Feasibility Study of the Food-sharing Model in the Context of Sustainable Economic Development

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ABSTRACT

The amount of both food supply and food waste can always reflect the economic level of nations, but few types of research done by scholars focused on the relationship between food and economic growth. Many economic growth models are related to the relationship between economic policies, climate changes, labour and economic growth, actually many factors such as food waste and food supply have potential relevance to economic growth. To explore and verify this viewpoint logically, this paper constructs a new Solow model based on the traditional Solow model and the Cobb-Douglas production function. The data of France (a developed country) are selected to analyse the correlation between the amount of food waste and economic growth. The least-square method OLS was used to fit the model function. the result indicates that there exists a positive relationship between the amount of food waste in France and gross domestic product in France. Based on this result, we propose two business models according to food sharing one starts with food wasted by hotel catering businesses, the other is person-to-person food-sharing trading. This business model will not only reduce the problem of food waste but also contribute to the development of economic sustainability.

Keywords: *Solow model, economic growth, food waste, food sharing.*

1. INTRODUCTION

1.1. Background

Some factors relating to food such as food supply, food security, and food waste were rarely linked to the economic growth, Agboola, M. O and Balcilar, M in Eastern Mediterranean University used the classical Solow model to study the impact of food security, food supply and other factors on economic growth in some African countries. Finally, they concluded that improving the food supply contributes to economic growth improvement [1]. Significantly, the idea of this paper is inspired by the research of these two scholars. The importance of the food-sharing economy cannot be recognized and emphasized enough as car-sharing and bicycle-sharing. However, although studies and papers related to food waste are not common, the necessity of studying food waste, economic sustainability, and environmental sustainability from the perspective of sharing economy was emphasized by some authors such as Ching-Hsu in the National Pingtung University of Science and Technology [2]. In addition, Tamar Makov suggested that a food-sharing economy may provide beneficial means of improving resources efficiency and descending the amount of food waste [3]. The findings and recommendations from these previous studies constricted a bridge between economic growth and several underlying factors. Besides, they suggested possible solutions about how to solve some problems according to food-wasting, such as food-sharing economy models. These studies contributed some innovative perspectives not only on environmental protection but also on sustainable economy.

1.2. Related research

Food waste is a major global issue, which has caused a series of economic problems. Many scholars have conducted in-depth research and debate on it. Agboola et al. use several econometric models to analyse the relationship between economic growth in Africa and food supply and food security by studying the growth of GDP in some African regions and their annual total food

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output. Most importantly, the correlation curve was obtained and concluded that if these countries can achieve food security, then economic growth will be much easier to attain [1]. Ching-Hsu et al. collected the data from various countries and regions to make a comparison, including the statistics on the proportion of food wasted around the world and the cost caused by food waste [2].

Davies, R. Urban uses case studies to analyse the factors influencing food sharing from different perspectives and consider the sustainability of its future development. The research, for the first time, distil three key elements –rules, tools and networks – that shape it and identify core issues for future research. It fills a sectoral gap in explorations of contemporary urban sharing and explicates the rise of ICT-mediated food sharing [4].

Zurek analyses the main challenges food sharing faces are public unacceptance and market fragmentation. [5] To deal with these two problems, many experts put forward their ideas. Morilla et al. focus on creating "Foodernity", an application focused on food donations. To release the pressure of people who require food to survive, this application will be a bridge to connect food donors and food beneficiaries with each other, gathering the separated market [6].

However, Saginova et al., via using not-for-profit and for-profit sales models and the "free exchange" model, conclude that general perception of food-sharing as free products for the poor significantly limits the ability to distribute such services. So in order to make food sharing more acceptable to the public, thus attracting more consumers and suppliers, it is important to introduce digital commercial platforms into the market to address food waste, not just limiting food sharing in charity or giving the food for free. This type of profit-oriented trade model implies that food is transferred to obtain profit or at least cover the cost of food. [7].

To further develop the business model, Moltene et al. identify the factors that influence the acceptance and use of such platforms by using the Extended Unified Theory of Acceptance and Use of Technology (UTAUT2). It mentions the key factor is effort expectancy for user behaviour and trust and gratefulness as the other two factors [8]. And Mazzucchelli et al. highlight the impacts and the connections between five drivers of the success of food sharing platforms and their role in favouring consumer behavioural responses. Three factors: consumer perception of environmental responsibility, consumer perception of social responsibility, and consumer familiarity are positively related to food-sharing consumer behavioural response, while the net effects of consumer perception of economic responsibility and community social support are not significant [9].

But food sharing should be evaluated comprehensively and consider the inevitable drawbacks when building a business model. Tamar's research, which mainly evaluated the cost saved by the point-to-point (P2P) food sharing model and the transportation cost caused by the food sharing economy, suggests that sharing food economy may also have some negative effects, rather than always be good as people think, while the amount of the greenhouse gas emissions reduced by avoiding food waste do exceed the amount it increased by increasing transportation [3].

1.3. Objective

This article analyzes the connection between the GDP of France and the amount of food waste by constructing a Solow model and reaches a conclusion that probably food waste is directly proportional to economic growth. This suggests that changing food waste can possibly promote economic development. So a new profit-oriented business model is built in order to better lower the quantity of food waste.

The second part of the research introduces the Solow model and builds a model regarding food waste, finding out the relationship between economic growth and the amount of wasted food. The third part reveals the process by which the pattern runs.

2. ECONOMETRIC MODEL

2.1. Solow model

Questions of economic growth are an old question which has been widely discussed. economists often use the data of Gross Domestic Product(GDP) to measure economic growth and explain the problem of economic growth by exploring the factors which influence it. One of the significant theories of economic growth is the Solow growth model. Solow's model is designed to show how the growth of the capital stock, the growth of the labour, and technological progress interact with each other, and how they affect the total output of goods and services of countries [10].

Only three factors (Technology, capital, labour) be considered in the basic Solow model. However, economic growth is not only restricted by technology, capital and labour, but also by many other factors such as food waste, which influence the sustainable and healthy development of the economy. [3] Hence, besides technology, labour and capital input, food waste was also considered a factor which interacts with capital input, labour input and economic growth each other.

In the basic form of the Solow model, the production function is:

$$Y=F(K, L, A) \quad (1)$$

Assuming that the technology factor is neutral, the production function can be expressed as:

$$Y=A(T)\cdot f(K, L) \quad (2)$$

Where economic output, capital input, labour input and technology are denoted by Y, K, L and A respectively. F represents the function relation between these four variables.

Taking the log of both sides of Equation (2), then take the derivative, thus:

$$\frac{\dot{Y}}{Y}=\frac{\dot{A}}{A}+\frac{\partial Y/Y}{\partial K/K}\bullet\frac{\dot{K}}{K}+\frac{\partial Y/Y}{\partial L/L}\bullet\frac{\dot{L}}{L} \quad (3)$$

Where $\frac{\partial Y/Y}{\partial K/K}$ and $\frac{\partial Y/Y}{\partial L/L}$ are the capital elasticity and labor elasticity respectively. Assumed that $\frac{\partial Y/Y}{\partial K/K}$ = αK, $\frac{\partial Y/Y}{\partial L/L}$ = αL (αK+αL=1), which can simplify the equation:

$$\frac{\dot{Y}}{Y}=\frac{\dot{A}}{A}+\alpha_K\bullet\frac{\dot{K}}{K}+\alpha_L\bullet\frac{\dot{L}}{L} \quad (4)$$

2.2. The construction of the model

Based on the traditional the Solow model, food waste, labour input and investment input are considered variables used to construct the new function. The new Solow model function is:

$$Y=F(K, W, L, A) \quad (5)$$

The Cobb-Douglas function is used to construct the new Solow model which assumed that the technology is neutral and the market's competition is complete. The new Solow model function is:

$$Y=A\bullet W^{\alpha W}\bullet K^{\alpha K}\bullet L^{\alpha L} \quad (6)$$

Then take the log of both sides of the equation (6), then take the derivative, thus

$$\frac{\dot{Y}}{Y}=\frac{\dot{A}}{A}+\alpha_w\bullet\frac{\dot{W}}{W}+\alpha_K\bullet\frac{\dot{K}}{K}+\alpha_L\bullet\frac{\dot{L}}{L} \quad (7)$$

Where $\frac{\partial Y/Y}{\partial K/K}=\alpha_K$, $\frac{\partial Y/Y}{\partial L/L}=\alpha_L$, $\frac{\partial Y/Y}{\partial W/W}=\alpha_W$ ($\alpha_K+\alpha_L+\alpha_W=1$). W is the annual food waste of the specific nation, the Gross national expenditure in France and L is the total labouring population of the specific nation.

Taking the log of both sides of the equation (7), thus:

$$\log(Y)=\beta+\alpha_W\log(W)+\alpha_K\log(K)+\alpha_L\log(L) \quad (8)$$

Where β = log(A).

2.3. Data sources and variables explanation

After selecting France as a sample nation, some statistics on France have been collected According to the demand of the variables in the new Solow model. The details of the variables and corresponding data are as follows:

Y: Annual Gross Domestic Product of France (2000-2010).

L: number of Labor population in France (2000-2010).

W: The amount of food wasted each year from 2000 to 2010 (including hen eggs in the shell, fresh; raw milk of sheep; tomatoes; Oats; Barley; Rice; Maize (corn); Wheat).

K: The Gross national expenditure in France

Data on the Y and K were obtained from The World Bank database, the data on W was obtained from the Food Loss and Waste Database of FAO, and the data on L was gained from the Hua Jing Industrial Research Institute in China.

2.4. Comparison of the gross national expenditure and the gross domestic product in France

Figure 1 shows a scattered diagram of the relationship between the gross domestic product in France and the gross national expenditure in France. Figure 1 shows that the statistics of GDP and the gross national expenditure in France are highly correlated. In addition, by using the function "CORREL" in Excel, a positive correlation (0.999045706) was obtained which strongly proves the positive correlation between these two variables. In order to avoid the condition that the high correlation between these two variables influences the result of the OLS regression in the next section, we decided to delete the variable "K" in the model. Hence, the function from (8) was changed to another function:

$$\log(Y)=\beta+\alpha_W\log(W)+\alpha_L\log(L) \quad (9)$$

$$\alpha_W+\alpha_L=1 \quad (10)$$

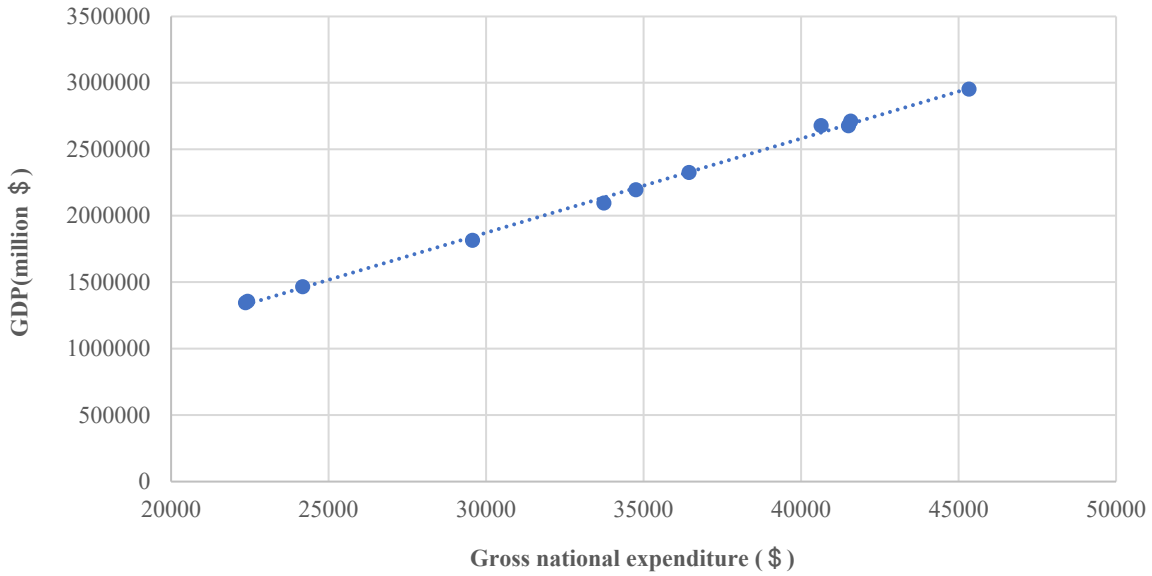

Figure 1 GDP versus gross national expenditure for France

2.5. Comparison of the amount of food waste and the gross domestic product in France

Figure 2 shows a scatter diagram of the relationship between GDP and the amount of part of the food waste. With a positive correlation of 0.82448882, the figure indicates that there probably has a positive relationship between food waste and economic growth.

3. RESULT AND DISCUSSION

In order to reflect the impact of food waste, investment and labour on the economy, Eviews7.0 was used to analyse the data which we collected. By using the linear regression equation (8), the relationship between the GDP in France, the food waste and the labour population in France can be obtained.

3.1. The relationship among GDP, food waste and labor

The least square method OLS was used for regression, the result in Table 1 show

that the Equation (11) is:

$$\log(Y)=2.747+0.370\times\log(W)+0.630\times\log(L) \quad (11)$$

As shown in the Table 1, the p-value of function (11) is 0.001275 which indicates that the significant level is 1%. Where the R^2 is 0.70, the adjusted R^2 equal to 0.67, which illustrates that the result is reliable.

Table 1. Quantitative relation among food waste, labour and GDP in France (2000—2010), from the Solow model

Basic model: OLS regression				
Dependent variable: Log (Y)				
Sample: relevant statistics from 2000 to 2010 in France				
Function: LOG(Y)=β+αW*LOG(W)+(1-αW)*LOG(L)				
	Coefficient	Std. Error	t-Statistic	P-value
β	2.747336 **	0.858849	3.198858	0.0109
αW	0.370474 ***	0.085532	4.331388	0.0019
squared: 0.702370				
F-statistics: 21.23886				
P-value: 0.001275				

Note: All variables are in log form and p-value in parenthesis with *** p<0.01, ** p<0.05, * p < 0.1)

Most importantly, the result proved that there is a positive correlation between food waste and economic growth. Additionally, since αW is equal to 0.370 and αL equal to 0.630, the elastic effects of food waste and labour factors on GDP were 0.370 and 0.630 respectively.

4. BUSINESS MODEL EXPLORATION

As described in the previous model results, the economy and food waste show a positive relationship. However, we need to mention here that the positive relationship between economic development and food waste is a causal one, in that it is economic development that may lead to food waste, rather than food waste that may lead to economic development. This suggests that it is possible to change food waste in a way that promotes economic development.

Furthermore, according to Toshiki's research, the gap between rich and poor within countries and regions tends to be more pronounced the more the economy grows [12]. This is because as the economy grows, the scope for food waste increases and so does the amount of food waste. At the same time, this allows room for the development of doing shared food. The fact that this wealth gap is regional and geographical in nature also increases the probability of developing our food sharing platform. As well as regional disparities between the rich and poor also present opportunities for food speculation with price differentials. This will be an important driver of profit momentum.

4.1. Win-win business model

With the development of the economy and the growth in people's food consumption, society is now facing an increasingly important question—food waste, while people in some parts of the world are facing survival problems due to food shortages. Food-sharing can solve this problem, but only governments and several large corporations can afford to donate food for free to starving people, which means rather than limit food-sharing to charity, companies can introduce a new business line.

4.1.1 Business line

Creating an application can efficiently make "second-hand" food flow. This application connects the supply and the demand, which means it connects restaurants and supermarkets, which have food surplus, with the starving people or anyone who want to save money on food. Different kinds of restaurants, bakeries and supermarkets must have excess vegetables, meat and bread left unsold, some of which still remain fresh. Companies purchase these foods in large quantities at a very low cost. For example, a loaf of bread is sold 5 dollars at a bakery, the company signed an agreement with the bakery to buy one hundred unsold bread at fifty dollars and sold bread on the application at two dollars each. Also, these foods can also be processed into new products, for example, salad and be sold at a price lower than the market price, attracting various groups of people who want to buy cheaper products.

4.1.2 Sales strategy

Firstly, the food supply every day depends on the food left that day, which is not fixed. Therefore, the platform can provide a "mysterious box" for their customers, giving little surprise. By trading this way, the company that runs the platform can profit from the price difference.

Secondly, the company can cooperate with Internet celebrities in marketing to introduce this new lifestyle, for instance, get their post "How can I get the best deal at Starbucks" on social networking sites, attracting teenagers surfing the internet. And inviting local influencers as endorsers in improving credibility, reaching different levels of customers.

4.1.3 Bound to the customer

To attract more customers, an application can develop a new function, building an online community where local people who lives nearby can post photos of food they don't need on the platform and chat with others who need it to decide how to trade.

Figure 2 The business model of win-win model

This kind of trading mode requires a perfect regulation system to ensure transaction security. For example, sellers must provide food expiration date and if the food does not match the description the seller gives, the buyer can complain to the system to end the transaction of this seller. In this way, not only can the company enlarge the market, but also encourage food flow on a small scale.

This business model enlarges the trading market and achieves a win-win situation. Firstly, restaurants that choose to cooperate with the application can lower their cost by selling their surplus food at a low price, instead of throwing them away. At the same time, people who want to save money on the aspect of food can reduce financial stress, for they can buy food at prices lower than market prices. Furthermore, a lot of food that would have gone to waste is saved.

5. CONCLUSION

In this paper, we construct a new Solow model based on the original Solow model and the Cobb-Douglas production function to investigate the impact of food waste on economic development using France as a data source. Our study finds a positive relationship between

the amount of food waste and the degree of economic development in France situation. With this finding, we propose a win-win business model: on the one hand, we join forces with merchants to buy surplus daily products from supermarkets at a low price and re-process them into reprocessed products for secondary sales to increase sales profit. On the other hand, the platform function to deepen the connection between proximity customers and the platform in a customer to customer mode, thus binding customers. It is also possible to combine the advantages of the Internet to deepen and expand the user base through the Internet. At the same time, the transaction system can be improved so that the security of the customer's transaction is guaranteed accordingly. This will result in a win-win situation in terms of food waste reuse and profit income.

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