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台灣麥當勞加盟策略之校準分析

A Calibration Analysis of McDonald's Franchising in Taiwan

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中 華 民 國 106 年 08 月

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Abstract

Fast food restaurants play an important role in our daily life; they are also one of the most important restaurant business types in Taiwan. The literature posits and examines models behind how franchisors and franchisees reach their franchising decisions, and how different factors affect optimal franchising rates. On that basis, they derive the optimal franchising rates, at which both franchisors and franchisees can maximize their utility. However, there is no literature on determining the reasonable range of variables in the model that we cannot observe in the real world. This study takes the initiative to unveil the model behind the franchising decision with proxies of variables by calibrating a basic economic model using data from McDonald's Taiwan. Our finding are that a higher importance level of effort results in a higher optimal franchising rate, and the level of franchisees' risk aversion and the market risk in metropolitan areas are higher than in non-metropolitan areas. In accordance with McDonald's Taiwan's strategy in the past years, we construct a more detailed model to capture the characteristics more accurately by adding a healthy food product line into the production function. The extended model can explain the real-world data better than the previous model. On the strategy side, we find that if healthy products account for a higher proportion of the production capacity, the model fitness level drops. In other words, the profit for both the franchisor and franchisees decreases when McDonald's Taiwan introduces more healthy food to the menu.

Key Words: fast-food industry, principal-agent model, calibration, franchising

摘要

速食食品不但在我們的生活中扮演重要的角色，在台灣，其亦是最重要的餐飲產業之一。文獻上有關於加盟總部與加盟商之間的決策背後的模型，各個因子如何影響彼此，最後加盟總部與加盟商皆能極大化他們的效用，達到一個最適加盟的平衡點。然而，未看到有使用校準分析(Calibration)的方式回推出無法觀察到變數之合理區間的文獻。本研究使用此方法及台灣麥當勞的資料來解開加盟與否決策背後模型的面紗。在最基本的經濟模型中，我們發現加盟商努力的重要性增加時會導致加盟率的下降。再者，都會區的加盟商風險趨避程度以及市場風險較非都會區高。為了針對麥當勞總部的市場策略，延續上個模型的設定，我們在生產函數中另外加入健康食品的產品線以建設出較細緻的第二種模型。此延伸模型相較於第一個模型能解釋更多資料。我們亦觀察到當健康食品佔麥當勞產能提高時，模型的適配度會下降。此現象可解釋為在其他條件不變下，當麥當勞在菜單內加入更多比重的健康食品時，加盟商與加盟主的獲利將低於現階段的水準。

關鍵字: 速食產業，委託代理理論，校準分析，加盟

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1 Introduction

Franchising is a crucial stage in the path of corporate growth. Through franchising, the franchisor enjoys lower cost of merchandise and logistics since all goods are purchased from a single source, so the franchisor has stronger bargaining power; the franchisor gains more exposure to consumers and builds up reputation when more and more outlets are established in different regions, while the franchisor does not have to bear total risk exposure, and so on . Franchising provides many advantages for corporations, serving as a foundation for the internationalization process of a brand.

The franchising industry is an important sector of the economy in Taiwan. In an industrial analysis of restaurant and food services industry in Taiwan from Taiwan Trend Research, the top corporates in this industry by revenue are listed, there are 6 corporates in the top 10 list adopt the franchising business models. This indicates how influential the franchising industry is. According to another research conducted by Taiwan Chain Stores and Franchise Association, there were 2,599 franchising brands and 104,391 outlets in Taiwan in 2016, comparing to 2,412 brands and 103,157 outlets in 2014. The number of franchising brands increased by 7.75%, and the number of outlets increased by 1.2% over those two years. The evidence shows that this industry is still growing, and this is why we specifically focus on this industry in this research.

One of the largest and most competitive markets within franchising industry is fast food sector; also, it is common seen in our daily life. In the fast food sector, it requires a standard operating process for employees to follow so that customers could have fast services. Franchising is the most efficient way to expand a firm's business so that the franchisor can assure their customers get great and standardized services in order to consolidate the reputation of the trademark. Fast food companies need to be sensitive to the change of the

consumer behavior, since fast food restaurants like McDonald's and KFC are considered as exotic food to Taiwanese, and hamburgers and French fries are not the food Taiwanese would eat on a daily basis, how to localize the menu while keeping the original flavor and their brand images is a key factor to survive through the competition.

Hence, the fast food sector is discussed in this research, due to the fact that its volatility is considered higher than other franchising sectors'. Take the convenience store franchises sector for example, such as 7-ELEVEN, FamilyMart, OkMart, and HiLife. These brands are so successful at implementing franchising business models that an outlet can be seen on nearly every corner of every block in Taipei City. These convenience stores sell a broader spectrum of products compared to fast food restaurants; they thus serve more types of customers than fast food restaurants. When there is a shock in the demand, the convenience store franchises sector will not be severely affected compared to the fast food sector given the broader spectrum of products. The monthly revenues of convenience store franchises and restaurant sector franchises in 2015 and 2016 is collected from Ministry of Economic Affairs is shown in Figure 1. It is obvious that restaurant business owners suffer higher volatility than convenience store owners. We believe that the model we build for the fast food sector would be well-conceived, robust, and more sensitive toward outside shocks compared to other franchising sectors .

When it comes to the fast food industry, the most successful and iconic company is McDonald's. Hsun Ta Wei first introduced McDonald's into Taiwan in 1983. The sales revenue of the very first week broke the record in the world after the grand opening of the first McDonald's outlet. After the news of the huge and successful sales figure spread out, other brands such as Wendy's, KFC, MOS Burger, and Lotteria entered Taiwanese market one after another, eating habits of Taiwanese were changed by the entrance of McDonald's as

the annual revenue of foreign fast food companies accounted for 32.16% of the whole restaurant industry (Lu, 2009). It is fair to say that McDonald's opened up a new page of Taiwanese fast food industry history.

Figure 1

Volatility of Restaurant Sector

Given the importance of franchising generally and the fast food industry, and the iconic McDonald's can be considered a fair representative of the fast food restaurant and the franchising industry in Taiwan; thus, the invisible business model that works behind those ordering counters is worth discussion. How does McDonald's Taiwan decide which is more profitable and which bears less risk – to franchise or to operate an outlet themselves? How would different characteristics of cities or counties affect the franchising decision of McDonald's Taiwan? In addition, is the healthily eating trend in recent years affecting McDonald's franchising strategy?

In this study, a theoretical economic model is applied to the real-world data on franchising of McDonald's in Taiwan, and through this process, we can have a peek into the confidential business model that McDonald's adopts. In the second part of the study, we

extend the model to discuss how the production of a second type of products would affect the optimal franchising rate. Unlike the typical fattening products when come to mind when we think of McDonald's, the second type of products is actually healthy food. It has been an unstoppable trend that eating and living healthily plays an important role in people's lives. Healthy fast food is a growing market that McDonald's Taiwan has been trying to break into for years. Thus, we derive a more detailed model that captures the behaviors of the majority of the McDonald's outlet by considering the second product in the production function.

The interesting thing is, McDonald's just franchised all of its outlets in Taiwan to a local company, De-Yu, whose representative is Chang-Lin Lee, who is also the president of the Ambassador Hotel, for around NTD 5 billion with approval from the Investment Commission, Ministry of Economic Affairs, in late April, 2017. It will be exciting to see what the new strategies of the new operator will be after taking over the management of every McDonald's outlet. What the optimal franchising rate will be if the new operator decides to prioritize the healthy food market is something we can model using the analysis in this thesis.

The model we extend from the basic theoretical model could be the starting point for more complicated future extension and variation, if other factors that affect the future trend of a specific industry are added into the model, the result could be used as guidance for firms' business strategies. For instance, if a company plans to enter a new market, after inputting all the data from that country, the estimated optimal franchising rate could be obtained, and business strategy can be set in advance on that basis. On the other hand, this model could be used in a scenario in which a franchisor is interested in launching another product line that has different properties to the existing product line; the franchisor could use the extended model we discuss in this research to forecast the eventual optimal franchising rate.

2 Literature Review

We aim to disclose the key factors that determine how McDonald's Taiwan would decide whether to franchise or to operate outlets on their own, and how those factors would have impact on the business model that we cannot observe. However, there is no related literature in such field, research papers regarding franchising in fast food restaurants in Taiwan are mainly about those restaurants' management and location strategies, how they can be so successful, and the quality of services they provide. The literature on discussing the franchising decision model in the fast food industry in Taiwan is limited.

Lafontaine and Slade (2002) construct a simple theoretical model called principal-agent (also franchisor/franchisee) model to capture the feature of franchise contracting, they further decompose the contract choice into six different aspects, and one of them is the aspect we will mainly focus on in this thesis — the importance level of an agent's effort. In the model setup, an agent needs to exert an effort level that will result in an outcome, and the importance of that effort level is what we will look deep into. As for how to quantify the importance level of the agent's effort level, we happen to have a database of more than 400 questionnaires, which were completed by every manager of every single McDonald's outlet in Taiwan from Wang, Lee, Ning, and Shao (2016). The database consists of abundant information, such as whether the outlet is franchised or company-operated, the demographic statistics of the location where the outlet is located, types of auxiliary services the outlet provides, the attractions nearby, and so on. We will construct an indicator from that database as a proxy to measure the importance level of an agent's effort level to see if the principal-agent model would fit the real-world data. More importantly, how the logical ranges of the key parameters in the model would look like so the model could explain the phenomena in the real world.

In reality, we observe that the eating habit has been changing among Asian countries. The food consumption patterns are showing signs of convergence toward a Western diet. (Pingali, 2006). With the push of urbanization and globalization, new dietary needs emerge, and people's lifestyle changes. (Regmi and Dyck, 2001). Consumers nowadays have stronger preferences toward meat, fish, dairy products, and processed convenience food. The new dietary behaviors show that Asians are consuming food with more fat and protein, comparing to the traditional Asian diet that emphasizes on carbohydrates (Parraga, 1990). Moreover, consumers in urban areas have easy access to the food retail outlets, and marketing campaigns makes them more exposed to non-traditional food choices (Reardon et al., 2003).

Taiwan, as an Asian country, also follows the same trend of this dietary change. Nonetheless, in the recent years, with the constant elevating consumption level, the awareness of living healthy lives has been raising, people start paying more and more attention on the food they consume. Evidence shows that consumers in Taiwan were in agreement as to the four most important factors when it comes to choosing food, those are, health, natural content, weight control, and convenience (Prescott, 2002). In another study shows that consumers in Taiwan would hope healthy-themed restaurants to provide healthier and more nutritious dishes, they also care much about how those restaurants process the food. Hence, more and more restaurants use low calories or disclose nutrition information of the food as marketing strategies to appeal more customers (Hsu, 2012).

The fact that healthy dining is a trend cannot be neglected. McDonald's Taiwan also sees that. It is obvious that McDonald's Taiwan has been trying to grab a market share of healthy food market. According to the newsroom database on McDonald's Taiwan's official website, where every press release was documented. They launched the first healthy product, grilled chicken sandwich, using the concept of low calorie and high fiber as their marketing strategy

in 2004. After the launch, McDonald's kept trying launching other healthy products to flip their brand image of "cheap and unhealthy". They tried chicken and beef rice wraps, and including fresh salad as a side dish choice like French fries. However, not every idea survived through the highly competitive market. The grilled chicken sandwich is considered as a successful example as it can still be seen on the menu nowadays. Although only one main meal made through the time, it doesn't mean McDonald's doesn't see healthy food market as an important battle field. Hence, we add in another type of products into the principal-agent model to see if it captures more characteristics of the real-world data comparing to the basic one.

Then, we use calibration process to find out the best combination of the parameters that we do not have access to, which will make the model eligible to explain the true observations we see in our world. How do we conduct calibration in practice? We manipulate the variables to obtain a match between the observed and simulated values (Oreskes, Shrader-Frechette and Belitz, 1994). We keep adjusting the parameters until the observed franchising rates fall into the theoretical ranges of optimal franchising rates. Our result shows that the basic model we use can explain 73.33% of the data. After we take the healthy meals into consideration of the production function, the extended model can explain 86.67% of the observations. Moreover, we check the tolerant range of the key parameter that measures the degree of risk aversion from empirical studies (Danthine and Donaldson, 2014), which is wider than ours, showing that our theoretical model setup is equitable and practical, and can be used with agility for future discussion.

3 Model

In this research, our goal is to explain what factors caused the franchising strategy of McDonald's Taiwan in every city and county by using an economic model called principal-agent model from Lafontaine and Slade (2002), specifically the principal-agent model that focuses on the importance level of an agent's effort.

Then, consider multiple attempts McDonald's Taiwan made on marching into the healthy food market, we adjust and extend the basic agent's effort model with the introduction of second type of products — healthy food, that McDonald's would sell to meet the uprising demand due to the rising awareness of healthy eating in Taiwan.

3.1 Model 1: Basic Agent Effort Model

Lafontaine and Slade (2002) discuss the principal-agent model in six different aspects of contracting problem and how each of them could affect the choices and the structure of the organizations. Through the dataset from the research in Wang, Lee, Ning, and Shao (2016), we observe that different McDonald's outlets provide different auxiliary services such as the length of business hours, free access to Wi-Fi, playground and parties, and Drivethru service. We adopt the model that emphasizes on the importance level of an agent's effort from Lafontaine and Slade (2002) to explain the franchising status of McDonald's in Taiwan.

In this model setting, an agent exerts an effort level, a, that results in an outcome, q, according to the production function: $q = \eta a + \varepsilon, \varepsilon \sim N(0, \sigma^2)$, where the parameter η is positive by assumption, which is a proxy for the importance level of the franchisee's effort in the sales production function.

The agent bears the cost of effort, $C(a) = a^2/2$, and receives utility from his income y, $u(y) = -\exp(-ry)$, where r is his coefficient of risk aversion. The agent behaves as he were

maximizing his certainty-equivalent income, *CE*, which is $E(y) - \left(\frac{r}{2}\right) Var(y)$, where *E* is the expectation operator, and *Var* is the variance function.

The risk-neutral principal offers the agent a contract, $s(q) = \alpha q + W$, where *W* is a fixed wage and α is a commission rate. That is, when $\alpha = 0$, the agent or franchisee only receive a fixed wage, the varying in sales revenue would not affect their income in the end. An outlet with the commission rate equals to zero can be further interpreted as a principal-owned outlet, while the one with the commission rate equals to one is seen as a franchised outlet in this study. Furthermore, we can explain α as McDonald's franchising rate.

Then, the agent's income net of the cost of effort is $y = \alpha q + W - a^2/2$.

In this model, the agent's certainty-equivalent income is given by

$$CE = \alpha\eta a + W - \frac{a^2}{2} - \frac{r}{2}\alpha^2\sigma^2 \tag{1}$$

$$Agent: \max_a \left[\alpha\eta a + W - \frac{a^2}{2} - \frac{r}{2}\alpha^2\sigma^2\right] \tag{2}$$

$$foc: a = \alpha\eta$$

The expected utility the agent receives must be higher than its other opportunities. The participation constraint is $\alpha\eta a + W - \frac{a^2}{2} - \frac{r}{2}\alpha^2\sigma^2 \geq \bar{u}$, where $\bar{u}$ denotes as the reservation level of utility, representing the utility level the agent receives from other opportunities in the market. The agent will find a certain level of effort to maximize its certainty equivalent, and the result of the first order condition $a = \alpha\eta$ is the incentive compatibility constraint the agent faces.

$$Principal: max_\alpha \left[\eta^2\alpha - \frac{\alpha^2\eta^2}{2} - \frac{r}{2}\alpha^2\sigma^2\right] \tag{3}$$

$$foc: : \eta^2 - \alpha\eta^2 - r\alpha\sigma^2 = 0$$

$$\alpha^* = \frac{\eta^2}{\eta^2 + r\sigma^2} \tag{4}$$

Through the function of the optimal α, we observe that the increase in the importance level of the franchisee's effort will result in a higher commission rate, so will the franchising rate.

We will discuss the proxy for η in the case of McDonald's Taiwan in Section 4.

3.2 Model 2: Extended Agent Effort Model

In Model 2, we discuss about the impact of producing second products on the optimal franchising rate.

With the uprising consumption level, people start paying more and more attention on whether they have a healthy diet, and even on a broader scope, whether they are adopting a healthy lifestyle. In the analysis from Prescott (2002), Taiwanese consumers would consider four factors when making choices for food — health, natural content, weight control, and convenience. In order to keep up with the trend, McDonald's adapted its menu with more fruits and vegetables in adults' menu combinations to compete for health-conscious customers.

Comparing to the first model where the production function is $q = \eta a + \varepsilon$, now with two types of products, original unhealthy food and newly added healthy food, being produced at the same time. The production functions of two products are given below.

Original products (unhealthy): $q_1 = \eta_1 a_1 + \varepsilon_1, \varepsilon_1 \sim N(0, \sigma_1^2)$

New products (healthy): $q_2 = \eta_2 a_2 + \varepsilon_2, \varepsilon_2 \sim N(0, \sigma_2^2)$

, where η_i $(i = 1, 2)$ represents the importance level of the agent's effort in the sales production function.

Agent's cost of effort is now $\frac{a_1^2}{2} + \delta a_1 a_2 + \frac{a_2^2}{2}$, where δ represents the additional or deductible cost of producing two products altogether. If $\delta < 0$, it represents that producing

two types of products at the same time is more cost efficient as the deductible cost lowers the total cost. If $\delta = 0$, it says that these two types of products are costly independent, also can be interpreted as there are two outlets in business, one only sells first type of products, the other one sells the second type of products. Cases when $\delta > 0$ are not in the scope of the discussion, since the principal can have two separate outlets producing different types of products to save cost. Hence, we set the range of $\delta \leq 0$.

After the same calculation shown in previous session[1], we derive our result,

$$\alpha^* = \frac{\frac{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2}{1-\delta^2}}{\frac{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2}{1-\delta^2} + r\left(\sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2\right)} \tag{5}$$

In another form:

$$\alpha^* = \frac{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2}{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2 + r\left(\sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2\right)(1-\delta^2)} \tag{6}$$

By differentiating the function above with respect to η_2 shows that $\frac{\partial\alpha^*}{\partial\eta_2} > 1$. This result shows that the higher level of importance of an agent's effort is in producing healthy food, or we can say the higher margin of production of the second product is; the more likely the outlet is to be franchised, or the higher the franchising rate is in Taiwan.

4 Data and Methodology

4.1 Data

According to the dataset provided by Wang, Lee, Ning, and Shao (2016), the detail information of McDonald's every outlet in Taiwan in 2014 is summarized. Such information includes whether an outlet is franchised or company-owned, what extra services an outlet

[1] For the detailed algebra derivation, please see Appendix I.

provides, demographic statistics of the district where an outlet is located, types of tourist spots nearby, and so on. From the theoretical model, the optimal commission rate of every franchising contract can be derived through the known relationship between the parameters. However, the data of the commission rates are unknown. Moreover, how the commission rate will be affected by the characteristics of the location such as how populated it is or how accessible it is also remains unknown since this type of information is considered as business confidentiality. In order to conduct the research, we assume that every city and county in Taiwan has a certain characteristic, and McDonald's Taiwan will determine the commission rate of the contracts according to it. That is to say, all franchisees in the same city or county receive the same commission rate. Table 1 shows the number of McDonald's outlets, the number of franchised outlets, and the franchising rate of every city and county in Taiwan, with the franchising rate ascending.

As for Chiayi City, we draw an inference that the reason why the franchising rate is zero is because that the potential franchisees' degree of risk aversion have extremely high level of risk aversion so that McDonald's Taiwan has to operate all the outlets. The reason of the extremely high level of risk aversion might be due to high competition of the service industry in Chiayi City, where the total are is only around 60 square kilometers. According to Chiayi City Government, the city is positioned as tourism and consumption driven city, the percentage of citizens working in the service industry is over 70%. Moreover, we observe that the outlets of McDonald's competitors such as K.F.C. and MOS Burger are all located right next to McDonald's outlets in the heart of the city. For the cause of the franchising rates of Keelung City, Taitung County, and Penghu County being zero, we conclude that the numbers of outlets in these area are too small to reflect the true behavior of the franchising decision.

Table 1

Franchising Status of Every City/County in Taiwan

City/County	Outlet	Franchised Outlet	Franchising Rate
Taipei City	78	0	0.0000
Chiayi City	7	0	0.0000
Keelung City	4	0	0.0000
Taitung Co.	2	0	0.0000
Penghu Co.	1	0	0.0000
New Taipei City	65	2	0.0308
Kaohsiung City	50	4	0.0800
Taichung City	58	7	0.1207
Taoyuan Co.	39	5	0.1282
Pingtung Co.	11	2	0.1818
Tainan City	27	7	0.2593
Chunghua Co.	15	5	0.3333
Chiayi Co.	3	1	0.3333
Miaoli Co.	8	3	0.3750
Hsinchu City	13	5	0.3846
Hsinchu Co.	5	2	0.4000
Yilan Co.	5	2	0.4000
Hualien Co.	4	2	0.5000
Yunlin Co.	5	3	0.6000
Nantou Co.	5	4	0.8000
Total	405	54	0.1333

Note. Co. = county

In the first model we discuss in this study — agent-franchisee's effort model, we observe from the theory that higher importance level in the agent's effort on sales is associated with higher commission rate, that is, the franchising rate. We use the auxiliary services McDonald's provides to measure η, Table 2 shows the variables we take into consideration sectioned by different cities and counties in Taiwan along with the franchising rate and number of outlets.

Table 2

Auxiliary Services by City/County

City	Franchising Rate	Outlet Number	24Hrs		WiFi		Drivethru		Playground	
			Number	Ratio	Number	Ratio	Number	Ratio	Number	Ratio
New Taipei City	0.0308	65	49	0.7538	59	0.9077	11	0.1692	48	0.7385
Taichung City	0.1207	58	37	0.6379	49	0.8448	27	0.4655	40	0.6897
Kaohsiung City	0.0800	50	29	0.5800	43	0.8600	19	0.3800	31	0.6200
Taoyuan Co.	0.1282	39	21	0.5385	34	0.8718	18	0.4615	23	0.5897
Tainan City	0.2593	27	18	0.6667	26	0.9630	15	0.5556	20	0.7407
Chunghua Co.	0.3333	15	7	0.4667	14	0.9333	10	0.6667	14	0.9333
Hsinchu City	0.3846	13	8	0.6154	12	0.9231	5	0.3846	4	0.3077
Pingtung Co.	0.1818	11	3	0.2727	10	0.9091	4	0.3636	6	0.5455
Miaoli Co.	0.3750	8	3	0.3750	8	1.0000	3	0.3750	6	0.7500
Hsinchu Co.	0.4000	5	3	0.6000	5	1.0000	4	0.8000	3	0.6000
Yilan Co.	0.4000	5	4	0.8000	5	1.0000	2	0.4000	4	0.8000
Yunlin Co.	0.6000	5	2	0.4000	5	1.0000	2	0.4000	4	0.8000
Nantou Co.	0.8000	5	2	0.4000	5	1.0000	4	0.8000	3	0.6000
Hualien Co.	0.5000	4	2	0.5000	4	1.0000	2	0.5000	3	0.7500
Chiayi Co.	0.3333	3	2	0.6667	3	1.0000	3	1.0000	3	1.0000
Total	0.1333	405	239	0.5901	366	0.9037	139	0.3432	261	0.6444

Note. Co. = county

Franchising Rate = number of outlets that are operated by franchisees divided by number of total outlets of the city/county

Number = number of outlets that provides the corresponding services in the top row in the city/county

Ratio = number of outlets that provides the corresponding service in the top row divided by the number of outlets of the city/county

The screening process of filtering out the best proxy for η involves comparing the degree of fitness of models with different indicators as proxies for η. After we locate the indicator that makes the model fit the real world data the best, we will continue using the proxy of η for η_1 in Model 2 to capture the importance level of an agent's effort on the healthy food products.

Another proxy to measure the importance level of agent's effort on the second type of products — healthy food products, is also required. It is an abstract variable, the most adequate and observable indicator we can discover is the ratio of the expenditure on dining out to total consumption. If we compare the ratio of the expenditure on dining out to total consumption in 2004, the year McDonald's Taiwan started to grab healthy food market share, with the ratio of the expenditure on dining out to total consumption in 2014, the year the survey was conducted by Wang, Lee, Ning, and Shao. We make an assumption that the increase in the ratio of the expenditure on dining out to total consumption is completely contributed by the consumption of healthy products from McDonald's, that is, the second type of products in Model 2. In order to make the ratio unit-free, we use 2004 as the basis year, 2014 as the current year as it is the year when our data was collected. Then, we calculated the change of the ratio of the expenditure on dining out to total consumption from 2004 to 2014. Consider the proxy of η_1 is a variable which has a range of 0 to 1, we standardize the data of the measurement for η_2 to values from 0 to 1 to gain consistency of the two proxies. Related information of how we derive the proxy for η_2 is listed in Table 3.

Now that all essential data needed are compiled for the principal-agent model, we will discuss how we screen out the best model setup that could explain the most phenomena happening in the real world in the upcoming section.

Table 3

Proxy for η_2

City	Ratio in 2004	Ratio in 2014	Change of Ratio	Standardized
New Taipei City	8.81	10.3	0.1691	0.1588
Taoyuan City	7.81	9.96	0.2753	0.3558
Taichung City	9.28	10.42	0.1228	0.0729
Tainan City	8.05	10.98	0.3640	0.5203
Kaohsiung City	7.92	12.54	0.5833	0.9273
Yilan Co.	5.8	7.86	0.3552	0.5040
Hsinchu Co.	6.49	10.53	0.6225	1.0000
Miaoli Co.	6.53	7.1	0.0873	0.0069
Chunghua Co.	7.3	8.18	0.1205	0.0686
Nantou Co.	6.22	7.33	0.1785	0.1761
Yunlin Co.	7.42	8.04	0.0836	0.0000
Chiayi City	6.46	9.63	0.4907	0.7555
Pingtung Co.	8.77	12.69	0.4470	0.6743
Hualien Co.	6.15	7.99	0.2992	0.4001
Hsinchu City	6.8	8.69	0.2779	0.3607

Note. Co. = county

Ratio in 2004 = ratio of the expenditure on dining out to total consumption in 2004.

Ratio in 2014 = ratio of the expenditure on dining out to total consumption in 2014.

Change of ratio = (Ratio in 2014 - Ratio in 2004) / Ratio in 2004.

Standardized = standardized *Chang of ratio* from 0 to 1.

4.2 Methodology

Recall the two main topics we discuss in this research — first, how the agent effort model functions under the scope of McDonald's Taiwan; second, how would producing a second type of products affect the theoretical optimal franchising rate.

In the first model, we have data of certain variables that used as a proxy to measure the importance level of an agent's effort from Wang, Lee, Ning, and Shao (2016). Those

variables that measure the franchisee's effort are — Wi-Fi, Playground, Drivethru, and 24Hrs. Therefore, we can use the data to calculate the theoretical optimal franchising rate from the principal-agent model, and by comparing the theoretical result and the observed actual franchising rate of every city and county in Taiwan, we can find the most compatible model.

According to the basic agent's effort model, which we adopt to discuss how auxiliary services (that show effort level of franchisees) could affect the optimal franchising rate. The production function is: $q = \eta a + \varepsilon, \varepsilon \sim N(0, \sigma^2)$. The optimal franchising rate is $\alpha^* = \frac{\eta^2}{\eta^2 + r\sigma^2}$. We assume that the theoretical model actually functions when McDonald's Taiwan (the principal) and the franchisees are making decision on the commission rate α, or when McDonald's Taiwan decides an overall franchising rate of a region. In reality, we do not have access to confidential data that could be a good measurement for η, such as number of employees over sales (Norton, 1998) and capital labor ratio (Scott, 1995). However, we do have observable data about different services every McDonald's outlet provides, which can be used as a proxy for importance of the agent's effort. Since we know the relationship between the variables in the agent's effort model, we can calibrate the reasonable value of variables that we cannot observe in reality. Thus, the methodology we adopt in this research is calibration. The description of the process of calibration, according to Oreskes, Shrader-Frechette and Belitz (1994), is:

> In earth sciences, the modeler is commonly faced with the inverse problem: The distribution of the dependent variable (for example, the hydraulic head) is the most well-known aspect of the system; the distribution of the independent variable is the least well known. The process of tuning the model—that is, the manipulation of the independent variables to obtain a match between the observed and simulated distribution or distributions of a dependent variable or

variables—is known as calibration.

Although the reference above is a thesis in the earth science field, the methodology can still be adopted in the case of McDonald's business model in Taiwan. The well-known dependent variable in this case is the franchising rate of every city and county. As for some of the variables in the model that we do not have fully access to, are to be disclosed through calibration.

4.2.1 Calibration of Model 1

In the first model of considering the effort from agents or franchisees, the optimal franchising rate of the result of both franchisor and franchisee maximizing their profits is function (4). In this equation, we only have the real-world observation of α^*, however, since we know the relationship between the optimal franchising rate and the importance level of agent's effort, the coefficient of risk aversion level, and the market risk, we could calibrate the rational and equitable range of variables that we do not have data of.

In Lafontaine and Slade (2002), other researchers use proxies such as the ratio of employees over sales ratio of restaurants and motels, whether full service is provided at gasoline service stations, and so on to measure the importance level of agent's effort (η). In our case, we use the services every McDonald's outlet provides as proxies to measure η. As mentioned in Section 4, data of auxiliary services every McDonald's outlet provides — availability of Wi-Fi, Drivethru, playground, and whether the outlet provides 24 hours of service.

As for how to construct our proxy for η, there are several candidates for it. First, the most intuitive one is to take an average of whether McDonald's outlets in a city or county fulfil the four services. In other words, we take an average of the ratio of outlets that provide

Wi-Fi, the ratio of outlets that provide Drivethru, the ratio of outlets that provide playground, and the ratio of outlets that open 24 hours a day in a city/county. As a result, every city or county ends up with a number ranging from 0 to 1 as a proxy for η.

The second candidate is based on the result from a probit estimation model[2], where the dependent variable is whether a McDonald's outlet is franchised or company-owned, and availability of the four services, the percentage of men in the area, and the population of the area variables from Wang, Lee, Ning, and Shao (2016). The result shows that only Drivethru and playground services have statistically significant on whether an outlet is franchised or not. Thus, the second candidate for the proxy of η is the average of the ratio of Drivethru and the ratio of playground of every city or county.

Another regression analysis[3] is conducted in this research, the dependent variable is also whether an outlet is franchised or not, the independent variables are the four services mentioned above. The result shows that only Drivethru and 24 hours of service are statistically significant on the franchising decision. Therefore, the third candidate is the average of the ratio of Drivethru and the ratio of 24 hours of service.

Through the process of the candidate selection, we cannot help but notice that the affluence of whether an outlet provides Drivethru service on whether an outlet is franchised cannot be neglected. Lastly, we choose the ratio of Drivethru itself as a candidate for the proxy of η. The summary of the calculation of these four candidates is shown in Table 4 below.

For the measurement of the market uncertainty, we adopt the standard deviation of the stock of McDonald's Corporation (MCD), listed in The New York Stock Exchange, in 2014 as a proxy. Ideally, it would be better to use the performance of index stocks of fast food

[2] Please see Table 10 in Appendix II
[3] Please see Table 11 in Appendix II

industry in Taiwan or the stock performance of McDonald's Taiwan to measure the uncertainty in the fast food market, unfortunately, there is no such index in Taiwan, nor is McDonald's Taiwan listed in Taiwan Stock Exchange. Hence, the next best proxy is the fluctuation of MCD in 2014. In order to improve the robustness of the calibration, we also use the standard deviation of the stock of YUM! Brands (YUM), also listed in NYSE, as another proxy for the market risk. YUM! Brands has recognizable brands such as KFC, Pizza Hut, and Taco Bell, and it has more than 43,500 restaurants in more than 135 countries. We can have more robust calibration results with the consideration of broader spectrum of the market risk.

The last variable in this model setup is r, the coefficient of franchisees' risk aversion. According to Danthine and Donaldson (2014), the empirical researches that discuss about CCAPM models would place degree of risk aversion in the range of 1 to 2. However, the model has to adopt extremely high degree of risk aversion ($\simeq$50) in order to be explanatory of the real-life data. We begin our calibration with r with the range of 1 and 2. Then broaden the range if necessary. Finally, we check the rationality of r with the benchmark of 50 mentioned in Danthine and Donaldson (2014). Therefore, we consider r as reasonable and acceptable if it does not exceed 50. All setup of parameters in Model 1 is listed in Table 4.

We then insert all the data into the model, with r inserted in a form of a certain range, therefore we will get 15 ranges of the theoretical optimal franchising rates respectfully for 15 cities/counties we discuss. Then we determine which model setup performs the best in terms of getting the most cities/counties' actual franchising rates fall into the theoretical ranges, which says the model captures the most features of the franchising decision model behind McDonald's Taiwan. After the first round of the calibration, we find the result far below our expectation, even in the best scenario, the percentage of cities/counties' actual franchising

rates falling into the theoretical ranges is less than 50%. We also observe that some actual franchising rates of certain regions are lower than the theoretical ranges of optimal franchising rates, while some of them are higher, and this phenomenon is highly associated with the population of the regions. Hence, it will be more ideal to discuss the model by sections – a section with high population and a section with low population, since a change in the same parameter makes ranges of 15 cities/counties shift toward the same direction all together. The population of the 15 cities/counties in Taiwan which we discuss in the research is listed in Table 5.

Table 4

Model 1: Parameters and Their Candidate Proxies

Parameter	Candidate Proxy/Value	Calculation
η	Average of 24Hrs, Wi-Fi, Drivethru, Playground	25%*Ratio of 24hrs+25%*Ratio of Wi-Fi+25%*Ratio of Drivethru+25%*Ratio of Playground
	Average of Drivethru, Playground	50%*Ratio of Drivethru+50%*Ratio of Playground
	Average of 24Hrs, Drivethru	50%*Ratio of 24hrs+50%*Ratio of Drivethru
	Drivethru	Ratio of Drivethru
σ	Standard deviation of the stock of McDonald's	Annualized standard deviation of MCD in 2014 σ=0.1267
	Standard deviation of the stock of YUM! Brands	Annualized standard deviation of YUM in 2014 σ=0.2125
r	≃50	Range under 50 would be considered rational

Tabel 5

Population by City/County

City/County	Population	Metropolitan Area
New Taipei City	3,966,818	Y
Kaohsiung City	2,778,992	Y
Taichung City	2,719,835	Y
Taoyuan City	2,058,328	Y
Tainan City	1,884,284	Y
Chunghua Co.	1,291,474	Y
Pingtung Co.	1,047,917	Y
Yunlin Co.	705,356	N
Miaoli Co.	567,132	N
Hsinchu Co.	537,630	N
Chiayi City	524,783	N
Nantou Co.	514,315	N
Yilan Co.	458,777	N
Hsinchu City	431,988	N
Hualien Co.	333,392	N

Note. Co. = county

According to the definition of a metropolitan area from National Statistics, R.O.C. is that an area with more than one million people dwell in is considered a metropolitan area. So now our data can be separated into two sections, metropolitan areas and non-metropolitan areas.

Since we use the stock performance of McDonald's and YUM! Brands' stock performances to measure the market risk in Taiwan. Consider how enormous the business scale of McDonald's and YUM! Brands are, the fluctuation in these two stocks must be much more robust than the market risk in Taiwan as they are globally functioning businesses. To capture the higher market risk in Taiwan, we add a multiplier in front of $r\sigma^2$ in metropolitan area, denoted as θ. Meanwhile, in order to capture the difference of the market risk and the

degree of risk aversion between metropolitan area and non-metropolitan area, we make another assumption that the market risk and the degree of risk aversion in non-metropolitan area is a certain number times of them in the metropolitan area. In another form, the total market risk and the degree of risk aversion in non-metropolitan area is $\lambda\theta r\sigma^2$, where it is $\theta r\sigma^2$ in the metropolitan area. With this setup, after doing many rounds of selection of λ and θ and calibration, the best result is when the proxy of η is the ratio of number of outlets provide Drivethru divided by number of all outlets in a city/county (Ratio of Drievthru). The other parameters are determined as Table 6 below. The result shows that 11 out of 15 (73.33%) cities/counties lie in the theoretical ranges. In other words, in the best setup of Model 1, it can explain 73.33% of the data. The result of whether the actual franchising rates lie in the theoretical franchising rate ranges can be seen in Table 7 and Figure 1.

Our best result shows that the multiplier of metropolitan area is 11.5 as shown in Table 6, where the non-metropolitan area is 11.5(θ)*0.15(λ)=1.725. This multiplier can be explain as the multiplier on the market risk only, the degree of risk aversion only, or both the market risk and the risk aversion level. In the first case, the result means that the market risk in the metropolitan area is 6.67 (11.5/1.725=6.67) times higher than the non-metropolitan area, which is intuitive due to the high competition in either fast food market or franchise restaurant market. If we view the multiplier in the second case, the result shows that the franchisee or agent's degree of risk aversion in metropolitan area is 6.67 times higher than the franchisee or agent in non-metropolitan area. Recall from the model, the higher the value of r is, the less likely an outlet will be franchised, as the α^* falls when r rises. It also interprets that the actual franchising rate will be lower in the metropolitan area comparing to the non-metropolitan area due to the higher degree of risk aversion. The average actual

franchising rate in the metropolitan area is 0.1898 and it is 0.4869 in non-metropolitan area.

Table 6

Model 1: Best Fit Scenario Parameters Combination

Parameter	**Value/Proxy**
η	Ratio of Drivethru
θ	11.5
λ	0.15
r	(1, 3.1)
σ	σ_{YUM}=0.2125

Table 7

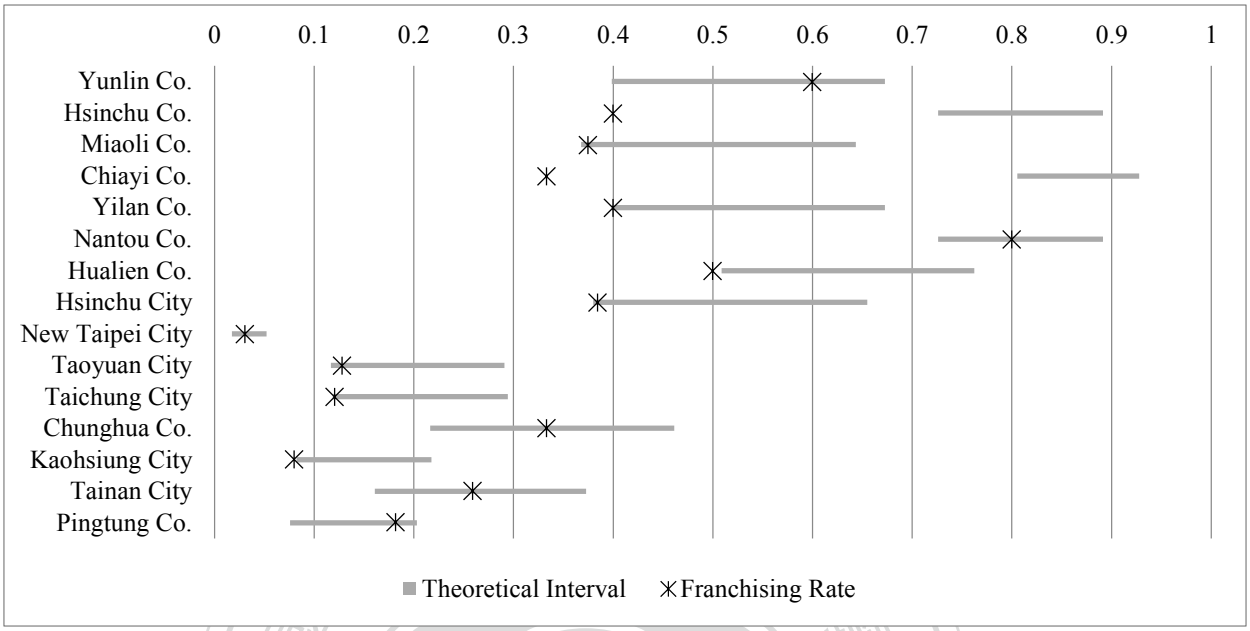
Model 1: Best Fit Scenario City/County Detail

City/County	**Franchising Rate**	**Lower Limit**	**Upper Limit**	**In the Range**
Yunlin Co.	0.6000	0.3985	0.6726	Yes
Hsinchu Co.	0.4000	0.7261	0.8915	No
Miaoli Co.	0.3750	0.3680	0.6435	Yes
Chiayi Co.	0.3333	0.8055	0.9277	No
Yilan Co.	0.4000	0.3985	0.6726	Yes
Nantou Co.	0.8000	0.7261	0.8915	Yes
Hualien Co.	0.5000	0.5087	0.7624	No
Hsinchu City	0.3846	0.3799	0.6551	Yes
New Taipei City	0.0308	0.0175	0.0523	Yes
Taoyuan City	0.1282	0.1169	0.2909	Yes
Taichung City	0.1207	0.1186	0.2944	Yes
Chunghua Co.	0.3333	0.2164	0.4612	Yes
Kaohsiung City	0.0800	0.0823	0.2176	No
Tainan City	0.2593	0.1609	0.3728	Yes
Pingtung Co.	0.1818	0.0759	0.2030	Yes

Note. Co. = county

Figure 2

Model 1: Best Fit Scenario City/County – Slider Chart



4.2.2 Calibration of Model 2

In the second model, we discuss the scenario where McDonald's produces second type of products which are healthy food along with the original, unhealthy products. The production function is now $q = \eta_1 a_1 + \eta_2 a_2 + \varepsilon_1 + \varepsilon_2$, where $\varepsilon_1 \sim N(0, \sigma_1^2)$ and $\varepsilon_2 \sim N(0, \sigma_2^2)$. The cost function of agent's effort is $a_1^2/2 + \delta a_1 a_2 + a_2^2/2$, where δ represents the deductible cost of producing new products. After the calculation based on the notion that both the principal and the agent would maximize their income, we finally derive the optimal franchising rate:

$$\alpha^* = \frac{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2}{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2 + r(\sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2)(1-\delta^2)} \quad (6)$$

Since a new product is added into the production function, we need to find a proper proxy for the importance of the agent's effort on the healthy food. Due to the rise of awareness of healthily eating habits and higher consumption level, people are paying more

and more attention on their health. According to a study on the relationship between consumers' healthy eating habits and the demand of healthy themed restaurants, the researchers found that Taiwanese consumers require restaurants to serve healthier and more nutritious food. They pay more attention on how restaurants process the food. More and more restaurants use low calories or provide nutrition information as a strategy to appeal consumers (Huang & Sung, 2008).

In 2004, McDonald's Taiwan launched the first burger that promotes its healthy ingredient, a burger consists of pan-fried, not deep-fried, pork chop, with lettuce in the middle, and whole grain buns on the outside. In the TV commercial of this burger, the advertising endorser mentioned eating healthily. This product launch could be considered a starting point of McDonald's Taiwan producing healthy food along with their original, unhealthy product line.

We calculate the difference between the two statistics from Directorate-General of Budget, Accounting and Statistics under Executive Yuan, R.O.C.(Taiwan): the ratio of the expenditure on food and beverage (including the cost of dining out) to total consumption, and the ratio of the expenditure on food and beverage (excluding the cost of dining out) to total consumption. Therefore, we will get the ratio of the expenditure on dining out to consumption.

Here, we make an assumption that ever since McDonald's Taiwan started to sell healthy products, which is the second type of products in the model, the increase in the ratio of the expenditure on dining out to total consumption from 2004 to 2014 is credited to McDonald's new healthy product line. That is, the rise in consumption in dining out was underpinned by the consumption in McDonald's healthy product line. Therefore, we use the rate of change of the ratio of the expenditure on dining out to consumption from 2004 to 2014 as a proxy to

measure the importance level of the agent or franchisee's effort on the second product — healthy food. In a formula format, that is:

$$\eta_2 = \frac{x_{2014} - x_{2004}}{x_{2004}} \quad (7)$$

, where x_{2004} denotes the ratio of the expenditure on dining out to total consumption in 2004, and x_{2014} denotes the ratio of the expenditure on dining out to total consumption in 2014.

As the proxy for η_1 is a variable with a range from 0 to 1, we need to make some adjustment for the proxy for η_2 in order to be consistent with our model setup. We set the minimum value of η_2 to be 0, and the maximum value to be 1, so η_2 is now a variable that ranges from 0 to 1. Another arrangement we make is the weighing of η_1 and η_2. Recall in Model 1, we use the ratio of Drivethru to measure the importance level of an agent's effort on selling McDonald's products. Now we look back from the extended Model 2, η in Model 1 can be interpreted as the margin profits of producing the products. Nonetheless, in Model 2, the capacity of McDonald's is now separated into two product lines with different weighs. We counted all main meals of McDonald's Taiwan, there are 21 main meals, and 20 of them are unhealthy (deep-fried) food, only 1 of them is healthy food. Hence, the weighing on unhealthy food, also the first type of product, is set to be 20/21. The weighing on healthy food, the second type of product, is set to be 1/21.

Since we have two different types of products, we need to consider the risk from two different markets. In Model 1, we find using the annualized standard deviation of YUM! Brands' stock results in better fitness of the theoretical model to the real world observations. Hence, we continue using σ_{YUM} to measure the risk of the first market — the market of unhealthy food. As for the risk of the second market — the market of healthy food, we use the annualized standard deviation of the stock of Panera Bread (PNRA) as a proxy. Panera

Bread is an American fast food chains that has long been promoting plant-based proteins, and it also makes vegetarian and vegan food products easily accessible. Its annualized standard deviation of stock performance perfectly fits the measurement for the risk of healthy food market.

Lastly, δ, the parameter that represents the deductible cost of producing new products, will be ranging from any value less than or equals to 0. Other parameters such as the multiplier of the metropolitan area and the non-metropolitan area remain unchanged as the setup in Model 1. In Table 8, we summarize the setup for the key parameters of Model 2.

Table 8

Model 2: Parameters and Their Proxies/Values

Parameter	**Proxy/Value**
η_1	Ratio of Drivethru with the weight of 20/21
η_2	Rate of change of the ratio of expenditure on dining out to consumption from 2004 to 2014 with the weight of 1/21
δ	$\delta \leq 0$
θ	11.5
λ	0.15
r	$(1, 3.1)$
σ_1	Standard deviation of YUM! Brands' stock σ_1=0.2125
σ_2	Standard deviation of the stock of Panera Bread σ_2=0.2254
ρ	Correlation coefficient of risk of two markets=0.3145

After trying different values of δ, we find that the model has the best performance when δ = -0.75. Showing that when producing two types of products, there will be a deductible effect on the cost of production. To put it another way, the cost for McDonald's to produce these two products together is lower than producing them separately. With this setup, the fitness level of Model 2 is elevated to 86.67%, which means Model 2 can explain 86.67% of

the data. It is clearly that we have to sacrifice Hsinchu County and Chiayi County to gain the highest level of fitness for the model. We speculate the reason why these two counties are behaving irrationally is that the numbers of outlets of those counties are small. 5 outlets in Hsinchu County and 3 outlets in Chiayi Counties. When the number of outlets is relatively small, with one more outlet being franchised in the area, the final franchising rate might act unstable, and the increase in the franchising rate does not indicate the same meaning as the same increase in the franchising rate in a region with a higher number of outlets.

Table 9

Model 2: Best Fit Scenario City/County Detail

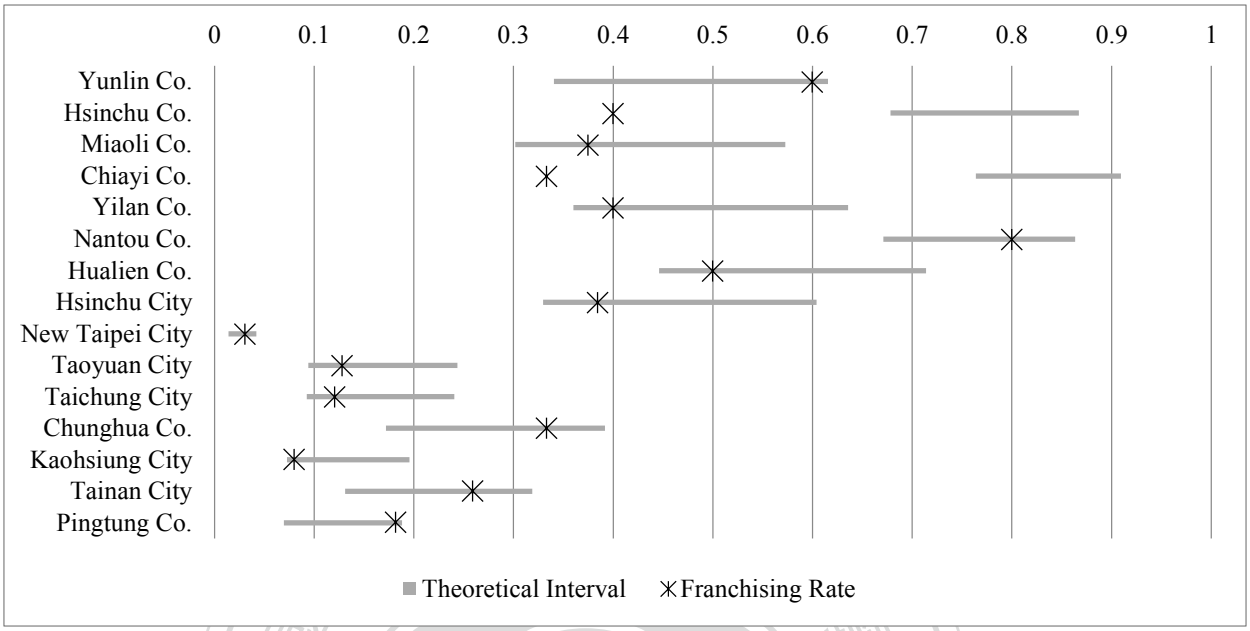
City/County	Franchising Rate	Lower Limit	Upper Limit	In the Range
Yunlin Co.	0.6000	0.3405	0.6154	Yes
Hsinchu Co.	0.4000	0.6782	0.8672	No
Miaoli Co.	0.3750	0.3019	0.5727	Yes
Chiayi Co.	0.3333	0.7640	0.9094	No
Yilan Co.	0.4000	0.3601	0.6356	Yes
Nantou Co.	0.8000	0.6710	0.8634	Yes
Hualien Co.	0.5000	0.4460	0.7139	Yes
Hsinchu City	0.3846	0.3298	0.6040	Yes
New Taipei City	0.0308	0.0140	0.0421	Yes
Taoyuan City	0.1282	0.0942	0.2438	Yes
Taichung City	0.1207	0.0927	0.2405	Yes
Chunghua Co.	0.3333	0.1720	0.3917	Yes
Kaohsiung City	0.0800	0.0728	0.1957	Yes
Tainan City	0.2593	0.1311	0.3187	Yes
Pingtung Co.	0.1818	0.0695	0.1881	Yes

Note. Co. = county

In the Range = if the franchising rate falls in the range of the theoretical optimal franchising rates

Figure 3

Model 2: Best Fit Scenario City/County – Slider Chart

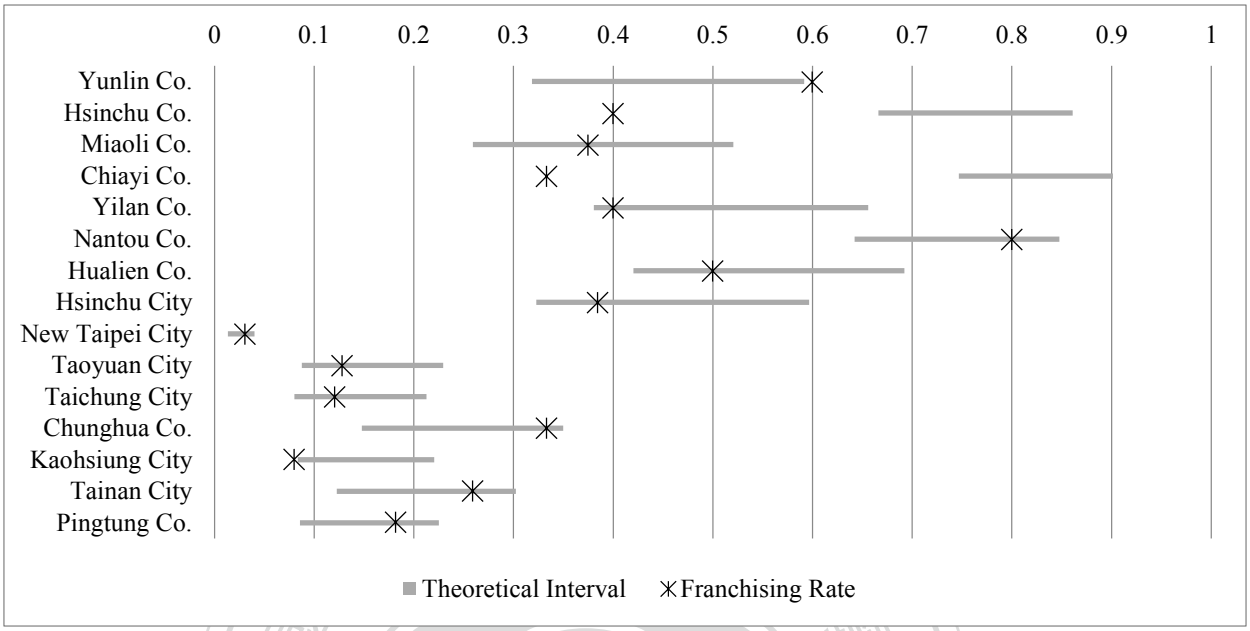


4.2.3 Further Discussion of Model 2

In Model 2, we use the proportion of the healthy food and unhealthy food on the menu to weigh η_1 and η_2. With that being said, we can use this concept to forecast the change in the optimal franchising rate when the structure of the menu changes. If we look back to McDonald's history in Taiwan, there were times that grilled chicken sandwich wasn't the only healthy product on the menu. In 2013, McDonald's Taiwan launched two relatively healthy products — chicken rice warp and beef rice wrap. Unfortunately, we don't have detail of the menu in that year, we assume that the number of McDonald's main meals was still 21, the proportion of the healthy food would be 3/21, the proportion of the unhealthy food would be 18/21. The fitness level of the model falls to 73.33%, comparing to the current level of 86.67%.

Figure 4

Weighing of Healthy Food=3/21, Unhealthy Food=18/21

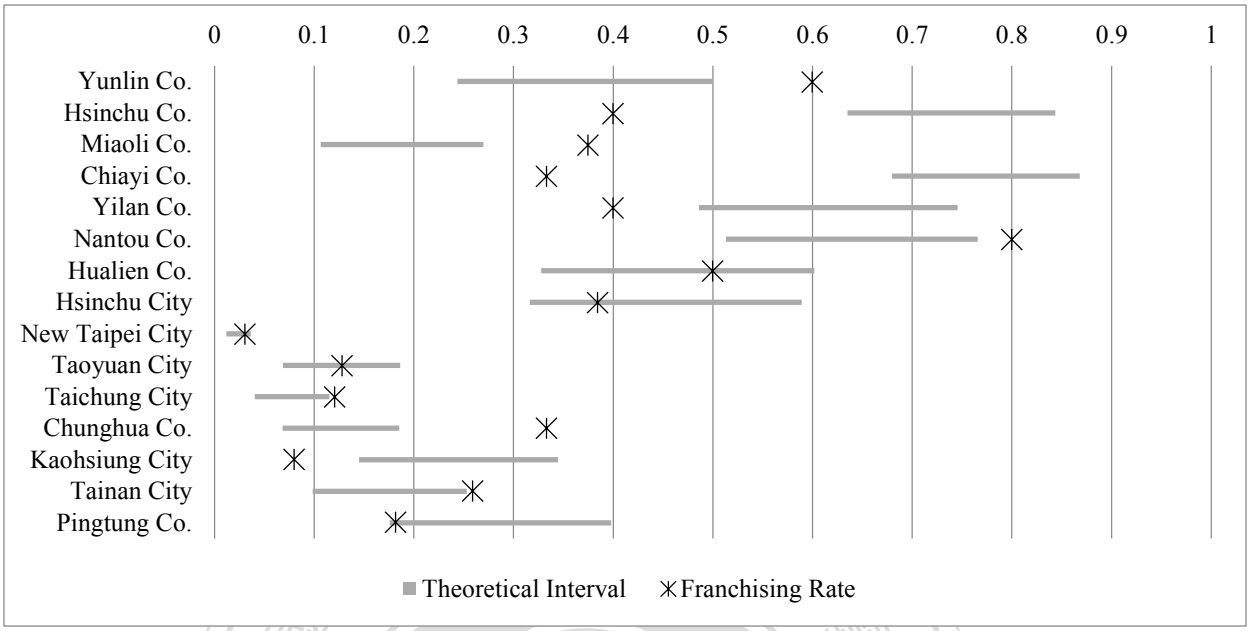


Considering another case, when the proportion of the healthy food that McDonald's sells is half of the main meals on the menu, that means the weighing on η_1 and η_2 is both 50%, the fitness level of the model drops to 33.33% as shown in Figure 5.

Every actual franchising rate is the result of maximizing both the principal and the franchisee's profit. The simulation shows that when having a higher weigh on healthy food, the less fit the model is, that more cities/counties' actual franchising rates are not in the theoretical intervals. If McDonald's Taiwan is stubborn about its strategy toward healthy food market and keeps introducing new healthy food to the menu to increase the proportion of healthy products, its profit will not be better than before because the theoretical projections will not fit the actual franchising rates.

Figure 5

Weighing of Healthy Food=50%, Unhealthy Food=50%



This finding also echoes with the news in 2016 (Lan, 2016). In the United States, McDonald's realized it did not have enough leverage to take over the healthy food market, so it went back to take the "traditional" rode, selling unhealthy food. This strategy surprisingly resulted in a huge success. The growth of profit margin of that quarter was 35%. McDonald's in the United States keeps marching to the unhealthy side with their pride.

5 Conclusions

The main purpose of this study is to construct a theoretical model that can explain the actual observations, and furthermore, predict the future outcome. In the first model, which only considers the scenario of McDonald's producing one product, using the ratio of outlets that provide Drivethru service in a city/county as a proxy to measure the importance level of

an agent's effort. While the market risk indicator is the annualized standard deviation of YUM! Brands' stock performance in 2014. Along with other parameters' setup such as the range of the degree of risk aversion is (1, 3.1), and the multiplier of the risk of the metropolitan areas is 11.5 while the non-metropolitan area is 1.725. With this combination, the model is able to simulate the theoretical optimal franchising rates with 73.33% of accuracy.

In the next model, we look closer to the production function as we separated the products as a whole into two parts — healthy meals and unhealthy meals. We believe the model can be more accurate during the simulation by taking another product line into consideration, as we observe that McDonald's has been putting out effort to win up the market share in the healthy food sector since 2004. With an additional product line, that means an additional market risk, and an additional importance level of an agent's effort on the second product. After rounds of calibration, the extended model is able to simulate the theoretical optimal franchising rates with higher accuracy than before, 86.67%.

In the process of calibrating Model 2, we also observe that the proportion of the two product categories of the whole product range plays a crucial role in the determination of theoretical optimal franchising rates. As the proportion taken by healthy food increases, the accuracy of the model drops sharply. In other words, if the conditions of the market remain unchanged, McDonald's Taiwan will not be more profitable if it puts more effort into engaging the healthy food market. Interestingly, this phenomenon is coherent with the news in 2016 that McDonald's US stopped trying to engage the healthy food sector; its revenue sharply increased in the quarter that they made this strategy change. In future, we can keep an eye on strategies that McDonald's Taiwan adopts, particularly regarding whether it will go with the direction of its parent company (all the way to the extremely unhealthy side) or

persist in finding its own way in the healthy food market. In addition, if they keep developing the healthy food sector, we can examine how their franchising rate will change.

Even though our model can fit 86.67% of the data we observe, there are still some areas we can improve in the future analysis. The difficulty we face when building these models is finding the suitable proxies for abstract variables that we do not have access to. For example, the importance level of an agent's effort on the healthy product. Unless McDonald's cooperate with the education institutes to provide their business-sensitive data, the closest proxy that is open to the public is the rate of change of the ratio of the expenditure on dining out to total consumption from 2004 to 2014. Moreover, we need to make a lot of bold assumptions to use this indicator as a proxy. Another setback of this study is the market scale of McDonald's Taiwan. Taiwan is a small country with only 405 outlets, comparing to the United States, where more than 14,000 McDonald's outlets are located. In order to exert calibration, we need to use city or county as a unit, removing cities/counties whose franchising rates are zero, we only have 15 cities/counties to discuss, while there are 50 states and more than 300 cities in the United States. Moreover, McDonald's Taiwan is not listed in Taiwan Stock Exchange, we can only settle for the stock of McDonald's and the stock of YUM! Brands in New York Stock Exchange to measure the risk of Taiwanese market. Even though we add a risk multiplier to capture the difference in market risk between Taiwan and the United States, we could deliver more convincing result if we use the stock performance of McDonald's Taiwan.

As mentioned in the Introduction, the models we discuss in this study can be considered as a framework for franchisors. Once abundant data that can fully represent variables are inputted, this model will be really helpful with corporate strategists for determining how many outlets should be franchised and how many outlets should be operated by the company,

so that both the firm and franchisees can maximize profit. More importantly, the model can be a good reference for whether the firm should start producing a different product line. These models can also be adopted for corporations in different industries if the proxy for market risk is well-adjusted.

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Appendix I: Algebraic Derivations of Model 2

Assume now McDonald's produces two kinds of products:

Original products (fat) $q_1 = \eta_1 a_1 + \varepsilon_1,\ \varepsilon_1 \sim N(0, \sigma_1^2)$

New products (healthy) $q_2 = \eta_2 a_2 + \varepsilon_2,\ \varepsilon_2 \sim N(0, \sigma_2^2)$

, where η_i is a proxy for the importance of the agent's effort in the sales production function

Agent's cost of effort: $\frac{a_1^2}{2} + \delta a_1 a_2 + \frac{a_2^2}{2}$, where δ represents the additional/deductible cost of producing new products.

The agent would maximize is certainty-equivalent income: $CE = E(y) - \left(\frac{r}{2}\right) Var(y)$

$E(y) = \alpha(q_1 + q_2) + W - \left(\frac{a_1^2}{2} + \delta a_1 a_2 + \frac{a_2^2}{2}\right)$, where α is commission rate, and *W* is a fixed wage.

Agent: $max_{a_1}\{\alpha(\eta_1 a_1 + \eta_2 a_2) + W - \left(\frac{a_1^2}{2} + \delta a_1 a_2 + \frac{a_2^2}{2}\right) - \frac{r}{2}\alpha^2(\sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2)\}$

$$f.o.c. \quad \alpha\eta_1 - a_1 - \delta a_2 = 0$$

$$a_1^* = \alpha\eta_1 - \delta a_2$$

Agent: $max_{a_2}\{\alpha[\eta_1(\alpha\eta_1 - \delta a_2) + \eta_2 a_2] + W - \left[\frac{(\alpha\eta_1 - \delta a_2)^2}{2} + \delta((\alpha\eta_1 - \delta a_2)a_2 + \frac{a_2^2}{2}\right] - \frac{r}{2}\alpha^2(\sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2)\}$

$$f.o.c. \quad -\alpha(\delta\eta_1 - \eta_2) + a_2(\delta^2 - 1) = 0$$

$$a_2^* = \frac{\alpha(\eta_2 - \delta\eta_1)}{1-\delta^2},\ a_1^* = \frac{\alpha(\eta_1 - \delta\eta_2)}{1-\delta^2}$$

The principal is assumed to maximize her total surplus, that is, to extract the fixed payment, *W*, from the agent's certainty-equivalent income.

Principal: $max_{\alpha}\{(\eta_1 a_1 + \eta_2 a_2) - \left(\frac{a_1^2}{2} + \delta a_1 a_2 + \frac{a_2^2}{2}\right) - \frac{r}{2}\alpha^2(\sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2)\}$

$$f.o.c.\ \frac{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2}{1-\delta^2} - \left[\alpha\left(\frac{\eta_1 - \delta\eta_2}{1-\delta^2}\right)^2 + 2\delta\alpha\left(\frac{\eta_1 - \delta\eta_2}{1-\delta^2}\right)\left(\frac{\eta_2 - \delta\eta_1}{1-\delta^2}\right) + \alpha\left(\frac{\eta_2 - \delta\eta_1}{1-\delta^2}\right)^2\right] - r\alpha(\sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2) = 0$$

$$\alpha^* = \frac{\frac{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2}{1-\delta^2}}{\frac{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2}{1-\delta^2} + r(\sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2)}$$

In another form,

$$\alpha^* = \frac{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2}{\eta_1^2 - 2\delta\eta_1\eta_2 + \eta_2^2 + r(\sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2)(1-\delta^2)}$$

Appendix II: Regression Models

Table 10

Probit Estimation Results of Franchising from Wang et al. (2016)

Variable	Franchised or not	
	Coefficients	**Marginal Effects**
Population	-0.0025***	-0.0004***
	(0.001)	(0.0001)
24Hrs	-0.2616	-0.0421
	(0.1993)	(0.0331)
WiFi	-0.1066	-0.0172
	(0.3253)	(0.0556)
Drivethru	0.4109***	0.0687***
	(0.2191)	(0.0379)
Playground	-0.3748**	-0.0617**
	(0.2191)	(0.0384)
Pct_men	0.3088**	0.0471***
	(0.1055)	(0.0166)
Attractions	-0.0141	-0.0021
	(0.0131)	(0.0019)

Significant levels: ***=0.01, **=0.05, *=0.1

Table 11

Regression Model with 4 Services as Independent Variables

Variable	Coefficients
Intercept	-1.0246*** (0.2568)
24Hrs	-0.6114*** (0.1860)
WiFi	-0.0411 (0.2975)
Drivethru	0.8209*** (0.1887)
Playground	-0.1005 (0.2006)

Significant levels: ***=0.01, **=0.05, *=0.1