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Intra-Business Group Transactions for Inducing Relationships between Network and Performance: Can the Network Be Optimized?

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ABSTRACT

This paper analyzes the relation between network linkage and firm performance through the intra-business group related-party transactions, and also explores whether the network linkage could be optimized. It is listed on the Taiwan Stock Exchange over 2006-2008 by using financial information for business groups. For whole samples, we find a U-shaped relation between ROA and related-party purchases network linkage, and there is an inverted-U-shaped association between related-party receivable-payable network linkages and debt ratio. We also find the sales expenses ratio is positively correlated with the number of related-party buyers, but negatively correlated with the related-party sales ratio. Moreover, for high related-party sales and high related-party purchases group, it demonstrates an inverted-U-shaped association between related-party sales and ROA, and the related-party receivable-payable gap ratio is negatively correlated with debt ratio. While for low related-party sales and low related-party purchases group, related-party purchases network linkage and ROA display a U-shaped characteristic, and there is a U-shaped association between total receivable-payable gap ratio and debt ratio.

Keywords: Intra-Business Group; Network Linkage; Return on Assets; Related-Party Transactions

1. Introduction

As the economic environment changes with time, firms can no longer rely on their own resources to compete in the market. Thus, firms are gradually turning away from the self-production models in the past, toward cooperation among supply chain firms, resulting in close interactions between the firms. Moreover, for the purpose of diversification and resource sharing, a firm usually has multiple and diverse cooperating firms.

Since Johanson and Mattsson [1] proposed the concept of network linkage, to explain the foundation of cooperation between firms. This issue has already been widely discussed. From the perspective of exchange, the main motivation for the linkage between dissimilar organizations is to acquire external resources (Echols and Tsai [2]; McEvily and Marcus [3]), such as market channels (Chen and Chen, [4]), technology and R&D (Burgers *et al*. [5]; Pittaway *et al*. [6]), different knowledge pools (Burt [7]), pooling of cooperation (Uzzi [8]), third-party endorsements (Stuart *et al*. [9]), and innovation (Pittaway *et al*. [6]; Zaheer and Bell [10]). From the perspective of homophily, the main purpose of the linkage between similar organizations is to pursue joint goals through cooperation (Wholey and Huonket [11]). In addition, based on social network theory, network relationship is an important social capital for a firm to create value (Tsai [12]).

Extensive studies on the firm performance have already been made. Dyer [13] and Rowley *et al*. [14] posed that closer links and sound cooperation can enhance the competitive advantage of firms. Kim [15] found the direct and indirect effects of supply chain integration increase firm performance. Zeng *et al*. [16] found access to customers and suppliers on the upstream and downstream network connection can improve the innovation of SMEs. Dyer and Hatch [17] stated buyers gain knowledge assets through a supplier network. Gulati *et al*. [18] and Rowley *et al*. [14] argued the firm performance is significantly influenced by inter-firm ties and strategic networks. Goerzen and Beamish [19] found a more dispersed multina-

tional enterprise alliance network that decreases firm performance. However, Goerzen [20] found if a firm continues to maintain an equity-based cooperative partnership will help improve firm performance. In addition, access to resources and improvements in operating capability gained through alliance networks are considered unique and irreplaceable assets (Gulati [21]). Therefore, network linkage is the foundation for a firm to gain strategic advantages (Gulati *et al*. [18]; Hagedoorn and Duysters [22]; Koka and Prescott [23]), and development and investment in the relationships between network partners will significantly influence a firm's performance and value (Blankenburg *et al*. [24]; Gulati *et al*. [18]; Tsai [25]; Kuo [26]; Kim [15]; Zeng *et al*. [16]). Exploring the network linkage of a firm not only allows further analysis of performance and an optimal network, but also leads to the extension of firm value related studies. Previous literatures discussed network relationships from different aspects, such as human relations network, knowledge network, alliance network, business network, and social network (Johanson and Mattsson [1]; Uzzi [27]). In this paper, we test the network linkage through related-party sales and purchases transactions for business group.

Under the trend of liberalization and internationalization, firms are facing harsher competition pressure; to expand production scale, diversify risk, expand the market, and increase economic efficiency and competitive advantages, they strengthen the linkage between firms through mergers, investments and cross holdings, to form affiliated enterprises or large business groups; and, through the cooperative relationship between related-parties, they can gain beneficial resources and decrease transaction costs, thereby increasing the firm's asset allocation efficiency and this, in turn, maximize the firms' profit and value (Yeh *et al*. [28]; Gordon *et al*. [29]; Cheung *et al*. [30]). For many developed countries and emerging market countries, business groups are major enterprises influencing the national economy (Hoshi *et al*. [31]; Chung [32]), and they have different characteristics. For example, American syndicates are monopolistic institutions formed by a small number of large companies in the same production sector for vast profits, whose integration is mainly dominated by horizontal merger. Japanese keiretsu groups are often formed by a group of companies horizontally or vertically (Lincoln *et al*. [33]). The horizontal keiretsus are formed by merger of banking Industry, e.g. Sumitomo Mistsui financial group, Mitsubishi UFJ financial group, and Mizuho financial group. The vertical keiretsus follow the supply chain to vertically integrate upstream and downstream firms, e.g. Toyota group, Nissan group, Honda group, Matsushita group, Hitachi group, Toshiba group, SONY group, and Nikon group. The Korean Chaebol groups are formed by the vertical integration of a family group (Kim [34]). In Taiwan, most of the business groups are formed by the growth, division, and evolution of family business (Hmailton and Kao [35]; Chung [32]), and therefore can be seen as derivatives of a family relatives or interpersonal network (Wong [36]). In addition, the ownership is highly concentrated on family members and the board of directors is also mainly controlled by the family shareholders (Yeh *et al*. [37]; Lin and Hu [38]).

Since business groups are integrated by a group of legally independent entities that formed network relationships by embedding equities in subsidiaries, a business group can be called the collective body of a network. The characteristic of "kinship" in Taiwanese family groups highlights the traits of a network relationship. Due to Taiwanese business groups generally have supply chain cooperation between group members through related-party sales and purchases to gain the resources, and through exchange of payables and receivables in the groups to get the funds. In this paper, we use the numbers of related-party buyer and supplier, the ratios of related-party sales and purchase, and the gap between accounts of payable and receivable as indicators of network linkage in the groups. And then, we analyze the relation between network linkage and firm performance through the intra-business group related-party transactions, and also explore whether the network linkage could be optimized. In addition, we also use the sales expenses ratio to measure the running costs generated from establishing a network linkage relationship, and to capture its negative effects on network linkage.

The organization of the reminder of this paper is as follows. Section 2 describes the data and our empirical models. Section 3 reports and discusses the outcomes of empirical analysis. Section 4 offers the conclusions.

2. Methodology

2.1. Data

Definitions of business groups are many and varied (Chung [32]; Khanna and Rivkin [39]). In our empirical analysis we employ the definition of Taiwan Economic Journal (TEJ) to define a business group as composed of companies having the same ultimate shareholder and fulfilling the following criteria: 1) most of the primary shareholders come from the same family (primary shareholder refers to the top ten largest shareholders or shareholders with more than 5% of shares); 2) at least one third of the board of directors are the same; 3) the identical primary management (*i.e*. with the same director or CEO); 4) existing a controlling or subordinate relationship (*i.e*. with actual controlling power); 5) existing a mutual investment relationship.

We collected data for listed business groups over 2006-2008 from TEJ financial statement database, TEJ

corporate governance database, Taiwan Stock Exchange Market Observation Post System (MOPS), and companies' annual reports. First, the 600 core companies of business groups are taken as main objects. Second, based on related-party data disclosed by MOPS and the core companies' annual reports, we check the names of related-party companies and related-party transactions one by one. This is the first level of related-party sales and purchases linkage. And then, according to the companies of the first level linkage, we continually repeat the same process to check the names of related-party companies and related-party transactions. This is the second level of related-party sales and purchases linkage. All the related supplier and buyer firms are placed in one group. The previous process will be repeated until a firm has already appeared in the linkage or the firm is another core company.

To analyze the influence of the related-party sales and purchases network linkage on firm performance, we divide the samples into four sub-groups based on the median of the three years average related-party sales (purchases) for the whole samples, *i.e.* high related-party sales and high related-party purchases (abbreviated HH), high related-party sales and low related-party purchases (HL), low related-party sales and high related-party purchases (LH), and low related-party sales and low related-party purchases (LL). A firm has the sales (purchases) over 100 million NT dollars or greater than 20% paid-in capital with related-party buyer (supplier) is to be related-party sales (purchases). In addition, we also divide the samples into information technology (IT) and non-IT firms[1], large and small firms based on the median of total assets for the whole samples, family and non-family firms according to the criteria of a family shareholding ratio greater than 20% is considered to be a family firm (La Porta *et al*. [40]). We use the Pearson's Chi-square test to explore the association among related-party sales and purchases, industry, firm size, and family control. The results are given in **Table 1**.

As shown in **Table 1 Panel A**, approximately 61% ~

Table 1. Results of Pearson's Chi-square.

	High related-party sales & High related-party purchases (HH)	High related-party sales & Low related-party purchases (HL)	Low related-party sales & High related-party purchases (LH)	Low related-party sales & Low related-party purchases (LL)	Number of Firms (%)
Panel A: Industry v.s. related-party transactions					
Information Technology	26firms (81.3%)	66 firms (61.7%)	28 firms (63.6%)	66 firms (50.0%)	186 firms (59.0%)
Non-IT	6 firms (18.8%)	41 firms (38.3%)	16 firms (36.4%)	66 firms (51.2%)	129 firms (41.0%)
Pearson χ^2 35.046*** Cramer's V 0.193***					
Panel B: Firm size v.s. related-party transactions					
Large size	16 firms (50.0%)	57 firms (53.3%)	17 firms (37.9%)	68 firms (51.35%)	158 firms (50.1%)
Small size	16 firms (50.0%)	50 firms (46.7%)	27 firms (62.1%)	64 firms (48.7%)	157 firms (49.1%)
Pearson χ^2 9.383***** Cramer's V 0.100**					
Panel C: Family firms v.s. related-party transactions					
Family	14firms (43.8%)	52 firms (48.6%)	26 firms (59.1%)	85 firms (64.4%)	177 firms (56.2%)
Non-Family	18 firms (56.3%)	55 firms (51.4%)	18 firms (40.9%)	47 firms (35.6%)	138 firms (43.8%)
Pearson χ^2 24.829*** Cramer's V 0.162**					
Number of firms (observation)	32 firms (96)	107 firms (321)	44 firms (132)	132 firms (396)	315 firms (945)

Note: The tests of Pearson χ^2 and Cramer's V are used to examine the relation among related-party sales and purchases network linkage, industry; firm size; and family control. **Panel A** reports the results of test for relation between industry and related-party transactions; **Panel B** reports the results of test for relation between firm size and related-party transactions; **Panel C** reports the results of test for relation between family control and related-party transactions. We divide the samples into four sub-groups based on the median of the three years average related-party sales (or purchases) for the whole samples, *i.e.* high related-party sales and high related-party purchase firms (HH), high related-party sales and low related-party purchase firms (HL), low related-party sales and high related-party purchase firms (LH), and low related-party sales and low related-party purchases firms (LL). The samples also are categorized into information technology (IT) firms and non-IT firms, large and small firms based on the median of total assets for the whole samples, family and non-family firms according to the criteria of a family shareholding ratio greater than 20% is considered to be a family firm (proposed by La Porta *et al*. [40]). Statistical significance is denoted by ***, **, * for 1%, 5%, and 10% levels, respectively.

[1]The information technology (IT) industry includes semi-conductor, computer and peripherals, optical electronics, communication networks, components, electronics vendors, and information service firms. The non-IT industry includes cement, food, plastics, textile, machinery, chemistry, biotechnology and medicine, steel, rubber, automobile, construction and material, transportation, and retailer firms.

81% of the firms in three sub-groups (including HH, HL, and LH) are IT firms, which suggest that IT firms appear to utilize the network linkage of intra-business groups, and to obtain resources of technology, innovation, as well as market channels. **Table 1 Panel B** shows there are 53.3% of large firms in the HL group and 62.1% of small firms in the LH group, this indicates large firms appear to use the network linkage of related-party sales to integrate marketing resources and channels and this, in turn, obtains favorable income benefits from sales network linkage, while small firms prefer using the network linkage of related-party purchase to integrate production and R&D resources and this, in turn, obtains advantageous cost benefits from production network linkage. Further, **Table 1 Panel C** shows, approximately 51% ~ 56% of the firms in HH and HL groups are non-family firms, while about 59% ~ 64% of firms in LH and LL groups are family firms, indicating non-family firms prefer the network linkage of related-party sales, while family firms prefer the network linkage of related-party purchase. **Tables 1 Panel B** and **Panel C** show the network linkage of intra-group related-party sales and purchases are not unique to large firms or family firms. Finally, the results of Pearson χ^2 and Cramer's V indicate there is a significant association among related-party transaction network linkage, industry, firm size, and family control.

In summary, we find that information technology groups tend to maximize their profit by related-party sales-purchase linkage. Large groups gain favorable revenue effects through related-party sales network linkage; however, small groups obtain favorable cost effects through related-party purchase network linkage. Furthermore, non-family groups prefer related-party sales network linkage, but family groups favor related-party purchase network linkage.

2.2. Research Variables

In this study, the firm performance is measured by return on assets (ROA). Concerning the phenomena generally existing in Taiwanese business groups, of supply chain cooperation through related-party transactions and of funding by related-party accounts of receivable and payable, we use the number of related-party buyers and suppliers and the ratios of related-party sales and purchases to proxy the transaction network linkage of intra-business group, and measure the funding network linkage of intra-business group by calculating the ratio of the spread between related-party accounts and notes payable and related-party accounts and notes receivable to total revenue (named related-party receivable-payable gap ratio). Meanwhile, this study also uses the total receivable-payable gap ratio and net receivable-payable gap ratio to measure the whole financial network linkage and external receivable-payable network linkage of the business groups. The total receivable-payable gap ratio is the ratio of the spread between accounts and notes payable and accounts and notes receivable to total revenue. The net receivable-payable gap ratio is the total receivable-payable gap ratio minus the related-party receivable-payable gap ratio.

In addition, we also take the negative effect of operating cost derived from building network linkage into account, which is measured by the sales expenses ratio. Since a firm's performance is also influenced by other factors such as firm size and financial leverage (Fama and Frehnch [41]; Sharma [42]), we uses the number of group member firms (*i.e.* group size), total asset (*i.e.* total asset size), and total revenue (*i.e.* revenue size) as proxies for firm size, and also use the ratio of total debt to total assets (*i.e.* debt ratio) as a proxy for financial leverage (or capital structure). The definition of variables is presented in **Table 2**.

2.3. Empirical Model

In our empirical analysis, we use square term to capture a U-shaped (non-linear) relation, and estimate the panel data regression models. Equations (1) and (2) are the main models for our analysis of relation between transaction (or financial) network linkage and firm performance.

$$\begin{aligned} ROA_{it} = {} & \alpha_i + \beta_1 Sale\_ratio_{it} + \beta_2 Sale\_ratio_{it}^2 \\ & + \beta_3 Purchase\_ratio_{it} + \beta_4 Purchase\_ratio_{it}^2 \\ & + \beta_5 SaleExp_{it} + \beta_6 LnTA_{it} + \beta_7 Debt_{it} + \varepsilon_{it} \end{aligned} \tag{1}$$

$$\begin{aligned} ROA_{it} = {} & \alpha_i + \beta_1 RGAP_{it} + \beta_2 RGAP_{it}^2 + \beta_3 NGAP_{it} \\ & + \beta_4 NGAP_{it}^2 + \beta_5 LnTA_{it} + \beta_6 Debt_{it} + \varepsilon_{it} \end{aligned} \tag{2}$$

Since Kuo [26] found network linkage and financial leverage are negatively correlated, we further take into account the effect of the related-party receivable-payable financial network linkage on capital structure. The Equation (3a) is the empirical model for HH, HL, and LH groups. Due to LL group has a lower related-party transaction and financial network linkages, the Equation (3b) is the empirical model for LL group.

$$\begin{aligned} Debt_{it} = {} & \alpha_i + \beta_1 RGAP_{it} + \beta_2 RGAP_{it}^2 + \beta_3 NGAP_{it} \\ & + \beta_4 NGAP_{it}^2 + \beta_5 LnTA_{it} + \varepsilon_{it} \end{aligned} \tag{3a}$$

$$Debt_{it} = \alpha_i + \beta_1 TGAP_{it} + \beta_2 TGAP_{it}^2 + \beta_3 LnTA_{it} + \varepsilon_{it} \tag{3b}$$

Moreover, we also employ Equations (4a), (4b) and (5) to examine the relation between network linkage and related-party transactions.

$$\begin{aligned} Sale\_ratio_{it} = {} & \alpha_i + \beta_1 Sale\_No_{it} + \beta_2 Sale\_No_{it}^2 \\ & + \beta_3 LnSale_{it} + \beta_4 GpSize_{it} + \beta_5 IND_{it} + \varepsilon_{it} \end{aligned} \tag{4a}$$

Table 2. Variable definitions.

Variables (Abbreviation)	Definition
Return on assets (*ROA*)	Return on assets = [Net earnings after tax/average total assets] × 100%.
Number of related-party buyers (*Sale_No*)	Number of related-party buyer firms having transaction amounts of over one hundred million NT dollars or above 20% of paid-in capital with the related-party.
Number of related-party suppliers (*Supply_No*)	Number of related-party supplier firms having transaction amounts of over one hundred million NT dollars or above 20% of paid-in capital with the related-party.
Related-party sales ratio (*Sale_ratio*)	Related-party sales ratio = [related-party sales/total sales] × 100%; in which related-party sales is the sales of over one hundred million NT dollars or above 20% paid-in capital with the related-party buyer.
Related-party purchases ratio (*Purchase_ratio*)	Related-party purchase ratio = [related-party purchases/total purchases] × 100%; in which related-party purchases is purchase of over one hundred million NT dollars or above 20% paid-in capital with the related-party supplier.
Total receivable-payable gap ratio (*TGAP*)	Total receivable-payable gap ratio = [(total accounts and notes receivable − total accounts and notes payable)/total revenue] × 100%.
Related-party receivable-payable gap ratio (*RGAP*)	Related-party receivable-payable gap ratio = [(related-party accounts and notes receivable − related-party accounts and notes payable)/total revenue] × 100%.
Net receivable-payable gap ratio (*NGAP*)	Net receivable-payable gap ratio = [(total accounts and notes receivable − total accounts and notes payables) − (related-party accounts and notes receivable − related-party accounts and notes payable)/total revenue] × 100%.
Sales expenses ratio (*SaleExp*)	Sales expenses ratio = [sales expenses/total revenue] × 100%.
Group size (*GpSize*)	Number of group member firms.
Total asset size (*LnTA*)	Total asset size = natural logarithm of total assets.
Revenue size (*LnSale*)	Revenue size = natural logarithm of total revenues.
Debt ratio (*Debt*)	Debt ratio = [total debts/total assets] × 100%.
Industry (*IND*)	We use dummy variables to divide the samples into information technology (IT) firms and non-information technology (non-IT) firms. If it is an IT firm, IND = 1; if it is a non-IT firm, IND = 0.

$$Purchase\_ratio_{it} = \alpha_i + \beta_1 Supply\_No_{it} + \beta_2 Supply\_No_{it}^2 + \beta_3 LnSale_{it} + \beta_4 GpSize_{it} + \beta_5 IND_{it} + \varepsilon_{it} \quad (4b)$$

$$RGAP_{it} = \alpha_i + \beta_1 Sale\_No_{it} + \beta_2 Sale\_No_{it}^2 + \beta_3 Supply\_No_{it} + \beta_4 Supply\_No_{it}^2 + \beta_5 Sale\_ratio_{it} + \beta_6 Sale\_ratio_{it}^2 + \beta_7 Purchase\_ratio_{it} + \beta_8 Purchase\_ratio_{it}^2 + \beta_9 GpSize_{it} + \beta_{10} IND_{it} + \varepsilon_{it} \quad (5)$$

Finally, we use Equation (6) to perform additional analysis on the relation between the related-party purchases network linkage and operating costs.

$$SaleExp_{it} = \alpha_i + \beta_1 Sale\_No_{it} + \beta_2 Sale\_ratio_{it} + \beta_3 LnSale_{it} + \beta_4 GpSize_{it} + \beta_5 IND_{it} + \varepsilon_{it} \quad (6)$$

The variables in Equations (1)-(6) are defined earlier and given in **Table 2**.

3. Results

3.1. Data Analysis

In this sub-section, we examine the descriptive statistics of the variables mentioned earlier and the tests of four sub-groups are given in **Table 3**. **Table 3 Panel A** shows that for the number of related-party buyers and suppliers, on average, are about 2.68 and 1.74, and the standard deviation are 3.54 and 2.08, which means that the related-party buyers are more dispersed. For related-party sales and purchases ratios, on average, are 21.98% and 29.81%, and the standard deviation are 31.93% and 23.73%, indicating the related-party purchases has a higher variability. For receivable-payable gap ratio and net receivable-payable gap ratio, on average, are −0.36 and 4.91, indicating intra-group related-party receivable-payable is a negative gap, while the extra-group receivable-payable is a positive gap. This means business groups can obtain spontaneous financing through internal financial network linkage, while external financial network linkage might be a financial pressure of the firm's working capital. For sales expenses ratio, on average, is 4.79%, the maximum and minimum, from 0% to 83.26%, display high variability.

Table 3 Panel B shows HH group has the highest ROA (6.82%), while the HL group has the lowest ROA (1.50%), however, from **Table 3 Panel C**, the ANOVA-test of ROA does not differ significantly among four groups, and the t-test of ROA does not differ significant between HH and LL groups. As shown in **Table 3 Panel C**, the ROA, related-party sales ratio, and related-party purchases ratio of HH group are significantly greater than HL, LH, and HL groups, respectively. This means that HH group appear to use related-party sales and purchases to create positive income effects (*i.e.* increasing income) and positive cost effects (*i.e.* decreasing costs), thereby increasing the firm's ROA. Furthermore, both

Table 3. Descriptive statistics and variance analysis.

	ROA	*Sale_No*	*Supply_No*	*Sale_ratio*	*Purchase_ratio*	*RGAP*	*NGAP*	*SaleExp*	*Total assets* (*thousand*)	*GpSize*	*Debt*
Panel A: Descriptive statistics											
Mean	5.22	2.68	1.74	21.98	29.81	−0.36	4.91	4.79	31,300,793	6.85	37.44
Maximum	53.1	29.00	17.00	100.00	100.00	191.70	39.27	83.26	648,633,988	36.00	86.86
Minimum	−47.38	0	0	0	0	−1761.02	−188.70	0	186,148	1	0.31
Standard Dev.	9.61	3.54	2.08	23.43	31.93	58.44	11.43	6.15	78,428,102	8.02	15.77
Panel B: Mean of sub-groups											
HH	6.82	3.92	2.80	37.51	76.27	−0.56	5.57	4.46	55,802,076	10.22	33.09
HL	1.50	4.00	1.50	42.54	12.32	7.37	−0.36	4.44	29,092,877	7.13	37.33
LH	4.78	1.48	2.05	5.24	78.30	−20.36	12.33	5.13	23,488,205	5.70	37.70
LL	5.57	1.71	1.56	7.15	16.56	0.10	6.55	5.03	29,755,033	6.14	38.50
Panel C: Variance analysis											
ANOVA-test	1.760	37.361***	11.998***	376.886***	775.842***	7.177***	51.083***	0.785	3.728**	7.730***	3.063**
t-test											
LL v.s. HH	−1.229	−5.389***	−5.295***	−15.913***	−28.865***	0.782	1.088	0.813	−2.301**	−4.125***	3.025***
LL v.s. LH	0.758	0.784	−2.957***	2.557**	−37.983***	1.534	−5.529***	−0.156	0.817	0.474	0.495
LL v.s. HL	1.518	−9.331***	0.361	−26.212***	3.298***	−9.175**	8.394***	1.586	0.120	−1.648	1.002
HH v.s. LH	1.495	4.615***	3.021***	16.013***	−0.906	1.264	−5.737***	−0.576	2.405**	3.930***	−2.107**
HH v.s. HL	1.967**	−0.194	5.079***	−2.203**	32.952***	−5.469***	4.119***	0.030	2.103**	2.982***	−2.382**
LH v.s. HL	0.266	−6.093***	3.050***	−24.901***	39.954***	−2.076**	9.505***	0.869	−0.841	−1.658*	0.228

Note: **Panel A** reports the descriptive statistics of variables; **Panel B** reports the mean of variables for the four sub-groups; **Panel C** reports the results of ANOVA analysis and T-test for the four sub-groups. *ROA* is return on assets = [Net earnings after tax/average total assets] × 100%. *Sale_No* is number of related-party buyer firms having transaction amounts of over one hundred million NT dollars or above 20% of paid-in capital with the related-party. *Supply_No* is number of related-party supplier firms having transaction amounts of over one hundred million NT dollars or above 20% of paid-in capital with the related-party. *Sale_ratio* is related-party sales ratio = [related-party sales/total sales] × 100%; in which related-party sales is the transaction amount of over one hundred million NT dollars or above 20% paid-in capital with the related-party buyer. *Purchase_ratio* is the related-party purchase ratio = [related-party purchases/total purchases] × 100%; in which related-party purchases are a transaction amount of over one hundred million NT dollars or above 20% paid-in capital with the related-party supplier. *RGAP* is the related-party receivable-payable gap ratio = [(related-party accounts and notes receivable − related-party accounts and notes payable)/total revenue] × 100%. *NGAP* is the net receivable-payable gap ratio = [(total accounts and notes receivable − total accounts and notes payables) − (related-party accounts and notes receivable − related-party accounts and notes payable)/total revenue] × 100%. *SaleExp* is the Sales expenses ratio = [sales expenses/total revenue] × 100%. Total assets are the amount of total assets. *GpSize* is the number of group member firms. *Debt* is equal to total debts/total assets × 100%. The four sub-sample groups include high related-party sales and high related-party purchases (HH), high related-party sales and low related-party purchases (HL), low related-party sales and high related-party purchases (LH), and low related-party sales and low related-party purchases (LL). Statistical significance is denoted by ***, **, * for 1%, 5%, and 10% levels, respectively.

ANOVA-test and t-test of related-party sales network linkage and intra- and extra-group receivable-payable network linkage show significant differences among four groups. However, the ANOVA-tests and t-tests of the sales expenses ratio do not differ significantly among four groups.

3.2. Results of Relationship between Related-Party Transaction Network Linkage and Performance

Table 4 Panel A shows a significantly positive linear relation between related-party sales ratio and ROA, indicating related-party sales create positive revenue effects and thus increase a firm's ROA. However, the association between related-party purchases ratio and ROA is U-shaped, and the related-party purchases ratio is negatively associated with ROA (*i.e.* the coefficient of $Purchase\_ratio^2$ is 0.001, $p < 0.05$ and the coefficient of *Purchase_ratio* is −0.112, $p < 0.10$). It demonstrates a non-linear characteristic. The ROA is differentiated with respect to the related-party purchases ratio, the critical value of the related-party purchases ratio is 56%. It means that when the related-party purchases ratio is lower than 56%, ROA is decreased the increase in related-party purchases ratio because of factors such as diseconomies of scale, illegal transfer of benefits and tunneling. However, when the related-party purchases ratio is greater than 56%, it might increase ROA with an increased related-party purchases ratio, because of positive cost effects such as securing resources of upstream supply-chain.

From **Table 4 Panel B**, we observe a non-linear inverted-U-shaped association between the related-party sales ratio and ROA (*i.e.* the coefficient of $Sale\_ratio^2$ is −0.009, $p < 0.10$) for HH group. The ROA is differentiated with respect to the related-party sales ratio, the critical value of related-party sales ratio is 29.67%. It means that when the related-party sales ratio is lower than 29.67%,

Table 4. Results of relationship between related-party transaction network linkage and performance.

Variables	Panel A	Panel B			
	All	HH	HL	LH	LL
Sale_ratio	0.135* (1.901)	0.534 (1.647)	0.191* (1.870)	−0.311 (−0.959)	0.212 (0.978)
Sale_ratio^2	−0.001 (−1.169)	−0.009* (−1.938)	−0.001 (−1.102)	0.007 (1.193)	−0.004 (−0.691)
Purchase_ratio	−0.112* (−1.789)	−0.257 (−1.098)	−0.185 (−1.243)	0.884 (1.437)	−0.118 (−1.139)
Purchase_ratio^2	0.001** (2.169)	0.003 (1.252)	0.0008 (0.300)	−0.006 (−1.397)	0.002* (1.693)
SaleExp	−0.292*** (−3.448)	−0.350 (−1.270)	−1.136*** (−2.876)	−0.103 (−0.928)	−0.558*** (−2.957)
LnTA	9.064*** (5.931)	8.439 (1.198)	7.783*** (2.987)	15.489*** (4.096)	6.302** (2.583)
Debt	−0.216*** (−5.474)	−0.241** (−2.325)	−0.224*** (−3.264)	−0.225** (−2.097)	−0.226*** (−3.358)
F-test	4.44***	4.06***	4.60***	5.88***	3.63***
LM-test	196.39***	11.74***	58.74***	30.45***	71.67***
Hausman-test	44.77***	15.69**	21.28***	16.18**	18.71***
Adj. R^2	0.5389	0.5502	0.5595	0.6505	0.4791

Note: **Panel A** reports the results of whole samples. **Panel B** reports the results of the four sub-sample groups (*i.e*. high related-party sales and high related-party purchases (HH), high related-party sales and low elated-party purchases (HL), low related-party sales and high related-party purchases (LH), and low related-party sales and low related-party purchases (LL)). The dependent variable is *ROA*, which is return on assets = [Net earnings after tax/average total assets] × 100%. *Sale_ratio* is related-party sales ratio = [related-party sales/total sales] × 100%; in which related-party sales is the transaction amount of over one hundred million NT dollars or above 20% paid-in capital with the related-party buyer. *Purchse_ratio* is the related-party purchase ratio = [related-party purchases/total purchases] × 100%; in which related-party purchases are a transaction amount of over one hundred million NT dollars or above 20% paid-in capital with the related-party supplier. *SaleExp* is the sales expenses ratio = [sales expenses/total revenue] × 100%. *LnTA* is the natural logarithm of total assets. *Debt* is equal to total debts/total assets × 100%. Statistical significance is denoted by ***, **, * for 1%, 5%, and 10% levels, respectively.

ROA is improved with the increase in related-party sales ratio because of factors such as advantageous market channels, positive income effects from strategic alliance, or higher intra-group transfer pricing. However, when the related-party sales ratio is higher than 29.67%, negative income effects such as the illegal transfer of benefits or tunneling may exist in related-party transactions, causing ROA to decrease with the increase in related-party sales ratio. For LL group, the related-party purchases ratio and ROA display a non-linear U-shaped association (*i.e*. the coefficient of *Purchase_ratio*^{2} is 0.002, $p < 0.10$). The ROA is differentiated with respect to the related-party purchases ratio, the critical value of related-party purchases ratio is 29.50%.

As findings earlier indicate a U-shaped relation between ROA and related-party purchases network linkage for Taiwanese business groups. This finding is in line with the view of past studies (Dyer [13]; Mowery *et al*. [43]; Uzzi [27]; Dyer and Singh [44]; Tsai and Ghoshal [45]; Gulati [21]; Gulati *et al*. [18]; Rowey *et al*. [14]; Tsai [12]; Hagedoorn and Duysters [22]; Koka and Prescott [23]) indicating that the network can contribute to firm performance. Moreover, for HH group, it demonstrates an inverted-U-shaped association between related-party sales and ROA, it displays that related-party sales network linkage can generate a positive income effect and this, in turn, increase the ROA of business group. While for LL group, related-party purchases network linkage and ROA display a U-shaped characteristic.

3.3. Results of Relationship between Financial Network Linkage and Performance

From **Table 5 Panel A**, it seems that related-party receivable-payable gap does not significantly affect the ROA, but it indicates a U-shaped relation between net receivable-payable gap ratio and ROA (*i.e*. the coefficient of *NGAP*^{2} is 0.011, $p < 0.05$). The ROA is differentiated with respect to the net receivable-payable gap ratio, the critical value of net receivable-payable gap ratio is a negative gap −3.81%.

Table 5 Panel B shows that for HH group, the net receivable-payable gap ratio is positively correlated with ROA. For HL group, the finding does not offer a significant correlation between the net receivable-payable gap ratio and ROA. For LH group, the association between related-party receivable-payable gap ratio and ROA is a U-shaped, and related-party receivable-payable gap ratio is positively associated with ROA (*i.e*. the coefficient of *RGAP*^{2} is 0.0008, $p < 0.05$ and the coefficient of *RGAP* is 0.154, $p < 0.05$). The ROA is differentiated with respect to related-party receivable-payable gap ratio, the critical value of related-party receivable-payable gap ratio is a negative gap −96.25%. For LL group, it shows a

Table 5. Results of relationship between financial network linkage and performance.

Variables	Panel A	Panel B			
	All	HH	HL	LH	LL
RGAP	0.044 (0.253)	−0.069 (−0.452)	0.066 (0.631)	0.154** (2.355)	0.044 (0.253)
$RGAP^2$	0.003 (0.486)	−0.002 (−0.205)	0.001 (0.441)	0.0008** (2.251)	0.003 (0.486)
NGAP	0.084 (0.604)	0.467** (2.504)	−0.067 (−0.503)	0.188 (0.916)	0.084 (0.604)
$NGAP^2$	0.011** (2.100)	−0.005 (−0.383)	−0.002 (−0.773)	−0.002 (−0.297)	0.011** (2.100)
LnTA	7.999*** (3.320)	1.039 (1.377)	7.707*** (2.981)	18.343*** (4.629)	7.999*** (3.320)
Debt	−0.211*** (−3.157)	−0.221*** (−3.042)	−0.219*** (−3.204)	−0.226** (−2.179)	−0.211*** (−3.157)
Intercept		−4.878 (−0.402)			
F-test	3.59***	4.13***	4.20***	6.30***	3.59***
LM-test	67.70***	20.71***	53.39***	26.27***	67.70***
Hausman-test	17.16***	20.71	15.16***	24.47***	17.16***
Adj. R^2	0.4730	0.5491	0.5282	0.6647	0.4730

Note: **Panel A** reports the results of whole samples. **Panel B** reports the results of the four sub-sample groups (*i.e.* high related-party sales and high related-party purchases (HH), high related-party sales and low related-party purchases (HL), low related-party sales and high related-party purchases (LH), and low related-party sales and low related-party purchases (LL)). The dependent variable is *ROA*, which is return on assets = [Net earnings after tax/average total assets] × 100%. *RGAP* is the related-party receivable-payable gap ratio = [(related-party accounts and notes receivable − related-party accounts and notes payable)/total revenue] × 100%. *NGAP* is the net receivable-payable gap ratio = [(total accounts and notes receivable − total accounts and notes payables) − (related-party accounts and notes receivable − related-party accounts and notes payable)/total revenue] × 100%. *LnTA* is the natural logarithm of total assets. *Debt* is equal to total debts/total assets × 100%. Statistical significance is denoted by ***, **, * for 1%, 5%, and 10% levels, respectively.

U-shaped association between the related-party receivable-payable gap ratio and ROA. The ROA is differentiated respect to related-party receivable-payable gap ratio, the critical value of related-party receivable-payable gap ratio is a negative gap −3.81%.

In summary, the findings present the critical values of both intra-group and extra-group receivable-payable gaps are negative gaps, indicating that while a negative gap can contribute to self-financing and ROA improvement.

According to the findings of Kuo [26], we perform additional analysis on the relation between receivable-payable financial network linkage and capital structure. **Table 6 Panel A** shows an inverted-U-shaped relation between the related-party receivables payable gap ratio and debt ratio and related-party receivable-payable gap ratio is negatively associated with debt ratio (*i.e.* the coefficient of $RGAP^2$ is −0.0007, $p < 0.01$ and the coefficient of *RGAP* is −0.133, $p < 0.01$). The debt ratio is differentiated with respect to the related-party receivable-payable gap ratio, the critical value of related-party receivable-payable gap ratio is a negative gap −95%. For HH group, the related-party receivable-payable gap ratio is negatively correlated with debt ratio. For HL group, both the related-party receivable-payable gap ratio and extra-group receivable-payable gap ratio are negatively correlated with debt ratio. For LH group, the finding does not offer a significant relation between financial network linkage and debt ratio. For LL group, there is a U-shaped association between total receivable-payable gap ratio (*TGAP*) and debt ratio (*i.e.* the coefficient of $TGAP^2$ is 0.010, $p < 0.05$). The debt ratio is differentiated with respect to the total receivable-payable gap ratio, the critical value of total receivable-payable gap ratio is a positive gap 8.05%.

As findings of **Tables 5** and **6**, which demonstrate an inverted-U-shaped association between intra-group related-party receivable-payable network linkages and debt ratio. Moreover, from **Table 3 Panel A**, it shows a negative related-party receivable-payable gap, indicating self-financing from related-party payables might decrease the cost of capital, and therefore increasing a firm's ROA. In addition, a positive extra-group receivable-payable gap, indicating the higher demands of working capital might increase the cost of capital, and therefore decreasing a firm's ROA.

3.4. Results of Relationship between Network Linkage and Related-Party Transaction

In this sub-section, we take into an industry dummy account to control the effect of industry, and estimate the industry random effects model.

Tables 7 Panel A and **Panel B** present an inverted-U-shaped between related-party sales (purchases) ratio and the number of related-party buyers (suppliers), and

Table 6. Results of relationship between financial network linkage and capital structure.

Variables	Panel A	Panel B			
	All	HH	HL	LH	LL
RGAP	−0.133*** (−2.715)	−0.435** (−2.051)	−0.269*** (−3.024)	−0.006 (0.094)	
$RGAP^2$	−0.0007*** (−2.744)	0.004 (0.375)	−0.0005 (−0.260)	−0.00007 (−0.193)	
NGAP	−0.008 (−0.133)	−0.058 (−0.227)	−0.239** (−2.215)	−0.199 (−0.918)	
$NGAP^2$	0.0002 (0.603)	0.019 (1.236)	0.0002 (0.082)	0.004 (0.903)	
TGAP					−0.161 (−1.334)
$TGAP^2$					0.010** (2.190)
LnTA	4.611*** (2.981)	2.709** (2.080)	0.932 (1.131)	14.361*** (3.687)	0.384 (0.424)
Intercept		−12.331 (−0.576)	24.435* (1.836)		32.269** (2.193)
F-test	14.61***	8.12***	11.42***	17.24***	19.55***
LM-test	618.98***	47.56***	182.64***	81.73***	291.23***
Hausman-test	9.83*	1.55	4.66	12.69**	3.24
Adj. R^2	0.8214	0.7295	0.7832	0.8561	0.8628

Note: **Panel A** reports the results of whole samples. **Panel B** reports the results of the four sub-sample groups (*i.e*. high related-party sales and high related-party purchases (HH), high related-party sales and low related-party purchases (HL), low related-party sales and high related-party purchases (LH), and low related-party sales and low related-party purchases (LL)). The dependent variable is *Debt Ratio*, which is equal to total debts/total assets ×100%. *RGAP* is the related-party receivable-payable gap ratio = [(related-party accounts and notes receivable − related-party accounts and notes payable)/total revenue] × 100%. *NGAP* is the net receivable-payable gap ratio = [(total accounts and notes receivable − total accounts and notes payables) − (related-party accounts and notes receivable − related-party accounts and notes payable)/total revenue] × 100%. *TGAP* the total receivable-payable gap ratio = [(total accounts and notes receivable − total accounts and notes payable)/total revenue] × 100%. *LnTA* is natural logarithms of total assets. Statistical significance is denoted by ***, **, * for 1%, 5%, and 10% levels, respectively.

the number of related-party buyers (suppliers) is positively related with related-party sales (purchases) ratio (*i.e*. the coefficient of $Sale\_No^2$ is −0.173, $p < 0.01$ and the coefficient of *Sale_No* is 6.014, $p < 0.01$; the coefficient of $Supply\_No^2$ is −0.621, $p < 0.01$ and the coefficient of *Supply_No* is 10.841, $p < 0.01$). As **Table 7 Panel C** shows the association between number of related-party suppliers (buyers) and related-party receivable-payable gap ratio is U-shaped and number of related-party suppliers (buyers) is negatively associated with related-party receivable-payable gap ratio (*i.e*. the coefficient of $Sale\_No^2$ is 0.165, $p < 0.05$ and the coefficient of *Sale_No* is −5.702, $p < 0.01$; the coefficient of $Supply\_No^2$ is 0.381, $p < 0.10$ and the coefficient of *Supply_No* is −7.518, $p < 0.01$). Moreover, it also presents an inverted-U-shaped between related-party receivable-payable gap ratio and related-party purchases ratio, and related-party purchases ratio is positively related with related-party receivable-payable gap ratio (*i.e*., the coefficient of $Purchase\_ratio^2$ is −0.12, $p < 0.01$ and the coefficient of *Purchase_ratio* is 0.929, $p < 0.01$). In addition, we also find the IT firms appear to have higher related-party sales and purchases.

As results report that the sales expenses ratio is negatively correlated with ROA. Therefore, we perform additional analysis on the relation between the sales expenses ratio and related-party transactions. **Table 7 Panel D** shows sales expenses ratio is positively correlated with the number of related-party buyers, but negatively correlated with the related-party sales ratio. This means that the larger related-party transactions might decrease the costs of network linkage because of the scale economy from network linkage, but the more number of related-party buyers (or the dispersion of related-party buyers) might increase the firm's operating costs. In addition, we also find IT firms appear to have lower sales expenses ratios than those of non-IT firms. For 186 IT firms, about 66 firms are attributed to low related-party sales and purchases (see **Table 1**). This indicates IT firms appear to use related-party upstream and downstream network linkage and this, in turn, might decrease a firm's operating costs.

4. Conclusions

This paper analyzes the relation between network linkage and performance through the intra-business group related-party transaction, and examine whether the network linkage could be optimized for a sample of business

Table 7. Results of relationship between network linkage and related-party transactions.

Variables	Panel A	Panel B	Panel C	Panel D
	Sale ratio	*Purchase ratio*	*RGAP*	*SaleExp*
Sale_No	6.014*** (13.451)		−5.702*** (−3.127)	0.255*** (3.002)
Sale_No^2	−0.173*** (−7.936)		0.165** (2.078)	
Supply_No		10.841*** (13.539)	−7.518*** (−2.585)	
Supply_No^2		−0.621*** (−9.936)	0.381* (1.726)	
Sale_ratio			0.863*** (2.938)	−0.021** (−2.163)
Sale_ratio^2			−0.005 (−1.464)	
Purchase_ratio			0.929*** (3.408)	
Purchase_ratio^2			−0.12*** (6.690)	
LnSale	−4.671*** (−6.689)	−3.371*** (−3.805)	13.846*** (6.690)	−2.154*** (−10.145)
GpSize	0.206 (1.461)	0.256 (1.318)	−0.291 (−0.919)	0.083** (2.006)
IND	5.646*** (2.687)	11.740*** (3.980)	3.828 (0.823)	−1.850*** (−2.981)
Intercept	78.229*** (7.428)	60.040*** (4.462)	−215.422*** (−6.882)	39.068*** (11.921)
Lagrange Multiplier test	601.93***	701.95***	4.16**	502.82***
Adj R^2	0.8691	0.9198	0.2627	0.7969

Note: **Panels A** and **B** report the results of Equation (4). **Panel C** reports the results of Equation (5). **Panel D** reports the results of Equation (6). The four sub-sample groups include high related-party sales and high related-party purchases (HH), high related-party sales and low related-party purchases (HL), low related-party sales and high related-party purchases (LH), and low related-party sales and low related-party purchases (LL). *Sale_ratio* is related-party sales ratio = [related-party sales/total sales] × 100%; in which related-party sales is the transaction amount of over one hundred million NT dollars or above 20% paid-in capital with the related-party buyer. *Purchase_ratio* is the related-party purchase ratio = [related-party purchases/ total purchases] × 100%; in which related-party purchases are a transaction amount of over one hundred million NT dollars or above 20% paid-in capital with the related-party supplier. *RGAP* is the related-party receivable-payable gap ratio = [(related-party accounts and notes receivable − related-party accounts and notes payable)/total revenue] × 100%. *SaleExp* is the sales expenses ratio = [sales expenses/total revenue] × 100%. *Sale_No* is number of related-party buyer firms having transaction amounts of over one hundred million NT dollars or above 20% of paid-in capital with the related-party. *Supply_No* is number of related-party supplier firms having transaction amounts of over one hundred million NT dollars or above 20% of paid-in capital with the related-party. *LnSale* is the natural logarithm of total revenues. *GSize* is the number of group member firms. *IND* is a dummy variable, an information technology firm, IND = 1; a non-information technology firm, IND = 0. Statistical significance is denoted by ***, **, * for 1%, 5%, and 10% levels, respectively.

groups listed on the Taiwan Stock Exchange over 2006-2008. For whole samples, we find a U-shaped relation between ROA and related-party purchases network linkage, and there is an inverted-U-shaped association between intra-group related-party receivable-payable network linkages and debt ratio. Moreover, we also find the sales expenses ratio is positively correlated with the number of related-party buyers, but negatively correlated with the related-party sales ratio. For HH group, it demonstrates an inverted-U-shaped association between related-party sales and ROA, and the related-party receivable-payable gap ratio is negatively correlated with debt ratio. While for LL group, related-party purchases network linkage and ROA display a U-shaped characteristic, and there is a U-shaped association between total receivable-payable gap ratio and debt ratio.

The results reported in this study can contribute to our understanding of the relation between intra-business group related-party transaction and performance. First, unlike previous studies, this study discusses the issue from the perspectives of related-party transaction network linkage, and uses the numbers of related-party buyer and supplier, the ratios of related-party sales and purchases, and the gap between accounts of payable and receivable as indicators of the network linkage in the groups. Our analysis provides a more insightful prediction of the interplay between network linkage and performance for business groups. Second, most Taiwanese conglomerates are developed from family or personal relationship networks, with strong "family ties" that highlight their characteristics of network linkage. Third, this study empirically supports the related-party network linkage could be optimized. Future studies can take corporate government into account, such as agency problems and earning management on related-party transactions.

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