dominates. The pearlescent diamond is idolized everywhere, while the bleak tears are negligible. Tears are buried behind the diamond, and unfortunately, this fact is seldom subject to public exposure. The wealth gap may become so large that brings the society unrest and disharmony. It is the time to realize the existence of wealth gap and take action to remedy it.

The wealth gap climbed to its peak when economy of Macau was in a difficult time in 1999. Amid the stumbling period, Gini coefficient officially announced by government is 0.43, and it is a precise measure of overall income inequality in Macau. Not until Macau Special Administration Region (MSAR) prompted the decision to open gaming industry did the economy better off in 2003, when Gini coefficient reached 0.45, a historical high. Afterwards, the economy started to grow. By 2006, Macau's gaming revenue surpassed that of the Las Vegas and related taxes occupies about 50%[1] of gross government revenue. In 2008, government revenue from gaming was set to double 2006 collections. The GDP skyrocketed at an incredible growth rate spanned within 15% to 28% per annum. Meanwhile, gaming industry provides a great number of job opportunities to local citizens, from which they can live upon a decent salary. One instance, the average income for a dealer in casinos amounts to Mop 12,000 monthly. Also the "Free Travel" policy brings millions of Mainland tourists flush into Macau. The prosperity of tourism and gaming industries leads to the development of other industries. As a result, the average salary per capita substantially increases over the years and Gini coefficient down to be 0.38 in 2007.

Figure 1.1 - Gap between mean and median income in Macau



Source: Employment survey, DSEC

[1] Source: Annual report (2006), Auditing Commission, MSAR

However, one evidence points that the problem is not mitigated yet. According to Figure 1.1 above, the gap between median and estimated mean income[2] roughly quadruples itself from 1992 to 2008, from Mop 736 to Mop 3015. It hints that more people are living under the average level, while ideally median and mean income should overlap each other. From another perspective, we can say there are a small proportion of the rich holding a large portion of fortune in society pushing up the average income level. As a result, it is a long-term objective to eliminate or at least mitigate the income inequality.

In this report, we want to explore the underlying reasons worsening wealth gap in Macau. More lights will be shed on how much impact of these factors has on the wealth gap by applying econometric model. Finally, we will try to give recommendations to solve the problem in order to narrow the huge income gulf.

1.3 Methodology

In this part, we will introduce meaning of Gini Coefficient and the procedures to develop the Gini coefficient based on log-logistic distribution due to scarce data available from official source.

1.3.1 Introduction to Gini Coefficient

Gini Coefficient is one of the most widely used measures for the income inequality. It is a ratio that lies between 0 and 1. The closer the Gini to 0 is, the more equally income is distributed in a given country. Here, we choose to use Gini Coefficient as the measure for the income inequality in Macau largely due to its simplicity since it is measured by means of a ratio analysis so that we can easily indicate how the distribution of the income has changed over a certain period of time as well as whether there exists serious income inequality in Macau or not.

Macau Statistics and Census Service department provides the information on Gini coefficient in its Household Budget Survey Report every five years. Therefore, we can only obtain the values of the Gini coefficient in two periods, they are, 0.44 in 2002/2003 and 0.38 in 2007/2008, based on the report. Comparing the values observed in this two periods, it appears that the magnitude of the inequality of income distribution of households has been reduced. However, it is hard to tell the story of the income inequality occurred amid two periods since the values of the Gini have not been provided. In addition, the incomplete data imposes difficulty on searching for the appropriate factors that influence the income inequality based on regression analysis. Thus, it would better estimate the Gini coefficients on our own in order to provide a clear picture on the income inequality condition in Macau.

1.3.2 Gini Coefficient Development

The **Log-logistic Model**, which was first introduced by Camilo Dagum[3] in his study on the income distribution of

[2] The estimated mean is calculated by Equation [8], Methodology, Part One
[3] Camilo Dagum, dedicated in development of study on income distribution, University of Ottawa

Introduction

Canada and several sub-regions of the country, will be used to estimate the Gini coefficient for Macau. The reason why we choose Log-logistic is that the annual mean income is not given so that the conventionally used lognormal distribution for the income density function can't be implemented. Also, the fits were surprisingly good in Dagum's study as well as in the later study on Japanese income distributions by Terukazu Suruga[4]. In order to substantiate its accuracy, we will do an error test after obtaining estimated Gini coefficients.

The income density function is:

$$f(y) = \frac{e^{\frac{\ln y - m}{k}}}{ky\left[e^{\frac{\ln y - m}{k}} + 1\right]^2} \quad \text{---------- [1]}$$

Where,
k = a scale parameter (k>0)
m = the log of the approximated median income M
y = income level
The corresponding cumulative income density function is specified as follows:

$$F(y) = 1 - \left[e^{\frac{\ln y - m}{k}} + 1\right]^{-1} \quad \text{---------- [2]}$$

Also, the reclassification of the income class based on deciles needs for the inverse CDF, therefore, the inverse cumulative income distribution is:

$$y = e^{k \ln\left[\frac{F(y)}{1-F(y)}\right] + m} \quad \text{---------- [3]}$$

In order to estimate the values of m and k appeared in the income density function, the annual household income classification table for Macau is in need. However, the census doesn't provide such kinds of information so that the Monthly employment earnings (excluding non-resident workers) reported by the annual Employment Survey will be used as a proxy for the household income since the employment earnings represent approximately 70%[5] of the total income received by a household on average.

After knowing the income classification, one can get a close estimate of the monthly median income M through a short-cut formula showed below:

[4] Terukazu Suruga, Professor of Economics, Kobe University
[5] Source: Household budget survey report (2007/2008), DSEC

$$M = L + \frac{(\frac{n}{2} - \sum_1^{i-1} f_0)(U - L)}{f_{0_1}} \quad \text{---------- [4]}$$

Where,
L = the lower limit of the income class containing the median income
U = the upper limit of the same income class
n = the total sample size
m = logarithm of M
$f_{0,\,i}$ = the number of sampling units in that class, i = 1, 2, 3…..

Referring to the scale parameter k, **Monte Carlo Simulation**[6] will be performed In order to estimate its value. Here, we arbitrarily select a value of k. By knowing the value of m ahead, the simulation is performed by generating n log-logistical random numbers with m and k already specified, when n is equivalent to the number of the total population in a sample observed. Then, we can obtain the estimated number of people fallen into a certain income class in a given year. The measures of goodness of fit can be calculated in the following:

$$MAD = \frac{\sum_1^{n_c} |f_0 - f_c|}{n_c} \quad \text{---------- [5]}$$

$$MSE = \frac{\sum_1^{n_c} (f_0 - f_c)^2}{n_c} \quad \text{---------- [6]}$$

$$CHISQ = \sum_1^{n_c} \frac{(f_0 - f_c)^2}{f_c} \quad \text{---------- [7]}$$

Where for each income class,
f_0 = the number of sampling units observed
f_c = the number of sampling units estimated by the model through simulation
n_c = the number of income classes

We simulate the values of MAD, MSE and CHISQ 300 times for the purpose of getting an average value of each measure of goodness of fit under the arbitrary value of k and defined value of m. The built-in function solver can help to find out the most appropriate estimate of k which minimizes the average value of CHISQ among all possibilities.

Knowing the estimates for m and k, the average monthly income as well as the Gini coefficient can be obtained as follows[7]:

1. The estimation of the Mean Value of the Income Distribution:

[6] Please refer to Appendix 5.1 for elaborated calculation for estimated Gini coefficient.
[7] Integration is all performed by MATHEMATICA, version 6.0

$$\mu_y = E(y) = \int_{-\infty}^{+\infty} f(y)\cdot y dy = \int_{0}^{+\infty} \frac{e^{\frac{\ln y - m}{k}}}{ky\left[e^{\frac{\ln y - m}{k}} + 1\right]^2}\cdot y dy \quad \text{---------- [8]}$$

2. Gini Coefficient for a Cumulative Distribution Function F(y):

$$Gini = 1 - \frac{1}{\mu_y}\int_0^{+\infty}\left[1 - F(y)\right]^2 dy = 1 - \frac{1}{\mu_y}\int_0^{+\infty}\left\{1 - \left[1 - \left(e^{\frac{\ln y - m}{k}} + 1\right)^{-1}\right]\right\}^2 dy \quad \text{---- [9]}$$

Besides, we can obtain the decile of the population by firstly substituting $p_1 = 0.1$, $p_2 = 0.2$, …, $p_9 = 0.9$ into the inverse of CDF to know the income cutoffs for the ten groups. Then, the flow of income to each decile can be estimated by integrating the first moment function below:

$$Y = N\int_{y1}^{y2} f(y)\cdot y dy = N\int_{y1}^{y2} \frac{e^{\frac{\ln y - m}{k}}}{ky\left[e^{\frac{\ln y - m}{k}} + 1\right]^2}\cdot y dy \quad \text{---------- [10]}$$

Where,
N = the total number of the population
Y = the amount of income flowing to the bracket (y_1, y_2)

The Lorenz Curve[8] can be graphed through the calculation of income shares after obtaining the flow of income to each decile. The estimated Gini coefficients are in Table 1.1 as follows:

Table 1.1 – Presentation of estimated Gini coefficients from 1992 to 2008

92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08
0.334	0.340	0.346	0.366	0.377	0.385	0.413	0.431	0.438	0.446	0.458	0.441	0.436	0.432	0.413	0.403	0.427

The estimated Gini coefficients will be broadly quoted in the following sections of this report, and they provide important information so that the report can offer a full-scale viewpoint to explain the income inequality in Macau, conduct analysis on factors, and eventually render possible alternatives to resolve problem.

[8] Appendix 5.1 presents the table of reclassification of Income class and the Lorenz curve in 2008 as an example

1.4 Limitation of Gini Coefficient

Though it has been proved to be effective in gauging income inequality historically, the use of Gini coefficient also brings three types of limitations as we discussed below.

First, money is the only factor being concerned in the Gini calculation, while some cash equivalents like food stamps are excluded. Such limitation causes the high Gini coefficient even in some welfare state. One instance, the US looks like less egalitarian than European countries – US provide more services to poorer people, but European countries provide money to them.

Second, the rich can access to more investment opportunities because of their capital advantage, while the poor don't confront with many choices distributing money on profitable investments. Therefore, the rich naturally acquire more capital income. In this respect, Gini coefficient fails to quantify such consideration.

Moreover, the Gini coefficient does not consider economic size. Ethiopia, Bangladesh, and Rwanda are all among the top 25 most economically egalitarian nations when only comparing the Gini coefficient, but that doesn't mean they have a better living standard than others. Additionally, the Gini coefficient tends to be higher in a large geographic area than that in a small area because of regional differences in economic structure. For example, the Gini coefficient differs greatly in Manhattan and Montana of United States, while this result is biased as it ignores the fact that housing costs are much lower in Montana.

However, Gini coefficient is still applicable to our research as Macau exhibits little regional difference, and a less developed social security system, where citizens receive less cash equivalents from government. Therefore, the Gini coefficient will be widely used throughout our research. In following parts, we will first explore some main factors that may influence the wealth gap theoretically, and then the relation between these factors and the Gini coefficient will be built to judge their weight on determining the Gini. Lastly, some recommendations will be given to narrow the wealth ditch.

PART TWO

FACTOR ANALYSIS

2.1 Economic Development

Economic development is one of the most important methods to combat with the wealth gap problem. It is a method that optimizes the first distribution of wealth. Developing economy can create more jobs and increase the average income, hence narrow the wealth gap. One measurement of economy development is GDP – the gross domestic production. So, it is very interesting to discover the relation between GDP and the measurement of wealth gap – Gini index[9].

2.1.1 GDP and the wealth gap

Simon Kuznets shaped the history of measurement of income inequality by inventing Kuznets Curve to discern the relationship between GDP per capita to the degree of wealth gap. It generally states that when GDP per capita is more than $1266, every time it doubles, the Gini coefficient will be deducted by 0.005 on average. The graph of this relationship is roughly plotted as below:

Figure 2.1 - The relation between inequality and income per capita

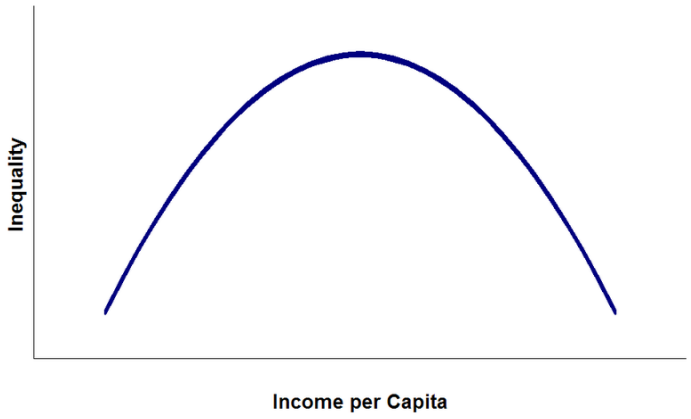
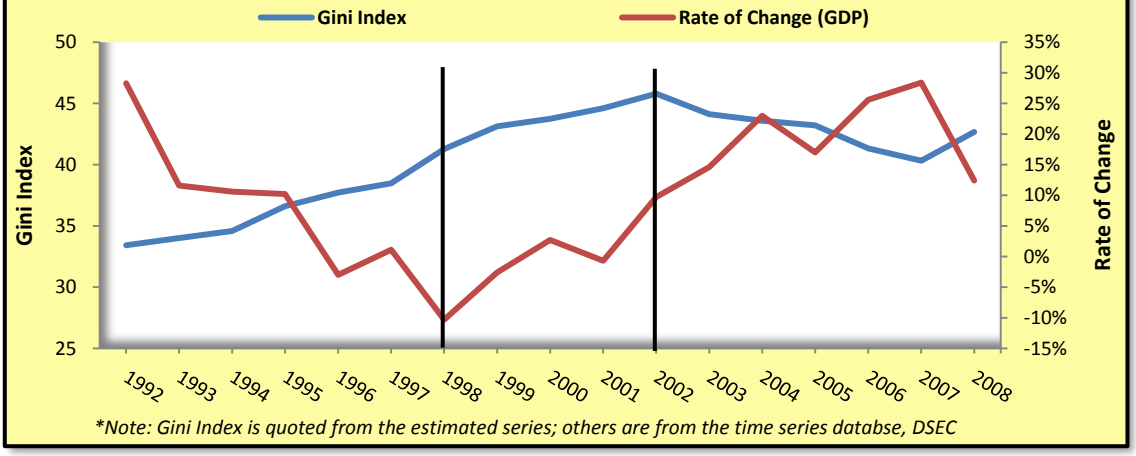


Figure 2.2 - Comparison of Gini index and rate of change in GDP



[9] Gini index is 100 times of Gini coefficient, and we use it here for convenience

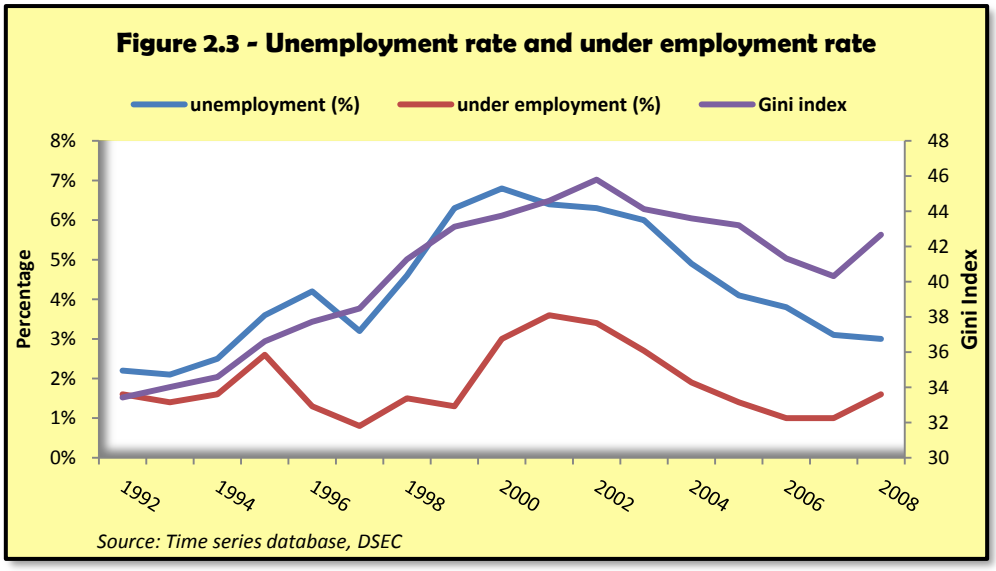
However, the relevant statistics of Macau provided does not support the theory as when GDP per capita increases from USD$12,352 in 1992 to USD$39,036 in 2008, yet the Gini Index reversely rises by 0.092 from 0.334 to 0.427 correspondingly. What triggers the abnormality could be explained by the less developed welfare system in Macau, which is assumed to be improving as the economy becomes stronger. Nonetheless, it is not convincing to say that economic boom worsens the income inequality problem in Macau. After linking Gini Index with GDP growth rate, we discovered a pronounced negative relationship of the two aforementioned.

Observed in Figure 2.2, the entire period is divided into 3 parts to deduce argument. Before 1998, Gini coefficient climbs by almost 24% from 0.334 in 1992 to 0.413 when the GDP growth rate is declining. Conversely, after 2002, when the economy recovered from its downturn, and being driven amazingly at a constant high growth rate in the following years, the Gini coefficient begins to decrease. In the interim period between 1998 and 2002, even though the growth rate is increasing, but it is not positive, signing a bad economy. In this case, a deteriorating economy is a stimulus of widening the gap between the rich and poor, even if it might be less bad sometimes.

Therefore, we can hypothesize the GDP growth rate as a proxy for the economic development to establish the link to income inequality in Macau. Regression research in Part Three will proceed deeper to analyze the relationship.

2.1.2 Unemployment rate and Gini index

A good economy directly leads to a lower unemployment and underemployment rate. Therefore, we hypothesis there will be a positive relationship between these two rates and Gini index. We can see this relationship from Figure 2.3 below,



From 1992 to 2001, the unemployment and underemployment both have a significant increasing. This is because of the shrink of manufacture industry. Many manufacturing company moved their factories to mainland due to the low labor cost, resulting in the high unemployment and underemployment rates in 1990's. These two figures steadily

increased throughout these 10 years and finally reached the highest point in 2000 and 2001. In this period, wealth gap was widened as we can see from the rising Gini index from Figure 2.3. The reason is obviously, many workers in manufacture industry lost their jobs and hence lost their source of income. They become much poorer compared to people in other industries.

After the complete opening of gaming industries in 2002 and 2003, the economy of Macau dramatically increased. A number of large casinos and hotels started to operate, in which large numbers of workers of many different positions were in need. As a result, the two indicators started to decline sharply and continuously. Also, the Gini index decreased correspondingly. In the first glance, the low unemployment and underemployment rates spurred effectively income inequality smoother. One of the reasons behind could be that the more employed, and the less people under poverty line. People previously have no income now have monthly earnings. Nevertheless, we still suspect that the two indicators have a direct relationship with the economic status in Macau, and therefore they might not be the causal factors that trigger income inequality but the worsened economy, or vice versa. To conclude, a pronounced positive relationship of unemployment rate and Gini index is found, and it will be one of the independent variable to be further studied in Part Three.

As the economy development can optimize first distribution of wealth, secondary distribution of wealth is also important when consider wealth gap problem. In the next part, we will explore the relationship between secondary distribution of wealth and the wealth gap.

2.2 Secondary Distribution

Secondary distribution is the reallocation of wealth by government. There are many kinds of secondary distribution, such as the social welfare and the public expenditure on medical service, education, and etc. All of these are greatly decided by tax revenue as it occupies the largest pie in government's annual budget. Only when government has enough tax revenue, should its reallocation impact the income distribution within the society. We will have a look on the tax structure in the first place, and then have an elaborated analysis on the social welfare system in Macau.

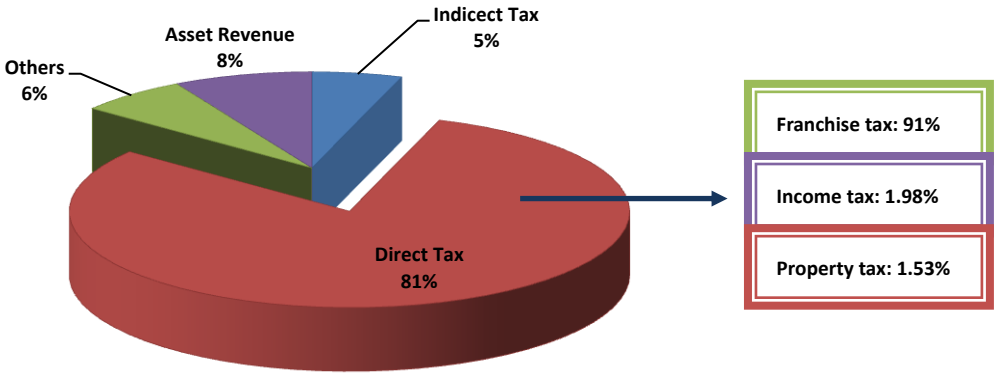
2.2.1 Tax

Stated in the Basic Law, the Macau Special Administrative Region (MSAR) shall have independent finances, and all the financial revenues of the MSAR shall be managed and controlled independently, and shall not be handed over to the Central People's Government. Moreover, The Central People's Government shall not levy taxes in the MSAR[10]. According to this article, Macau is allowed to regulate its own tax items and rates, and both are highly influential to the secondary allocation.

[10] It is in Article 104, Macau Basic law.

MSAR collects its fiscal revenue mainly from two ways: Ordinary revenue[11] and capital revenue[12]. Among all the revenue, the tax revenue stands over 50% in all, which significantly determine the amount of total fiscal revenue. Figure 2.4 below illustrates the percentage of tax in the ordinary revenue in 2006. Two kinds of taxes are included: direct and indirect tax. In all years, the direct tax is the major component of tax revenue.

Figure 2.4 - The compositions of ordinary revenue in 2006



Franchise tax is the major source for the direct tax, over 90% in 2006[13]. The tax is collected from the casinos and public service companies certified with special operation permission. In one hand, it is reasonable for government to levy higher tax rate up to 35% to gaming industry as a profit. On the other hand, overdependence on a single industry may lead to unexpected fluctuation in government's fiscal revenue due to economic cycle. As a consequence, the social protection expenditure cannot maintain stability to combat income inequality. Besides, the personal tax and property tax ranks 2nd and 3rd after franchise tax. Personal tax in Macau is levied in accordance with the amount of salaries. It generally applies the **progressive tax method**, aiming to differentiate tax rates for seven categories of income levels in Table 2.1.

Table 2.1 – Comparison of the progressive tax rates in Macau, Singapore and Mainland China

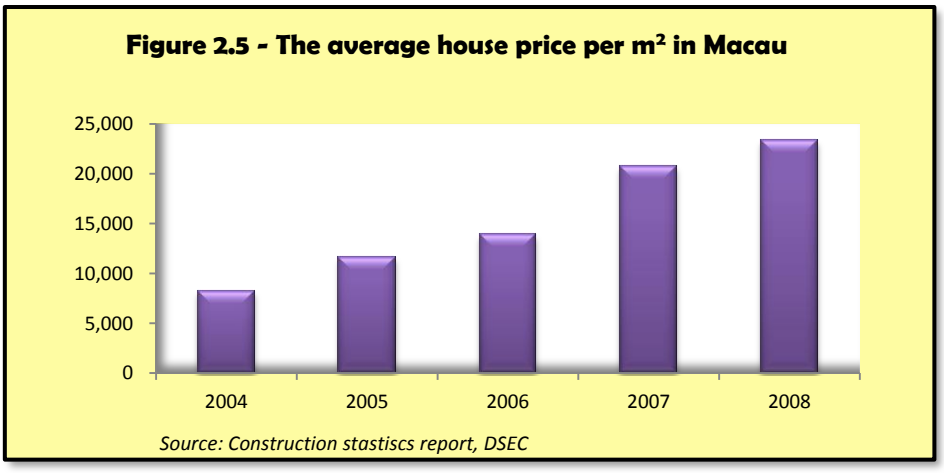
Salary Level	Macau	Singapore	China
Category 1	0	0	5%
Category 2	7%	3.50%	10%
Category 3	8%	5.50%	15%
Category 4	9%	8.50%	20%
Category 5	10%	14%	25%
Category 6	11%	17%	30%
Category 7	12%	20%	35-45%

Note: Salary categories are ranked at an ascending order, the range of the same category differs among the 3 regions
Source: The regulation of income tax, Auditing report (2008), Auditing Commission, MSAR;
Personal tax rate bulletin, Inland Revenue Authority of Singapore;
Income tax rate, China tax 2006

[11] Ordinary Revenue including direct tax, indirect tax, property revenue, fix asset transfer revenue and so on.
[12] Capital Revenue including revenue from investment asset sold out, transfer and annual asset balance from previous years.
[13] We choose the data from 2006 since the data is comprehensive and conceivable

Again, from Table 2.1, by comparing the personal tax rates with those in other areas, such as Mainland China and Singapore, Macau is a heaven of tax. It is illustrated that the minimum annual income to be charged with tax starts from annual income of Mop 102,660 and the tax rate sways from 7% to 12% with the rise of income level. When the annual income is higher than Mop 360,000, the tax rate is permanently fixed at 12%. In contrast, Singaporean government adopts a wider range of tax rate, 3.5% to 20% such that there is a larger difference in tax rates imposed between rich and poor. The range is further magnified in terms of progressive tax system in China from 5% up to 45%. In this case, the narrower tax range indicates that the Macau government is less able to smooth the wealth gap by income tax as it applies relatively identical tax burdens on all groups of citizens. Opposite to our expectation, the rich may obtain more benefits than the poor under such progressive tax method as they can gain more capital income to compensate or even exceed the loss from a bit higher tax rates.

The property tax is relatively higher in Macau. The tax is levied when the rent takes place. The tax varies with the types of properties. In recent years, the fast expansion of the property market spurs up the price of the house, and the increasing trend is plotted in Figure 2.5. Also, the house price per m^2 has dramatically increased by 182.31% in merely 5 years! Such increase in price also stimulates the property tax, exacerbating burden of tenants, who mainly comes from the lower income class as they may not afford to houses.



To sum up, the progressive tax system enforced currently in Macau is not effective to narrow wealth gap and the situation is even aggrandized the tax levied on renting transactions. Apart from the particular items, the tax system roots on monotone revenue from gaming industry, and government might be at a loss to sustain the social protection expenditure when bad economic climate comes.

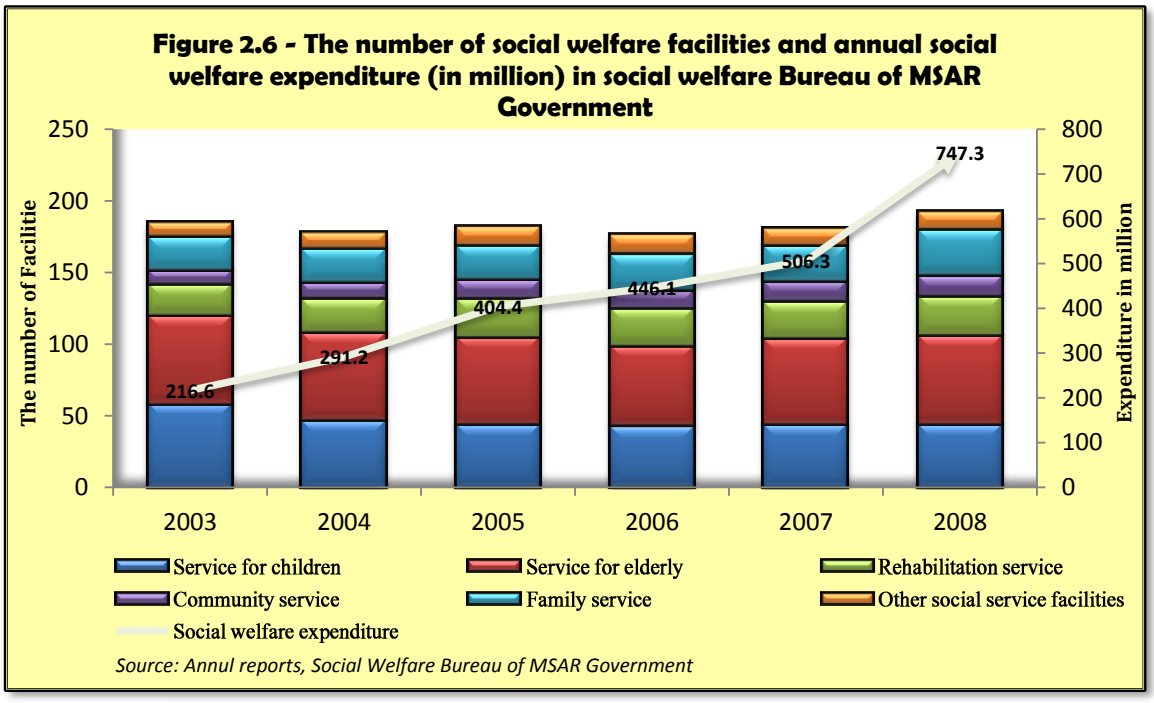
As tax is the major revenue for the government, it affects government's ability to income redistribution realized by social protection expenditure and other forms of social benefits. A good conjecture is that the amount of tax might have an indirect connection with income inequality as social protection expenditure is a portion of tax revenue. We will discuss the social welfare system to verify our guess in the next session.

2.2.2 Social Protection

The social protection system in Macau is primarily composed of two sub-organizations: Social Welfare Bureau of MSAR Government (SWBMG) and Social Security Fund (SSF). The former one distributes cash aid to citizens in need of special assistance and the latter is responsible for creating wealth for beneficiaries who invest in SSF. They act crucial roles to measure the government's effort to make use of secondary allocation to fight income inequality. In regard to both number of beneficiaries and scale of utilized financial resource, SSF is the vital backbone for the entire protection system. We will discuss on their past performance according to historical data.

2.2.2.1 Social Welfare Bureau of MSAR Government

We will evaluate the SWBMG's endeavors to improve the poor's life quality by looking at the number of social welfare facilities as well as the annual social welfare expenditure, because they are two fundamental means for SWBMG to redistribute wealth back to society. According to figure 6 below, on one hand, the total number of facilities remains relatively steady from 2003 to 2008, yet the family service enjoys a substantial lift from 23 in 2003 to 32 in 2008, while service for children reduces from 58 to 44. This phenomenon can be partially explained by land limitation in Macau. On the other hand, it is easy to observe that the social welfare expenditure rides on a drastic rising trend, which in 2008 nearly quadruples against 216.6 million in 2003.

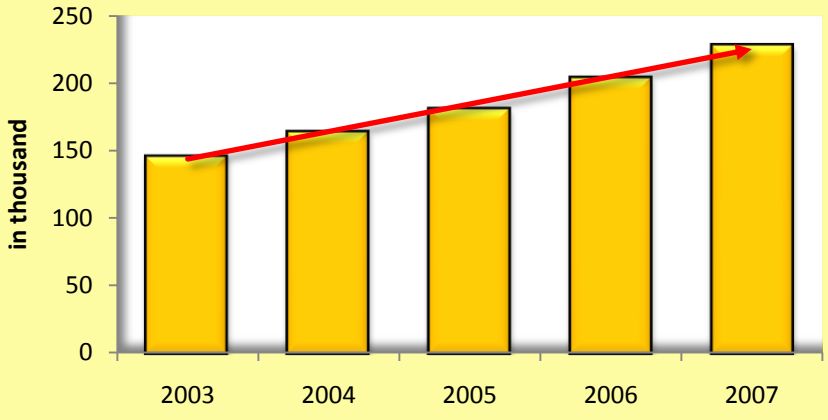


Put simply, we can conclude that SWBMG are continuously delivering more cash aids to help fighting poverty since 2003, yet the physical investment proved to be not sufficient to correspond to the drastic increase in cash aid. Nonetheless, SWBMG is much less influential than SSF, so we are not yet to make a solid conclusion only after examining the performance indicators of SSF.

2.2.2.2 Social Security Fund

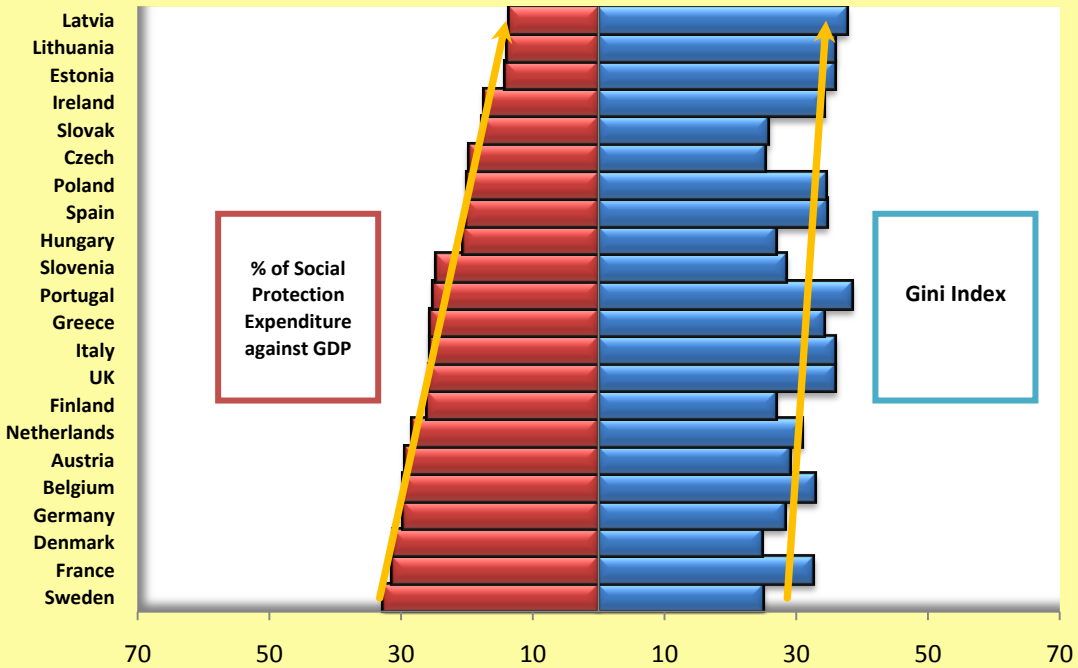
According to the information given on Figure 2.7 below, the number of beneficiaries, or the people who donate money to social security fund, has increased from roughly 146,000 in 2003 to 228,000 in 2007. However, besides the larger population is now bound with SSF, we have to conduct a comprehensive analysis to examine the relationship of wealth gap and the social protection expense, and the latter is the one of the significant channels for government to redistribute money collected from various types of taxes.

Figure 2.7 - The number of beneficiaries in the social security fund from 2003 to 2007, in thousand



Source: Public Finance, Statistical Yearbook published by DSEC

Figure 2.8 - The percentage of government social protection expenditure against GDP vs. Gini index, 2007



Source:
1. Statistical Yearbook 2007, Statistics Denmark
2. World Bank. 2007b. World Development Indicators 2007. CD-ROM. Washington, D.C.

Factor Analysis

The argument that social protection expenditure can alleviate the income inequality problem has been validated in the international community, according to Figure 2.8, where we can observe apparently that the trend of decreasing percentage of social protection expenditure against GDP corresponds positively to the rise of Gini Index, indicating a deteriorating income inequality of that country. Therefore, we run a simple linear regression of the social protection expenditure against Gini Index in the sample, retrieving:

$$Gini = 38.45439 - 0.290514 SPEGDP$$
$$t \quad = \quad (10.186) \qquad (-1.874)$$

Gini = Gini Index
SPEGDP = Percentage of social protection expenditure against GDP

In this regression, it is conclude that Gini Index is negatively influenced by social protection expenditure at 10% significance level. However, the social welfare service in Macau is still far under the international standard, as exhibited in Table 2.2:

Table 2.2 – The proportions of public expenditure from government against GDP

Item	2003	2004	2005	2006	2007
Social Protection	1349.9	1372.4	1374.4	1477.3	2067.3
Health	1384.1	1421	1701.2	1797.2	1966.2
Education	1838.5	1907.3	2219.5	2610.5	3027.9
Sub Total	4572.5	4700.7	5295.1	5885	7061.4
GDP	63566.3	82233.9	92191.3	113708.9	149456.6
% of Social Protection	2.12%	1.67%	1.49%	1.30%	1.38%
% of Subtotal	7.19%	5.72%	5.74%	5.18%	4.72%

Units: in million, Macau patacas
Source: Public Finance, Statistical Yearbook published by DSEC

The interesting phenomenon is that the wealth gap in the recent years has been narrowed, though the percentage of public expenditure against GDP decreases from 7.19% to 4.72%, opposite to the conclusion drawn previously. As the government have a number of instruments to remedy income inequality, one of the possible explanations could be that the primary allocation on society level exerts a stronger influence such that the secondary allocation with a less important role. The conjecture will be corroborated in the section of ***Industry Structure***. Therefore, we still can assert that Macau has leeway to improve its secondary allocation by assigning a larger budget on social protection in the interest of the citizens.

To sum up, we have discovered a prominent correlation between social protection and income inequality, and we hypothesize that the more of its proportion against regional GDP will make the income distribution more balanced. However, the proportion of tax against GDP will be used to delegate the proportion of social protection expenditure in regression analysis in Part Three due to insufficient data. In spite of difference, we deem the proxy appropriate as the percentage of social protection expenditure in government budget is relatively static over years.

2.3 Poverty line

Poverty line is the minimum level of income deemed necessary to achieve an adequate standard of living in a specific country. There are many methods to calculate the poverty line. In this report, we choose International Poverty Line Standard, equal to the half of median income of a country as a relative measurement of the poverty as being below some relative poverty threshold. Though easier to figure out, this standard is only applicable to the developed countries. As indicated in 2008, the GDP per capita of Macau is US$39,036, far exceeding the average benchmark of a developed country so that we can use it for analysis.

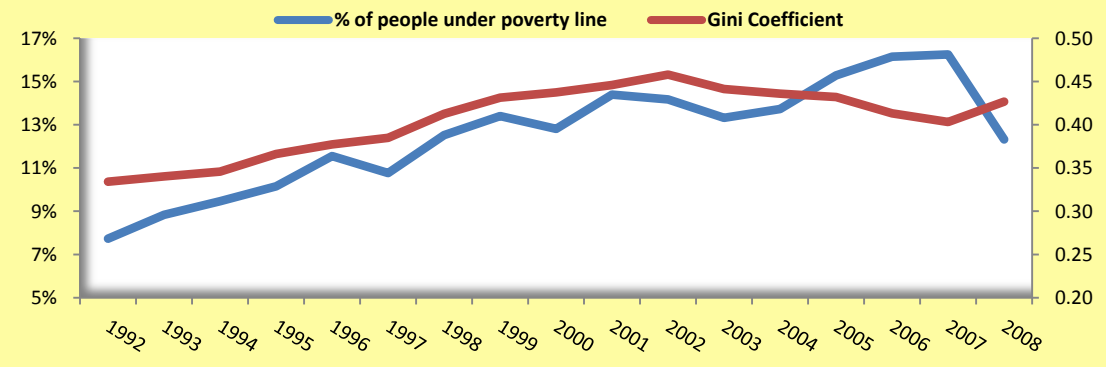
Table 2.3 - Statistics on poverty line of Macau, 2002-2008

Years	No. of people below poverty line	% of people below poverty line in the labor force	Poverty line (in Mop)
2002	28430	14.17%	2336
2003	26978	13.32%	2400
2004	29931	13.73%	2583
2005	36346	15.28%	2886
2006	43063	16.15%	3350
2007	48820	16.25%	3900
2008	39800	12.32%	4000

Source: Employment Survey, DSEC; the poverty line is calculated by bisecting the median income of each year

From Table 2.3, we can find the poverty line is increasing in recent several years along with the rise of average income in Macau, from MOP 2336 in 2003 to MOP 4000 in 2008. This great leap largely benefits from the boom of gaming industry. However, the percentage of people under poverty line in the labor force reversely climbs over years until 2008. This phenomenon triggers thought that the earning distribution might present imbalance across industries. For example, gaming industry thrives while others like manufacture industry still remain stagnant. Therefore, the poverty line is pushed up by those industries of high growth. Yet, for those industries with little change in earnings, they tend to be relatively poorer to others.

Figure 2.9 - Trend of percentage of people under poverty line against Gini coefficient

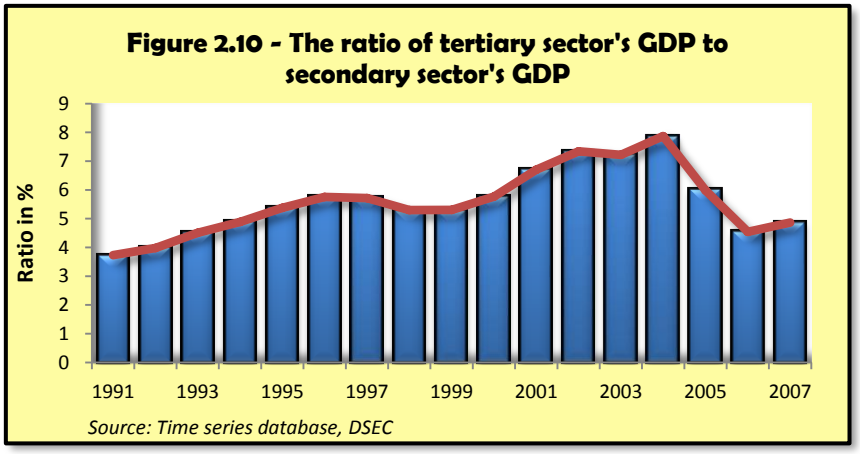


Source: Time series database and employment survey, DSEC

The drop in 2008 to 12.32% could be explained that government is carrying out the Wealth Partaking Scheme to retard poverty from exasperating. Excluding the special circumstance in 2008, simultaneous increase of poverty line and percentage of people under poverty line is an imperative concern to deal with, for it is a sign that income inequality becomes more severe. It is sensible that this anomaly only occurs when the poor is poorer and the rich is wealthier. We can also find the close relationship between the percentile of people below poverty and Gini index from Figure 2.9. Therefore, we can assert that the percentile of people under poverty line is an effective indicator for the income inequality in Macau.

2.4 Industry Structure

Both manufacturers and gambling-related tourism are mainstays bolstering Macau's economy. Manufacturing industry belongs to secondary sector of the economy, and tourism industry belongs to tertiary sector. It is defined that secondary sector includes those economic sectors that create a finished, usable product: manufacturing and construction, whereas tertiary sector (also known as the service sector) includes those companies that produce a service instead of just an end product.



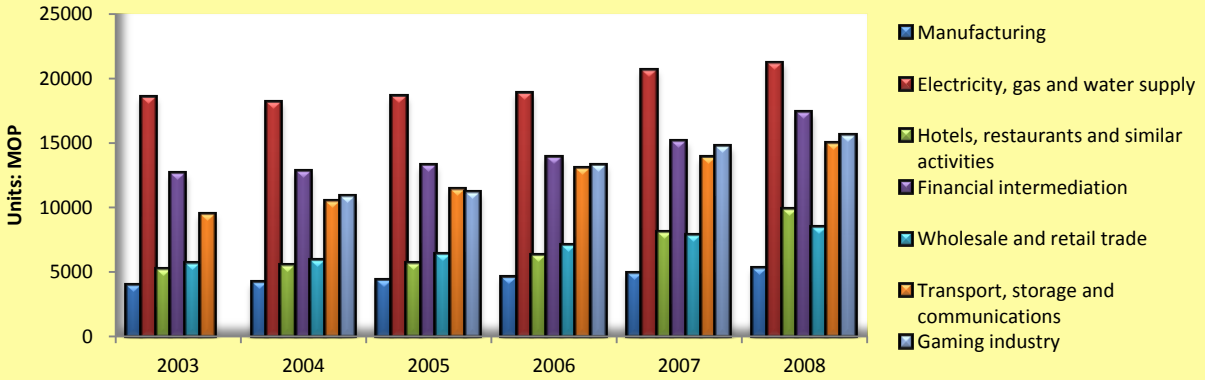
Before 1990s, manufacturers were supporting the economy of Macau. In its golden age in the 1980s, it accounted for about 40% of Macau's GDP. However, the manufacturing sector has experienced a gradual decline since the early 1990s, and the tourism industry started to grow up. The ratio of tertiary sector's GDP to the secondary's GDP sector increase steadily throughout 1990s and the beginning of 2000s as indicated in Figure 2.10. Tertiary sector poses a decisive position in Macau's economy. It has become the largest industry. Only in 2005 and 2006, there was a sudden drop of the ratio, caused by the construction due to the market demand for new casinos as well as residences. In these two years, there were many new casinos started to construct. As the completion of these hotels and casino, we can expect the ratio will bounce back. In the future, the service sector industry will still be core of Macau's economy.

Factor Analysis

As the changing of industry structure, the earnings of gambling-related tourism industry moved up quickly. From Figure 2.11, we can find in 2008, the average monthly earning of gambling industry was MOP 15595, and this figure was only MOP 10805 in 2004. The vibrant gaming industry exerts positive ripple effect to the stimulus of other industries, bringing the earnings of industries like hotels and restaurant go up. The large demand of workers and high salary of casinos attracted many people to work in. In 2008, more than 95,000 people work in the family of gaming industry. Many employees who previously had low earnings can have monthly wage over MOP 12,000 now. The growth of gaming industry has broadened the size of the middle income class.

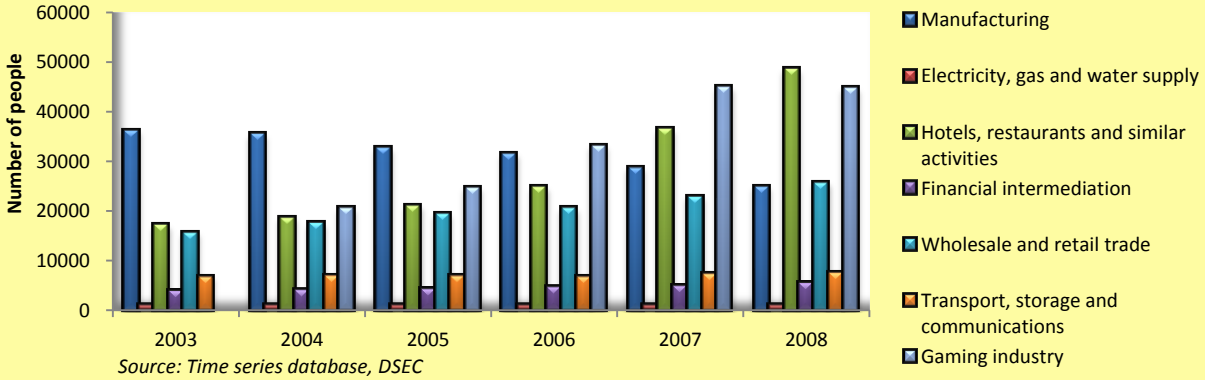
Despite the increasing number of people in the middle class, the Gini index still increasing through 2000 to 2007. To explain it by Figure 2.11, employees in manufacturing do not enjoy the same increase in salary as those in gaming industry. From 2003 to 2008, workers in manufacturing has only increased by Mop 1,279, yet the amount reaches Mop 4,790 in gaming industry, not to mention its base salary is much higher. Therefore, at two extremes, the gap is still widening, befuddled by the guise of a booming economy.

Figure 2.11 - Average monthly earnings of full time employees by industry



Source: Time series database, DSEC

Figure 2.12 - The number of paid employees by industry



Source: Time series database, DSEC

The size of manufacturing is not negligible even if it shrunk these years, and it still makes up nearly 9% of total labor force in 2008. The huge income gap between those workers and people in gaming industry has intensified the social contradiction and aggravated the overall wealth gap.

Knowing the change of industry structure from manufacture industry to gambling-related tourism industry provides limited content on study on income inequality, we also want to find out how much impact the ratio has. Therefore, we will quantify the impact for further analysis. In Part Three, the ratio of second sector's GDP to tertiary sector's GDP is used as one regressor to measure the influence of industry structure transformation.

2.5 Education

The population's average education level is a proper reflection of the quantity of "human capital" in a region. In some context, the education level can be used to explain the differences in wage earnings of employees. Also, we define education level as the average years of schooling received. This part will analyze the income inequality based on the education level differed in professions as well as its overall influence to income distribution. The jobs in Macau are classified into nine main categories exhibited in Table 2.4:

Table 2.4 - The job classification in Macau

Group	Occupations
Group 1	**Legislators, senior officials of government, directors and managers of companies**
Group 2	**Professionals**
Group 3	**Technicians and associate professionals**
Group 4	**Clerks**
Group 5	**Service and sales workers**
Group 6	**Skilled agricultural and fishery workers**
Group 7	**craftsmen and similar workers**
Group 8	**Plant and machine operators, drivers and assemblers**
Group 9	**Unskilled workers**

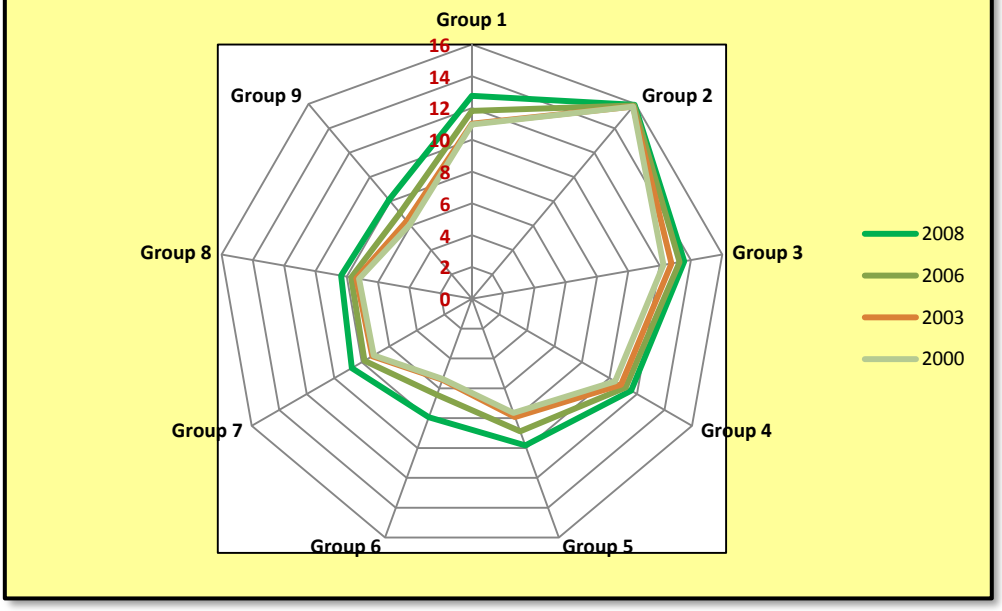
Source: Household budget survey, 2007/2008, DSEC

According to the data of the education levels for the above nine group, Figure 2.13 is plotted to illustrate the change and differences of the education level in each group. In Figure 2.13[14], the education level for every group has been increasing constantly over time. For instance, in the Group 1, the education level on average has increased from 8.6 year to 10. 4 year in eight years. Due to the globalization, the market demand for talent is increasing and hence the labor force has to acquire more to satisfy the rising need. The abnormal changes in education level of group 3 and group 7 can be used to illustrate this idea. The group 3 has the highest average schooling years, among nine groups. As it remains on the top all the time, there is no potential growth. Through 2000 to 2008, the variation of the education level in group 3 is only 0.0049, which is quite small. Yet for group 7 composed of the craftsmen, the education level altered with larger volatility up to 0.34. Besides the two anomalies, the variations in other groups

[14] Year 2001, 2002, 2004, 2005, and 2007 are omitted for simplicity purpose

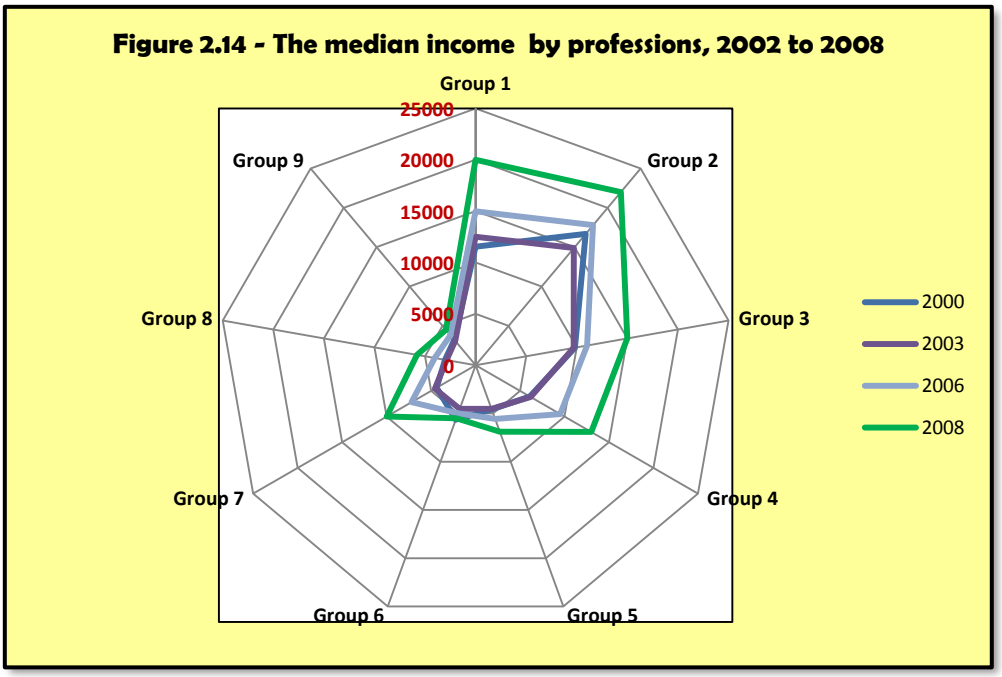
fall into a normal tier. Here we expect the education level has positive relation with income level, jointly exhibited in Figure 2.14 and 2.15, where generally higher education corresponds with higher median income by professions. Quite interesting, the average years of education for the first 3 groups are always higher than the overall average, while the rest are always lower. The situation in median income is exactly the same apart from Group 7.

Figure 2.13 - The average years of education by professions



Units: years
Source: Employment survey, DSEC

Figure 2.14 - The median income by professions, 2002 to 2008



Units: Mop
Source: Employment survey, DSEC

Figure 2.14[15] shows the median wage for each group. Two observations can be drawn. First, there is an inevitable trend that employees with higher education are prone to earn more. The income for group 1 has the highest average income with Mop 13,959.77, whereas the lowest shown in group 9 is Mop 3,488.77. Second, the percentage growth of income during the eight years observed is more obvious in groups with higher education. For instance, the average income for group 1 increases by as many as 73% in 8 years, while for group 9, is only around 45% average growth. Put simply, the inequality in education received in labor force will aggrandize the income inequality problem as the rich can gain faster than the poor, and subsequently it results in a gulf in regard to earning power.

In addition, it is an intriguing topic to test its relation with income inequality to see whether it improves or worsens the status-quo. However, it is too tedious to compute it based on job classification, and thus we use the overall education of the entire population to attain purpose. In course of calculation, weights are assigned based on population density of each group and cut-off values to represent average years of education are given to a certain group, as shown in Table 2.5. A monotonic increasing trend in overall education level could be spotted in the first glance, in contradiction with our hypothesis that it might be decreasing before 2000 when Gini coefficients are increasing. It appears that education either has no or little influence over income inequality, in contrast with social common knowledge. Thus, it is still intuitive to investigate the true relationship later in Part Three by regression analysis, as the Gini coefficient might be biased by other stronger factors.

Table 2.5 – Illustration of calculation process of weighted average years of education

	Years	Total	Pre-school	Primary School	Middle School	High School	University	Weighted Average Years of Education
Cut-off Values	-	-	0	6	9	12	16	
Weights	1992	1.00	0.19	0.35	0.30	0.11	0.05	**6.90**
	1996	1.00	0.13	0.29	0.34	0.15	0.09	**8.05**
	2000	1.00	0.10	0.27	0.33	0.17	0.13	**8.63**
	2004	1.00	0.10	0.24	0.31	0.20	0.16	**9.10**
	2008	1.00	0.05	0.17	0.30	0.27	0.21	**10.37**

Source: Employment survey, DSEC

[15] Year 2001, 2002, 2004, 2005, and 2007 are omitted for simplicity purpose

PART THREE

REGRESSION

3.1 Prologue

In order to verify the relationship between the value of Gini coefficient and that of other factors, the econometrical regression analysis will be performed in this section. Here, we postulate seven factors that may relate to the value of Gini coefficient, namely, unemployment rate (X_1), underemployment rate (X_2), GDP growth rate (X_3), percentage of the population below the poverty line (X_4), the secondary and tertiary industry rate (X_5), the ratio of the average higher education level to lower education (X_6), and the ratio of taxation to GDP level (X_7).

Before performing the regression analysis, it is better to understand the correlation among each factors and the regressor. The correlation coefficient matrix among the postulated dependent variable Y as well as the seven explanatory variables is presented in Table 3.1:

Table 3.1 - Correlation Coefficient Matrix

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Y	1.00							
X_1	0.88	1.00						
X_2	0.48	0.66	1.00					
X_3	-0.17	-0.42	-0.19	1.00				
X_4	0.81	0.53	0.09	0.14	1.00			
X_5	0.74	0.68	0.58	-0.15	0.41	1.00		
X_6	0.60	0.22	-0.15	0.43	0.92	0.23	1.00	
X_7	-0.03	-0.34	-0.14	0.90	0.26	-0.04	0.50	1.00

It appears that the value of the Gini coefficient correlated most with the level of unemployment rate and that of the percentage of the population below the poverty line since the correlation coefficients are approximately 0.88 and 0.81 respectively. Also, the correlation coefficient between the value of the Gini and that of the secondary and tertiary industry rate is 0.74, which is pretty high. However, on the contrary, it seems that there is little correlation between the value of Gini coefficient and that of the ration of taxation to GDP level. Yet, it doesn't mean that taxation is not important, but it simply reveals that the amount of taxation in Macau is too small to affect the income inequality. When it reaches at a reasonably large scale, it will help the region to combat income inequality. This is why we will suggest government either increase taxation or social protection expenditure in Part Four. However, we will rule out this regressor statistically.

3.2 Ordinary Least Square Regression

Our sample covers a period of 16 years, from year 1992 to 2007. As the sample size is small while the number of explanatory variables we postulated is relatively large, it is better to use the **Stepwise regression** procedure to

decide on the "best" set of explanatory variables for the regression model. The decision to add or drop a variable is usually made on the basis of the contribution of that variable to the ESS judged by F-test. Also, the correlation matrix mentioned above can help better to drop certain variables that have low relationship with the regressand.

The OLS Regression Equation is:

$$Y_t = \beta_0 + \sum_{i=1}^{k} \beta_i X_{it} + \mu_t$$

There are two hypothesis tests we performed to check the validity of regression as follows:

Simple t-test

The simple t-test will be implemented here to check for the significant of the individual regressor in the multiple linear regression.

The hypothesis statements are:

H_0: $\beta_i = 0$

H_1: $\beta_i \neq 0$

$\rightarrow$ Reject H_0 if TS > CV or TS < -CV[16]

F-test (or Ward Test)

F-test is used to verify the overall significance of the regression.

The hypothesis statements are:

H_0: $\beta_1 = \beta_2 = \ldots = \beta_i = 0$

H_1: At least one of the above β is nonzero

$\rightarrow$ Reject H_0 if F-statistic > CV

Referring to Table 3.2, we drop out one insignificant regressor that has the lowest relationship with the regressand at a time, denoted as NA in the next step. We finally find out the most appropriate OLS regression that makes all the coefficients of the explanatory variable statistically significant and the regression overall significant. Besides, the table exhibits that the adjusted R-squared increases from Step 1 to Step 5, showing that the goodness of fit has been improved after each step. In the end, X_1, X_4, and X_5 remained to be the regressors left for further analysis.

However, we cannot still ignore the remedies of the heteroskedasticity as well as the serial correlation that may make the regression results inaccurate. Therefore, two more hypothesis tests need to be performed to check for the existence of the heteroskedasticity and the serial correlation.

[16] TS stands for Test Statistics, and CV stands for Critical Value

Table 3.2 Summary results for Stepwise Regression

Variable	Step 1	Step 2	Step 3	Step 4	Step 5
Unemployment rate	1.51***	1.41***	1.40***	1.36***	1.25***
	(0.39)	(0.36)	(0.33)	(0.29)	(0.19)
Underemployment rate	-0.19	-0.16	-0.14	NA	NA
	(0.51)	(0.50)	(0.39)	NA	NA
GDP growth rate	-0.03	0.003	NA	NA	NA
	(0.06)	(0.04)	NA	NA	NA
% below poverty line	0.43	0.58	0.55	0.55	0.74***
	(0.59)	(0.54)	(0.41)	(0.39)	(0.09)
2nd to 3rd industry rate	0.0075**	0.0080**	0.0080**	0.0077**	0.0078**
	(0.0032)	(0.0031)	(0.0029)	0.0027	(0.0026)
Education ratio	0.014	0.008	0.01	(0.011)	NA
	(0.038)	(0.036)	(0.023)	0.022	NA
Ratio of tax to GDP	0.15	NA	NA	NA	NA
	(0.20)	NA	NA	NA	NA
C	0.21***	0.22***	0.22***	0.22***	0.21***
	(0.041)	(0.037)	(0.027)	(0.026)	(0.013)
R-squared	0.971	0.970	0.970	0.969	0.969
Adjusted R-squared	0.947	0.950	0.955	0.958	0.961
F-statistic	39.36***	48.23***	64.25***	87.19***	123.96***
DW-statistic	2.15	1.81	1.78	1.68	1.71

1. the value in the parentheses under the value of coefficient presents the standard error of estimates for each variable
*2. ***, ** and * represent the significance level at 1%, 5% and 10% respectively*

3.2.1 White general heteroskedasticity test

Since the sample size is relatively small (contains only 16 observations), the auxiliary regression that regress the square of residual on all the X variables, and their squares. However, the cross-product terms are not included in the auxiliary regression, which is:

$$\hat{u}_t^{\,2} = \alpha_0 + \alpha_1 X_{1t} + \alpha_2 X_{4t} + \alpha_3 X_{5t} + \alpha_4 X_{1t}^{\,2} + \alpha_5 X_{4t}^{\,2} + \alpha_6 X_{5t}^{\,2}$$
$$\alpha = 0.05$$

Hypothesis Testing

H_0: There does not exist heteroskedasticity

H_1: There exists heteroskedasticity

$\alpha = 0.05$

Chi-distribution will be used as testing distribution with degree of freedom = 6

Reject H_0 if TS > 1.63539

TS = n * R^2 = 1.056460<1.63539 $\rightarrow$ Do not reject H_0

Therefore, there is no existence of the heteroskedasticity in the best fitted OLS Regression.

3.2.2 Breusch-Godfrey (LM) test for serial correlation

AR(2) Scheme, that is: $\mu_t = \rho_1\mu_{t-1} + \rho_2\mu_{t-2} + \varepsilon_t$, will be used for checking the serial correlation.

H_0: There does not exist serial correlation

H_1: There exists serial correlation.

Chi-distribution will be used as testing distribution with degree of freedom = 6

$LM = n*R^2 = 16*0.107381 = 1.718096$

P-value = $0.4236 < 0.05 \rightarrow$ cannot reject H_0

Therefore, there is no serial correlation in the best fitted OLS Regression. After verifying that there are no remedies like Heteroskedasticity and Serial Correlation in the best fitted OLS Regression we selected through the method of Stepwise Regression, we can use this to draw some statistical inference for the value of Gini Coefficient after knowing the corresponding value of unemployment rate(X1), percentage of the population below the poverty line(X4), the secondary and tertiary industry rate(X5).

3.3 Granger Causality Test

Although the regression analysis deals with the dependence of one variable on the other variables, it is not necessary to draw the inference that one variable causes another. Therefore, the Granger Causality Test will be performed here to verify the direction of the influence. The test involves estimating the pair of regressions as follows:

$$Y_t = \sum_{i=1}^{n} \alpha_i X_{kt-i} + \sum_{j=1}^{n} \beta_j Y_{t-j} + u_{1kt}$$

$$X_{kt-i} = \sum_{i=1}^{n} \lambda_i Y_{t-j} + \sum_{j=1}^{n} \delta_j X_{kt-i} + u_{2kt}$$

Where

Y_t = the value of Gini Coefficient

X_{kt} = the value of the factor k (k=1, 2, 3…, 7) from the seven postulated factors and,

The disturbance terms u_{1kt} and u_{2kt} are assumed to be uncorrelated.

The conventional F-test will be performed to verify the direction of the causality and the Testing Hypothesis are stated as following:

$$F = \frac{(RSS_R - RSS_{UR})/q}{RSS_{UR}/(n-k)}$$

Where

RSS_R = the sum square of residual in the restricted equation,

RSS_{UR} = the sum square of residual in the unrestricted equation,

q = the number of restrictions imposed on the initial unrestricted equation and
k = the number of regressors in the unrestricted equation (constant term is included).

Hypothesis Test 1:

H_0: Y does not granger cause X_k or $\lambda_1=\lambda_2=....=\lambda_n=0$

H_1: Y granger causes X_k or not all of the above λ is zero.

Hypothesis Test 2:

H_0: X_k does not granger cause Y or $\alpha_1 = \alpha_2 =....= \alpha_j = 0$

H_1: X_k granger causes Y or not all of the above α is zero

Criteria for making a decision under Granger Causality Test:

1. If both the null hypothesis in Test 1 and in Test 2 are not rejected, there exits the independence between Y and factor X_k.
2. If both the null hypothesis in Test 1 and in Hypothesis Test 2 are rejected, there exists the feedback or bilateral causality relationship between Y and factor X_k.
3. If the null hypothesis in test 1 is rejected while that of in test 2 is not rejected, there exists the unidirectional causality from Y to X_k.
4. If the null hypothesis in test 1 is not rejected while that of in test 1 is rejected, there exists the unidirectional causality X_k from to Y.

The results are shown in Table 3.3 in the next page.

3.4 Conclusion

To conclude, this section uses the econometric models to analyze the relationship between Gini Coefficient and seven factors we postulated. With the help of the Stepwise Regression Procedure, it is easier to select the best fitted Ordinary Least Square Multiple Regression Model that may help to make further inference on the value of Gini Coefficient by knowing the corresponding value of unemployment rate (X_1), percentage of the population below the poverty line (X_4), the secondary and tertiary industry rate (X_5). The practical implication is that government can estimate the future Gini coefficients without doing household budget survey every year.

However, the remedies of heteroskedasticity and autocorrelation may impose uncertainty to the results of forecasting due to the fact that those remedies may not only make the estimates of the coefficients biased, but also lead to the inefficient of the estimate so that the statistical testing may become invalid. After making the White General Heteroskedasticity Test and the Breusch-Godfrey (LM) Test for Serial Correlation, it shows that there is no necessity to remedy the initial regression. Therefore, we can conclude that the regression model obtained in Step 5 in the Stepwise Regression Procedure is the best fitted one.

Regression

In addition, it is not sufficiently to draw the inference that one variable causes others based on simply OLS Regression Analysis although it deals with the dependence of one variable on the other variables. Thus, an additional Granger Causality Test has been performed to verify the direction of the influence which is listed below.

Table 3.3 - Summary results for the Granger Causality Test

Direction of Causality	Lags	F-value	P-value		Decision
$X_1 \rightarrow Y$	2	0.89936	0.4405	No	Unidirectional Causality from Y to X_1
$Y \rightarrow X_1$	2	3.91854	0.0597	Yes	
$X_1 \rightarrow Y$	3	0.52817	0.6792	No	Interdependence
$Y \rightarrow X_1$	3	1.97448	0.2193	No	
$X_2 \rightarrow Y$	2	0.47539	0.6364	No	Interdependence
$Y \rightarrow X_2$	2	0.20821	0.8158	No	
$X_2 \rightarrow Y$	3	0.26940	0.8455	No	Interdependence
$Y \rightarrow X_2$	3	0.83056	0.5238	No	
$X_3 \rightarrow Y$	2	6.31689	0.0193	Yes	Bilateral Causality
$Y \rightarrow X_3$	2	6.19325	0.0203	Yes	
$X_3 \rightarrow Y$	3	22.7613	0.0011	Yes	Bilateral Causality
$Y \rightarrow X_3$	3	7.77451	0.0172	Yes	
$X_4 \rightarrow Y$	2	0.67287	0.5341	No	Interdependence
$Y \rightarrow X_4$	2	0.08209	0.9219	No	
$X_4 \rightarrow Y$	3	1.12824	0.4097	No	Interdependence
$Y \rightarrow X_4$	3	1.49634	0.308	No	
$X_5 \rightarrow Y$	2	0.54360	0.5986	No	Interdependence
$Y \rightarrow X_5$	2	2.98000	0.1016	No	
$X_5 \rightarrow Y$	3	0.42872	0.7399	No	Unidirectional Causality from Y to X_5
$Y \rightarrow X_5$	3	4.30271	0.061	Yes	
$X_6 \rightarrow Y$	2	2.43046	0.1432	No	Interdependence
$Y \rightarrow X_6$	2	0.72262	0.5116	No	
$X_6 \rightarrow Y$	3	9.96881	0.0095	Yes	Unidirectional Causality from X_6 to Y
$Y \rightarrow X_6$	3	2.68153	0.1404	No	
$X_7 \rightarrow Y$	2	6.06018	0.0215	Yes	Bilateral Causality
$Y \rightarrow X_7$	2	12.3138	0.0027	Yes	
$X_7 \rightarrow Y$	3	10.6504	0.0081	Yes	Bilateral Causality
$Y \rightarrow X_7$	3	28.6168	0.0006	Yes	

PART FOUR

REMEDY

4.1 Summary

Combining factor and regression analysis, we deem that the most important factors influencing income inequality in Macau are GDP growth rate, industry structure, percentage of people and education under poverty line respectively, in which the former three factors are significant in regression analysis. Therefore, the government should put the four issues on top of agenda. In fact, all factors revolve around the core issue we will elaborate on, namely the economic development, as it affects the instruments of income allocation for government to remedy wealth gap.

4.2 Three-tier system

In total, three types of income allocations are widely in the society,

1. Primary distribution: It is not directly controlled by the government, yet it is the first tier to distribute wealth to society mainly through payments to labors. Thus, strong economy creates job opportunities, driving down the unemployment rate. Meanwhile, the average income per head increases, jointly shortening the wealth gap.
2. Secondary allocation: Government can make a contribution to narrow the gap between rich and poor artificially by effective secondary allocation through tax redistribution to society. Again, the amount of tax is largely determined by the economic conditions.
3. Third allocation (Donation): Donation from association or entrepreneur is also a feasible way to improve the living standard of low-income population. If more rich people are willing to donate money to the low-income class, the gap is one step closer to be evened.

In the next part, we will share some ideas on how to maximize the effective use of the three-tier system.

4.3 Recommendations

There are three recommendations that we come up with as useful remedies to fight against income inequality in Macau, in perspectives of industry, social welfare system and education.

4.3.1 Industry transformation

This is a two-step procedure to implement simultaneously. First, we encourage the continuous development of industries in vantage position on condition that the government can transfer more profits from gaming industry to manufacturers or other inferior industries in secondary sector. We've witnessed the tremendous rippling effects

brought by the boom of gaming industry. It is the most competitive industry correspond to the regional attributes and economic structure, they are easy to survive and expand if we continue to take advantage of it. Therefore, sustainable progress in gaming industry is undoubtedly a facilitator to a better economy.

Second, Macau government should also inject capital to strengthen relatively inferior industries like manufacturers. Regression analysis shows that the ratio of second sector to tertiary sector affects income inequality. When the economy heated up since 2003 with the open of gaming industry, the proportion of the second sector is negatively related with Gini coefficients. Thus, Macau governments can subsidize the industries with material production so that a more balanced economic structure can be integrated. As a result, the income gap between industries will be alleviated.

4.3.2 Improvement of social welfare system

Government is able to improve the life of the poor by enhancing the distribution policy through social security fund, social protection expenditure and etc. International evidence has proved that the bigger proportion of government budget on social welfare, the lower the Gini coefficient. Therefore, it is advisable to:

- Encourage citizens to invest more in the social security fund
- Build more social welfare facilities
- Increase the budget on social protection expenditure
- Raise the span of tax rates in the progressive tax system
- Cease wealth partaking scheme when necessary, though it aims to assist locals counteract inflation and poverty by issuing cash subsidy to citizens. However, the transitory improvement will die out in the long term.

As a result, we are expected to see less people under poverty line by receiving more benefits from the government. Apparently, it will reduce the Gini coefficients in turn according to regression analysis.

4.3.3 Development of overall education level in workforce

It is a long-run strategy to deal with income inequality problem. As we have validated, education determines the potential increase of the salary level in a particular profession. Thus, it is urgent to distribute more incentives among low-income class in purpose of a high average education level. We encourage the government to:

- Prolong the duration of compulsory education applicable to all local citizens in the long term. It will effectively reduce the number of people without any education.
- Strengthen the education fund by giving out more tuition assistantship so that more people can afford to school
- Construct public education facilities such as libraries, museums and etc
- Provide professional/diploma programs in institutes of higher education such as University of Macau.

In conclusion, the income inequality can be reduced to an acceptable level as long as the government makes full use of the three-tier distribution system to balance economic structure, improve social welfare system and

popularize higher education.

PART FIVE

APPENDIX

Appendix

5.1 Calculation of Gini Index

We will demonstrate how **Monte Carlo Simulation** is used to retrieve estimated Gini coefficients in 2008, and it applies identically to the rest of years. The software realizing the simulation is EXCEL and its macro functions, and data pre-processing is jointly performed by MATHEMATICA. In general, the process consists of two steps:

5.1.1 Generation of random numbers under log-logistic distribution

EXCEL does not provide built-in function specifically for log-logistic distribution. However, EXCEL macro enables us to insert program to create a user-defined function. Characterizing the features of log-logistic model, the function is programmed to be varied with two parameters m and k by using log-logistic density function.

We've already known the value of m previously, and subsequently we need to identify the most suitable value for parameter k. In order to generate random numbers, we arbitrarily give a value for k. The population size is 314,700, and we simplify it to 3,147 by dividing 100. Afterwards, we obtain the 3,147 random numbers and reclassify them into income range by counting how many random numbers fall into each corresponding range, and the results is shown in Table 5.1.

Table 5.1 – Presentation of income reclassification into original income range[17]

Income Range	Fitting	Real	Error	MSE	MAD	CHISQ
≦ 3 499	344	334	-10	100	10	0.29
3 500 - 3 999	96	64	-32	1024	32	10.67
4 000 - 4 499	98	151	53	2809	53	28.66
4 500 - 4 999	110	113	3	9	3	0.08
5 000 - 5 999	242	279	37	1369	37	5.66
6 000 - 7 999	479	483	4	16	4	0.03
8 000 - 9 999	425	350	-75	5625	75	13.24
10 000 - 14 999	694	707	13	169	13	0.24
15 000 - 19 999	305	272	-33	1089	33	3.57
20 000 - 29 999	201	229	28	784	28	3.90
30 000 - 39 999	67	89	22	484	22	7.22
40 000 - 59 999	46	48	2	4	2	0.09
60 000 - 79 999	20	13	-7	49	7	2.45
≧80 000	20	15	-5	25	5	1.25
Total	**3147**	**3147**	**-**	**968.28**	**23.14**	**77.35**

Units: in hundred people
Source: Employment survey 2008, DSEC

In the Table 5.1, we can also obtain values for error measurements, MSE, MAD and CHISQ respectively. They are

[17] It is just one of the many possible results as the simulation will change every time

the criteria for us to find the optimal value for k. Then, we **What-If analysis** to simulate the values for three error indicators for 300 times, and subsequently obtain the average value for MSE, MAD and CHISQ, using Equation [5], [6] and [7]. The most interesting phenomenon is that there is only one variable in the complicated deduction process. Therefore, Solver function built in EXCEL can be applied to search for the optimal value for k on condition that it minimizes the value of CHISQ. As a result, we can find out the best value for k and the log-logistic distribution is then permanently positioned by two known parameters.

5.1.2 Attainment of the Lorenz Curve and Gini coefficient

In fact, by knowing the two given parameters, Equation [9] can directly estimate the Gini coefficients for 2008. However, in order to depict a vivid picture of status-quo of income inequality in Macau, we need to graph the Lorenz Curve as visual aid for understanding.

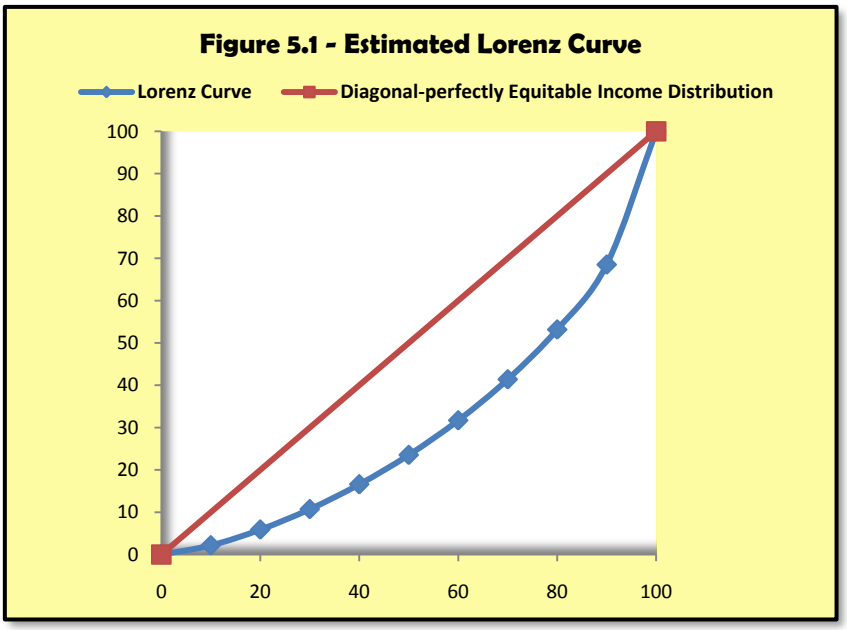
Now that the two-parameter log-logistic distribution is obtained, the cut-off points to divide the population into ten equal shares can be calculated by Equation [3] in Part One. For example, if the first cut-off point is assumed to be Mop 3,647, it basically means that on average there are statistically 10% of people with monthly salary below this point. Likewise, the other 9 cut-off points can be estimated, and subsequently, 10 new income classes can be arrayed between each two cut-off points in ascending order. According to Equation [10], by integrating the log-logistic distribution function for an income class, say from 0 to 3,647, we can get the total income earned from this group. Repeating the procedures to other income classes, we are able to construct the table as follows:

Table 5.2 – Presentation of constructing new income class with income share in the population

Decile	Cumulative % of population	Cut-off Point	New Income Class (Mop)	Income in million	Income Share	Cumulative Share
1	0.1	3647	≦ 3647	80284.1	2.17	2.17
2	0.2	5060	3648-5060	137886	3.73	5.90
3	0.3	6290	5061-6290	178679	4.83	10.72
4	0.4	7518	6291-7518	216970	5.86	16.59
5	0.5	8854	7519-8854	256857	6.94	23.53
6	0.6	10429	8855-10429	302494	8.17	31.70
7	0.7	12465	10430-12466	358537	9.69	41.39
8	0.8	15494	12467-15494	435668	11.77	53.17
9	0.9	21494	15495-21494	567799	15.34	68.51
10	1	NA	≧ 21495	1165230	31.49	100.00
	-	-	Total	3700404	100	-

Apparently, the top 10%, namely the richest, accumulates 31.49% of the total wealth, much more than the 10% at the bottom, which only has 2.17%. Plot the cumulative income share with the cumulative population size, the Lorenz Curve can be graphed on the next page.

Appendix



In terms of the accuracy of the estimations, we will compare the three actual Gini coefficients in 1998/1999, 2002/2003, and 2007/2008 with those searched by computers.

Table 5.3 – Comparison of actual and estimated Gini coefficients

	1998	2002	2007
Actual	0.43	0.45	0.38
Estimated	0.413	0.458	0.403
Error	4.2%	-1.7%	-5.7%

As we can see from the Table 5.3, the error of estimation is quite small, less than 5% overall. The difference could be jointly caused by unavoidable error of using log-logistic distribution to fit the true population and the partial representations of income level by salaries. However, we deem the methodology is still valid as it provides a relatively accurate results, and we are not interested in predicting the values of Gini coefficients, where forecasting usually requires to minimize error measures among all kinds of distributions. In other words, it is sufficient for us to conduct good regression analysis to study the significance of influencing factors.

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