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Financial returns of implementing a circular economy: A firm's perspective

Pard Teekasap

International Business Department, Faculty of Business Administration, Thai-Nichi Institute of Technology, Bangkok 10250, Thailand

Abstract

Economic growth is considered to be desirable for all countries. However, the limited resources on our planet present a problem with the infinite resource assumption of infinite growth economic models. The circular economy concept seeks to reduces these problems by unbundling resource limitation from economic growth through the reduce, reuse, and recycle approach. This concept has been strongly adopted globally using a top-down approach. An example of this is when the Chinese government enacted a circular economy law. In other countries, however, that are driven by the private sector, the implementation has stagnated due to a perception that firms will have lower return from implementing a circular economy production system. Little research exists to confirm if their perceptions are correct or not. This paper, therefore, aims to fill this gap by studying the financial benefit/cost of implementing a circular economy from a firm's perspective.

A system dynamics method has been used in this study because no public firm was found in Thailand that claimed that they have fully implemented a circular economy concept. The system dynamics approach enables this data limitation to be overcome as this methodology allows us to examine the impact of a circular economy based on a theoretical analysis. In addition, this method shows results using graphs which are easy to understand and analyze.

The results of the study show that firms that implement a circular economy concept will have better performance than firms that do not. Firms implementing a circular economy approach will have a higher profit due to an increase in revenue and also lower costs in the long term. Higher revenues come from selling products at a higher price. Even though the price increases have a negative effect on the demand, the effect is minimal and it takes a long period for this effect to happen.

Keywords: Circular economy, financial returns, system dynamics, sustainable development goals
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1. Introduction

Economic growth is key policy aim for the majority of governments around the world. However, the global economic growth ratio is only around three percent per year [1]. In the same period global population growth has been 30% between 1990 and 2010 [2]. This comparison indicates that infinite economic growth faces some obstacles, and one of these obstacles is limited resources.

Classical economic growth theories assume that production can be increased exponentially with no upper limit. It is widely considered that this assumption is not valid any more. With current production levels and plans for further expansions in production, many countries such as China have already faced problems with resource scarcity [3]. This is a serious problem that will affect world prosperity in a long run.

The circular economy has been proposed as a promising solution to reduce this resource limitation problem. A circular economy is an approach to unbundle the use of new resources from economic growth through 3R (Reduce, Reuse, Recycle) processes [4]. China has implemented this approach widely and strongly through Circular Economy Promotion Law. This was enacted in order to avoid the slowdown of the country's rapid economic growth [5]. However, this is a rare case. Most countries still do not consider a circular economy as a strategic policy because the benefits of a circular economy besides an environmental aspect is unclear and these countries do not have a resource scarcity problem yet [5, 6]. This situation is a 'tragedy of the commons' that will lead to the resource depletion in the future if no intervention has been made [7].

Because the threat from this situation is high in a long run, The United Nations considers this issue within their sustainable development goals. Goal 12

*Corresponding author; email: pteekasap@gmail.com

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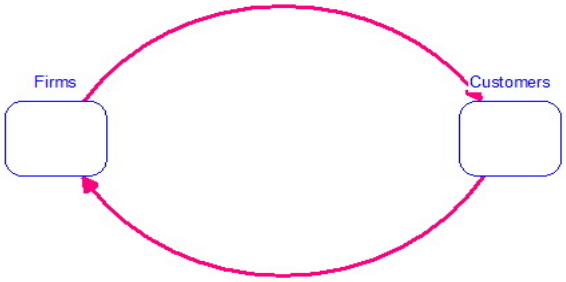

Figure 1: Interaction of two modules.

relates to responsible production and consumption. The UN aims for these goals to be achieved by 2030. However, this goal is not well received by the private sector as most firms believe the environmental improvements will lead to an economic burden [8].

This is the theoretical gap that this paper aims to fill. This paper aims to examine whether a circular economy approach, which is considered as an environmental policy, would have a negative affect on the financial performance of firms implementing the policy.

One problem of conducting studies on this topic is the data is often considered to be insufficient. Unlike the traditional business approach which operates over a relatively short time frame, the circular economy is a long-term policy that requires longer for results to emerge [9]. Therefore, it is hard to identify if the results come from the policy. The circular economy policy was fully implemented in China in 2008. Most companies in China do not use a circular economy approach [10]. Therefore, the data that is available is not sufficient for a statistical approach. This constraint was overcome in this research by using a system dynamics approach. A simulation tool was developed to analyze the future possibilities for manufacturers if a circular economy approach was implemented in their firms.

The results show that firms implementing a circular economy approach will face a higher cost in a short run. It was found that this could be partially offset by setting a higher product selling price. In the longer term, the operating cost of firms using a circular economy approach will be lower leading to higher profits in the future.

2. Circular Economy

Even though a circular economy is a relatively new term, the underlying concepts have been in use since 1966. One author considered the globe to be giant spaceship voyaging in an infinite journey with limited resources [11]. However, this concept was viewed as naïve in the past due to the trend of rapid industrialization growth in many countries [4]. In addition, economists considered that the resources were infinite as higher market prices would lead to more production.

Issues of resource scarcity became a serious issue in China and they proposed the Circular Economy Promotion Law in 2008 [3].

The circular economy is based on the concept of "3R: Reduce, Reuse, Recycle." In the traditional production process, most materials do not form part of the final product but are waste that is generated during the process. Examples of this include mining waste and product packaging [12]. The first step that should be carried out is to reduce the use of materials when manufacturing products. In addition, to maximize the utility of the finished products, the products should be reused to reduce the need for the production of new products. Finally, when the products and their constituent parts cannot be any more, products should be recycled to provide an alternative source of raw materials.

Due to the characteristics of this 3R concept, a circular economy was portrayed as a solution for environmental and resource scarcity issue to foster continuous economic growth [13]. Most literature focuses on the benefits of using a circular economy on environment. The economical returns of using a circular economy are less clear. Many scholars have proposed key performance indicators of a circular economy that can be used in order to estimate the economic benefits by using factors such as the value-based resource efficiency [14].

Even though China has successfully implemented a circular economy, other countries cannot follow China's steps. The implementation process of circular economy in China was unique due to its administrative system. The implementation in China was enforced by the government using a top-down process [3]. The approach used by most countries around the world work differently and can be broadly seen as bottom-up policy making processes. All stakeholders' benefits and costs must be reviewed and the policy must be thoroughly debated to ensure that the policy can serve all stakeholders' needs.

In order to support the implementation of a circular economy concept in a bottom-up process, the decision process that involves multiple stakeholders with different needs and perspective is essential. Solid and scientific evidence is required so that it can be used as a basis for discussions. One such area of data that is required is a summary of the overall benefits and costs of implementing a circular economy. Many papers have shown that the circular economy can support economic growth in environments with resource scarcity and that it can reduce the impact of manufacturing on the environment. It is considered that the economic benefits of implementing a circular economy has historically been understudied [3, 5, 6]. This is especially the case in areas with abundant resources. Studies that have been carried out focus on the cost-

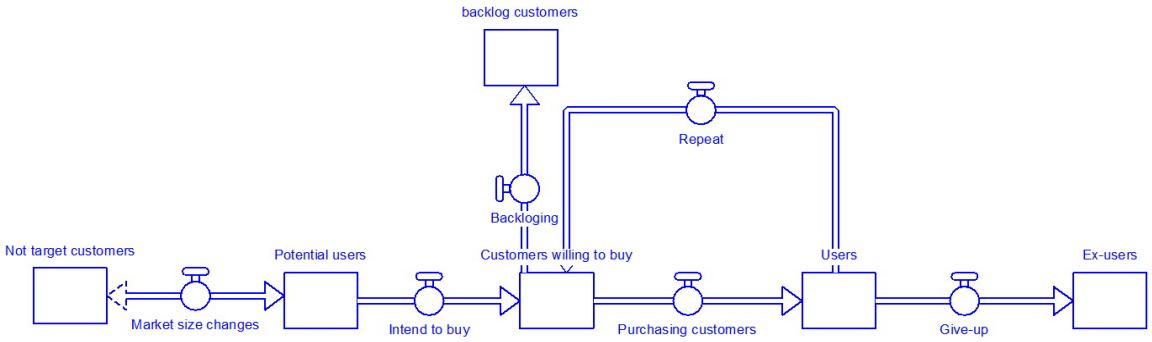

Figure 2: Flow of customers.

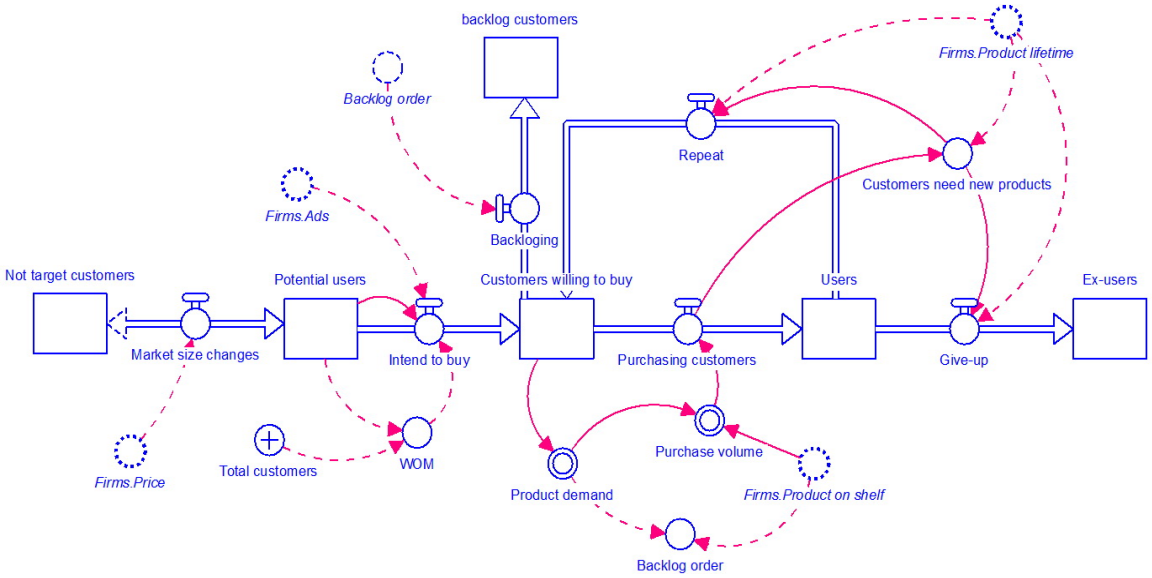

Figure 3: Factors affecting flows of customers.

benefit analysis of implementing a circular economy on a country wide basis. To convince individual firms of the business case for the circular economy analysis at a company level is required. The focus of this paper is therefore to study the potential financial impacts for firms implementing a circular economy approach.

3. System Dynamics

System dynamics a mathematical simulation method. The method has a strength in dealing with complex situations that involve lots of factors. It is particularly useful when all of these factors interact with each other in a dynamic way [15]. System dynamics is developed from a feedback approach where all actions create an impact that eventually feeds back to itself [16]. Therefore, system dynamics can be used where the relationships between factors are non-linear and where the system contains feedback loops [17].

The system dynamics method is suitable in this study because the implementation of a circular economy affects and are influenced by multiple parties in the supply chain. These parties include suppliers, manufacturers and customers. Each of these parties has different needs, goals and strategies. Therefore, the relationships between these parties are complex and the linear-approach methodologies such as linear regression are not suitable for analysis.

System dynamics is a simulation tool, it can therefore be used to analyze the future possibilities of the situations in different scenarios. This can include situations that have not happened before in reality [15]. Due to these unique characteristics, this method has been substantively used to analyze the complex problems and to validate policy recommendation before actual implementation in many fields. These include oil and gas industry projection, electricity and carbon emission estimation and natural resource management [18-20].

The model that is presented in this paper was developed from the basic business operation and literature on the circular economy. In addition, the effect of a circular economy was analysed based on what was found in the literature. The effect of a circular econ-

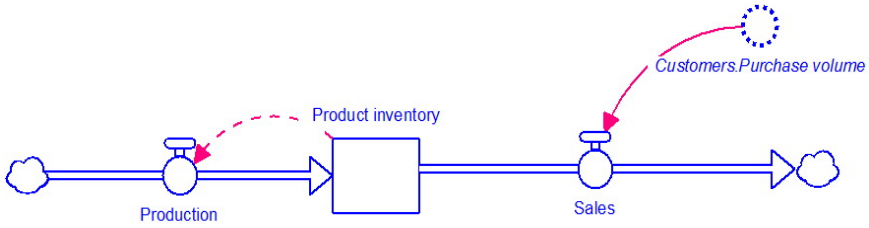

Figure 4: Production part of firms module.

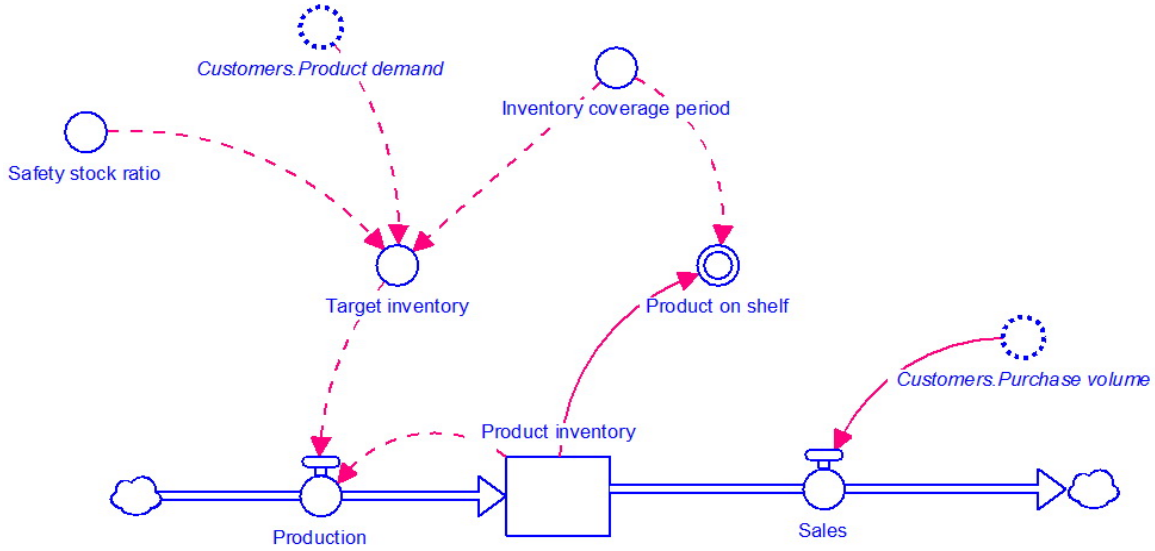

Figure 5: Factors affecting a production plan.

omy, on company performance, has not been found in the literature therefore the amplitude of the effect of a circular economy is theorized. A sensitivity analysis was also carried out for the model in order to to strengthen the robustness of the results.

4. Model

The model was developed based on a perspective of customers and manufacturing firms. The model was therefore divided into two modules. These two modules interact with each other through market mechanisms. Firms sell products to customers at a particular price. Customers can decide whether to buy or not based on their price preference and their demand. The demand is in turn influenced by the marketing activities of the firms. The demand and sale of products is fed back to firm's production plan for its next year of operation. The relationship is shown as a closed loop and can be seen in Figure 1.

The population of customers was categorized into different groups according to their preferences and behaviors. Six groups were used. These were not target customers, potential users, customers who are willing to buy, users, backlog customers, and ex-users. The 'not target customers' group was people who were not the target group of the firms and who did not have an interest in the product. The 'potential users' were a group of people who were the target group of the firm but did not yet buy their product. The 'customers who are willing to buy' was people who were interested in the products and wanted to buy them but had not yet bought them. 'Users' were people who already had the product and were using it. 'Backlog customers' were customers who wanted to buy products, but it was not available when they wanted to buy. Lastly, 'ex-users' were people who had used the products before but did not like them and will not purchase again.

The flow of people through the groups started with them not being target customers. Then, with some changes from external and internal factors, they will became potential users. After that, potential users could be influenced by the firms' activities and their social connection. This leads to them feeling interested in buying a product and they became part of the 'customers who are willing to buy,' group. When they wanted to buy, they made a purchase and became 'users,' However, if the products were not available to buy at this time , some of the people changed their mind and decided not to buy the products. They there-

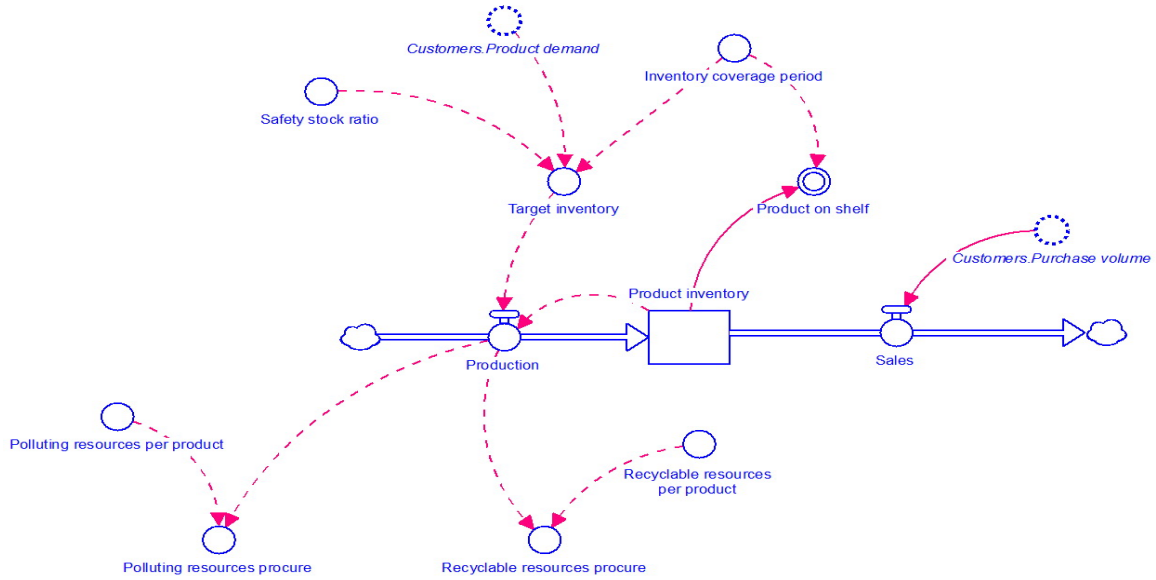

Figure 6: Procurement of raw materials.

fore became part of the 'backlog customers' group. 'Users' used the products until they wore out and at this point they decided if they would like to make a repeat purchase and become 'customers who are willing to buy' again. Alternatively, some decided to go for other brands and become 'ex-users.' The aforementioned flow is illustrated in Figure 2.

The flow between each population group is depended on many factors which are shown in Figure 3. People who are not target customers can become potential users according to the changes in their preference and product-related factors. In the model, change of preference was based on a normal random distribution. It was assumed that the portion of people who changed their preference to favor and not to favor the product was approximately the same, and that they cancelled each other out. For this reason, the changes in preference were not considered in the model. For this reason, people changing from being 'not targeted customers' to 'potential users' depended solely on the price of the products.

'Potential users' could have an interest in products due to marketing campaign from companies and also from social interactions. For this reason, in the model, the flow of people from the 'potential users' group to the 'customers who are willing to buy' group was driven by advertising and word-of-mouth.

'Customers who were willing to buy' became 'users' if they purchased products and became 'backlog customers' if the products were not available to purchase. These two flows were therefore depended on the balance between product demand from 'customers who are willing to buy' and products that were available to buy.

In the model products had a limited lifespan. Customers could decide whether to repurchase products or switch to another manufacturer. The flow of people from the 'users' group to the 'ex-users' group and to the 'customers who are willing to buy' group were therefore depended on the products' lifespan.

Figure 3 shows that the flows of people in different categorizes were altered by firm-related factors. These were the products' price, advertising, availability of products, and the products' lifespan. These factors were drawn from the 'firms' module in the model.

In the firms module, the model was started with the production part of the firm. It was assumed that the business was a build-to-stock business. It was therefore assumed that products would be produced and kept in inventory until they were required. The products were then distributed through distribution channels and were purchased according to the demand from the customers module. This relationship is shown in Figure 4.

Production was depended on a production plan. The production plan in turn was derived from estimated product demand as shown in Figure 5. It can be seen that the production plan was derived from the product demand, safety stock level and inventory coverage ratio. The level of product inventory in turn determined the number of products that were available for purchase.

Companies must have raw materials in order to produce according to production plan. George *et al.* propose that the raw materials for production can be categorized as recyclable resources and polluting resources [21]. The recyclable resources are resources that can be recycled again such as certain types of plastics and paper whereas the polluting resources are resources that cannot be recycled and must be produced from minerals, which have limited reserves. Figure 6 presents the aforementioned explanation.

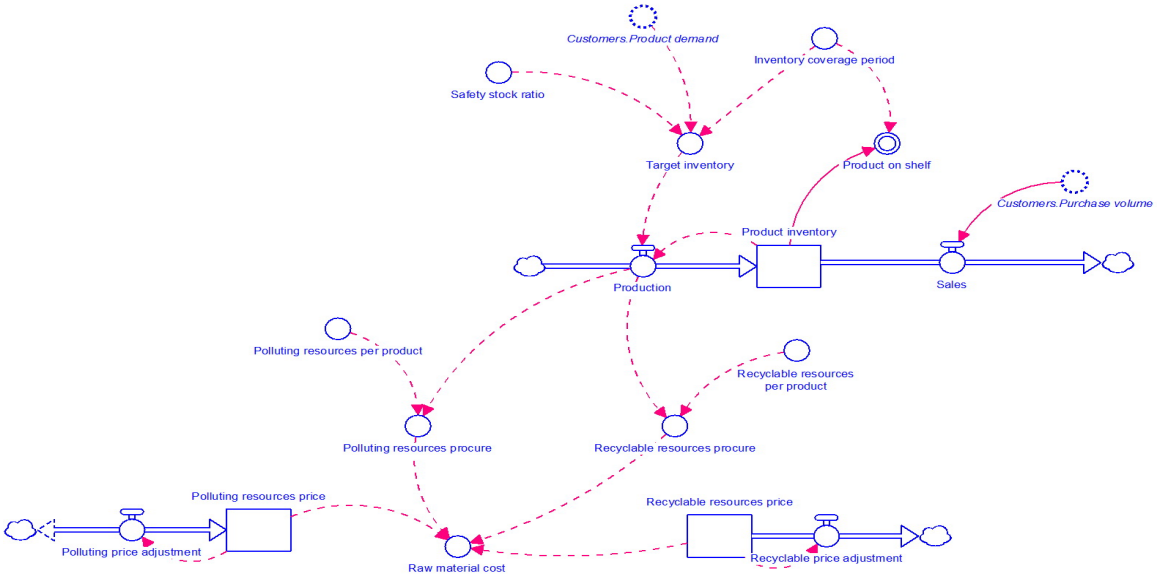

Figure 7: Products' raw material cost.

The price of raw materials varies continuously. Literature suggests that the polluting resources' prices tend to increase significantly over time due to a continuously increase in demand while the supply is limited and may become depleted. One example is the price of coal which is increased significantly during last couple years. On the other hand, the price of recyclable resources is, in general, higher than the price of polluting resources. However, due to an increase in a recyclable resource usage, the cost of processing recyclable resources tends to gradually reduce over time. The cost of both recyclable resources and polluting resources were added together to give an overall raw material cost of the product. This is shown in Figure 7.

Raw material cost is only one part of the total cost. In this model, marketing cost was also added. The difference between the revenue received from the sale of products and the cost of production and marketing was the net profit. This was accumulated into a retained earning, as shown in Figure 8.

The revenue of the firm was calculated from the sale volume, which came from customers module, and the price per product. The price was determined by the cost per unit. This in turn was derived from the total cost and production volume. To make the model realistic it was noted that firms cannot change a price freely. There are limited percentage of price increase that firms can do, which is called 'max price increase ratio.' This was incorporated into of the firms module and is illustrated in Figure 9.

This is the core diagram of the model. The equations used for the the model are not shown here due to space limitations. However, equations are available upon request.

5. Situation Under Base Scenario

In order to analyze the financial return of implementing a business model based on the circular economy principles, a base scenario was first created. This was the situation of the business using a traditional non circular manufacturing approach. This was then compared with the same business after a circular economy business model was implemented. The outputs from the model were shown using multiple factors, not just a profit of a firm, in order to gain a more in-depth understanding of the implications to business. The simulation was carried out from years -2 to year 10. Until year 0 a traditional manufacturing process was used.

The data that was used for the base scenario was sample data representing a generic firm in Thailand. The usability of the data used in the base scenario was validated through sensitivity analysis. Details of this are given later in the paper. The initial income of the firm is shown in Figure 10. The income of the firm shows an inverse-U shape. The income is seen to gradually increase from the start of the simulation until around year 7. After this it was seen to drop significantly. However, because the firm is still in profit it's retained earnings continue to increase.

The income of the firm is derived from sales volume and price. Therefore, analysis was started by looking at the sales volume. In order to understand the whole production process, the sale volume was mapped with production volume and inventory levels. This is shown in Figure 11. The graphs show the same pattern as with the income. Sales, inventory level and production volume all have an inverted-U shape graph. However, the peak of the graph is around year 4, instead of year 7 in the income graph.

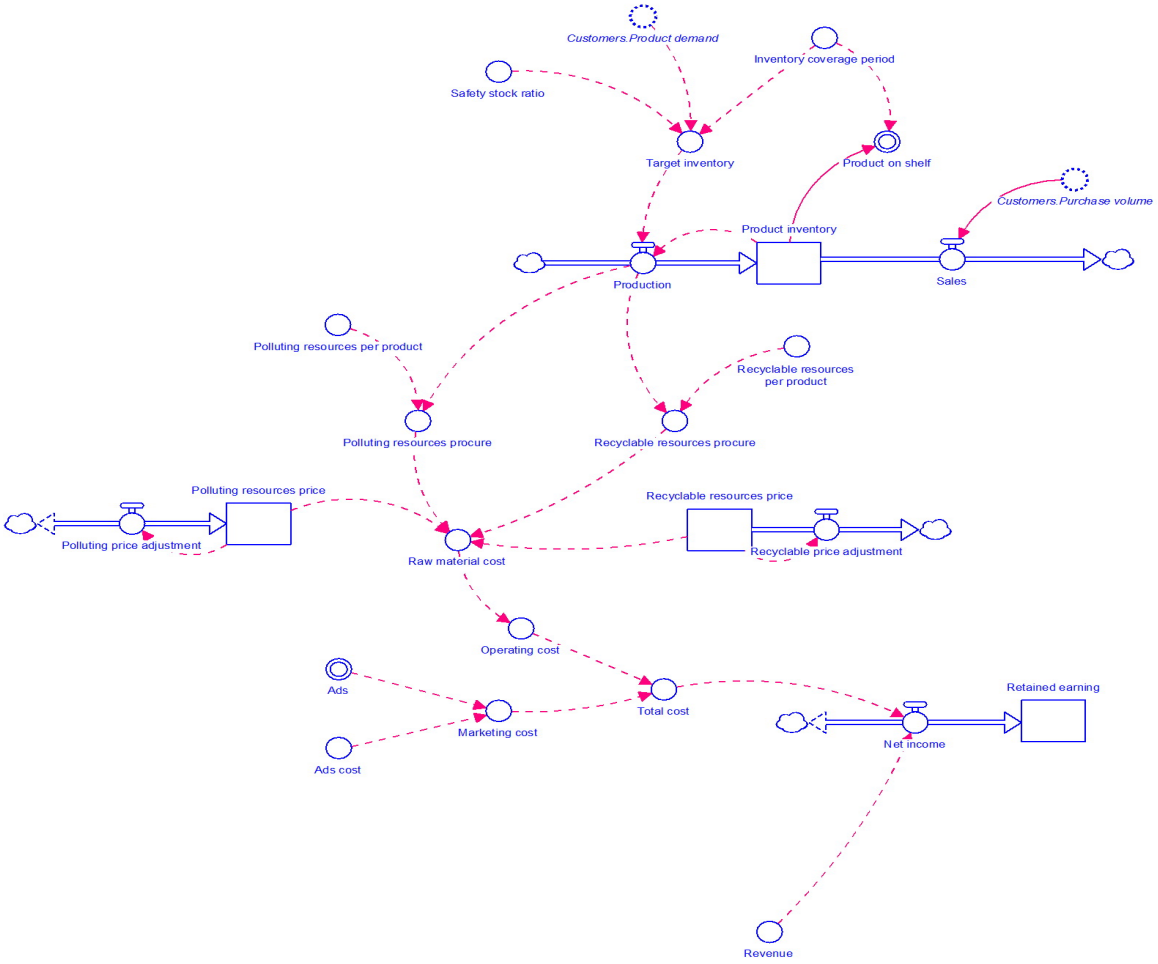

Figure 8: Profit of the firm.

The next graph that was considered was the price of the product. This is shown in Figure 12. The graph was surprising. The shape of the graph is an inverse of other graphs that have been discussed. The price dropped during the first 2 years, and then gradually increased. It shows that the profit in the business mainly comes from a higher volume of sales and not from a higher product price.

To understand the drivers behind changes in sales volumes, a number of customers need to be investigated. Based on the people flow in customers module that was discussed earlier, 'users' and 'customers who are willing to buy' were the focus of our investigation. This is because the flow of people between these two groups are equal to the sales volume. Figure 13 shows that the changes of the numbers of customers in both groups have the same pattern as the sales volume.

Another dimension that was observed was the firm's lost sales. This is the sales that the firm failed to make due to not having sufficient stock and those that decided to not become repeat customers. The graph in Figure 14 indicates that the firm lost many potential sales through ex-users and backlog customers. The number in both groups of customers was seen to increase gradually over time.

In the next section a discussion will be made of the simulation which was run once the firm had implemented the principles of the circular economy.

6. Effect of Circular Economy

The concept of a circular economy is "Reduce, Reuse and Recycle." "Reduce" comes from the concept that the production process will create waste. Therefore, if the production is lower, the waste is lower. "Reuse" is to maximize the usage of the product. Last, "Recycle" is to transform the unused product into raw materials which are then used again in the production process in place of virgin materials.

The aforementioned concept focuses on a customer's perspective. To focus on the perspective of the firm, an investigation was made into firms could do to enhance the circular economy approach. "Reduce" approach is to redesign the products so the products use less materials. "Reuse" can be done by redesigning products so they can be reused. Lastly, "recycle" can be done by making products from recyclable materials

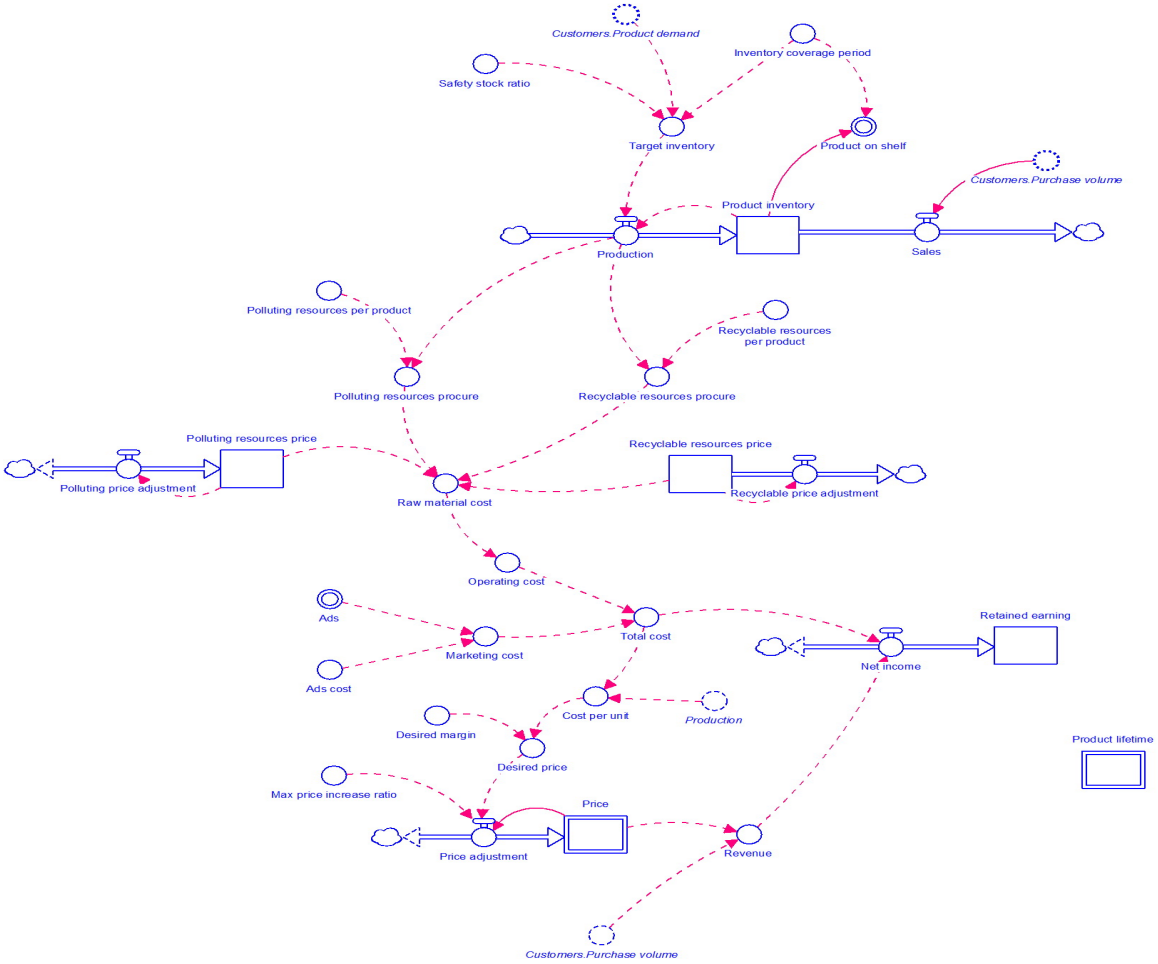

Figure 9: Completed firms module.

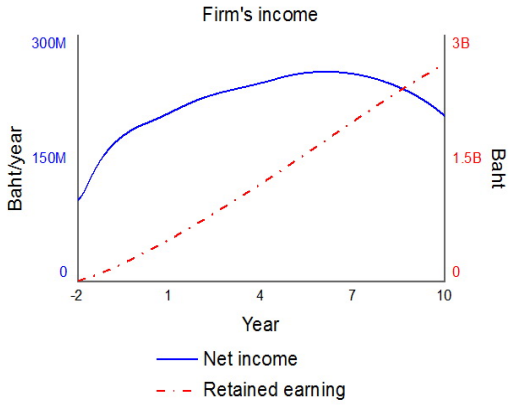

Figure 10: Firm's income and retained earnings: Base scenario.

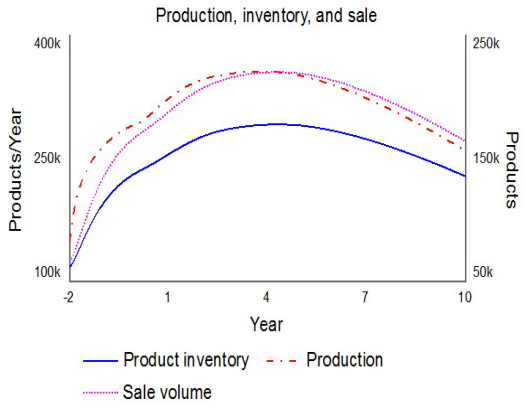

Figure 11: Firm's production, inventory, and sales: Base scenario.

so they can be recycled once products are beyond their useful lives.

Following on from the explanation above, the concept of "reduce" is shown in the model through a lower number of raw materials required per product. The "Reduce" concept is implemented by increasing the product's useful lifespan. Lastly the, "Recycle" concept is illustrated through an increase in percentage of materials that used in the product that are recyclable. These modifications are shown in Figure 15. The changes are shown as highlighted variables. No modifications were made to the customer's module as

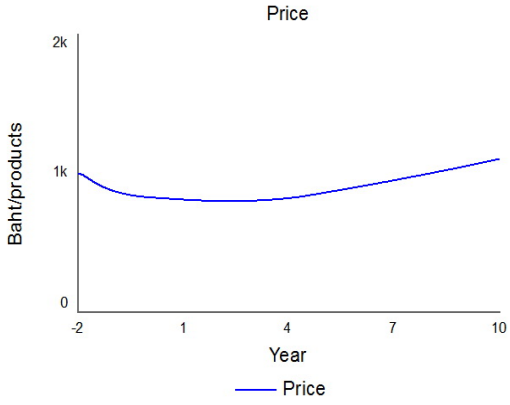

Figure 12: Price of the product: Base scenario.

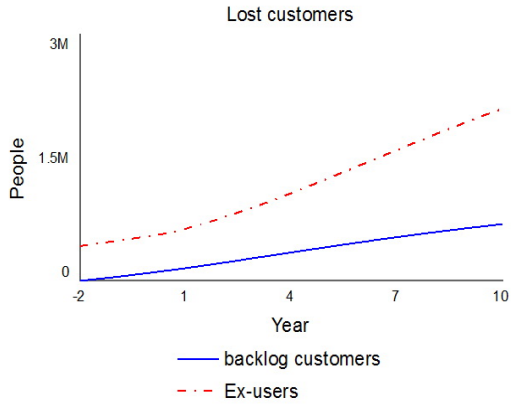

Figure 14: Lost customers: Base scenario.

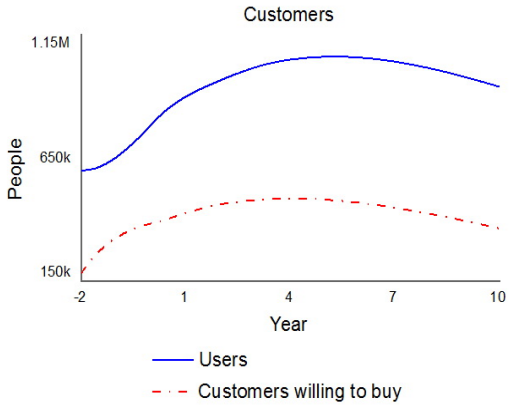

Figure 13: Graph of customers: Base scenario.

it was assumed that the changes happened only from a firm's perspective.

In order to implement circular economy concepts in the model the usage of raw materials was reduced by 5%, the lifetime of the products was increased by 20% and the 10% polluting raw materials that were previously used in the product would be replaced by recyclable materials. The implementation of the circular economy concepts started in the model in year 0 but was undertaken gradually and was fully implemented by the end of year 2.

The impact of the changes that were made were as follows. The impact on the income of the firm is positive, as shown in Figure 16. This shows that the implementation of a circular economy can improve firms' income. An analysis was made to determine if this improvement came from an increase in revenue or a reduction in costs.

The revenue graphs for the two scenarios show the same patterns as the graph of income. This is shown in Figure 17. The firm's revenue increases gradually from the implementation of the circular economy concepts. The differences became more significant once the circular economy was fully implemented. It is therefore more likely that the improvement in the firm's income came from an increase in firm's revenue than a reduction in costs.

The total cost in both scenarios is shown in Figure 18. When the firm switched from using polluting materials to recyclable materials, the cost was seen to increase significantly. This was due to the fact that recyclable materials are more expensive than polluting materials. In the long run, however, the price of polluting materials rises continuously while the recyclable materials' price declines. Because of this, the total long term cost of implementing the circular economy concept is lower than when the firm does not implement it.

It was confirmed that the improvement in net income that was observed comes from higher revenues in the short term and comes from both higher revenues and lower costs in the long term. The next part of the paper will analyze if this rise in revenue comes from higher sales or from product price increases.

Figure 19 indicates that the increase in revenue that was observed came from selling products at a higher price. The firm's costs were increased after it implemented the circular economy concept. The firm therefore decided to increase its products' price to cover these higher costs. A higher cost would normally negatively affect the demand.

The sales volumes that were observed when the firm decided to implement the circular economy concept was lower than that in the base case. This is shown in Figure 20. The effect, however, is relatively small when comparing with an increase in price. In addition to this, the increase in price takes a long period of time to be clearly noticed. In this scenario, it is therefore concluded that implementing a circular economy concept has a positive impact on the firm in term of a higher revenue since the start of an implementation and a lower cost in the long run.

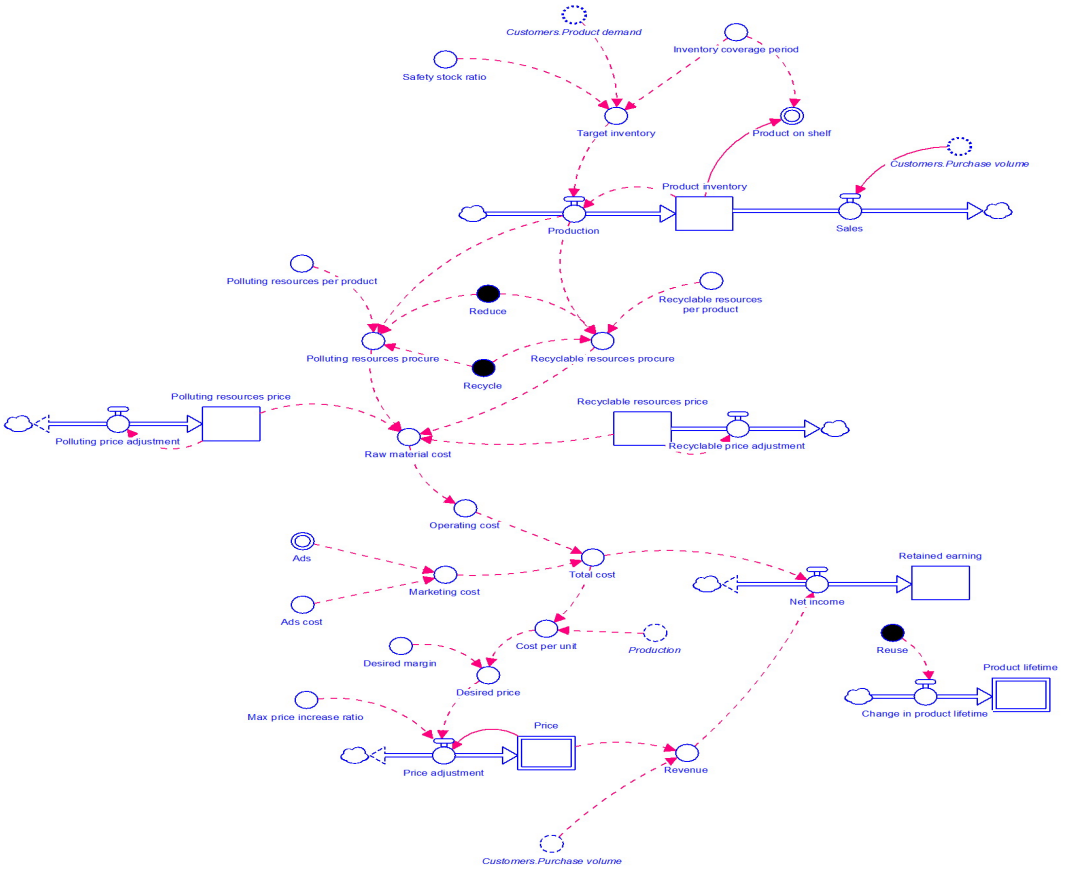

Figure 15: Firms module with a circular economy implementation.

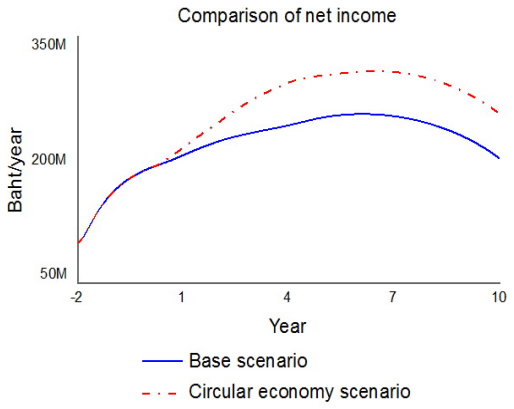

Figure 16: Comparison of net income between base scenario and circular economy scenario.

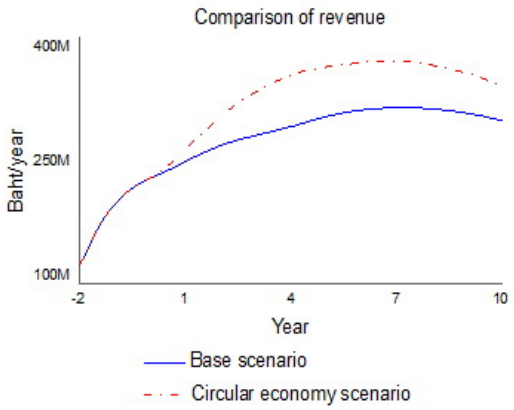

Figure 17: Comparison of revenue between base scenario and circular economy scenario.

7. Conclusion and Implication

The circular economy has been presented as a good environmental policy and a solution for countries with resource scarcity problems. However the wider benefits for firms implementing circular economy principles is understudied. This paper has shed some light in to this unexplored area by investigating the financial return for firms that implement circular economy principles in areas without resource scarcity problem. The findings were counter-intuitive and showed that firms can gain financial returns in both the short-term and long-term from implementing these policies. This is despite the fact that firms using circular economy principles will initially incur higher costs. Over the long term the difference in production cost will reduce due to a rise in polluting material cost.

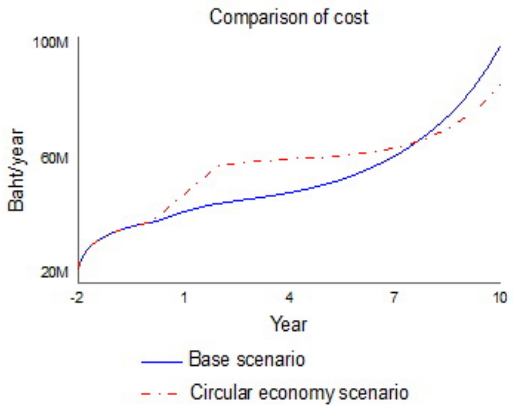

Figure 18: Comparison of cost between base scenario and circular economy scenario.

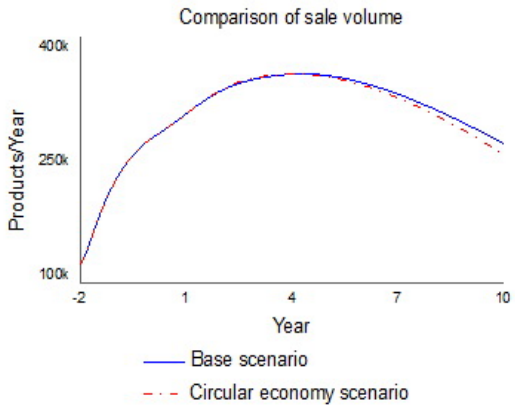

Figure 20: Comparison of sale volume between base scenario and circular economy scenario.

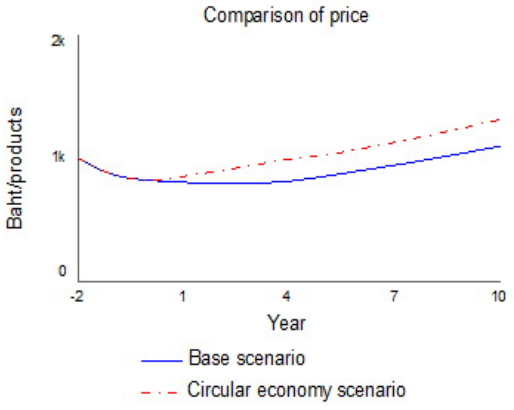

Figure 19: Comparison of price between base scenario and circular economy scenario.

This paper has presented a major theoretical contribution to the circular economy field. The financial returns of firms using a circular economy have rarely been studied due to the limited data availability. Through using a system dynamics method, this paper showed that firms can gain positive financial returns from implementing circular economy principles. It is hoped that this finding will lead to other research studies that aim to analyze an implementation of circular economy principles by the private sector in other contexts.

The practical implications of this work are also significant. Environmental policies are often considered to be burdensome and costly by companies around the world. This paper presents counter-intuitive findings that economical returns and environmental benefits can go hand in hand. This finding will support firms in making a decision whether to implement circular economy principles. If firms include circular economy principles into their business strategies it is more likely that goal 12 of the UN's sustainable development goals will be achieved.

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