Empirical Paper

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The global cross-border mergers and acquisitions network between 1990 and 2021

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Abstract: The literature is characterized by a lack of research analyzing cross-border mergers and acquisitions (CBM&A) as a network. This article aims to evaluate the topology properties (the geographical and sectoral structure) of the global CBM&A network in 1990–2021. A quantitative study is conducted by using the social network analysis (SNA) method. The countries' structural power in this global system is measured by the centrality indicators. From a geographical perspective, the study shows that in 1990–2021, the United States, the United Kingdom, Germany, Canada, and France occupied the most central place in the network. From the beginning of the 21st century, there has also been a marked increase in the importance of Asian countries, with China and India receiving a large inflow of foreign capital. In turn, entities from Hong Kong, Singapore, Japan, and China invested heavily abroad through M&A. The Asian countries' economies also played the role of important intermediaries in the global CBM&A network. From a sectoral perspective, it can be stated that in 1990–2021, mainly entities operated in the financial, industrial, basic materials, technology, and consumer cyclical sectors made transactions in the global CBM&A network. They were also the main investment targets within this network.

Keywords: centrality, cross-border mergers and acquisitions, network analysis
JEL Classification: D85, G34, L14

1 Introduction

The ongoing globalization and liberalization of flows in the world economy contribute to the growth of economic interdependencies, which relate to trade, business, and investment links. In particular, cross-border mergers and acquisitions (CBM&A) – the dominant form of foreign direct investment (FDI) – are an example of relational data, and they have increasingly taken the form of a network (system). Thus, these processes can be examined from the perspective of the vast and dynamic network structure, as there are complex systems of interactions between the participating business entities in these transactions. This approach allows for the analysis of economic phenomena from a completely new perspective, which can be investigated by means of network analysis based on social network analysis (SNA).

In the literature, theoretical and empirical studies on the determinants of mergers and acquisitions (M&A) are extensive. Economists' analyses focus on CBM&A aspects such as motivation, value creation, and payment methods, as well as organizational aspects and cultural challenges. M&As offer important tools that firms can use to acquire new knowledge and capabilities while seeking growth [Tarba et al., 2020, p. 1]. However, despite

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the importance that is attached to M&A transactions in terms of growth and value creation, few studies address the topological characteristics of CBM&A as networks of complex interactions between countries [among others, Sánchez-Díez et al., 2016; Dueñas et al., 2017; Galaso and Sánchez-Díez, 2020]. The lack of research in this area is due to the fact that publicly available statistical data published by UNCTAD do not provide detailed information on bilateral CBM&A transactions at the country and sector levels simultaneously.

The main aim of the paper is to evaluate the topology properties (the geographical and sectoral structure) of the global CBM&A network between 1990 and 2021. It is done based on statistical data taken from the Refinitiv M&A database. The global CBM&A network is analyzed using the SNA method, and the role of particular countries and the interdependencies between them are determined from the network viewpoint. This is achieved by measuring the structural power of each country using the degree, betweenness, and eigenvector centrality methods. Two software packages (Gephi 0.9.2 and Ucinet 6) are used to visualize the CBM&A network and calculate the values of the network indicators.

The rest of this article is structured as follows. The next section presents a literature review of the prior studies that have used SNA to research M&A. Section 3 describes the research methodology, especially the network analysis metrics used in the analysis of M&A. Section 4 reveals the results of empirical studies. Finally, Section 5 contains concluding remarks and discusses the study's limitations.

2 Literature review regarding the use of SNA in research in M&A

SNA is an interdisciplinary research method initially used in sociology, mathematics, biology, computer science, and physics. This approach is not yet widespread in economics, although it is increasingly applied to study enterprise networks and international financial crises [Elliott et al., 2014], business networks [Vitali and Battiston, 2014], economic networks, and trade networks [Dong, 2022]. In the latest research, network analysis has also been widely adopted when examining research collaborations, including the transfer of knowledge and technology [Kim et al., 2016; Jacob and Duysters, 2017]. In particular, studies on the network-based approach to analyzing FDI have proliferated in recent years, e.g., Lima et al. [2020] and Li et al. [2018] used network analysis tools to analyze the structure of FDI.

Several studies have used network analysis to investigate M&A data. Table 1 presents a survey of the network statistics (SNA parameters) employed in these studies. They can be divided into several areas, i.e., research focused on the macro [Sánchez-Díez et al., 2016; Dueñas et al., 2017; Galaso and Sánchez-Díez, 2020; Guo et al., 2021; Chen et al., 2022], meso [Brózda-Wilamek, 2020; Brózda-Wilamek, 2021; Waßenhoven et al., 2021], and micro levels [Guo et al., 2019].

Sánchez-Díez et al. [2016] analyzed the changing role of Spanish investment through M&A operations in Latin America. Using the SNA methodology, which they believe enables a more complex analysis than traditional approaches, they examined the position of individual countries as members of a network being analyzed. Using centrality and density indicators, they revealed the structure of the network and how it changes through time, thus showing the relative position of each country investing in Latin America. Their empirical study indicated that between 1999 and 2012, the international M&A networks in Latin America were very concentrated. Spanish enterprises were leading players in this region, but their role has gradually decreased with the arrival of new investors (among others, BRA, USA, MEX, and CHN). However, when they analyzed CBM&A transactions in individual sectors (i.e., telecommunications, energy, and finance), they noticed that sectoral M&A networks were somewhat less concentrated than the overall network.

Using SNA analysis techniques, interesting research at the macro level was also conducted by Chen et al. [2022] and Guo et al. [2021], focusing on selected sectors. Chen et al. [2022] checked the connectedness of acquirer-target countries for CBM&A transactions in the banking sector between 1995 and 2009. They found that the acquiring banks are commonly interconnected with the targeted banks and that some of acquiring banks are visibly concentrated in Asian countries, including China, Hong Kong, and Philippines. Guo et al. [2021] explored global M&A in the oil and gas sector using network analysis. Additionally, a pioneering study of the entire international M&A network using a complex network approach was conducted by Galaso and Sánchez-Díez [2020] and Dueñas et al. [2017].

Table 1. The synthesis of SNA parameters used in selected research concerning M&A transactions

Analysis level	Authors of research	Period	Network type	Nodes	Edges	Network indicators
Macro	Sánchez-Díez et al. [2016]	1999–2012	The overall weighted-directed CBM&A network in Latin America	Countries	Value of CBM&A transactions	Density, total degree, centrality, eigenvector, out-degree, in-degree
			Three weighted-directed sectoral CBM&A networks for the energy, finance, and telecommunications sectors			
	Dueñas et al. [2017]*	1995–2010	The binary-directed CBM&As network	Countries	Number of CBM&A transactions	Density, reciprocity, degree, average nearest-neighbor degree, clustering coefficient
			The weighted-directed CBM&As network		Value of CBM&A transactions	
	Galaso and Sánchez-Díez [2020]	1999–2013	The binary-directed CBM&As network	Countries	Number of CBM&A transactions	Density, reciprocity, core-periphery model, in-degree, out-degree, eigenvector
			The weighted-directed CBM&As network		Value of CBM&A transactions	
Meso	Brózda-Wilamek [2020]	2000–2017	The directed Chinese CBM&As network	Industry sectors	Number of CBM&A transactions	Degree, in-degree, out-degree, closeness, eigenvector
	Brózda-Wilamek [2021]	2010–2020	Three separate directed networks for Hungarian, Czech, and Polish CBM&A transactions	Business sector	Number of CBM&A transactions	Degree, in-degree, out-degree, betweenness, eigenvector
	Waßenhoven et al. [2021]	1995–2018	The industry-directed network of M&A data	Industry sectors where at least one sector is related to the bioeconomy	Number of M&A transactions	Density, average geodesic distance, reciprocity, degree, out-degree, in-degree, betweenness
Micro	Guo et al. [2019]	2000–2017	The directed Chinese company M&A network	Chinese companies	Value of M&A transactions	Out-degree, in-degree, betweenness, closeness, PageRank

*For this survey, both sets of network statistics are used in their corresponding directed versions.
Source: Own study.
CBM&A, cross-border mergers and acquisitions; M&A, mergers and acquisitions; SNA, social network analysis.

Duenas et al. [2017] found that the global M&A network is a highly concentrated and low-density network, with low levels of reciprocity, revealing that most countries are targets of a few acquirers. They also compared the results of the analysis conducted for the CBM&A network with the network parameters representing the international trade network (ITN). They noted that the most relevant difference between these networks is the level of relationship reciprocity. In contrast to M&A transactions, which are mainly

unilateral, trade relations are typically reciprocal, leading to a higher density and full connectivity. However, both the CBM&A and the ITN are characterized by highly unbalanced bilateral flows. In the ITN, developed countries have more balanced trade relationships than developing countries.

Finally, Galaso and Sánchez-Díez [2020] estimated the fitness of Borgatti and Everett's [2000] core-periphery model to the international M&A network. They found that the fitness is high, and any changes over the years are minimal. Using network analysis techniques, between 1999 and 2013, the hard-core (CAN, GBR, and USA), core, and semiperiphery countries were identified. Eight developed countries (AUS, FRA, DEU, ITA, JAP, NLD, ESP, and SWE) and four emerging economies (BRA, CHN, HKG, and IND) were found to be the core of the network. A larger and more heterogeneous semiperiphery (with 41 countries), including developed economies of intermediate size, emerging nations, and tax havens, was also observed.

In the literature on the subject, network analysis is also a valuable tool for detecting inter-industry collaborations. For instance, Waßenhoven et al. [2021] used this research method to analyze the structure of the bioeconomy. They visualized emerging business ecosystems using the industry network analysis of M&A data. Network analysis allowed them to identify crucial (central) industry sectors, such as the chemical and food industry, in this network. The relationships between individual economic sectors were also analyzed as part of cross-border investments in specific regions of the world.

Brózda-Wilamek [2020] considered the structure of the Chinese M&A market using network analysis measures. Attention was focused on sectoral CBM&A transactions, in which the acquiring company is a Chinese firm and the target company is foreign. After the network analysis, she stated that since the beginning of the 21st century, Chinese companies have aspired to be very active participants in the global M&A market, as they are also active investors in non-Asian countries. Chinese enterprises from the finance, energy, automobiles, and electronics sectors have played an important role in CBM&As, occupying a central place in the network.

In turn, Brózda-Wilamek [2021] evaluated the geographical and sectoral structure of the Polish, Czech, and Hungarian CBM&A networks between 2010 and 2020. As a result, she found evidence that Polish, Czech, and Hungarian companies are characterized by investment activity not only in Central and Eastern European countries, but also in Western Europe, RUS, and the USA. Enterprises from the financial, industrial, consumer cyclical, and technology sectors have played an important role in CBM&A networks.

There are also studies [e.g., Fox et al., 2013] that used network analysis to model relationships between and inside firms, as well as the overall entity structure of a selected industry. Meanwhile, Guo et al. [2019] assessed the Chinese M&A market structure using network analysis measures. Considering the data on financial flows made exclusively by Chinese companies, they created the directed M&A network, using basic centrality indicators (degree, betweenness, and closeness) and the PageRank algorithm. Interesting studies were also conducted by Barros et al. [2022] and Chaudhry et al. [2022]. Barros et al. [2022] tested hypotheses regarding the relationship between small-world network[1] properties and M&A based on a sample of large publicly listed corporations in Brazil between 2000 and 2015. In turn, Chaudhry et al. [2022] examined the role of the social network hierarchy of financial advisory companies in the M&As framework. In both of the studies mentioned above, network analysis and regression techniques (OLS) were used simultaneously.

The literature review revealed that previous research focused mainly on specific countries, industry sectors, or enterprises. The only exceptions were Dueñas et al. [2017] and Galaso and Sánchez-Díez [2020], although they covered the periods 1995–2010 and 1999–2013, respectively. Therefore, the results are out of date, and it is necessary to extend the time frame for such analysis. It can therefore be concluded that a more holistic research perspective in conjunction with a network approach is needed to analyze the multi-level structure of the global CBM&A network in the relatively long term.

1 A small-world network is a type of network structure in which nodes are highly clustered and at short distances without being directly linked.

3 Research method and data section

SNA was initiated as a scientific research method in the USA at the end of the 1960s. Also known as structural analysis, it allows the study of various relationships (multi-element or multi-level) that form and operate within the economy between various types of entities, i.e., people, enterprises, organizations, countries, or sectors. It derives from graph theory, matrix algebra, and statistics [Wasserman and Faust, 1994] and makes the graphical visualization of data possible. With a set of analytical tools, it enables the detailed identification of relationship characteristics and dependencies between entities that are not visible from an individual point of view. In the case of M&A analysis, the SNA method makes it possible to show networks of business relations as a kind of superior structure and to identify indirect capital links that were thus far unnoticeable.

In SNA, the network is composed of entities and connections. Thus, two main elements that form a network can be distinguished [Barabasi, 2012]:

- nodes (vertices) – entities included in the system,
- edges (relations) – relationships that reflect interactions between entities in the system.

In empirical research, networks are often presented in the form of graphs. The node is presented as a circle and the edge as a straight line linking two nodes.

In this paper, similar to Guo et al.'s study [2021], the directed M&A network was analyzed, with taking home countries and host countries as nodes. Edges refer to the investment relationship between countries established by M&A transactions.

The literature review shows that a wide range of indicators different from traditional statistical methods is used in the M&A network analysis. A detailed list is presented in Table 1. For this study, the following network statistics were selected:

(1) The indicators that reveal general characteristics of the network [Abramek, 2021, pp. 114–119]:

- density – measures how close the network is to being complete, i.e., a complete network has all possible edges and a density equal to 100%,
- reciprocity (mutuality) – measures the number of ties that are reciprocated in a network. This indicator reflects the ratio of feedback compounds to the number of all compounds in the network.

(2) The indicators that make it possible to observe the position of a given node (country) in the network [Yang et al., 2017, pp. 61–88]:

- degree centrality – the number of direct connections,
- betweenness centrality – the gatekeeper between other nodes,
- eigenvector centrality (prestige centrality) – the influential position of a node.

The interpretation of these indicators should be adapted to the type of considered network.

For the CBM&A network, the first dimension of centrality, i.e., degree centrality, makes it possible to specify the number of direct transaction relations between acquirer countries (i.e., investors) and target countries (i.e., countries hosting capitals from a foreign country). Galaso and Sánchez-Díez [2020, p. 40] point out that in the case of directed networks for a given node, the following can also be calculated:

(1) out-degree centrality – in this paper, it measures the number of outgoing links that represent the investments from the country through CBM&A operations,
(2) in-degree centrality – in this paper, it measures the number of incoming links that represent the investments in the country through CBM&A operations.

Betweenness is a measure of centrality in a network based on the shortest paths. It shows how often the analyzed entity is on the shortest relationship path between the vertices and indicates, and which nodes are the most significant in the context of communication between nodes [Lee and Sohn, 2016, p. 84]. For instance, in CBM&A networks, betweenness centrality determines the extent to which a country is a link between two other countries.

Another indicator to determine the relative importance of a country in the CBM&A is eigenvector centrality, also known as prestige centrality. It identifies which vertices are associated with the most related nodes that form the network. It measures the relative prominence of entities by considering not only their direct links, but also the links of their direct and indirect neighbors [Galaso and Sánchez-Díez, 2020, p. 37]. This indicator is used to identify the most prestigious vertices and determines the quality of connections between nodes. A high eigenvector centrality value indicates that the nodes are leaders in the network because they have many relations with other entities that hold a significant position in the system [Lee and Sohn, 2016, p. 111].

In an attempt to use centrality measures to study the topology properties of the global CBM&A network, the data were taken from the Refinitiv Eikon database. The research sample was constructed in two stages. In the first stage, the companies-level data on M&A were aggregated at the countries and economic sectors level. In the second stage, there was a removal of all domestic M&A operations and transactions in which the home or host country was unknown. The final research sample includes all completed CBM&A operations from 1990 to 2021. The sample covered all countries operating in the global economy. Deals were assigned to years depending on their date of completion. Disallowed or withdrawn transactions were ignored. Only the number of CBM&A transactions was considered; the value of these transactions was omitted due to the lack of complete data. For most of the M&A transactions listed in Eikon's Refinitiv database, the deal value was not specified.

For the purposes of this study, separately for each year, 32 networks for the aggregated at the countries-level CBM&A transactions were constructed. Based on the values of individual centrality indicators, the separate ranking lists have been prepared for these networks. Then, to study the evolving characteristics of the global CBM&A network, the results were divided into eight 4-year timeframes. The last column (see Tables 2–5) shows the averaged values of the network indicators for the whole period covered by the research sample. The constructed networks are stable since removing the relatively crucial node (in this study USA was chosen) from the system does not dramatically change the ranking lists. Comparing the data in Table A1 in Appendix with the data in Tables 3 and 4, it can be seen that in most cases the same countries are included in the top 10 rankings for the main centrality measures.

Table 2. The main investment destinations of the top 10 countries with the highest average out-degree value, 1990–2021

		Average number of CBM&A transactions								
Source country	**Target country**	**1990–1993**	**1994–1997**	**1998–2001**	**2002–2005**	**2006–2009**	**2010–2013**	**2014–2017**	**2018–2021**	**1990–2021**
USA	GBR	123	211	309	193	244	246	318	335	247
	CAN	84	174	264	187	271	227	272	307	223
	DEU	47	118	113	115	115	98	102	98	101
	AUS	23	52	83	49	78	88	90	102	70
	FRA	45	79	87	64	68	58	74	74	68
GBR	USA	113	152	229	132	176	141	185	213	168
	DEU	35	54	70	54	71	50	60	62	57
	FRA	47	60	69	48	41	35	48	58	51
	AUS	17	23	46	32	56	38	37	41	36
	NLD	25	30	37	23	25	21	42	59	33
CAN	USA	76	160	257	230	275	263	299	368	241
	GBR	13	24	23	20	25	27	35	44	26
	AUS	3	10	13	13	21	23	18	24	16
	MEX	1	5	4	11	31	23	9	5	11
	FRA	5	11	10	7	8	9	10	10	9

(*Continued*)

Table 2. Continued

		Average number of CBM&A transactions								
Source country	**Target country**	**1990–1993**	**1994–1997**	**1998–2001**	**2002–2005**	**2006–2009**	**2010–2013**	**2014–2017**	**2018–2021**	**1990–2021**
DEU	USA	20	29	90	36	53	45	68	54	49
	GBR	23	25	53	31	39	26	39	39	34
	FRA	28	34	47	29	31	27	30	33	32
	CHE	15	24	50	24	41	26	28	28	29
	AUT	12	21	41	20	29	19	24	24	24
FRA	USA	24	24	64	37	51	42	59	58	45
	DEU	27	41	38	27	32	31	42	41	35
	GBR	29	23	46	23	36	34	43	45	35
	ESP	22	15	29	21	31	24	44	49	29
	ITA	27	24	29	15	23	20	30	38	26
NLD	CHN	4	26	66	102	132	154	186	111	97
	USA	8	8	13	8	15	17	25	14	13
	AUS	4	5	8	9	20	27	14	17	13
	SGP	4	5	11	13	11	9	17	15	11
	GBR	10	7	5	3	8	7	15	12	8
JPN	FIN	12	26	35	22	31	19	26	48	27
	NOR	9	9	29	23	36	37	34	40	27
	USA	8	10	27	15	26	22	27	38	21
	DNK	10	9	22	20	26	25	27	31	21
	GBR	12	8	19	15	23	14	17	29	17
HKG	USA	90	36	46	27	43	59	70	80	56
	CHN	1	5	7	14	13	24	17	14	12
	GBR	16	7	7	8	8	14	22	14	12
	VNM	0	1	0	0	4	15	15	18	6
	IND	1	1	5	3	6	18	18	16	9
SWE	DEU	17	40	44	28	37	30	35	37	33
	USA	14	22	44	13	29	21	25	31	25
	GBR	16	20	34	21	30	23	22	29	24
	BEL	11	14	23	19	25	16	19	21	18
	FRA	9	20	29	15	15	13	18	14	17
CHE	DEU	17	29	34	34	54	40	50	44	38
	USA	12	20	30	19	36	30	38	36	28
	FRA	16	14	15	12	15	11	16	20	15
	GBR	8	8	14	9	17	12	11	18	12
	ITA	6	6	14	5	11	11	13	13	10

Source: Own calculations.
CBM&A, cross-border mergers and acquisitions.

Table 3. The ranking of the top 10 countries for different degree centrality measurements, 1990–2021

Place in the ranking	Average place								
	1990–1993	1994–1997	1998–2001	2002–2005	2006–2009	2010–2013	2014–2017	2018–2021	1990–2021
	Degree centrality								
1	USA	USA	USA	USA	USA	USA	USA	USA	USA
2	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR
3	FRA	DEU	DEU	DEU	DEU	CAN	DEU	CAN	DEU
4	DEU	FRA	FRA	CAN	CAN	DEU	CAN	DEU	CAN
5	CAN	CAN	CAN	FRA	FRA	FRA	FRA	FRA	FRA
6	JPN	NLD	NLD	AUS	AUS	AUS	CHN	NLD	NLD
7	NLD	AUS	SWE	CHN	CHN	CHN	HKG	AUS	AUS
8	ITA	CHE	AUS	NLD	NLD	NLD	NLD	ESP	SWE
9	SWE	SWE	CHE	HKG	SWE	HKG	AUS	SWE	CHN
10	CHE	ITA	ITA	SWE	HKG	RUS	ESP	CHN	HKG
	In-degree centrality								
1	USA	USA	USA	USA	USA	USA	USA	USA	USA
2	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR
3	FRA	DEU	DEU	DEU	DEU	DEU	DEU	DEU	DEU
4	DEU	FRA	FRA	CHN	CAN	CAN	CAN	CAN	CAN
5	ITA	CAN	CAN	CAN	CHN	CHN	CHN	ESP	FRA
6	CAN	AUS	AUS	FRA	AUS	AUS	FRA	FRA	AUS
7	ESP	ITA	NLD	AUS	FRA	RUS	ESP	NLD	CHN
8	NLD	NLD	ESP	HKG	IND	FRA	AUS	AUS	ESP
9	AUS	ESP	ITA	ESP	RUS	IND	ITA	ITA	NLD
10	SWE	SWE	SWE	SWE	SWE	BRA	NLD	CHN	ITA
	Out-degree centrality								
1	USA	USA	USA	USA	USA	USA	USA	USA	USA
2	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR
3	FRA	CAN	DEU	CAN	CAN	CAN	CAN	CAN	CAN
4	JPN	DEU	FRA	DEU	DEU	DEU	FRA	FRA	DEU
5	DEU	FRA	CAN	FRA	FRA	FRA	DEU	DEU	FRA
6	CAN	NLD	NLD	NLD	NLD	HKG	HKG	JPN	NLD
7	NLD	CHE	SWE	HKG	AUS	JPN	JPN	SWE	JPN
8	CHE	SWE	CHE	SGP	HKG	NLD	CHN	NLD	HKG
9	SWE	JPN	BEL	SWE	SWE	CYP	SGP	SGP	SWE
10	ITA	AUS	JPN	AUS	CHE	SGP	NLD	HKG	CHE

Source: Own calculations.

Table 4. The ranking of the top 10 countries in terms of the betweenness and eigenvector centrality, 1990–2021

Place in the ranking	Average place								
	1990–1993	1994–1997	1998–2001	2002–2005	2006–2009	2010–2013	2014–2017	2018–2021	1990–2021
	Betweenness centrality								
1	USA	USA	USA	USA	USA	USA	USA	USA	USA
2	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR
3	FRA	FRA	FRA	CAN	CAN	CAN	FRA	FRA	FRA
4	DEU	DEU	CAN	DEU	AUS	AUS	CAN	CAN	CAN
5	HKG	CAN	RUS	FRA	FRA	RUS	DEU	AUS	DEU
6	CAN	ZAF	DEU	AUS	DEU	FRA	HKG	DEU	AUS
7	ITA	SGP	AUS	ESP	RUS	DEU	AUS	ESP	RUS
8	AUS	AUS	ZAF	IND	NLD	ESP	SGP	NLD	ESP
9	NLD	ITA	ESP	RUS	ITA	CHN	CHN	SGP	NLD
10	ESP	NLD	IND	CHE	ESP	ZAF	ZAF	HKG	ZAF
	Eigenvector centrality								
1	USA	USA	USA	USA	USA	USA	USA	USA	USA
2	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR
3	FRA	DEU	CAN	CAN	CAN	CAN	CAN	CAN	CAN
4	DEU	CAN	DEU	DEU	DEU	DEU	DEU	DEU	DEU
5	CAN	FRA	FRA	FRA	AUS	AUS	FRA	AUS	FRA
6	ITA	AUS	AUS	AUS	CHN	FRA	AUS	FRA	AUS
7	ESP	ITA	NLD	CHN	FRA	BRA	ESP	ESP	NLD
8	NLD	NLD	ITA	NLD	IND	IND	NLD	NLD	ESP
9	AUS	ESP	ESP	ESP	NLD	CHN	ITA	ITA	ITA
10	SWE	CHE	BRA	IND	ESP	ESP	IND	IND	CHN

Source: Own calculations.

Table 5. Average percentage shares of individual economic sectors in the global CBM&A network, 1990–2021

Economic sector	1990–1993	1994–1997	1998–2001	2002–2005	2006–2009	2010–2013	2014–2017	2018–2021	1990–2021
	TRBC* economic sector of the acquirer								
Financial	17%	17%	19%	25%	29%	32%	36%	37%	26.4%
Industrial	22%	23%	22%	19%	18%	18%	17%	17%	19.4%
Basic materials	18%	17%	17%	14%	12%	12%	12%	10%	14.0%
Technology	16%	14%	11%	11%	11%	10%	8%	7%	10.8%
Consumer cyclicals	6%	8%	12%	12%	11%	10%	11%	14%	10.4%
Healthcare	9%	8%	6%	7%	5%	6%	5%	5%	6.4%
Consumer non-cyclicals	5%	4%	4%	5%	5%	5%	5%	6%	5.0%
Energy	4%	4%	3%	4%	4%	4%	3%	2%	3.5%
Telecommunications services	1%	2%	3%	3%	2%	1%	1%	1%	1.9%
Utilities	1%	1%	2%	2%	2%	1%	1%	1%	1.6%

(*Continued*)

Table 5. Continued

Economic sector	1990–1993	1994–1997	1998–2001	2002–2005	2006–2009	2010–2013	2014–2017	2018–2021	1990–2021
	TRBC* economic sector of the target								
Industrial	25%	25%	27%	22%	22%	22%	21%	21%	23.2%
Financial	20%	20%	17%	16%	16%	16%	16%	14%	17.0%
Technology	11%	11%	12%	13%	14%	14%	16%	14%	13.1%
Consumer cyclicals	7%	7%	12%	13%	13%	12%	15%	19%	12.2%
Basic materials	15%	15%	11%	12%	12%	13%	9%	8%	11.8%
Consumer non-cyclicals	10%	9%	8%	8%	7%	8%	9%	7%	8.2%
Healthcare	6%	5%	5%	6%	6%	6%	7%	9%	6.3%
Energy	4%	4%	3%	4%	5%	6%	4%	3%	4.3%
Utilities	1%	2%	3%	3%	2%	2%	1%	2%	2.0%
Telecommunications services	1%	1%	2%	2%	2%	2%	2%	3%	1.9%

*TRBC.

Source: Own calculations.

CBM&A, cross-border mergers and acquisitions; TRBC, The Refinitiv Business Classifications.

4 Discussion and results

The literature on the subject emphasizes that the CBM&A scale has increased significantly over the last two decades [Tarba et al., 2020, p. 1]. As illustrated in Figure 1, throughout the analyzed period, CBM&A transactions, on average, accounted for about 25% of the total number of all M&A operations taking place in the global economy. Moreover, the data in Figure 1 show that both the number of domestic and cross-border M&A showed the same development trend, corresponding to the trends in the global M&A market.

In particular, between 1990 and 2000, the number of all types of M&A transactions increased more than threefold. However, from 2000–2002, the dynamic upward trend was reversed, which could have been caused by, *inter alia*, increased investor caution after the dot-com boom burst. In 2007, the number of global M&A transactions increased by about 80% compared to 2002, before recording a slight decrease due to the beginning of the global financial crisis. Between 2009 and 2013, the number of global M&A operations remained relatively stable, but since 2013, the number has systematically increased. In 2018, it exceeded the level before the subprime crisis. In 2020, the lockdown introduced in many countries as a result of the COVID-19 pandemic also translated into reduced investor activity in the global M&A market.

Figure 2 summarizes the overall results of the CBM&A network analysis between 1990 and 2021. Compared to the results of the study by Galaso and Sánchez-Díez [2020, p. 38] and Dueñas et al. [2017, p. 4], the analyzed network (despite its directional character) was characterized by a relatively high density (on average, about 26%) in the entire analyzed period, recording the highest level between 1998 and 2001. It means that between 1990 and 2021, the global CBM&A network was, on average, approximately 26% complete.

Until the beginning of the 21st century, the number of countries (nodes) that engaged in CBM&A transactions systematically (gradually) increased, reaching a peak in 2006–2009. After the global financial crisis, the number of nodes forming the global CBM&A network remained at a relatively stable but slightly lower level. Between 2010 and 2021, economic entities that established network relations within CBM&A came from, on average, 173 different countries (see Figure 2). Therefore, from the beginning of the 21st century, practically all countries that function in the world economy were, to a greater or lesser extent, involved in international M&A.

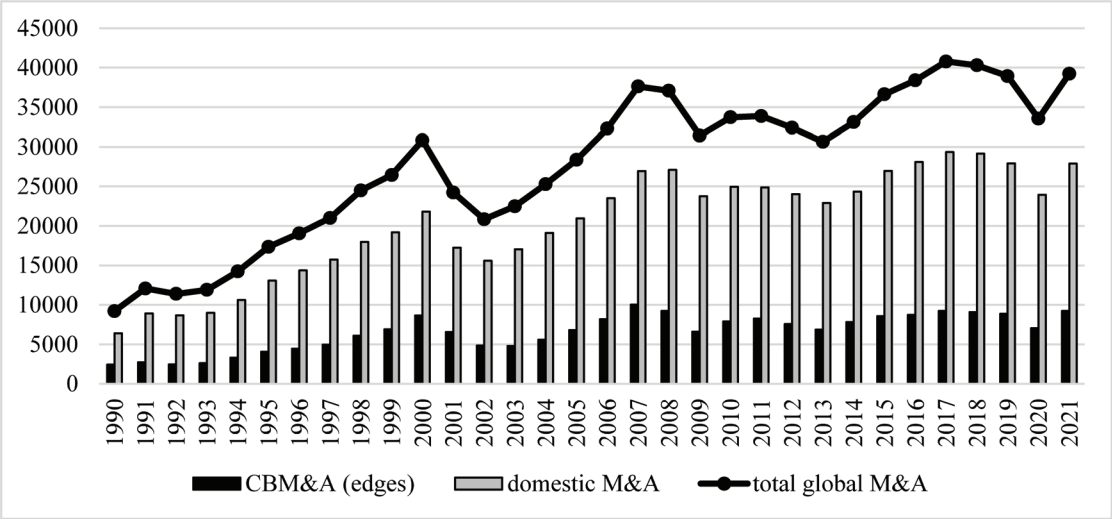


Figure 1. Number of global M&A transactions per year.

Source: Own calculations. CBM&A, cross-border mergers and acquisitions; M&A, mergers and acquisitions.

Figure 2 also shows that between 1990 and 2021, on average, about 30% of CBM&A transactions between countries were reciprocal, bilateral connections. Additionally, in the entire analyzed period, the average level was about 10 percentage points higher than that in Dueñas et al.'s study [2017].

An overview of the major nodes (ranking list) according to the individual centrality measures is provided in Tables 3 and 4. As in the study by Galaso and Sánchez-Díez [2020], between 1990 and 2021, the highest level of the three degree centrality measurements (Table 3) was recorded by the top five countries: USA, GBR, DEU, CAN, and FRA. Throughout the analyzed period, these nodes were the most central actors in the network as they maintained the majority of relationships with all actors participating in the system. Furthermore, enterprises originating mainly from these countries expanded their activities abroad through CBM&A. These countries also received the largest inflow of foreign capital.

The dominance of these countries is additionally confirmed by the global CBM&A network visualization for 2021. The network shown in Figure 3 is very extensive and relatively densely connected. There is a clear division of nodes into the strict center (countries with the most investment relations with other countries) and the periphery of the network (the countries on the outskirts of the graph where economic entities are located that concluded individual M&A transactions with foreign partners in 2021). The nodes located in the center of the graph largely coincide with the countries classified by Galaso and Sánchez-Díez [2020] as the core of the global CBM&A network between 1999 and 2013.

When analyzing the data in Table 2, attention should also be paid to polarized investment relations between the central countries that formed the CBM&A network between 1990 and 2021. For instance, while the USA showed increased investment activity in GBR, CAN, DEU, AUS, and FRA, these countries, excluding AUS, also conducted M&A with American economic entities. Within this group of countries, two-way CBM&A transactions also took place between British, German, and French companies.

Apart from the aforementioned top five countries, other Western European countries (i.e., NLD, SWE, ITA, and CHE) also recorded a relatively high level of degree centrality (see Table 2). Moreover, between 1990 and 1993, JPN also occupied a central position in the global CBM&A network, although its role decreased in subsequent periods. In 1994, JPN was overtaken by Australian economic entities, which, from 2002–2013, were in sixth place (see Table 2). From the beginning of the 21st century, attention should also be paid to the growing importance of Asian countries (i.e., CHN and HKG). However, their role in the global CBM&A network decreased significantly between 2018 and 2021.

When assessing the level of in-degree centrality, it should be noted that apart from the aforementioned top five countries, the most common M&A facilities were Chinese enterprises (since 2002), and between 2006 and 2013, Indian companies, too. Additionally, between 1990 and 2021, AUS, ESP, NLD, and ITA also received a relatively large inflow of foreign capital in the global CBM&A network.

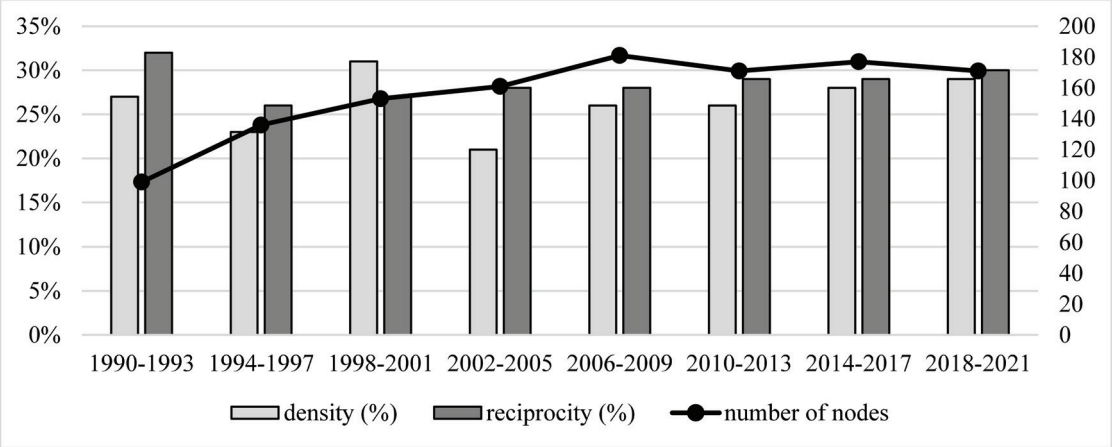


Figure 2. The topological characteristics of the global CBM&A network from 1990 to 2021.
Source: Own calculations. CBM&A, cross-border mergers and acquisitions

Based on a detailed analysis of the out-degree centrality, it can be concluded that apart from the above-mentioned top five countries, other European and Asian countries also invested heavily abroad (see Table 2). In particular, in the remaining Western European countries, increased investment activity was characterized by (see Table 3):

- Dutch companies – in CHN, USA, AUS, and SGP;
- Swedish companies – in DEU, USA, GBR, BEL, and FRA;
- Swiss companies – in DEU, USA, FRA, GBR, and ITA.

Moreover, between 1990 and 2001, Japanese companies initiated CBM&A transactions, mainly in the USA and on the European continent (i.e., FIN, NOR, DNK, and GBR). However, after 2002, their place was taken by entities from HKG, SGP, and to a lesser extent, CHN. There has been a renewed increase in the activity of Japanese companies that initiate the M&A processes of foreign enterprises since 2010 (see Table 2).

Throughout the analyzed period, the American, British, French, Canadian, German, and Australian economies were leaders in terms of the betweenness centrality (see Table 4), although a relatively high value of this indicator was also recorded in the Russian, Spanish, Dutch, Italian, and South African economies. The above-mentioned nodes acted as the main bridges between the countries that form the global CBM&A network. Since 2010, the economies of Asian countries (i.e., CHN, HKG, and SGP) were also important intermediaries in the analyzed network, while between 1998 and 2005, IND could also be included. China's growing role in global M&A markets was confirmed by Wolf et al. [2011].

Based on the eigenvector value, it can be concluded that, on average, between 1990 and 2021, for relatively important nodes in the CBM&A network (flagship entities), apart from the above-mentioned countries of North America (USA and CAN), Europe (GBR, FRA, DEU, ESP, and NLD), and AUS, there were also ITA, CHN, IND, and BRA. Enterprises with headquarters in these countries conducted M&A transactions mainly with entities located in the other most central countries in the global CBM&A network.

The analysis of the sectoral global CBM&A network structure leads to the following conclusions. Generally, between 1990 and 2021, transactions in the following sectors played a marginal role: healthcare, consumer non-cyclicals, energy, telecommunications services, and utilities.

Over the past 30 years, companies assigned to the financial (26.4%), industrial (19.4%), basic materials (14%), technology (10.8%), and consumer cyclicals (10.4%) sectors have expanded their activities through CBM&A. Based on a detailed analysis of the acquirer's economic sector, it can be stated that the importance of the financial sector has increased significantly, while the role of the technology, basic materials, and industrial sector has slightly decreased.

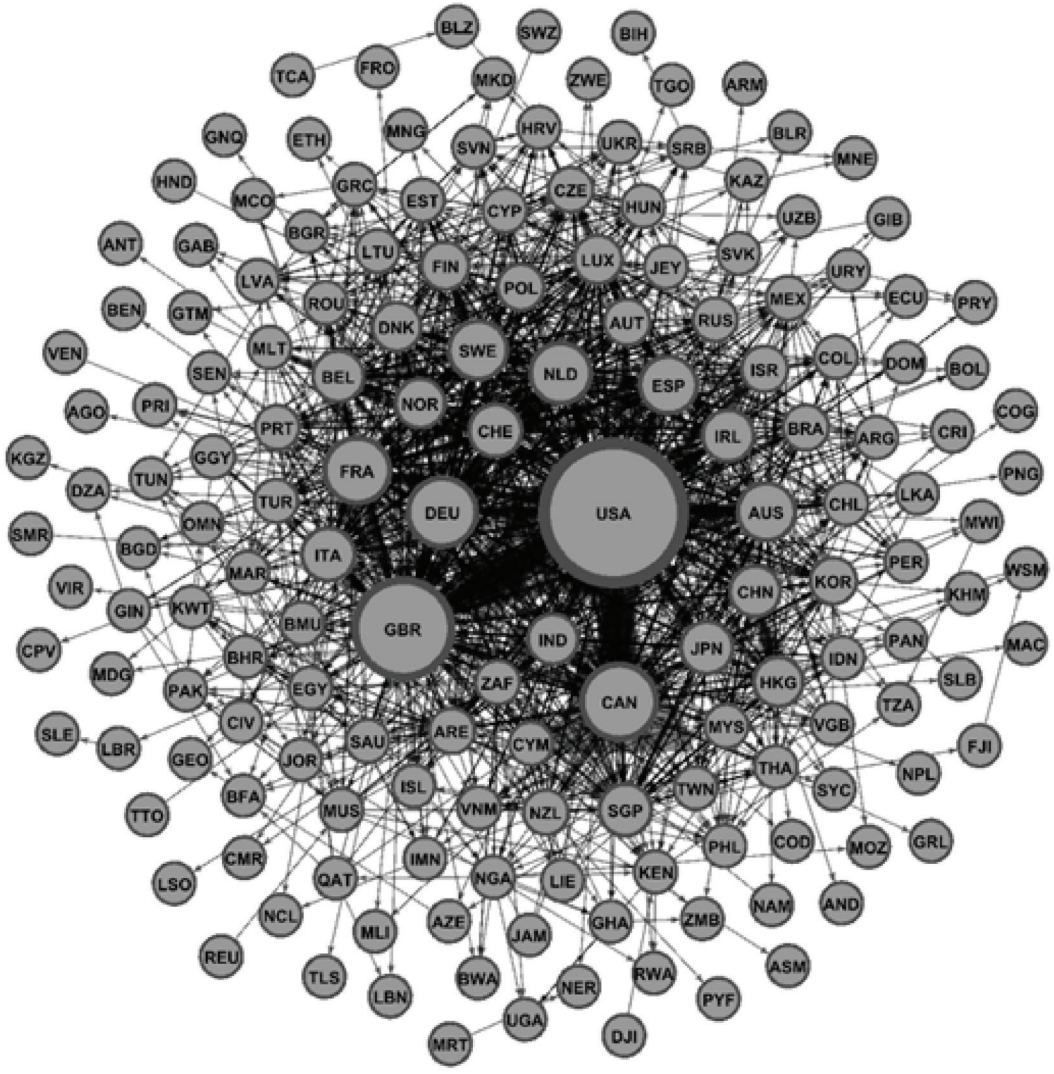


Figure 3. The global CBM&A network in 2021. *Nodes are represented by countries, and the tie strength is reflected by the number of transactions. The Fruchterman-Reingold algorithm is used to visualize the network. The size of the nodes replicates the level of the degree indicator.
Source: Own calculations in Gephi 0.9.2. CBM&A, cross-border mergers and acquisitions.

In turn, when assessing the target's economic sector, across the entire period, entities from the industrial (23.2%), financial (17%), technology (13.10%), consumer cyclicals (12.2%), and basic materials (11.8%) sectors were the main investment targets in the global CBM&A network. It is also noteworthy that between 1990 and 2021, within the target's economic sector, the importance of the consumer cyclicals sector increased, while the share of transactions conducted in the industrial, financial, and basic materials sectors slightly decreased.

5 Conclusions

This paper analyzed the structure, evolution, and topological characteristics of global CBM&A networks over the past 30 years. To summarize, the results of this study, like those of Galaso and Sánchez-Díez [2020], reveal that the directions of FDI implemented in the form of CBM&A are driven by polarized and unequal relationships between countries.

In particular, between 1990 and 2021, the global CBM&A network was characterized by relatively high density and a stable geographical structure. There was a considerable number of interrelationships between the given country pairs that engage in CBM&A. While businesses from the financial, industrial, basic materials, technology, and consumer cyclicals sector made transactions in the global CBM&A network, they were also the main investment targets. In turn, transactions in the healthcare, consumer non-cyclicals, energy, telecommunications services, and utilities sectors played a marginal role.

Throughout the period under review, the economies of the USA, GBR, DEU, CAN, and FRA occupied the most central place in the network as they maintained the majority of investment relationships with all entities in the system. These countries played a key role in all calculated network metrics. Depending on the applied indicators, attention should also be paid to other Western European countries (NLD, SWE, ESP, ITA, and CHE), AUS, and BRA, and in the case of intermediation, also to RUS and ZAF.

Moreover, from the beginning of the 21st century, there has been a significant increase in the importance of Asian countries in the global CBM&A network, with CHN and IND receiving a large inflow of foreign capital. Entities from HKG, SGP, JPN, and CHN invested heavily abroad through M&A. Asian economies (i.e., CHN, HKG, SGP, and IND) also played the role of crucial intermediaries in the global CBM&A network.

Finally, it is important to highlight some limitations of the study. First, the results are presented for aggregated data at the country and economic sector levels. Comparative global ranking tables at the individual business sector and transnational corporation levels would be too extensive and thus illegible. Second, only the number of CBM&A transactions is considered; the value of these transactions is omitted due to the lack of availability of complete data in the Refinitiv M&A database.

Despite these limitations, it is also relevant that the study of the CBM&A topology using network analysis gives a kind of order to economic reality. This study showed which sectors are the most active and which countries play the important role of intermediaries in the global CBM&A transactions. Thus, the paper reviewed the main areas for consideration by policy-makers.

This publication presents a new perspective on evaluating the global CBM&A network, taking advantage of the relational nature of the M&A data. This article is an introduction to an in-depth analysis of CBM&A processes in the context of a network approach (using SNA tools). The issues discussed in this study require further analysis, the subject of which may be research on the ownership structure of the merging entities. It would also be worth identifying the structure of the CBM&A network, especially for the individual countries identified in this study as the most central nodes.

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Appendix

Table A1. The ranking of the top 10 countries for different centrality measurements, 1990–2021 (the node representing USA was removed from the network)

Place in the ranking	Average place								
	1990–1993	1994–1997	1998–2001	2002–2005	2006–2009	2010–2013	2014–2017	2018–2021	1990–2021
	Degree centrality								
1	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR
2	FRA	DEU	DEU	DEU	DEU	DEU	DEU	DEU	DEU
3	DEU	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA
4	NLD	NLD	NLD	HKG	AUS	CHN	CHN	NLD	NLD
5	ITA	AUS	SWE	NLD	NLD	AUS	HKG	ESP	SWE
6	SWE	CAN	CHE	CHN	CHN	RUS	NLD	SWE	AUS
7	CHE	SWE	ESP	AUS	SWE	HKG	SGP	CHN	HKG
8	ESP	CHE	ITA	SWE	HKG	CAN	ESP	SGP	CHN
9	JPN	ITA	AUS	SGP	CAN	NLD	AUS	AUS	CAN
10	AUS	HKG	BEL	CAN	CHE	SGP	CAN	HKG	ESP
	Betweenness centrality								
1	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR
2	FRA	DEU	FRA	CAN	CAN	CAN	FRA	FRA	FRA
3	DEU	FRA	CAN	DEU	AUS	AUS	CAN	DEU	CAN
4	CAN	CAN	DEU	FRA	FRA	FRA	DEU	CAN	DEU
5	HKG	AUS	ESP	AUS	DEU	RUS	AUS	ESP	AUS
6	ESP	ZAF	AUS	ESP	RUS	DEU	ESP	AUS	ESP
7	ITA	NLD	CHE	NLD	ESP	ESP	NLD	NLD	NLD
8	AUS	SGP	RUS	HKG	NLD	CHN	RUS	SGP	RUS
9	CHE	ITA	ZAF	CHE	ITA	SGP	HKG	ZAF	HKG
10	NLD	ESP	NLD	IND	IND	HKG	ITA	HKG	ITA
	Eigenvector centrality								
1	FRA	DEU	DEU	DEU	DEU	DEU	DEU	GBR	DEU
2	DEU	FRA	FRA	GBR	GBR	GBR	GBR	DEU	GBR
3	GBR	GBR	GBR	FRA	AUS	AUS	FRA	ESP	FRA
4	ITA	ITA	ESP	CHN	FRA	FRA	ESP	NLD	ESP
5	ESP	NLD	NLD	ESP	CHN	CHN	ITA	FRA	ITA
6	NLD	ESP	ITA	AUS	ESP	ESP	NLD	ITA	NLD
7	CHE	CHE	CHE	ITA	ITA	CAN	CHN	AUS	AUS
8	BEL	AUS	AUS	NLD	CAN	RUS	AUS	BEL	CHE
9	SWE	POL	SWE	CHE	SWE	NLD	CAN	IRL	CHN
10	AUS	AUT	BEL	SWE	RUS	ITA	CHE	SWE	SWE

Source: Own calculations.