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# **The Task Environment, Resource Commitment, and Reverse Logistics Performance: Evidence from the Taiwanese High-Tech Sector**

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## **The Task Environment, Resource Commitment, and Reverse Logistics Performance: Evidence from the Taiwanese High-Tech Sector**

**Abstract:** The purpose of the study was to construct a model in order to understand the empirical effects of the task environment on reverse logistics resource commitment and resulting performance. The Taiwanese computer, communication, and consumer electronics (3C) manufacturing and retail industries were investigated by questionnaire administration. Structural equation modeling was employed to model relationships among the latent constructs of the task environment, resource commitment, and environmental and economic performance. From 349 valid responses, it was found that the task environment has a positive and significant influence on resource commitment. In turn, resource commitment positively and significantly influences the economic and environmental performance of reverse logistics separately. Additionally, environmental performance significantly and positively influences economic performance, thus showing it pays to be green. Under a climate of increasingly strict international regulations, governmental legislation, and the increase in consumer environmentalism, firms are advised to reappraise their RL resource commitments appropriately.

**Keywords:** Task environment, resource commitment, reverse logistic, Taiwan, environmental performance

# **The Task Environment, Resource Commitment, and Reverse Logistics Performance: Evidence from the Taiwanese High-Tech Sector**

## **1 Introduction**

Effective reverse logistics (RL) management has been variously discussed as driving numerous benefits for firms including being a competitive advantage, a positive profit center, a tool to cut costs, and a tool to improve customer satisfaction (Dekker *et al.* 2004, Richey *et al.* 2005, Li and Olorunniwo 2008). The majority of supply chain management research has focused on the forward flow that transforms raw materials into final products, from suppliers to end customers (Prahinski and Kocabasoglu 2006). The reverse materials movement has received much less attention (Rogers and Tibben-Lembke 2001, Stock *et al.* 2002, Li and Olorunniwo 2008, Jämsä 2009). In recent years however, interest has been growing in RL, with the amount of RL literature mounting ever since the concept was first introduced to the academic sphere (Jämsä 2009). Despite these advances, the availability of holistic theoretical literature on RL is scarce (Dowlatshahi 2005).

Firms in the Taiwanese computer, communication, and consumer electronics (3C) industry were adopted as the respondents for this study, with this industry being considered favorable for a study on RL. Firstly, not only is Taiwan a significant international producer of information, electronic, and electrical related products, but the Taiwanese 3C and high technology industries specifically are prominent globally. Additionally, due to characteristics inherent to 3C products, including remarkably high rates of turnover and complex repair, recycle, reuse, and resale cycles (Daugherty *et al.* 2001), RL is central to the operations of 3C companies (Blumberg 1999, Wu and Chen 2006).

Furthermore, Taiwan has experienced an especially sharp and steady rise in logistics costs over recent years. Based on the 2007 Taiwan Logistics Yearbook, logistics costs

represented 11.67% of Taiwanese GDP. As expected, the major consumer of these logistics services was the 3C industry, comprising 37.7% of logistics costs (Ministry of Economic Affairs Taiwan 2008). From the perspective of volume, the recovery of electrical and information technology products alone accounted for approximately 1.5 and 2.8 million units respectively in 2008 (Environmental Protection Administration Taiwan 2009). Furthermore regarding the recent regulatory environment, the Taiwanese government has promulgated recycling laws and regulations which compel both manufacturers and importers to take back their products. The implementation of RL in Taiwan is thus certainly worth exploring, as it is apparent that the overall amount of RL in this emerging economy is large and will continue to grow.

In complex and dynamic environments, the ability to adapt to changing conditions and deploy limited resources where needed to critical positions is essential in determining firm performance and competitive advantage ( Teece *et al.* 1997, Eisenhardt and Martin 2000, Teece 2007). Theoretically, a firm's RL activities depend on internal factors such as resource commitment (Daugherty *et al.* 2005), external factors such as stakeholder pressure (Álvarez-Gil *et al.* 2007), or a combination thereof (Carter and Ellram 1998). Previous studies have argued that internal factors have a positive influence on RL performance (Daugherty *et al.* 2005). However, no research has explored how external factors (such as the task environment) drive internal factors (such as resource commitment) and, consequently, RL performance. The present research may help to fill this gap.

In the past, many companies took the view that corporate environmental management was an unnecessary investment, and even a potential impediment to growth and development. As such, it has often been argued that there is an inherent conflict between environmental and economic performance. However, no research has explored the relationship between the

environmental and economic performance of RL. This shortcoming in the literature represented another gap this study aimed to overcome.

## **2 Contributions of 3C Industries in Taiwanese Economy**

During much of the past two decades, Taiwan's high-tech sector, in particular the information industry, has experienced phenomenal growth in terms of both scale and revenues. In 1983, while only 37 high-tech firms were located in the Hsinchu Science Park, the first and largest high-tech industrial park in Taiwan, the number of firms had soared to 440 in 2009, and together they yielded total revenues amounting to US \$28.5 billion (Directorate-General of Budget 2010). The 3C Industry has contributed obviously to Taiwan's economy, for example, 3C Industry have the real GDP from 5.61 to 13.42 higher than other five industries during 2000 to 2008. The figures show in Table 1. As we know that some of Taiwan's industries, especially the computer, and electronics sectors, have become world leaders in manufacturing. For instance, computer monitors, printed circuit boards, and image scanners produced in Taiwan account for 50 percent of global market share (Huang and Wu 2010).

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Place Table 1 about here

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## **3 Literature review**

### **3.1 Reverse logistics**

The various definitions of the RL concept that have been put forward in the literature have been extremely heterogeneous (Álvarez-Gil *et al.* 2007). As an example of this diversity

of understanding, definitions were encountered that alone consider economic (Fassoula 2005, Rogers and Tibben-Lembke 2001), environmental (Carter and Ellram 1998, Stock *et al.* 2002), or service aspects (Blumberg 1999, Amini *et al.* 2005, Sundin and Bras 2005), or a combination thereof (Kroon and Vrijens 1995, Srivastava 2007). From the business logistics perspective, Stock (1998) defined RL as product returns, source reduction, recycling, materials substitution, reuse of material, waste and disposal, as well as refurbishing, repair, and remanufacturing. RL has been further defined as the process of planning, implementing, and controlling the flows of raw materials, in process inventory, and finished goods from the point of use back to a point of recovery or point of proper disposal (Álvarez-Gil *et al.* 2007). What such definitions have in common is an emphasis on the processes of planning, implementing, and controlling the movement of products or materials in the opposite direction (that is, from customer to supplier) for the purpose of creating or recapturing value, or for proper disposal (Rogers and Tibben-Lembke 2001).

The performance of RL operations has been considered multi-dimensional in nature, encompassing cost containment and the meeting of financial goals, improved / maintained customer relations, adherence to regulatory mandates, and managerial satisfaction with overall RL system operation (Daugherty *et al.* 2002). In this study, RL performance was defined as two distinct dimensions: economic performance and environmental performance. Regarding economic performance, effectively managed RL can deliver benefits including competitive advantage, better visibility, improved customer satisfaction, improved profitability and enhanced operational efficiency (e. g., productivity, cost) through improved space utilization, labor planning, and inventory control (Marien 1998, Rogers and Tibben-Lembke 2001, Jayaraman and Luo 2007).

Concerning environmental performance, external environmental effectiveness, firm

environmental efficiency, green image, and environmental flexibility have been proposed (Azzone and Noci 1996). Furthermore, Shuangyu and Kohji (2007) identified key indicators characterizing environmental performance, representing numerical measures that provide key information regarding environmental impact, regulatory compliance, organizational systems, and stakeholder relations (Ilinitich *et al.* 1998, Chinander 2001, Shuangyu and Kohji 2007).

### **3.2 Task environment influences on resource commitment in reverse logistics**

A given organization's task environment consists of the specific customers, suppliers, financiers, and other entities with which it must interact to grow and survive (Castrogiovanni 1991). The task environment may include a firm's competitors, customers, suppliers, strategic partners, and regulators (Scott and Lane 2000), and in RL contexts specifically, the four task environment actors: customers, suppliers, competitors, and government agencies have been described as being particularly salient (Carter and Ellram 1998). Such entities can provide functional information of specific interest to the organization as well as highlight the dependence of firms on their task environment for resources (Scott 1992).

Teece *et al.* (1997) defined dynamic capabilities as a firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments. Dynamic capabilities can be understood as the routines that guide and facilitate the development of a firm's capability by altering its underlying resource base (Eisenhardt and Martin 2000). Success requires the creation of new products and processes and the implementation of new organizational forms and business models. Firms require dynamic



capabilities to adapt to changing environments and maintain competitiveness through enhancing, combining, protecting, and reconfiguring their intangible and tangible assets (Teece *et al.* 2007). Firms have to be able to sense environmental change, capture market trends, understand customer needs, and further integrate, reconfigure, renew, and recreate their resources and capabilities in response to changes in the external environment (Hou 2008). Therefore, the task environment may have a direct impact on changes in resource commitment. Despite the existence of this potentially revealing connection, no research has explored the relationship between the task environment and resource commitment in RL. This study asserted that the task environment has a positive effect on resource commitment.

*H1. The influence of the task environment has a positive effect on resource commitment in reverse logistics.*

### **3.3 Resource commitment impacts on reverse logistics performance**

Firm resources include all assets, capabilities, organizational processes, firm attributes, etc. controlled by a firm that enable it to conceive of and implement strategies that improve its efficiency and effectiveness (Daft 1983, Hall 1992). Firms have to allocate their limited resources between the two fundamental processes of creating value and appropriating value that include extracting profits in the marketplace (Mizik and Jacobson 2003). Sweeny and Szejczewski (1996) showed that as managers commit more financial, human, and physical

resources to a program or process, superior financial performance may be realized. High resource commitment has positive impacts on perceived economic performance, employee retention rates, and overall customer satisfaction (Isobe *et al.* 2000).

Regarding RL specifically, the commitment of RL resources has positive impacts on the achievement of RL program goals, including environmental regulatory compliance, reduced inventory investment, improved profitability, and increased economic performance (Daugherty *et al.* 2001, Daugherty *et al.* 2002). A more recent study suggests that resource commitment makes RL programs more efficient and more effective (Richey *et al.* 2005). However, the resources must be utilised in such a manner as to develop innovative approaches to handling returns. A well-managed RL program can be a huge cost-driving area for greater profitability and customer satisfaction, as well as a boost to the environment (Jayaraman and Luo 2007).

*H2. Resource commitment is positively associated with economic performance in reverse logistics.*

Chen *et al.* (2006) defined green innovation as a firm's capabilities in developing green products or processes, including innovations in technologies that are involved in energy saving, pollution prevention, waste recycling, green designs, and corporate environmental management. Such innovations are capable of boosting the performance of environmental management in order to satisfy regulatory requirements and environmental protection

conventions. RL can be viewed as a manifestation of green innovation.

Firms investing heavily in environmental management and green innovation can not only improve overall productivity, minimize production waste, increase corporate green image, develop new markets, and further enhance profitability and competitiveness, but can also prevent environmentalist protests and penalties. Such investments in environmental management will become increasingly important under the rising trends of popular environmentalism, consumer conscientiousness, and a climate of strict international environmental protection regulations ( Hart 1995, Shrivastava 1995, Chen *et al.* 2006, Chen 2008).

*H3. Resource commitment is positively associated with environmental performance in reverse logistics.*

### **3.4 The effect of environmental performance on economic performance in reverse logistics**

With respect to the relationship between environmental and economic performance, it is often argued that an intrinsic conflict exists between the competitiveness of firms and their environmental performance ( Wagner *et al.* 2002, Filbeck and Gorman 2004, Yuriko *et al.* 2007). This negative perspective argues that environmental investment merely introduces costs, including those of opportunity, which end up inevitably reducing profit ( Walley and Whitehead 1994, Greer and Bruno 1996,). Several studies further indicate no significant

relationship between environmental and economic performance ( Wagner *et al.* 2002, Telle 2006, Yuriko *et al.* 2007).

In contrast, a more positive perspective argues that as firms increase their investments in environmental technology, competitive advantages and increased profits can be realized ( Porter and van der Linde 1995, Hart 1997). A firm's environmental performance is not only a potential source of competitive advantage as it can lead to more efficient processes, improvements in productivity, lower costs of compliance, and the opening up of new market opportunities, but can also have a significant positive relationship with economic performance ( Russo and Fouts 1997, Chen *et al.* 2006, Galdeano-Gómez 2008).

RL focuses on both environmental and economic goals. Both views promote RL practices (González-Torre *et al.* 2004; Jämsä 2009). Although many previous studies have explored the relationship between environmental and economic performance, no research has explored this crucial relationship in a RL context (Klassen and McLaughlin 1996, Wagner and Schaltegger, 2001; González-Benito and González Benito 2005, Rao and Holt 2005). Therefore, this study aimed at addressing this gap and asserted that RL environmental performance has a positive effect on RL economic performance.

*H4. The environmental performance of reverse logistics is positively associated with the economic performance of reverse logistics.*

The conceptual model representing the hypothesized relationships is depicted in Figure 1.

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Place Figure 1 about here

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## **4 Methodology**

### **4.1 Sampling and data collection**

The primary survey variables employed in the questionnaire instrument were sourced from the literature (Das and Tang 2000, Autry *et al.* 2001). However, most items required modification to be applicable to our research context. Through the conducting of in-depth interviews, an additional source of input for the survey design were the insights of five business managers involved in resource commitment. Before the primary study was implemented, the instrument was pretested with 35 respondents (10 individuals from the academic, consulting, and business sectors, and a further 25 representatives of the 3C manufacturing and retail industries). The readability and understandability of the instrument was subsequently improved based on the comments and suggestions from these respondents.

The surveys were mailed to the 750 member companies of the 3C Retailer Association of Taiwan and 450 3C manufacturers. A total of 349 usable responses were received. This was comprised of 209 early respondents (59.9% response rate) and 140 late respondents (40.1% response rate). Thirty surveys were returned as undeliverable. The overall effective response rate was thus 29.8% (349/1170). The analysis of non-response bias was conducted

by comparing early and late respondents (Armstrong and Overton 1977). No significant differences were found ( $p > 0.05$ ) between the two groups. As such, there was no need to further consider non-response bias.

#### **4.2 Responding Company Profile**

The 349 respondent companies represented a diverse profile of different size firms. Over 52% of the respondents belonged to small category (number of employee below 200), 28.7% belonged to medium category (number of employee between 201 and 500) and 18.6% belonged to large (number of employee over 501) category of firms. Of the companies who responded, approximately 71% gained ISO 14001 accreditation and about 29% did not gain ISO 14001 accreditation. Annual company sales ranged from US \$2.5 to \$25.23 million dollars with mean sales of US \$9.36 million dollars (exchange rate as of December 1, 2009). Since the northern part of the country is relatively more industrialised compared to southern and eastern part, it was not surprising that the majority of the responding firms were located in the northern part of Taiwan. The respondents were senior level managers with an average working experience of 11.12 years of which an average of 5.41 years of experience in the reverse logistics operations.

#### **4.3 Measurement development**

Four constructs were of central interest: the task environment, resource commitment, environmental performance, and economic performance. Although existing scales were

employed in the research, modifications were necessary to adapt the items to a logistics context. Descriptive statistics and Cronbach alpha coefficients for each scale item and constructs are described in details in Table 2.

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Place Table 2 about here

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#### **4.3.1 The task environment**

Based on the task environment definitions of Castrogiovanni (1991), Scott (1992), Carter and Ellram (1998), and Scott and Lane (2000), the task environment in the context of the present study was defined as the collective set of organizations or groups that impact on goal setting and attainment, and which have the capacity to affect decisions, actions, and outcomes.

Respondents were asked to consider separately government, customers, suppliers, and competitors regarding the level of influence exerted on RL and the handling of returned merchandise within their firms. Firstly, it was asked whether the task environment group had the influence to enforce its expectations, and second, whether or not the expectations of the group were considered legitimate by management. A 7-point Likert scale was employed where 1 = “strongly disagree” and 7 = “strongly agree”. The mean values for the task

environment related items were: 5.49 Government influence, 5.63 Customer influence, 5.67 Supplier influence and 5.45 Competitors influence (see Table 2).

#### **4.3.2 Resource commitment**

The resource-based view of the firm argues that efficient and effective resource deployment is the key to the development of sustainable competitive advantage (Barney, 1986). In RL research specifically, three types of resource commitment have been identified, that is, technological, managerial, and financial (Daugherty *et al.* 2005, Richey *et al.* 2005). Technological resources are those specific forms of technology used in or adapted to the management of RL activities. Managerial resources refer to the level of managerial commitment to the implementation of effective RL activities. Financial resources measure actual funds allocated to RL activities. Respondents were asked to indicate their levels of resource commitment in implementing RL and the handling of returned merchandise within their firms as related to these three components: technological, managerial, and financial. Items were measured on a 7-point Likert scale where 1 = “little” and 7 = “substantial”. The respondents’ highest commitment to reverse logistics is in the area of Technological resource commitment with a mean score of 5.54. Managerial and Financial resource commitments were lower with mean scores of 5.23 and 5.05 respectively.

#### **4.3.3 Environmental performance**

The next construct in Table 2 is Environment performance. Definitions of environmental



performance from Azzone and Noci (1996), Ilinitich, *et al.* (1998), and Jasch (2000) were adopted in defining environmental performance as environmental regulatory compliance, the limiting of environmental impact beyond compliance (Judge and Douglas, 1998), and corporate green image enhancement (Jayaraman and Luo 2007, Chen 2008). Respondents indicated how successful they had been in reaching these environmental RL objectives. Again, a 7-point scale was used (1 = “not at all effective” and 7 = “extremely effective”).

Enhancement of corporate green image related to reverse logistics received the highest mean score (5.60) followed closely by Compliance with environmental regulations (5.53) and Limiting environmental impact beyond compliance (5.44).

#### **4.3.4 Economic performance**

The fourth construct in Table 2 is Economic performance. The central goal of logistics and supply chain managers is to maximize economic performance through a continual process of striving for the correct fit between the level and cost of service. Based on such an understanding, a scale of economic performance was developed for this study (Daugherty *et al.* 2001). The definitions of Melbin (1995), Rogers and Tibben-Lembke (2001), and Biederman (2006) were considered in defining economic performance inclusive of the operational, financial, and customer satisfaction aspects of RL. The eventual scale items addressed not only performance outcomes but also cost control. These items are: recovery of

assets, cost containment, improved profitability, improved labor productivity, improved customer service, and reduced inventory investment. Again, a 7-point scale was used (1= “not at all effective” and 7 = “extremely effective”). The respondents were asked how effective their companies have been in achieving their economic objectives. Recovery of assets and Cost containment related to reverse logistics received the highest mean score (5.23). The mean scores for the other items were: 4.97 improved customer service, 4.96 Improved profitability, 4.90 Reduction in inventory investment and 4.88 for Improved labour productivity.

## **5 Analysis and results**

### **5.1 The measurement model**

LISREL is an analysis procedure that combines path analysis with factor and multiple regression analyses (Jöreskog and Sörbom, 2001), which this study adopted (version 8.53) to analyze the structural equation model. Measurement model analysis was used to refine the measurement scale. In our case, four latent variables were constructed from 16 items. We tested the measurement model by considering individual item reliability, internal consistency (Table 3) and discriminant validity (Tables 4).

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Place Table 3 about here

Place Table 4 about here

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In order to assess construct reliability, each of the task environment, resource commitment, and RL performance constructs were checked for their Cronbach's alpha coefficient values. The alpha for the task environment was 0.84 whereas the alpha coefficient for resource commitment was 0.75. The two performance constructs also exhibited high alphas with environmental performance (0.84) and economic performance (0.92). Table 2 details results of reliability tests on the four major constructs. All four scales were considered reliable since their alpha's were greater than the commonly accepted 0.70 threshold (Nunnally and Bernstein 1994).

The composite reliability and average variance extracted (AVE) were utilized to examine the internal consistency of each latent construct (Fornell and Larcker, 1981). The composite reliability values for each construct exceeded the threshold value of 0.70 (Nunnally 1978). AVE values ranged between 0.55 and 0.67 exceeded the threshold value of 0.50 (Fornell and Larcker 1981). As displayed in Table 3, the composite reliability and AVE values were satisfactory for all constructs.

There are a number of ways to assess discriminant validity between constructs. However, it appears that the Fornell and Larcker (1981) technique represents the best method to apply (Farrell, 2010). According to this technique, to test the discriminant validity it is required to

compare the AVEs for any two constructs with the square of the correlation estimate between those two constructs. AVEs for both the constructs should be greater than the squared correlation estimate (Hair et al, 2006). Table 4 shows the correlation matrix for the constructs, with the diagonal elements being replaced by the constructs' AVE. Adequate discriminant validity was demonstrated since these diagonal elements were greater than the square of the off-diagonal elements in the corresponding rows and columns.

#### **4.2 The structural model**

The results of the structural model are presented in Figure 2.

##### **Goodness of fit:**

The  $\chi^2$  statistic was significant (415.70,  $df = 100$ ,  $p = 0.000$ ), which suggested a degree of model misspecification. It is well recognized however that this statistic is sensitive to sample size (Arbuckle and Wothke, 1999). Thus, other structural diagnostics capable of determining overall model fit while not being sensitive to sample size were additionally considered (Bentler and Bonnett 1980). The root mean squared error of approximation (RMSEA) is such a statistic (Steiger, 1990). RMSEA is an estimate of the discrepancy between the original and reproduced covariance matrices in the population. A RMSEA of 0.05 represents a close fit and RMSEAs of less than 0.08 represent reasonable fits (Cudeck and Browne 1983). The RMSEA of 0.07 of the present model was thus within that acceptable range. Additional goodness-of-fit statistics including the incremental fit index (IFI) (Bollen, 1989) of 0.90, the comparative fit index (CFI) (Bentler 1990) of 0.90 and Tucker-Lewis index (TLI or NNFI) (Hu and Bentler 1999) of 0.949 all met the 0.90 common threshold, implying an acceptable fit. When taken together, the above mentioned structural diagnostics indicated a very good relative fit of the proposed theoretical model to the underlying data.

### **Hypotheses testing:**

As Figure 2 and Table 5 demonstrate, significant support was found for the hypothesized relationships. Hypothesis 1 proposed that the task environment would positively effect on resource commitment in reverse logistics. This hypothesis was strongly supported ( $\gamma_{11} = 0.64$ ,  $p < 0.01$ ). This means that the commitment to deploy resources for reverse logistics depends on the external environment.

Support was also found for the hypotheses predicting both economic (H1:  $\beta_{31} = 0.22$ ;  $p < 0.05$ ) and environmental performance (H3:  $\beta_{21} = 0.77$ ;  $p < 0.01$ ). This means that, for firms, commitment of resources has positive impact on a firm's performance. However, the relationship between deployment of resources and environmental performance is stronger than the relationship between deployment of resources and economic performance. Finally, Hypothesis 4, which predicted that the environmental performance of reverse logistics is positively associated with the economic performance of reverse logistics was also strongly supported ( $\beta_{32} = 0.52$ ;  $p < 0.01$ ).

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Place Figure 2 about here

Place Table 5 about here

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## **5 Discussion and Conclusions**

This study has made key academic contributions, and it is hoped that the empirical results can be beneficial to researchers, managers, and governments. Previous research has placed much of the focus on exploring the task environment, resource commitment, and the relationship between environmental and economic performance. However, there has been no such work exploring how the task environment influences resource commitment as well as the relationship between environmental and economic performance specifically in RL contexts. The present work attempted to fill these research gaps, asserting that the task environment has a positive effect on resource commitment, and further that RL environmental performance has a positive effect on RL economic performance.

As the empirical results demonstrated, the task environment is positively associated with resource commitment. This result indicates that the deployment of a firm's RL resources depends on external environmental change. Clearly, firms cannot seclude themselves from the external environment, especially the task environment. Under a climate of rapid changes in technology, industry, and markets, firms have to learn to identify opportunities, detect threats, and seize trends based on their task environment. To respond to these rapid changes in the task environment, firms must be able to reallocate their limited resource when and where needed to critical positions.

This study divided RL performance into environmental and economic performance to

explore whether resource commitment has a positive influence on those aspects. The empirical results showed that resource commitment was positively associated with environmental performance. Businesses can achieve compliance with environmental regulations, a reduction of environmental impact beyond compliance, the meeting of customer expectations, and the enhancement of corporate green image. During times of increasingly stringent international environmental regulations and governmental legislation, such findings are of particular relevance, as environmental innovation and investment (including RL) have become imperative for firms. The rise of consumer environmentalism has additionally influenced the implementation of RL.

The empirical results also indicated that resource commitment is positively associated with economic performance. Based on a financial and technological perspective, as businesses invest considerable resources into RL activities, they can reduce inventory investments, increase recovery of assets, enhance cost containment, and improve business profitability. From a managerial perspective, as managers make the necessary efforts to implement RL programs, they can not only enhance labor productivity but also improve customer service.

This study additionally tested the relationship between the environmental and economic performance of RL. In the past, these aspects were viewed as being inherently in conflict. In stark contrast, this study demonstrated that environmental performance is positively

associated with economic performance in RL. For most businesses and managers, it is not easy being green, as green efforts are often seen in a cost only light. Being green or adopting environmental management inevitably increases operating costs. Previously, most firms focused on end-of-pipe technologies as the major approach towards pollution control and environmental performance improvements, and environmental investments were often seen as superfluous costs. In recent times however, more and more firms are spending considerable sums adapting to green technologies and adopting proactive environment-friendly practices.

Yu *et al.* (2009) discussed the benefits of being green, focusing on the “spillover” or intangible benefits. The potential improvements to a firm's image and reputation resulting from the adoption of green innovations may allow firms to attract more talented workforces and strengthen the loyalty of the increasingly green-conscious customer, potentially increasing the value of a firm’s products (Yu *et al.* 2009). Active promotion of environmental innovation initiatives may thus be as critical as the efforts themselves (Yu *et al.* 2009). In the short term, environmental performance may be a source of profitability; in the long term, it can become a competitive advantage.

## **5.1 Limitations**

First, this study exclusively considered whether or not firms commit their resources to RL activities. Second, this study focused specifically on manufacturers and retailers in the



Taiwanese 3C industry, thus potentially limiting the generalizability of the conclusions.

Further studies may wish to focus on other industries or countries, allowing for future comparability.

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