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Impact of circular economy network building: resilience strategy to climate action

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Abstract

Purpose – This study aims to examine how external and internal conditions drive the impact of circular economy mechanism by decomposing into three policy networks in terms of reduce, reuse and recycle, to better understand the contingency model of climate change and effect of firm size on subsequent performance.

Design/methodology/approach – Drawing on circular economy network and resource-based view (RBV)-network-resilience strategy framework, a pooled longitudinal cross-sectional data model is developed using a sample of 4,050 Taiwanese manufacturing multinational corporations (MNCs) making foreign direct investment between 2013 and 2018. Structural equation modeling analysis is used to comprehensively examine and investigate each circular economy policy network in the context of climate change and firm size. Post hoc multigroup analysis (MGA) is also conducted.

Findings – MGA shows that the reduce policy network is positively and negatively related to manufacturing know-how and production size, respectively. The impact of reuse policy network can enhance the competence of large firms. The recycle policy network is more prominent in terms of competence enhancement of climate change.

Practical implications – MNCs are seeking to build circular economy policy networks to a greater extent, given climate change pressure and guidelines.

Originality/value – This study adds to the circular economy and RBV-network-related literature on climate change and interactions to enhance performance, echoing the recent call on the sustainability of the circular economy of MNCs.

Keywords Circular economy, Climate change, Reduce policy, Reuse policy, Recycle policy, Competence enhancement

Paper type Research paper

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1. Introduction

This study examines regional and global circular economy network-building for the purposes of developing resilience [1] and foreign direct investment (FDI) strategies of multinational corporations (MNCs). This approach can help face competition (reduce) and boost policy and cooperation (reuse). The relevant policy implications have received substantial scholarly attention (Carro *et al.*, 2018; Huang *et al.*, 2019; Ye *et al.*, 2022). Against the backdrop of changing local conditions (external climate change and internal institutional capability) in host countries, the adaptation and recycling capabilities of MNCs are becoming increasingly significant from a global perspective (Chaudhuri *et al.*, 2022). Numerous relevant studies have investigated firms' FDI network from the perspective of alliance/network structures. However, the most recent studies on circular economy have focused on the effects of reduce, reuse and recycle (3R) [2]. This capability differentiation is being studied as sustainable advantage addressed using a resource-based view (RBV) (as shown in Table 1).

A few studies have examined how interorganizational networks affect firm strategy and performance (Burt, 2005; Marques and Manzanares, 2022). Other studies have examined the differences in the positioning of MNCs in network-building to bridge broker information (access to the resource and information flows stemming from such networks) (Burt and Soda, 2021). This study investigates the important mechanism of circular economy as a foundation of the resilience strategy, which is becoming more complex and global. This is because the network "[...] [...] can simultaneously be a recipient and contributor of knowledge, products, and services [...][...]" (Asmussen *et al.*, 2009, p. 42). This study defines the circular economy mechanism as policy-building that allows firms to operate in a network to access extended resources. These firms can also enhance their competitiveness in terms of reduce, reuse and recycle policies in comparison with firms that operate independently (Hitt *et al.*, 2002). Asmussen *et al.* (2009) have decomposed network-building into three dimensions, namely, technology, marketing and supply chain capabilities, to help MNCs overcome the liability of foreignness (LOF) and their weak position in a network (Liu *et al.*, 2020). However, the literature has relatively disregarded the impact of circular economy mechanism on network-building in FDI network coopetition as a gap, which is shown in Figure 1. Birkinshaw and Hood (2000, p. 151) have proposed the importance of network-building as follows: "networked firms as well as the specific characteristics of the network in question impact the likely role". Currently, the knowledge of the network policies of such circular economy networks and their impact is scant. Therefore, we seek to elucidate three circular economy network policies of network-building that can enhance resilience strategy motivation. Accordingly, we aim to fill the research gaps in previous studies. The key research questions of this study are as follows:

RQ1. How to build a circular economy network?

RQ2. How does an FDI-related circular economy influence local competence enhancement?

RQ3. Do the impacts of climate change and firm size vary across different circular economy scenarios?

This study contributes to the literature on circular economy and network-building, such as Burt and Soda's (2021). We propose climate change-oriented managerial practices and organizational resilience strategies as sustainability practices in two major ways. First, by integrating the RBV and network perspectives, we add explanatory power to the analysis of circular economy network-building (Kristoffersen *et al.*, 2021). Consequently, this study

Author (year)	Theory/ perspective	Concept of circular economy	Independent variable	Moderator	Dependent variable	Finding
Chaudhuri *et al.* (2022)	Resource-based view and Ambidexterity	*Recycle*	Resources for Circular economy/ Capabilities for Circular economy	Digital resources/ Capabilities for digital technology implementation	Value to customers	Our findings reveal that SMEs focusing on circular economy initiatives demonstrate exploitation and adaptive capabilities in utilising their CE resources followed by exploration and adaptive capabilities while implementing digital technologies
Antonioli *et al.* (2022)	Natural-resource based view	*Reuse and Reduce*	CE-related innovations	Nature of CE innovations/ Type of CE innovation	Firms' economic performance	The evidence shows that in the short run, it is difficult to obtain economic gains from circular economy related innovations when taken in isolation, especially for Small and medium-sized enterprises (SMEs), who may also experience negative returns
Böhmecke-Schwafert *et al.* (2022)	NA	*Recycle, Reuse and Reduce*	Technical challenges of blockchain/ CE drivers and barries	Blockchain CE innovation	Circular economy/Blockchain CE innovation	While our findings indicate that blockchain CE innovation strengthens technical drivers, there is considerable uncertainty about the exact fit between the technological requirements for CE applications and blockchain
Saura *et al.* (2022)	N.A	*Reduce*	Users' satisfaction/Perceived ease of using digital reservation systems/ Perceived usefulness/Attitude toward using/Behavioral intention to use	NA	Entrepreneurs' trust/Users' satisfaction/Entrepreneur Confidence/Perceived usefulness/Attitude toward using/Behavioral intention to use/Actual system use	The results showed a positive relationship between usability and perceived ease of use and user satisfaction and trust in using digital reservation systems to boost circular entrepreneurship in hospitality. Adopting a digital reservation system

(*continued*)

Table 1.
Circular economy literatures

Author (year)	Theory/ perspective	Concept of circular economy	Independent variable	Moderator	Dependent variable	Finding
						can increase the efficiency of entrepreneur resources, as well as lead to creation of sustainable knowledge, augment the use of new sources of user information, improve prediction of services and demand and, consequently, boost sustainability and circular economy
Kristoffersen *et al.* (2021)	Resource-based view and Resource orchestra	*Reduce*	Business analytics resources	NA	Competitive performance/CE implementation/Resource Orchestration capability/ Business analytics capability/Resource orchestration	Based on the results, we develop a deeper understanding of the importance of taking a holistic approach to business analytics when leveraging data and analytics towards a more efficient and effective digital-enabled circular economy, the smart circular economy
Patwa *et al.* (2021)	NA	*Recycle, Reuse and Reduce*	3R/Extended life cycle of products/ Ecological balance and protect/Big data and Information flow/ Government policies/Consumer behavior	NA	The adoption of circular economy/3R/Extended life cycle of products/The adoption of ecological balance and protection activities	The study highlights the strong influence of factors such as consumer behaviour on the acceptance of remanufactured products and using products as a service to encourage the adoption of CE practices in emerging economies
Le *et al.* (2022)	Resource-based view and Stakeholder theory	*Recycle, Reuse and Reduce*	Circular economy practices/Circular economy entrepreneurship	Circular economy entrepreneurship	sustainable supply chain management/ sustainable performance	The main finding of this study is twofold. First, it sheds light on how CEE associates in strengthening the influence of CEP on sustainable SCM. It reveals how sustainable SCM mediates the link between CEP and SP

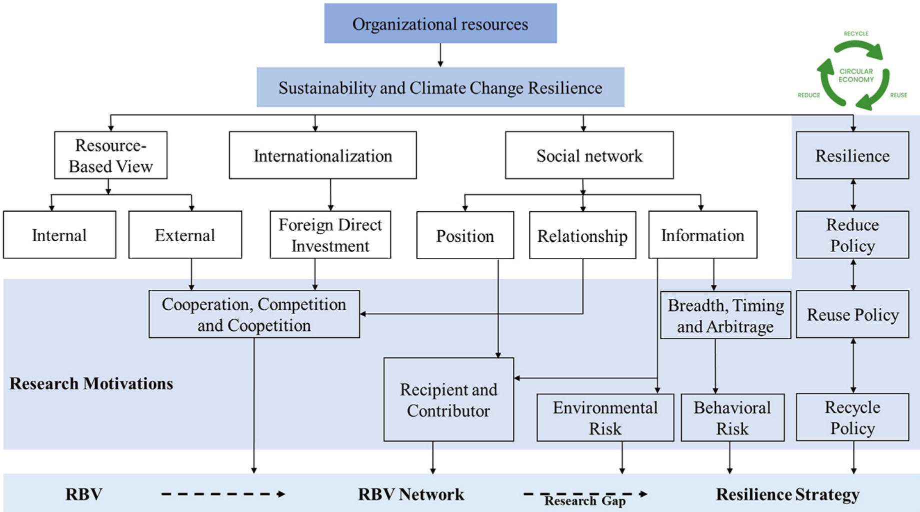
(*continued*)

Table 1.

Table 1.

Author (year)	Theory/ perspective	Concept of circular economy	Independent variable	Moderator	Dependent variable	Finding
Ki *et al.* (2020)	Moral Responsibility Theory	*Recycle and Reuse*	Perceived corporate moral responsibility on consumers' attitude/Perceived consumers' moral responsibility for their attitude/ Consumers' perceived corporate hypocrisy on attitude/Interplay of corporate and consumer moral responsibilities for attitude	NA	Consumers' attitude on behavioral intention/ Consumers intend to take part in the companies' CF offerings	The results confirmed the positive main effects of CorpMR and ConsMR on consumers' attitudes, and the negative interaction effect on their attitudes. The negative effect of CorpHY on consumers' attitudes and the positive effect of those attitudes on engagement intention were confirmed through the ordered probit model
Marques and Manzanares (2022)	Social network theory	*Recycle, Reuse and Reduce*	Narrowing strategy/Slowing strategy/Closing strategy/Blended strategies	NA	Betweenness Centrality/ Eigenvector centrality/ Network density	Four theoretical propositions enlighten how betweenness centrality, eigenvector centrality and network density can explain the shift from linear to circular supply networks across the three CE strategies of narrowing, slowing and closing

Note: NA: Not Available
Source: Authors



Source: Adapted from Burt and Soda (2021) and Filho *et al.* (2023)

Figure 1.
RBV-network-resilience strategy development framework

conducts a comprehensively examines circular economy network-building among offshore subsidiaries of Taiwan-based MNCs to improve the understanding of the three circular economy network policies and local competence enhancement (replaced by their relationships with competence enhancement of offshore subsidiaries in the host country). Second, as shown in Figure 1, this study fills the resilience strategy gap by incorporating the literature on FDI and climate change action with a post hoc multigroup analysis (MGA) (Filho *et al.*, 2023; Noh and Park, 2023; Wu and Deng, 2020). The empirical results provide a holistic view of the path influence of the reduce, reuse and recycle policy networks on subsidiaries' competence enhancement related to production size, manufacturing know-how and production quality.

This study focuses on international network-building in the context of three circular economy policies. It also presents the empirical results of a national survey that includes data from 4,050 FDI subsidiaries of Taiwan-based MNCs. The host countries included in the survey are located in both high climate change pressure (e.g. Mexico, other Central and South American countries, China, Malaysia, Thailand, Indonesia, Philippines, Vietnam, India and African countries) and low climate changing pressure circumstances (e.g. USA, Canada, UK, European countries, South Korea, Japan, Singapore and Australia). In this study, the path analysis of climate change pressure between cross-border network-building and competence enhancement reveals that each circular economy policy of network-building drives subsidiaries' competence enhancement. The study findings on circular economy network-building postulate different resilience levels for offshore subsidiaries' competence enhancement in the host countries facing low and high climate change pressure.

The remainder of this study is organized as follows:

- Section 2 reviews the development of circular economy framework and hypotheses;
- Section 3 describes the data and research design of structural equation modeling (SEM) and MGA;

- Section 4 reports the full model and post-hoc findings and discusses the major empirical results; and
- Section 5 concludes the study with four scenarios related to climate change pressure and firm size.

2. Literature review and conceptual development

2.1 Resource-based view-network perspective and the importance of circular economy buildings

The RBV framework is widely applicable to building and cross-using network capabilities (Arroteia and Hafeez, 2021; Burt and Soda, 2021; Gulati, 1999; Paul *et al.*, 2021). This includes status, position and ties (Eng *et al.*, 2020; Kim and Kim, 2018; Macaulay *et al.*, 2018; Sun and Lee, 2013; Yang *et al.*, 2010). Previous studies on international business have focused on the policy, suggesting that richer and broader access to information and resources through various network capabilities is crucial for the success of MNCs' international expansion (Musteen *et al.*, 2010). The concept of network-building refers to a policy of spanning multiple resource pools (Iurkov and Benito, 2018). According to the RBV-network perspective, offshore subsidiaries with broader brokerage networks are more likely to gain access to different market resources in the host country (Glinska-Newes *et al.*, 2018). Therefore, they can contribute to reducing operational wastage and environmental costs (Pfeffer and Salanick, 1978).

The tendency to integrate the RBV to RBV-network perspective and circular economy in the resilience strategy reflects the developments in the RBV-network-resilience strategy perspective. The related phases are shown in Figure 1. This circular economy process diagram depicts the benefits of reusing and recycling internal resources and external resource endowments of network partners (Barney, 1991, 2001; Burt and Soda, 2021; Penrose, 1959; Wernerfelt, 1984). Moreover, Conner (1991) has indicated that simultaneous competitive (reduce) and cooperative (reuse) interactions among a subsidiary, its business partners and the external economic environment (circular triangle) can contribute to the subsidiary's performance. Supporting this notion, this study assumes that an offshore subsidiary owns and controls some circular economic resources in the host country (Hsu and Chen, 2017).

2.2 Circular economy of reduce policy network and local competence enhancement

Circular economy reduce policy network can allow subsidiaries to access critical knowledge and resources, acquire high-value-adding products and conduct value-creating endeavors such as appropriation of franchising licenses (Chaudhuri *et al.*, 2022; Le *et al.*, 2022). Offshore subsidiaries that build strong network capabilities through the circular economy of reduce policy can develop a competitive edge that cannot be easily imitated by competitors (Burt and Soda, 2021, p. 8). This study examines the circular economy of reduce policy as a secure integration of resources based on knowledge familiarity and strongly connected skills of efficiency. Böhmecke-Schwafert *et al.* (2022) and Chaudhuri *et al.* (2022) have found that subsidiaries' performance is influenced by the technological prominence of their network partners. Rothaermel (2001) has confirmed that incumbents in the biopharmaceutical industry perform better after acquiring complementary resources to reduce the waste from technology providers. Circular economy of reduce policy network tends to bridge the differences among various types of business partners (such as supply chains, distributors and customers) (Glinska-Newes *et al.*, 2018; Ki *et al.*, 2020; Luo, 2003). By including more local partners in their reduce policy network, offshore subsidiaries can improve the breadth and diversity of their network-related technology resources, decrease environmental waste and risk and upgrade their know-how using valuable information flow (Malnight, 1996; Saura *et al.*, 2022). This allows offshore subsidiaries to acquire rich technological information, up-to-date knowledge and other efficiency resources to attain technological superiority (Sánchez *et al.*, 2019). This might also allow them to reduce the wasted technological capabilities and increase production growth in the local market (Lee *et al.*, 2001). Therefore, such network bridges can benefit MNCs' foreign operations in terms of competent performance (Hsu and Chen, 2017). More specifically, this circular economy of policy network can provide the required resources for generating superior subsidiary performance (Lu, 2001; Musteen *et al.*, 2010). Therefore, we propose a direct effect of international circular economy of reduce policy network on competence enhancement, as represented by the following hypotheses:

H1a. An offshore subsidiary's circular economy of reduce policy network is positively related to its local production size.

H1b. An offshore subsidiary's circular economy of reduce policy network is positively related to its local manufacturing know-how.

H1c. An offshore subsidiary's circular economy of reduce policy network is positively related to its local production quality.

2.3 Circular economy of reuse policy network and local competence enhancement

In this study, reuse policy network refers to a loose integration of communicating and controlling resource orchestration in reusing or remaking. Patwa *et al.* (2021) have advocated that reusing and remaking capabilities of network partners increase a subsidiary's sales growth. Reuse policy network is associated with the ability of an offshore subsidiary to regulate resource flows and increase its bargaining power with network participants by developing trust, common norms and behavioral patterns (Coleman, 1988; Iurkov and Benito, 2018). Reuse policy network denotes the extent of linkage between an offshore subsidiary and its local and/or international strategic alliance partners in a specific network cluster. A very strong linkage implies superior network-building (Gnyawali and Madhavan, 2001).

Reuse policy network also depends on the volume of information and communication exchanged either more frequently or more closely (Ofoegbu and New, 2021; Saura *et al.*, 2022). First, according to the RBV-network perspective, greater reuse policy network can allow access to better bargaining power in value creation and marketing-related resources, such as early access to media and control over communication and diffusion channels in the host country (Burt, 2005). Second, subsidiaries may cooperate with network partners to acquire a better price for frequently used resources and legal rights to reuse and remake specific products. By establishing strong linkages in a cooperative reuse policy network and enabling a certain extent of resource exchange, offshore subsidiaries can gain a critical position and achieve competitiveness in the host country (Gulati *et al.*, 2000).

Third, offshore subsidiaries establish strong relationships with their local and/or international strategic alliance partners (Glinska-Newes *et al.*, 2018). Therefore, they can reduce LOF by acquiring additional reused resource support from their network partners (Huang *et al.*, 2019). Reuse policy network helps subsidiaries gain valuable advertising and communicating experience from their partners, which consequently enables them to leverage their core competencies and capitalize on growth opportunities in the host country (Zhou *et al.*, 2007). Therefore, to thrive in global market, an offshore subsidiary must develop a network with robust collaboration and trust. Accordingly, they can obtain sustainable reused resources and access exclusive information, valuable markets or imperfect imitable distributing channels to augment the firm's competitive edge, offset its LOFs and enhance performance (Gulati *et al.*, 2000). Therefore, we hypothesize that reuse policy network positively impacts competence enhancement:

H2a. An offshore subsidiary's circular economy of reuse policy network is positively related to its local production size.

H2b. An offshore subsidiary's circular economy of reuse policy network is positively related to its local manufacturing know-how.

H2c. An offshore subsidiary's circular economy of reuse policy network is positively related to its local production quality.

2.4 Circular economy of recycle policy network and local competence enhancement

The underlying logic of the third dimension of the circular economy of recycle policy network is based on managers combining resources by bridging various suppliers (e.g. local and foreign suppliers) to gain a recycling competitive advantage. These efforts consequently shape MNCs' international expansion strategies for better capability enhancement (Cross *et al.*, 2003; Lee *et al.*, 2001; Yli-Renko *et al.*, 2002). The various network-bridging activities in the recycling supply chain can allow network members to access valuable information and improve their overall competitive position. This can encourage offshore subsidiaries to further expand the scope of their recycle policy network range in the host country. Thus, an enlarged recycling supply chain network reinforces the network breadth, timing and arbitrage and improves their performance (Burt and Soda, 2021).

Previous studies have shown that local conditions in subnational regions, location-bound advantages and local density can influence supply chain operations (Hsu and Chen, 2017; Ma *et al.*, 2013; Miller and Eden, 2006). Some scholars have indicated that local market rules must be followed to maintain good bridges with local recycling supply chain partners. This can be achieved by exchanging useful resources (Morgan *et al.*, 2009; Zhou *et al.*, 2012). However, in the case of FDI, foreign investors are less protected, and it is essential for them to engage with local networks to gain access to the required resources. As previously mentioned, to reduce the environmental impact of MNCs in the host country, a subsidiary establishes its own local network and aims at cultivating strong cooperative relationships in the supply chain. Long-term orientation and strong linkage of recycle policy network can yield sustainable benefits for all involved parties, enabling them to pursue common goals and cooperation based on trust (Glinska-Newes *et al.*, 2018). An offshore subsidiary's recycling supply chain network-building is influenced by trust, especially in the early stages of a subsidiary's market entry (Puffer *et al.*, 2010). According to the network theory, organizations attempt to build a network structure with important external partners. Through interactions with these external network partners, the subsidiaries of MNCs are able to acquire different market resources in the host country (Johanson and Mattsson, 2015). Accordingly, they can reduce environmental waste and costs (Pfeffer and Salanick, 1978). Such network-building bridges subsidiaries using recycle policy on aspects such as parts, materials and half-done products, allowing for additional value-creation (Le *et al.*, 2022). Hence, we propose our third set of hypotheses as follows:

H3a. An offshore subsidiary's circular economy of recycle policy network is positively related to its local production size.

H3b. An offshore subsidiary's circular economy of recycle policy network is positively related to its local manufacturing know-how.

H3c. An offshore subsidiary's circular economy of recycle policy network is positively related to its local production quality.

3. Material and methods

3.1 Data collection procedure and sample size

In recent years, firms based in host countries facing climate change-related circumstance have become increasingly active in FDI worldwide. For example, in the case of Taiwanese firms, more than 80% of foreign investors have chosen to target high climate change pressure-facing countries as host countries (UNCTAD, 2019; CCPI, 2023). Target host countries typically include Mexico, Vietnam, Malaysia and the Philippines, among others. These countries are characterized by greater extent of climate change adversity and relatively crowded labor factory structures (CCPI, 2023; Luo, 2003; Wasowska and Postula, 2018).

The sample data were extracted from the Survey of FDI (SFDI), a database maintained by the Statistics Bureau, Ministry of Economic Affairs, Taiwan, ROC, over two decades (Ministry of Economic Affairs Taiwan, 2018). This research context was chosen for several reasons. First, as a newly industrialized economy, Taiwan has been very active in outward FDI since the late 1980s (Chiao and Ying, 2013). Over the years, Taiwanese MNCs have become inclined toward building circular economy networks, such as sustainable industrial clusters, when entering a new market. Second, the Chinese or Asian business community is renowned for its sustainable industrial cluster and network relationships. Related empirical findings have shown that Taiwanese MNCs are specialized in circular economy network-building, capability-leveraging and FDI engagement (Marques and Manzanares, 2022). Third, the sample extracted from the database allows us to conduct post-hoc MGA, observing 2*2 scenarios between climate change and firm size. This approach provides some insightful implications regarding effective circular economy network-building for MNCs' global expansions. Fourth, the selected governmental FDI survey database is updated every year and can be used only by Taiwanese academical studies. Taiwanese government of Economic Affairs sector sends out an annual questionnaire to MNCs to record their FDI activity data. The research integrates all questionnaire responses and systemically analyzes circular economy network-building results. Therefore, our sample of Taiwanese offshore subsidiaries is appropriate for empirically studying circular economy network-building in host countries. Therefore, we compile our sample from the SDFI database using longitudinal cross-section and panel data that include FDI cases of Taiwanese manufacturing firms [3] from 2013 until 2018. Consequently, a sample of 4,050 Taiwanese manufacturing firms' circular economy in dealing with climate change was obtained for this study.

3.2 Measures

3.2.1 Competence enhancement. Circular economy network can enhance subsidiary performance (Gulati *et al.*, 2000). Accordingly, Conner (1991) has indicated that local performance is also influenced by varied resources. We evaluated the local operational performance of MNCs based on their competence enhancement, including production size, manufacturing know-how and production quality. According to Peng (2001) and Knight and Kim (2009, p. 257), competences can be enhanced as valuable, unique and hard-to-imitate resources to achieve better performance in global competition. The *local productions size*, *local manufacturing know-how* and *local production quality* of an MNC reflect its performance after establishing a circular economy network (Chaudhuri *et al.*, 2022; Kristoffersen *et al.*, 2021; Le *et al.*, 2022). Therefore, this study investigates how circular economy network-building influences focal firm's local operation (production size, manufacturing know-how and production quality). Table 2 depicts this scale.

3.2.2 Circular economy network building. Adapted from Asmussen *et al.* (2009), this study's measure of circular economy network-building decomposes into reduce, reuse and recycle policy networks. The *reduce policy network* was evaluated based on the number of the following resource efficiency and sources control used for reducing environmental waste and bridging offshore subsidiaries bridged (Marques and Manzanares, 2022; Saura *et al.*, 2022):

- headquarters;
- individual researcher;
- local technology firms;
- joint venture partner;
- Taiwanese R&D institute;
- local R&D institute;
- Taiwanese original equipment manufacturer (OEM) and original design manufactures (ODM) technology cooperating;
- local OEM and ODM technology cooperating;
- third-country technology authorization; and
- among others.

For each item, the respondents answered either "Yes" (coded 1) if they bridged the source or "No" (coded 0) otherwise. The total score accounted for 0–10 points; the higher the score, the more bridged the reduce policy network partners. The *reuse policy network* was evaluated based on the number of the following intermediation sources, representing the reusing and remaking capability of the offshore subsidiaries bridged (Antonioli *et al.*, 2022; Le *et al.*, 2022):

- headquarters;
- individual reusing and remaking worker;
- Taiwanese reusing and remaking institute;
- local reusing and remaking institute;
- third-country reusing and remaking institute; and
- others. For each item, the respondents answered either "Yes" (coded 1) if they bridged the source or "No" (coded 0) otherwise.

The total score accounted for 0–6 points; the higher the score, the more bridged the reuse policy network partners. The *recycle policy network* was evaluated based on the number of following sources of green supply chain, on which the offshore subsidiaries were bridged (Böhmecke-Schwafert *et al.*, 2022; Chaudhuri *et al.*, 2022):

- raw materials from local Taiwanese firms;
- raw materials from local non-Taiwanese firms;
- product components from local Taiwanese firms;

Table 2.
Variables indicators and sources

Construct	Variable indicators			Variable sources
Circular economy network building				
RDP	RDP1. Headquarters	RDP6. Local R&D institute		Marques and Manzanares (2022), Saura *et al.* (2022)
	RDP2. Individual researcher	RDP7. Taiwanese OEM and ODM cooperating		
	RDP3. Local technology firms	RDP8. Local OEM and ODM technology cooperating		
	RDP4. Joint venture partner	RDP9. Third country technology authorization		
	RDP5. Taiwanese R&D institute	RDP10. Others		
RUP	RUP1. Headquarters	RUP6. Others		Antonioli *et al.* (2022), Le *et al.* (2022)
	RUP2. Individual reusing and remaking worker			
	RUP3. Taiwanese reusing and remaking institute			
	RUP4. Local reusing and remaking institute			
	RUP5. Third country reusing and remaking institute			
RCP	RCP1. Raw materials from local Taiwanese firms			Böhmecke-Schwafert *et al.* (2022); Chaudhuri *et al.* (2022)
	RCP2. Raw materials from local non-Taiwanese firms			
	RCP3. Product components from local Taiwanese firms			
	RCP4. Product components from local non-Taiwanese firms			
	RCP5. Raw materials from third country firms			
	RCP6. Product components from third country firms			
Competence enhancement				
PS	PS1. Smaller production size	PS2. None-influence	PS3. Larger production size	Kristoffersen *et al.* (2021)
MK	MK1. Worse manufacturing know-how	PS2. None-influence	PS3. Better manufacturing know-how	
PQ	PQ1. Worse production quality	PQ2. None-influence	PQ3. Better production quality	
*Multigroup analysis – 2*2 Scenarios*				
Climate Change	*Climate Change* Performance Index = 40%GHG Emissions + 20%Renewable Energy + 20%Energy Use + 20%Climate Policy			CCPI.org (2013–2018)
Firm Size	≦250 employees refers to *small and medium firm* size; >250 employees refers to *large firm* size			Antonioli *et al.* (2022)

Notes: RDP = reduce policy network; RUP = reuse policy network; RCP = recycle policy network; PS = production size; MK = manufacturing know-how; PQ = production quality
Source: Authors

- product components from local non-Taiwanese firms;
- raw materials from third-country firms; and
- product components from third-country firms.

For each item, the respondents answered either "Yes" (coded 1) if they bridged that source or "No" (coded 0) otherwise. The total score accounted for 0–6 points; the higher the score, the more bridged are the recycle policy network partners. Table 2 depicts this scale.

*MGA analysis of climate change * firm size (2*2) scenarios*. We adopted Climate Change Performance Index 2013–2018 to measure the *Contingency 1* of climate change pressure (high and low)(CCPI, 2023); the number of employees is used as the proxy variable for firm size for the *Contingency 2* (Antonioli *et al.*, 2022). The quantity "≦250 employees" refers to small and medium firm size; ">250 employees" refers to large firm size. We conducted an MGA by dividing the full sample into four groups under different combinations of climate change pressure (high/low) and firm size (small and medium/large), which resulted in subgroups of 996 (Low|Small), 1,368 (Low|Large), 574 (High|Small) and 1,112 (High|Large) observations. The sample size in the subgroups was acceptable.

3.2.3 Control variables. Our research drew on previous literature and proposed several relative control variables (at the firm, action and country levels) to further prevent interference of other variables in the hypotheses. We comprehensively illustrated the control variables as follows: at the firm level, we first controlled *subsidiary age* by subtracting the year of establishment or incorporation from the period between 2013 and 2018. Next, we then controlled *subsidiary R&D propensity* using the subsidiary's R&D expenses as a proportion of the total R&D expenses of the MNC. Third, we controlled the *internationalization degree* by evaluating the MNC's total overseas employees as a proportion of the total employees as the proxy variable.

3.2.4 Common method variance. After collecting data on reduce, reuse and recycle policy networks, production size, manufacturing know-how, production quality and competence enhancements of the same company, we tested our results to ascertain whether they could have been contaminated by the common method bias. Accordingly, we used two strategies recommended by Podsakoff *et al.* (2003). First, we used Harman's single-factor test to examine the extent to which a common or single-method factor existed. This would account for the variance in our findings. We conducted exploratory factor analyses by entering the items from all the three scales (i.e. three dimensions of each circular economy network), and more than one factor emerged. Our findings indicated that the single general factor model explained only 20.134% of the total variance, while the three-factor model explained a total variance of 75.286%. Therefore, the three-factor model fits the data better than the single general-factor model.

Second, to manage possible bias in the competence enhancement, we adopted an additional variable, namely, sales growth for robustness check. We included this factor to test the hypotheses; the common method variance was not an alternative explanation for the effect of subsidiary performance, similar to the method proposed by Campbell and Fiske (1959) and Lindell and Whitney (2001). Theoretically speaking, common method bias should equally affect the coefficients involving sales growth and subsidiary performance. The results of both aforementioned analyses affirmed that our findings were not be significantly contaminated by common method/source bias.

4. Results

4.1 Full model results

Table 3 presents the means, standard deviations, scale reliability and correlations of all variables used in our analysis. All items show substantial variation and correlation. We conducted confirmatory factor analysis by calculating the constructs' alpha and the composite reliabilities. The average variance extracted for all constructs was larger than 0.5 (Table 3), presenting our measurement items capture sufficient reliability (composite reliabilities exceed the threshold value of 0.7) in the underlying construct (Fornell and Larcker, 1981). For discriminant validity, we further tested for multicollinearity among the standardized variables by calculating variance inflation factors (VIF). The VIFs for all variables were well below the threshold value of 10. Table 4 and Figure 2 report the full model of the results of the *H1a*–*H1c* main testing, which predicted a positive relationship between reduce policy network and manufacturing know-how but a negative influence on production size. *H1a* and *H1c* were not supported because the coefficient for reduce policy network was not positively significant; however, *H1b* was supported with a positively significant coefficient. The coefficients of reuse and recycle policy networks were positively significant for production size, manufacturing know-how and production quality. This suggested that *H2a*–*H2c* and *H3a*–*H3c* were all supported. Overall, the theoretical model sufficiently fit the data. The chi-square value accounted for 1,012.023, with a degree of freedom (df) of five, χ^2/df = 202.405, comparative fit index (CFI) of 0.949 and root mean square error of approximation (RMSEA) of 0.056.

4.2 Post hoc analysis

The results of the SEM analysis demonstrated the entire model of the effects of circular economy network. To gain further insight into these relationships, we adopted a post hoc analysis to validate the notion that the three circular economy network-building mechanisms were important for achieving superior competence enhancements across different external climate change environments and internal firm size configurations. Aligned with previous research and based on the RBV network theory, as shown in Figure 1, different climate change environments and varied firm capabilities across each country shaped the different information breadths, timings and arbitrage situations (Burt and Soda, 2021). Cross-cultural or economical aspects have been identified as key contingencies in FDI (Wright *et al.*, 2005). The global FDI network coopetition is typically characterized by the index of climate change and economy environment (Miller *et al.*, 2021). This can signal pressure to build circular economy networks (Peng, 2003). Institutions can be subject to "high-extent" and "low-extent" climate change aspects that involved regulative, normative and cognitive social pressures (Peng, 2003). This leads to the establishment of differently sized firms (North, 1990). These "aspects" or "rules" are ubiquitous in society. Therefore, subsidiaries cannot escape these configurations in the host country and eventually impact the local competences (Pelto and Karhu, 2019; Wu and Deng, 2020).

Table 5 summarizes the MGA results. Figure 3 shows the graphic overview. Expectedly, compared to the full model, different management practices predicted competence enhancement under different climate change circumstances and firm size configurations. In the low/small and medium firm scenario (Scenario A in Figure 3), the recycle policy networks are statistically significant predictors of competence enhancement. Comparatively, in the high/small and medium firm scenario, the reduce policy network significantly predicts manufacturing know-how and production quality (Scenario C in Figure 3). In the low/large firm scenario, the reuse policy network predicts competence enhancement (Scenario B in Figure 3). Conversely, in the high/large firm scenario, reuse policy network is also a statistically significant predictor of competence enhancement

Table 3. Descriptive statistics, scale reliability and correlation matrix of variables

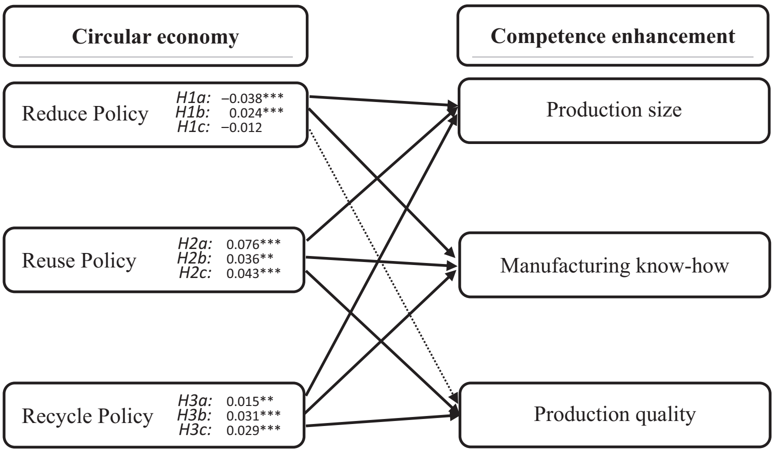
	Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1	Production size	0.486	0.564	*na*	0.341	0.402	–0.023	0.081	0.020	0.110	0.037	–0.001	–0.009	0.081
2	Manufacturing know-how	0.390	0.494		*na*	0.222	0.066	0.086	0.095	0.092	0.087	0.047	–0.003	0.079
3	Production quality	0.362	0.491			*na*	0.049	0.086	0.091	0.087	0.069	0.037	–0.005	0.064
4	Reduce policy network	1.330	0.776				*0.83*	0.411	0.238	–0.157	0.072	0.103	–0.005	0.056
5	Reuse policy network	1.368	0.769					*0.80*	0.217	–0.062	0.082	0.059	0.009	0.117
6	Recycle policy network	1.972	1.745						*0.85*	–0.300	0.267	0.150	–0.006	0.156
7	Climate change	61.862	11.721							*na*	0.078	0.157	0.015	0.307
8	Firm size	0.612	0.487								*na*	0.360	–0.031	0.261
9	Firm age	23.354	14.877									*na*	–0.054	0.118
10	R and D propensity	77.920	26.803										*na*	–0.039
11	Internationalization degree	55.516	34.235											*na*

Notes: Na: not applicable. Because this is a single-item scale, average variance extracted values are not meaningful. The root of average variance extracted values are italicized on the diagonal. Correlations greater than 0.13 are significant at $p = 0.05$ (two tailed)
Source: Authors

Path analysis	Hypothesis	Path coefficient	*t*-value	CIS	*p*-values	Support
RDP → PS	*H1a*	–0.038	–3.031**	[–0.060, –0.016]	0.002	Negative
RDP → MK	*H1b*	0.024	2.241*	[0.006, 0.044]	0.025	Yes
RDP → PQ	*H1c*	0.012	1.136	[–0.006, 0.033]	0.256	No
RUP → PS	*H2a*	0.076	6.149***	[−0.056, 0.097]	0.000	Yes
RUP → MK	*H2b*	0.036	3.336***	[−0.017, 0.054]	0.000	Yes
RUP → PQ	*H2c*	0.043	3.955***	[−0.024, −0.062]	0.000	Yes
RCP → PS	*H3a*	0.015	2.833**	[−0.006, −0.025]	0.005	Yes
RCP → MK	*H3b*	0.031	6.530***	[−0.023, −0.038]	0.000	Yes
RCP → PQ	*H3c*	0.029	6.137***	[−0.021, −0.036]	0.000	Yes

Notes: RDP = reduce policy network; RUP = reuse policy network; RCP = recycle policy network; PS = production size; MK = manufacturing know-how; PQ = production quality; CIS = 95% (bias-corrected) confidence intervals. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
Source: Authors

Table 4.
The results of SEM and hypotheses



Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; Model fit: $\chi^2 = 1012.023$; df = 5; χ^2/df = 202.405; CFI = 0.949; RMSEA = 0.056. Bold arrows represent hypothesized significant path relationships; dotted arrows represent hypothesized non-significant paths
Source: Authors

Figure 2.
Diagram of hypothesized relationships and SEM results

(Scenario D in Figure 3). The post hoc qualitative analysis validates the notion that the three circular economy networks are important for achieving superior competence enhancements, such as production size and manufacturing know-how, across countries with different climate change pressures and firm size configurations.

5. Discussion and conclusion

5.1 Theoretical implications

Our findings fill a gap in the literature on network-building. It also extends RBV theory using empirical tests to validate the impact of circular economy network-building on local

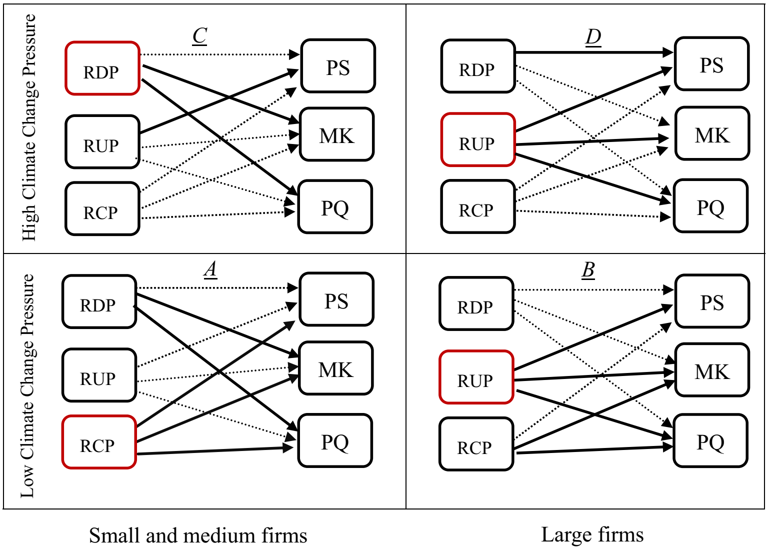
Table 5. The results of MGA path analysis

Path analysis	Model	Path coefficient	t-value	CIS	p-values	Sig
RDP → PS	Model A	0.025	0.722	[–0.037, –0.087]	0.470	No
	Model B	–0.044	–1.501	[–0.089, –0.001]	0.133	No
	Model C	0.009	0.191	[–0.068, –0.100]	0.849	No
	Model D	–0.133	–4.254***	[–0.202, –0.072]	0.000	Yes
RDP → MK	Model A	0.077	2.198*	[0.017, 0.137]	0.028	Yes
	Model B	0.019	0.673	[–0.030, 0.069]	0.501	No
	Model C	0.123	2.657**	[0.040, 0.211]	0.008	Yes
	Model D	0.012	0.382	[–0.043, 0.067]	0.703	No
RDP → PQ	Model A	0.103	2.912**	[0.042, 0.161]	0.004	Yes
	Model B	–0.003	–0.112	[–0.052, 0.046]	0.911	No
	Model C	0.102	2.226*	[0.019, 0.192]	0.026	Yes
	Model D	–0.028	–0.873	[–0.082, 0.026]	0.383	No
RUP → PS	Model A	0.039	1.112	[–0.029, 0.108]	0.266	No
	Model B	0.111	3.768***	[0.059, 0.159]	0.000	Yes
	Model C	0.122	2.703**	[0.051, 0.188]	0.007	Yes
	Model D	0.123	3.921***	[0.076, 0.168]	0.000	Yes
RUP → MK	Model A	0.008	0.235	[–0.049, 0.072]	0.814	No
	Model B	0.068	2.351*	[0.013, 0.120]	0.019	Yes
	Model C	–0.007	–0.149	[–0.071, 0.071]	0.882	No
	Model D	0.102	3.243***	[–0.050, 0.154]	0.000	Yes
RUP → PQ	Model A	–0.021	–0.608	[–0.077, 0.039]	0.543	No
	Model B	0.071	2.439*	[–0.015, 0.123]	0.015	Yes
	Model C	0.026	0.563	[–0.040, 0.105]	0.573	No
	Model D	0.136	4.331***	[0.085, 0.186]	0.000	Yes
RCP→ PS	Model A	0.080	2.470*	[0.027, 0.135]	0.014	Yes
	Model B	0.046	1.674	[–0.001, 0.093]	0.094	No
	Model C	–0.053	–1.276	[–0.125, 0.015]	0.202	No
	Model D	0.012	0.379	[–0.035, 0.058]	0.705	No
RCP → MK	Model A	0.099	3.028**	[0.043, 0.154]	0.002	Yes
	Model B	0.179	6.603***	[0.135, 0.223]	0.000	Yes
	Model C	0.010	0.241	[–0.064, 0.078]	0.810	No
	Model D	–0.023	–0.754	[–0.074, 0.029]	0.451	No
RCP → PQ	Model A	0.091	2.790**	[0.037, 0.143]	0.005	Yes
	Model B	0.171	6.313***	[0.130, 0.215]	0.000	Yes
	Model C	0.015	0.371	[–0.062, 0.082]	0.710	No
	Model D	–0.003	–0.089	[–0.053, 0.048]	0.929	No

Notes: RDP = reduce policy network; RUP = reuse policy network; RCP = recycle policy network; PS = production size; MK = manufacturing know-how; PQ = production quality; CIS = 95% (bias-corrected) confidence intervals. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
Source: Authors

competence enhancements. Our results enrich the sustainable business management literature and provide a foundation for future studies on the circular economy strategy of offshore subsidiaries that have participated in FDI. The results of this study are based on the usage of circular economy network of reduce, reuse and recycle policy networks for bridging firm capabilities. This study integrates the RBV-network perspective (i.e. the reduce, reuse and recycle dimensions of policies) to investigate the impact of offshore subsidiaries' network-building on local competence enhancement in the host country.

First, instead of considering circular economy network-building as an aggregate construct, we highlighted the distinct effects of the offshore subsidiaries' circular economy network-building on competence enhancement in terms of reduce, reuse and recycle aspects.



Notes: RDP: Reduce policy network; RUP: Reuse policy network; RCP: Recycle policy network; PS: Production size; MK: Manufacturing know-how PQ: Production quality; Bold arrows represent hypothesized significant path relationships; dotted arrows represent hypothesized non-significant paths; Red box represent dominant network in that scenario
Source: Authors

Figure 3. Graphical summary of findings

For this, we used three compelling policy network characteristics and the RBV-network perspective (Puffer *et al.*, 2010). Our study extends the literature by empirically confirming that the competitiveness of an offshore subsidiary can be enhanced by the complex interplay between its inter-organizational network-building and circular economy (Hitt *et al.*, 2002). Our findings extend the conjecture that a foreign distinctive circular economy significantly influences offshore subsidiaries in foreign countries via FDI (Hitt *et al.*, 2002). By bridging circular economy network-building, an offshore subsidiary can improve its competitive advantage to overcome the inherent environmental challenges of LOF and achieve its desired objectives of sustainability. Our study shows that circular economy continues to play a central role in corroborating the core notions of the RBV-based network perspective (Burt and Soda, 2021).

Second, by considering climate change pressure and firm size as two dimensions for MGA, we study offshore subsidiaries' circular economy network-building capabilities in the host country. Our findings reveal the critical role of climate change – commonly considered a key environmental and industrial parameter. Consistent with Hitt *et al.* (2002), in countries with greater extent of climate change pressure, subsidiaries relentlessly interact with external partners to bridge the necessary circular economy networks and access various resources needed to perform effectively (Ye *et al.*, 2022). Therefore, their capabilities are enhanced or constrained by their social surroundings and their own capacity (Pfeffer and Salanick, 1978).

In conclusion, our results support Iurkov and Benito's (2018) and Skouloudis *et al.* (2023) springboard view. Particularly, we demonstrate that the global business expansion of an MNC is fostered by its offshore subsidiary's local network, which serves as an important catalyst of the required strategic competence. Circular economy network-building, the cooperation between MNCs and local firms in the host country, allows offshore subsidiaries to bridge sustainable capabilities. Such practices and systems encourage them to transfer the benefit to the domestic competences of potential opportunities in the host country (Sun *et al.*, 2018). However, the comparison between high and low extent of climate change pressure in terms of circular economy is lacking. Circular economy between varied sizes and cross-border climate change pressures is an ideal empirical setting to echo the past research on sustainability in overcoming climate change-related economic turbulence (Ofoegbu and New, 2021; Ye *et al.*, 2022).

5.2 Managerial implications

Our research contributes to the existing real-life Taiwanese manufacturing practices in three significant steps.

5.2.1 Step 1 is being aware of the dark side. Our finding in *H1a* is consistent with those of Crick (2020) and Sabri *et al.* (2020), who argue the dark side of circular economy network-bridging. We suggest that MNCs be aware of the subtleties of their circular economy bridging partners. Therefore, when the reduce policy network focuses on achieving better efficiency and breadth of environmentally friendly knowledge, its production shrinks. Our test results show that the reduce policy network positively impacts manufacturing know-how only (Table 4). Regarding the reduce policy network, manufacturers build their network by bridging their sources with different partners to reduce wastage of knowledge, skills, patents, engineers and other resources. However, as shown in Scenarios A and C in Figure 3, the reduce policy network of small and medium firms impacts manufacturing know-how across countries with high and low extent of climate change pressures. This result extends the past literature on how small and medium firms in facing greater climate change pressure compete with large multinational firms. In this context, Prashantham and Birkinshaw (2008) and Prashantham and Dhanaraj (2015) have stated the following quote: "throw out a minnow to catch a whale", highlighting the importance of developing reduce policy on building circular economy network.

5.2.2 Step 2 is being aware of how climate change pressure can impact circular economy network-building for large sized firms. According to Scenarios B and D in Figure 3, reuse policy network helps large Taiwanese manufacturers acquire local knowledge and information, adapt to greater climate change pressure environments, carry out cross-border sustainability effectively and increase the volume of production. These findings on the reuse policy network echo those of Hitt *et al.* (2002), who have stated that only large firms with reuse policy networks serve as an important resource and alternative form of governance; therefore, they should have a greater positive impact on the access to greater know-how.

5.2.3 Step 3 is being aware about how climate change pressure can impact circular economy network-building of small and medium-sized firms. Regarding the recycle network, various upstream and downstream green suppliers enable Taiwanese manufacturers to transport inbound and outbound raw materials, parts and product components. They also reinforce intermedia logistics by improving channel usage and frequency. However, in Scenario A, which includes greater climate change pressure and cross-border sustainability, the recycle network induces volumes and frequency. However, in case of small and medium Taiwanese manufacturers, this network increases intermedia logistics. Consistent with Tashman *et al.* (2019), in Scenarios C and D, our findings show that under the same greater climate change pressure circumstance, a larger firm that enhances the impact of reuse policy network can mitigate the impact of reduce and recycle policy networks on the competence of production size. Therefore, the recycle policy network attenuates competence under less intense climate change pressure circumstances. These empirical results echo the recent call that conflicting findings may lead to theoretical advancement (Sartor and Beamish, 2018). Moreover, climate change pressure evidently controls local market access and a variety of policy and resources (Sun *et al.*, 2021, p. 599). In host countries facing high climate change pressure, offshore subsidiaries could easily bridge with circular economy partners by supplying scarce resources (Orr and Kennedy, 2008). Moreover, the circular economy network is trust-based; bridging among subsidiaries and local firms seems to be supported by smaller firms (Puffer *et al.*, 2010).

5.3 Limitations and future research directions

Although our study extends the understanding of circular economy network-building to create a resilience strategy against climate action through sustainability, it has several limitations that present opportunities for further research. First, the data set used in this study limits the study's empirical boundaries. For instance, our data were gathered from the period between 2013 and 2018 and excluded consistent firms. There was no repetitive survey data for our empirical tests. Future research could collect consistent firms' longitudinal data through surveys this line of research (3R to 10R/Phase 1 to Phase 3)[2] (Burt and Soda, 2021). Second, this study investigates how the competence of offshore subsidiaries could be enhanced by circular economy network-building under the contingencies of climate change and firm size. Future research could extend local network conditions beyond the three network dimensions to further investigate the process of circular economy and examine how firms can eliminate environmental and survival risks across differently characterized markets (Gnyawali *et al.*, 2006). In conclusion, future research could also investigate the mediating effects and missing links in the aforementioned circular economy building process to further the understanding of the heterogeneity of sustainability performance.

Notes

1. Resilience strategy – the strategy formulated by capabilities such as anticipating, coping with, recovering from and adapting to periodic shocks and major disruptions (Oh and Oetzel, 2022) – is called for at various levels (e.g. capability, network and economy) to cultivate preparedness against global crises (Ciravegna and Michailova, 2022).
2. 3R = reduce, reuse and recycle. These are the principles of circular economy. Vermeulen *et al.* (2018) have addressed 4R (refurbish), 5R (remanufacture)... to 10R for future direction. In this study, we focus on 3R as short loops of circular economy's phase 1 for the period 2013–2018 (EU, 2020; MSFI, 2021). Future studies could investigate Phase 2 (2025) and Phase 3 (2030) (EU, 2020; MSFI, 2021).
3. Taiwanese manufacturing firms in this research data collection extracted from Taiwanese Economic Affair Survey database. Survey of Foreign Direct Investment (SFDI) database includes many industrial sectors of Taiwanese manufacturing firms as follows: 1.food; 2.beverage; 3. tabaco; 4. clothes; 5.leather; 6.paper; 7.electronic parts; 8.oil products; 9.metal; 10.drugs; 11. furniture; 12.equipments; 13.cars; 14.computers; 15.plastics.

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