Global City Formation in Climate Governance

Mapping city hierarchies in trans-national municipal climate networks

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MASTER'S THESIS

in partial fulfilment of the requirements for the
4CITIES Erasmus Mundus Joint Master Degree in Urban Studies

Submitted to Universität Wien, 15 June 2025
To be defended in Vienna, 4 July 2025

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Abstract (EN)

The urban governance of climate change is increasingly being rescaled to the global level by cities' evolving role in climate adaptation, resilience, sustainability, and environmental management policies within international organisations and institutions, and directly between each other. The rise of trans-national municipal climate networks (TMCNs) has spawned a body of literature investigating the connections between involved cities to determine the cities leading the overall global urban governance of climate change. However, previous studies have relied on a binary conception of city membership in TMCNs, either in or out, which ignores and demotes the gradient, asymmetric connections of cities to TMCNs. The oversimplification of membership prohibits the evolution of global city theory within TMCNs despite the known emergence of command-and-control centres, specialisation of cities, and hierarchical disposition of cities in TMCNs. Therefore, this study analyses the possible evolution of global city theory and global city formation within the context of TMCNs to reveal the potential divergences and parallels from the classically globalised cities in the world economy. Complete membership data of 40 city climate networks was gathered to compile the nonbinary membership data of over 16,000 cities and generate an index of membership depth in TMCNs. These were subsequently tested in a regression analysis against 39 centricity, vulnerability, globality, and path-dependency variables to identify trends in the depth of integration of cities in TMCNs. The study finds that 85% of TMCNs have some sort of internal stratification of membership which selects a narrow body of cities to act as conduits of global urban climate governance power and command-and-control centres, creates specialisations of cities by way of different TMCN integration methods, and attracts cities in well-developed, knowledge-based economies over those more at risk from the adverse effects of climate change. These facets imply an emerging aspect in global city formation from global urban climate governance; however, it does not materialise in all economically-integrated cities and shows a deviation from being concentrated in classical financial cities (particularly those in Asia, which are shallowly integrated). This may be due to the ability of some cities to re-specialise in global urban (climate) governance, the willingness to do so, and the role of city officials and decision-makers within cities. Future studies should focus on exploring qualitatively the factors that influence city membership depth and refining this study's methods.

Abstrakt (DE)

Städtische Klimapolitik wird zunehmend global ausgerichtet, da der Austausch von Städte innerhalb internationaler Organisationen und Institutionen sowie direkt untereinander eine immer wichtigere Rolle bei der Anpassung an den Klimawandel, der Widerstandsfähigkeit, der Nachhaltigkeit und den Managementstrategien spielt. Der Aufstieg transnationaler kommunaler Klimanetzwerke (trans-national municipal climate networks, TMCNs) hat eine Reihe von Veröffentlichungen hervorgebracht, die die Verbindungen zwischen den beteiligten Städten untersuchen, um die Städte zu ermitteln, die eine weltweit führende Rolle in der städtischen Klimapolitik einnehmen. Frühere Studien stützen sich jedoch auf ein binäres Konzept der Stadtmitgliedschaft in TMCNs – entweder Mitglied oder Nicht-Mitglied – was einen Informationsverlust hinsichtlich der Abstufungen und asymmetrischen Verbindungen von Städten zu TCMNs zur Folge hat. Diese übermäßige Vereinfachung der Mitgliedschaft verhindert die Weiterentwicklung der Global-City-Theorie innerhalb von TMCNs, obwohl bekannt ist, dass sich in TMCNs Kommando- und Kontrollzentren und Spezialisierungen sowie hierarchische Anordnungen von Städten herausgebildet haben. Diese Studie analysiert daher die mögliche Weiterentwicklung der Global-City-Theorie und der Global-City-Bildung im Kontext von TMCNs, um die potenziellen Unterschiede und Parallelen zu den klassischen Global Cities in der Weltwirtschaft aufzuzeigen. Dafür wurden vollständige Mitgliederdaten von 40 Städteklimanetzwerken gesammelt, um die nicht-binären Mitgliederdaten von über 16.000 Städten zusammenzustellen und einen Index für die Mitgliederstärke in TMCNs zu erstellen. Diese wurden anschließend in einer Regressionsanalyse mit 39 Variablen zu Zentralität, Vulnerabilität, Globalität und Pfadabhängigkeit getestet, um Trends in der Integrationsstärke von Städten in TMCNs zu identifizieren. Die

Studie kommt zu dem Ergebnis, dass 85% der TMCNs eine interne Mitgliedschaftsstruktur aufweisen, die eine kleine Gruppe von Städten als Vermittler der globalen städtischen Klimapolitik und als Kommando- und Kontrollzentren hervorbringt. Zudem haben unterschiedliche TMCN-Integrationsmethoden eine Spezialisierung der Städte und eine Bevorzugung von Städten in gut entwickelten, wissensbasierten Volkswirtschaften gegenüber Städten, die stärker von den negativen Auswirkungen des Klimawandels bedroht sind, zur Folge. Diese Befunde deuten auf einen neuen Treiber der Entstehung von global cities hin, der sich aus der weltweiten städtischen Klimapolitik ergibt. Dieser Aspekt betrifft jedoch nicht alle wirtschaftlich integrierte Städte und die Verteilung von Städten mit klimapolitischer Vorreiterrolle weicht von derer klassischer globaler Finanzstädte (insbesondere jener in Asien, die nur schwach integriert sind) ab. Dies könnte auf die Fähigkeit und Bereitschaft mancher Städte, sich auf die globale (Klima-)Stadtpolitik neu zu spezialisieren, sowie auf die Rolle der Stadtbeamten und Entscheidungsträger innerhalb der Städte zurückzuführen sein. Zukünftige Arbeiten sollten sich darauf konzentrieren, die Faktoren, die die Tiefe der Stadtmitgliedschaft beeinflussen, qualitativ zu untersuchen und die in dieser Studie verwendeten Methoden zu verfeinern.

31 498 words

Acknowledgments

Throughout this thesis, many influential voices have provided invaluable feedback, thoughts, and ideas that have shaped this work into what it is. In particular, I wish to thank:

My supervisor, Prof. Rosa de la Fuente, for the knowledgeable and indispensable conversations that helped guide this research and for taking me on as a supervisee amid her incredible work.

The attendants of the 4CITIES thesis seminars in Vienna, Copenhagen, and Madrid for providing insightful discussions and feedback at critical stages of the thesis process and for braving my sometimes-nonsensical ramblings.

The 4CITIES teaching and administrative staff for making such an exceptional program possible and putting in the time, effort, and love in teaching us about all things urban and herding 4CITIZENs around their beautiful cities.

My family for their consistent and unwavering support halfway across the world, enabling me to participate in this programme.

And, lastly, my family among the 4CITIZENS of Cohort 15, which have made these last two years unforgettable in inspiration, conversation, experiences, and friendship.

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List of abbreviations

APS	Advanced Producer Services
B40	B40 Balkan Cities Network
BCN	Barcelona Challenge for Good Food and Climate
C40	C40 Cities Climate Leadership Group
C4F	Cities4Forests
CFM	Cities for Mobility
CO2	Carbon Dioxide
COP	Conference of the Parties
ESC	IDB Emerging and Sustainable Cities Program
EU	European Union
GaWC	Globalization and World Cities research network
GCoM	Global Covenant of Mayors for Climate and Energy
GDP	Gross Domestic Product
GHG	Greenhouse Gas(es)
GNI	Gross National Income
HDI	Human Development Index
ICLEI	Local Governments for Sustainability
IDB	Inter-American Development Bank (Cities Network)
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Country
LLDC	Landlocked Developing Country
LULUCF	Land Use, Land-Use Change, and Forestry
MCR2030	UNDRR Making Cities Resilient 2030
MedCities	Mediterranean Cities Network
METROPOLIS	World Association of Major Metropolises
Mt CO2	Megatons of Carbon Dioxide
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
PPM	Parts Per Million
PPP	Purchasing Power Parity
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
TMCN(s)	Trans-national Municipal Climate Network(s)

U20	Urban20
UBC	Union of the Baltic Cities
UCLG	United Cities and Local Governments
UN	United Nations
UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change
UNGC	United Nations Global Compact
USD	United States Dollar
WECP	World Energy Cities Partnership
OPEC	Organization of the Petroleum Exporting Countries

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1 INTRODUCTION

This first section provides a general introduction to this study. Beginning by naming the general theories involved, establishing the territory of inquiry and the current research, it then reviews gaps in the existing pool of knowledge and research frameworks through which existing theories and concepts have been investigated. Once the context is reviewed, the scope of research is presented with an outline of the guiding research questions used as the line of inquiry of the ensuing study. An overview of the rest of the study is then provided alongside the expected results, their potential implication, and their discussion.

1.1 Context

1.1.1 Global city theory

By the end of the 20th Century and well into the 21st Century, the concept of a — or the — global city emerges to conceptualise the agglomeration of factors that lend certain urban places more significance within the growing globalised, networked world and economy (Sassen 2002). The onset of telecommunication and information technologies has given rise to knowledge-based economies globally, concentrated in places where pre-existing conditions such as strong technological capacities, existing centricity, and a predisposition to facilitating capital flows through deregulation and privatisation are present (Hall 1996; Aust 2015). As processes settle in specific cities where facilitating factors are abundant, they affect the urban fabric within cities by rescaling the local to the global, opening new territorializations and forms of governance, creating new identities and cross-territorial communities, and perpetuating the neoliberal factors which maintain them. The places where this happens are posited as global cities, formed via their role as central nodes and command-and-control centres within the global economic network (Sassen 2005; Castells 2002).

As such, many investigations and theories of global city formation are predicated on economic factors complemented by policy and governance, historical and geopolitical contexts, and human elements of globalisation. Under this contemporary conceptualisation, global cities are more tangibly characterised in their concentration and consolidation of economic power by hosting multinational corporations, financial institutions, and advanced service firms while afflicted by internal characteristics of social polarisation, inequality, and the entrance of private capital into the urban fabric (Taylor 2001; Castells 2005; Sassen 2005). Within this context, global city theory and global city formation are well-established. Yet shifting trends, evolving material realities, and changing political climates are transforming the role of cities beyond capital tools and social spaces, into new realms of governance faced by mutating challenges and externalities (Bouteligier 2012; Aust 2015). These new challenges which force cities to undertake new responsibilities in a changing urban world, are in turn altering the principles of centrality that cities have held in predominantly capital-oriented circuits.

1.1.2 Cities and the climate crisis

Simultaneously with the emergence of global city theory, there has been rampant development in the discussion of climate change and international governance strategies to meet its growing challenges (Hale 2020). As incredibly dynamic constructions, cities are predisposed to the adverse effects of climate change from their assortment of housing, mobility, natural, technological, economic, cultural, and social dimensions, and the complexities of such in the urban sphere (Castells 2008; Bulkeley, Broto, and Edwards 2015). Though they are centres of population and associated precarity, cities are also hubs for the technological, cultural, and political innovations

often deemed necessary for developing successful adaptation, resiliency, and sustainability strategies. Among global cities where global phenomena are localised into urban spaces and inequality or risk are intensified, the effects of climate change are similarly magnified. Yet, the inverse relationship of local experiences and strategies being globalised and elevated also manifests in global cities. The increasing globality and connectedness of cities, therefore, have propelled them into new roles of climate governance (Dietrichsen and Niekerk 2017; Leffel 2021; Manfredi-Sánchez 2021).

This re-scaling and intensification has seen city-level actors thrust into the chain of local-level innovation to international problem solving and generated a relative idealisation of cities' role in global issues — particularly climate change — among media and academia (Acuto, Kosovac, and Hartley 2021; Manfredi-Sánchez 2021). The emphasis placed on urban actors has been further characterised by the feeling of nation-state-level incapability and unwillingness to move past gridlocks and the perception of ageing, unshifting political institutions as plagued by barriers in traditional diplomacy (Chan 2016; Leffel 2021). Since COP 20 and COP, the inescapably growing presence of cities in the realm of adaptation and sustainability has generated an entirely new typology of a "post-Paris Agreement" governing of climate change by city actors (Gordon and C. A. Johnson 2017; Aust 2018). In this new realm of urban climate governance, cities are increasingly mobilising in climate change adaptation, resilience, and sustainability circles where urban capital, politics, and sociocultural facets are progressively more globalised (Aust 2018).

1.1.3 Trans-national municipal climate networks

Within global urban climate governance, as the concept gradually becomes more pronounced, city actors have largely self-organised through inter-city action, city-to-city circuits, international organisations and the NGO sphere, and direct partnerships evoking a variety of city networks[1] (Bulkeley and Schroeder 2012; Balbim 2023). These TMNCs have emerged as a popular, prolific, and academically probed toolset, where scholars and stakeholders commonly cite the C40 Climate Leadership Group, ICLEI Local Governments for Sustainability, the Global Covenant of Mayors for Climate and Energy (GCoM), and other prominent, high-membership, high-visibility groups as examples of cross-city exchange platforms. Current research attributes the rise of these TMCNs to ongoing globalisation processes, the value of information exchange in the network society, and the prevailing theme of the commons in the climate adaptation paradigm (Lee 2013; Haupt, Zevenbergen, and Herk 2020). TMCNs take on various forms, shapes, and sizes, from large panels to small, narrowly-focused working groups, making their heterogeneity particularly interesting for the relative nimbleness and geographic attention necessitated in climate strategies (Lee and Jung 2018).

Despite this, TMCNs have predominantly been explored with a homogenous understanding of the character of their membership patterns. Although studies have demonstrated asymmetric exchanges and circuits within their internal processes (Mocca 2017, 2018), the most recent studies that systematically evaluate cities' membership in TMCNs do so with a simplified structure. Observing membership between networks as a horizontal phenomenon, the latest research posits that the cities with the most connections between networks are the most relevant among networks and those with the most sway, an approach which has been consistently replicated (Lee 2013; Acuto and Leffel 2020; Leffel et al. 2023; Acuto, Pejic, et al. 2024). Yet, as internal relationships are equally apparent, this simplification of ingroups and outgroups at best ignores and at worst eliminates the dynamics of cities' membership in TMCNs and the potential implications that a nuanced view of a membership gradient may provide. The oversimplified studies are therefore unable to systematically investigate the dynamics of cities' participation and integration into TMCNs in a fuller sense and draw conclusions about which cities are more powerful conduits of

[1] Or transnational city networks, city-to-city (C2C) networks, trans-municipal networks, etc; in this study as 'trans-national municipal climate networks' (TMNCs).

global urban climate governance, as opposed to simply more connected. As such, the impacts of the varied levels of integration of cities into TMCNs and the implications of such variety for the imbalances of global urban climate governance remain unexplored and unclear, completely decoupled from the broader phenomenon of global cities and their roles as conduits for globalisation and coordination.

1.2 Research scope

1.2.1 TMCNs and global cities

At present, systematic statistical research of TMCNs is predicated on an oversimplified, binary membership dynamic, an operational circumstance disproven by the stratified knowledge exchange, policy development, agenda setting, and capital mobilisation practices found within numerous high-profile TMCNs (Betsill and Bulkeley 2004; Bouteligier 2012; Kosovac et al. 2021). As TMCNs recurrently show signs of internal hierarchical governance and leadership structures through a gradient of membership, ranging from observer and non-voting members to executive boards and host city privileges, this gap sidelines the logic utilised in the construction of dominant city hierarchies, focal nodes, and the emergence of command-and-control centres. Therefore, the potentially reflective elements of global city theory and global city formation outside of classical economic integration that may appear within the stratified memberships of TMCNs lack significant, systematic investigation to determine their presence and relationship with the traditional outlook of global cities. Applying an extension of the logic utilised in the construction of a dominant city hierarchy between global cities via integration in global economic flows, the depth and level of participation or integration that a city holds within TMCNs would reflect the position of the city as an actor and node in the global web of TMCNs.

Understanding that the hierarchy of global cities is derived from the theory that globalisation has stratified geographic locations through the influenceability of network flows and the idea of leadership through deep connection within networks, rather than simply high nodal connectivity, has grounds as a facet of contemporary city hierarchy formation. If a global city manifests itself as the most complex and significant hub within the internal system — as defined by links binding it to other cities with direct tangible effects on global affairs, for example, global climate governance — then the links and the depth of cities' connectivity within TMCNs are hypothetical grounds for an evolving global city network. Evaluating the depth of connectivity may, therefore, provide insight into how cities as actors are globalising within the climate adaptability paradigm, the cities leading such initiatives, and the potential for such to reflect a more nuanced view of global city formation alongside the traditional financial framework.

1.2.2 Research questions and structure

The purpose of this study, then, is to extend global city theory and global city formation into the context of global urban climate governance, using the lens of the varying degrees of cities' integration in TMCNs. The critical focus is on whether the stratification of cities' integration in TMCNs invokes the same principles as global city formation, such as the specialisation of cities' roles, the emergence of focal nodes for facilitation and coordination, the production of command-and-control centres, and the re-scaling of space. If the phenomenon is present, the investigation will additionally compare global city formation through economic integration to urban climate governance integration, revealing the reflections and deviations from the dominant aspect of global city theory. Through this approach, the study is guided by the research question:

- How do cities' differing degrees of membership integration in trans-national municipal climate networks (TMNCs) contribute to uneven global city formation?

The study further investigates a set of additional methodological sub-questions to reach these conclusions:

1. How do cities' differing degrees of membership integration in TMCNs manifest?
2. Why do cities have differing degrees of membership integration in TMCNs?

The first sub-question examines the governance of membership among TMCNs and how they are composed, stratified, and made exclusive to understand the factors contributing to membership depth. It then systematically explores the quantity, hierarchy, and depth of cities' memberships, the geographic positioning of membership depths, and the most vital links and interconnections between networks and cities. The second sub-inquiry attempts to conclude why some cities, if any, are more deeply integrated in TMCNs than others, and the implications of such for global city formation. As the second sub-question is an incredibly complex and sophisticated question, this study provides a generalised answer based on a broad, generalised analysis.

To answer these questions, this study produces an overview of all TMCNs and their internal patterns of governance and hierarchies. It then gauges the differing degrees of integration among TMCN member cities and analyses them against a set of tested variables to observe trends. Ultimately, a discussion on the implications of the results for global city formation is constructed. In providing these answers, this study encompasses multiple parts, beginning with a review of current literature, concepts, theories, and debates on global cities, climate governance, TMCNs, and the interplay between them. It then overviews the methods of data collection and analysis utilised to answer the research questions, including the conceptual approach and limitations of the study. The results of data collection and analysis are then provided and subsequently evaluated and discussed. Lastly, the study concludes with a review of key findings, its contribution to the field, and avenues for future research. An appendix of references, data sources, and results of the data collection and analysis follows at the end.

2 LITERATURE REVIEW

This section contains this study's review of the relevant theories, ongoing debates, and current knowledge on the topic of research. It begins with a conceptual overview of global city theory and its emergence and identification, followed by the evolution of the urban governance of climate change and TMCNs. Lastly, it combines the earlier elements to review the interplay between global cities and global urban governance, the implications of such for city networks, and the gap between the two. The current literature is then synthesised with the line of inquiry to substantiate the research area and contributions to the field expected from the exploration of the topic.

2.1 Global city theory

2.1.1 Characteristics of the global city

Since the *World City Hypothesis* by Friedmann (1986) and the concurrent agenda for research into the formation of "world cities" by Friedmann and Wolff (1982), the debate on the nature of certain cities able to be characterised as more important, prevalent, or connected than others has progressively evolved. Today, the idea of the "global city" has been thoroughly developed through seminal works by Hall (1996) and Sassen (2001), complemented by a quantification by Taylor (2001) and broadened by Castells (2005) with an emphasis on the underlying networks central to the idea. In the dominant conceptualisation of the global city, cities become global actors, and the space within them is re-scaled, shifting the dynamics of space and power within and between cities. The primary interpretation of this effect has been the growing reality and underlying pressures of globalisation (Sassen 2002, 2005). Per the foundational theories, the emergence of the global city phenomenon is rooted in the context of the changing global economic system.

Sassen (2001) emphasises the significance of information technologies and the increased mobility and liquidity of capital in reshaping the economic landscape, highlighting the rescaling of strategic territories — i.e. urban spaces — as a result of privatisation, deregulation, and the growing participation of national economic actors in global markets. The global city concept arises through the evolution of global command-and-control centres. These spatial units are the effective 'ground zero' where the dynamics and processes that become territorialised are global in scope and scale. Hence, the global city becomes a site for new types of political operations, transnational labour, and the formation of trans-local communities and identities (Sassen 2002; Castells 2005, 2008). Linked cities become strategic terrains for politics and engagement; their centrality manifests in various geographic forms, including central business districts, a grid of metropolitan nodes, and trans-territorial centres constituted through telecommunications and intense economic transactions and commodification. Rescaling these spaces allows actors and actions within them to correspondingly rescale and assume new meaning, capabilities, and challenges (Castells 2002). Under contemporary conceptualisations, these places are further characterised in more directly tangible ways, such as the concentration of economic power by hosting multinational corporations, financial institutions, and advanced service firms (Taylor 2001; Sassen 2005), and elements of greater social polarisation including marginalisation and social stratification (Sassen 2005; Castells 2005).

The concept, therefore, strongly emphasises networked economies and connectivity through financial flows and telecommunications services drawn from the influence of new communication technologies on centrality. This emphasis is further testified to by Hall (1996) and later Castells (2002) in which networked economies have supplanted vertically-integrated economic chains in favour of functionally specialised nodes within the global economic scale and given rise to emerging new politico-cultural alignments within global cities, where systems of command and control proliferate, and a new hierarchical assembly of actors develops. Broadening the scope of

globalisation through the lens of the global city, an emphasis is placed on the role of the connected city in the localisation of global processes and the formation of new claims to space. Accordingly, growing inequalities between advantaged and disadvantaged sectors and spaces of the city are additionally reconceptualised alongside the ideas of action and economics (Sassen 2002; Castells 2008). In these perspectives, which make up the core of the theory, networks are seen as the critical tool which shape and are shaped by global cities (Hall 1996; Castells 2000; Taylor 2001; Sassen 2002; Aust 2015).

2.1.2 Global city formation and identification

Although networks have been solidified as the primary object contributing to the distinction of global cities, there is a range of complex processes of economic globalisation and technological advances alongside historical, policy, and development contexts that contribute to the formation of global cities (Friedmann 1986; Hall 1996; Sassen 2005). The factors which underpin the emergence of global cities also contribute to the evolution and maintenance of certain cities' central roles in the global sphere, stressing the scope, scale, and typology of integration and uneven development (Hall 1996; Castells 2002, 2005). Under Friedmann (1986), an underpinning idea of global city formation within urban hierarchies is the world-city theory, wherein the role of capital exchanges and processes is central. Central points for controlling global capital accumulation and distribution become stressed and more valuable as accumulation and distribution — even to a limited set of actors — become increasingly compounded and complex as capital exchanges grow globally. Capital processes will inherently conglomerate into these "basing points" (ibid., pp. 71) to eliminate overhead and access the wider network. Decision-making also factors considerable power through the presence of international organisations, embassies, governance and government institutions, and regulatory bodies. Therefore, a hierarchical system of cities develops: global cities are highlighted at the top through the concentration of economic and political influence. In contrast, secondary cities and regions often become dependent on the global cities for access to the broader network and are particularly beholden to the decision-making power withheld by global cities.

Following those frameworks, Sassen (2002, 2005) draws on continued economic globalisation and structural transformations as extensions of the new network society. The economic transition from industrial manufacturing to knowledge-based, service-oriented economic principles and the proliferation of multinational corporations have evolved where traditional industries gave way to existing concentrations of capital and labour. The emergence of nodes has thus expanded into transnational networks to facilitate the coordination of dispersed global operations between specialised spaces in a coupled project. Deregulatory patterns popularised during the initial neoliberalisation of market economies in Western states stimulated, in part, the growth of international capital markets in labour and production, real estate, investments, etc. Coupled with the unprecedented development of information technologies and communication methods, instant contact between different spaces across the globe allowed for focal points deregulating capital flows to other places to remain dominant market nodes, creating hierarchies within networks. Expanding on this, Castells (2002) and Hall (1996) paint a broader, more nuanced description of the elements impacting global city formation. Although echoing similar aspects of the general theory on the role of economic, further emphasis is placed on the nature of the capital and information flows. The growing prominence of technological reliance necessitates sophisticated technological and physical infrastructure capable of supporting communication, transportation, economic, and production activities. Cities specialise in particular industries based on their position within global networks, taking on specific roles as part of their integration. Therefore, although technological advancements reduce the inherent need for geographic proximity for particular needs, they underscore the centrality of cities as hubs of connectivity and nodes for capital, information, and labour exchanges. While the networked society certainly decreases the emphasis on vertically integrated economic processes, it increases the emphasis on horizontally integrated economic processes where spaces specialise in specific roles.

The combination of structural and contingent factors previously highlighted as contributing to the formation of global cities is therefore essentially predicated on economic factors complemented by policy and governance, historical and geopolitical contexts, and human elements of globalisation. In recent periods, cities have emerged as sites for global investment and the localisation of capital, leading to urban restructuring and the commodification of space in certain cities, becoming concentrators of capital and investment. Onset by policies and governance shifting into trends of deregulation, privatisation, and international investment, greater emphasis has been placed on advanced service firms, multinational companies, and the reduction of vertical integration. Yet, these shifts have been most prominent in historically and geopolitically significant cities where legacies of colonial power, trade, widespread industry, transportation, and concentration of knowledge are foundational elements in the telecommunication restructuring, decision-making power, and nodal predisposition of specific cities. Strategic geopolitical positions or capabilities of key places have additionally been leveraged by certain cities and capital powers, particularly for creating new spaces of investment and development. Broader trends in new migration patterns have additionally contributed heavily to the localisation of labour and skills, contributing to the economic diversity and reflective specialisation of cities. In these senses, an influential pattern of path-dependency additionally arises in the formation of global cities; historically significant spaces continue to accrue influence and prominence, or spaces can re-specialize and grow in influence due to resources allotted by their previous status. Hall (1996) particularly stresses this aspect alongside the notion that global cities act as centres of innovation and intellectual activity, not simply economic power, and that localised conditions and power dynamics may contribute to global city formation where local contexts of cities shape their global roles. These factors holistically contribute to the growing prominence of cities on the world stage, not simply as global cities concentrating economic power and influence, but as actors on the global stage (Bulkeley and Schroeder 2012; Smeds and Acuto 2018; Davidson, Coenen, Acuto, et al. 2019; Acuto, Kosovac, and Hartley 2021).

2.2 Cities, governance, and climate change

2.2.1 Trends in global urban governance

Meanwhile, cross-city action has been present in its most basic form since the early 20th Century as urban units became increasingly coordinated, valuable, and powerful, and has continued to evolve since (Dietrichsen and Niekerk 2017; Acuto, Kosovac, and Hartley 2021). The modern iteration arose as an initial form of paradiplomacy between individual cities through based on humanitarian, cultural, and economic ambitions and ideals (Acuto, Kosovac, and Hartley 2021). In the 1980s and 90s, the growing trend of 'municipal foreign policy' grew more complex through inter-city campaigns to tackle ongoing issues of nuclear armament and poverty alleviation and urban development in the Global South (Acuto, Kosovac, and Hartley 2021; Leffel 2021). At this time, experimentation in the formalisation of broader cross-city initiatives unfolded through the development of international organisations, secretariats, multilateral agreements, and concentrated policy initiatives, which dramatically expanded the capabilities and reach of the burgeoning field (Dietrichsen and Niekerk 2017; Balbim 2016; Acuto, Kosovac, and Hartley 2021). Extensive formalisation, institutionalisation, and developing membership bases through generational cohorts of members during this period provided the foundation for the expansion into urban governance seen in the subsequent evolution of city-to-city action.

At the turn of the millennium, city-to-city initiatives stepped into the realm of exchanges and dialogue between cities and other multilateral organs, predominantly supranational organisations such as the United Nations and European Union, economic organisations, and a variety of formal advocacy groups (Aust 2015; Manfredi-Sánchez 2021). Today, a renewed emphasis is placed on urban actors in light of a growing feeling of nation-state-level incapability and perceived unwillingness to breach gridlocks and traditional diplomatic barriers in global problems and ageing,

unshifting political institutions (Chan 2016). This emphasis sees city-level actors being thrust into the notion of local-level innovation to international problem solving, and the consequent idealisation of this phenomenon in media and academia (Acuto, Kosovac, and Hartley 2021; Manfredi-Sánchez 2021). Nonetheless, the phenomenon of 'global urban governance' which emerges is increasingly prevalent: cities progressively seek to garner attention and relations with national and supranational institutions, while simultaneously being increasingly referred to and acknowledged in the necessary devolution of addressing global-level strategies, such as economic development and competition, and global-level difficulties, such as climate change, inequality and inequity, and migration (Chan 2016; Balbim 2016; Acuto, Kosovac, and Hartley 2021). Shifting global priorities and the impact of sudden-onset disasters such as the recent COVID-19 pandemic have additionally stressed the dynamics between national priorities and city priorities, testing the ability of urban governance systems between cities to address varying policy areas and collectively mobilise to show their flexibility and often greater rapidity in addressing varied problems (Acuto, Kosovac, and Hartley 2021; Kosovac et al. 2021; Manfredi-Sánchez 2021).

Global cities and urban governance

Throughout these evolutions of city-to-city organisations, global cities have regularly been at the forefront, particularly in recent shifts towards seemingly usurping some nation-state policy action and continuously developing soft power capabilities (Chan 2016; Manfredi-Sánchez 2021). The most globalised and interconnected cities often face the greatest and harshest associated difficulties of migration, environmental management and climate adaptation, commodification and tourism, and inequality, therefore eliciting — from the perspective of these cities — a significantly more direct and comprehensive degree of policy action than the nation-state is often capable or willing to provide (Manfredi-Sánchez 2021). This pushes cities with common problems, to varying degrees of specificity or common geography, to come together and share tactics, policy ideas, technical figures, etc., among each other and make collective cases to address collective problems (Balbim 2016; Aust 2018). Although this primarily manifests itself through highly visible city officials, business leaders, and political figures, the core idea of policy mobility, policy action, and policy capability drawn from the city level and shared between city actors or elevated to international organisations places a renewed emphasis on the governance capabilities of cities on the global stage (Chan 2016; Leffel 2021; Manfredi-Sánchez 2021). Global cities provide a unique foundation from which urban governance is enacted and funnelled: the typologies put forward in global city theory inherently provide specific urban spaces with the economic, political, and infrastructural capabilities to mould international development and practices (Manfredi-Sánchez 2021).

Even without the typical legal basis expected of a sovereign entity, global cities hold the necessary concentration of economic and business actors, decision-making power, capital flows, and academic institutions while housing many non-state international institutions to implicitly or explicitly influence international policy frameworks and actions (Dietrichsen and Niekerk 2017; Leffel 2021; Manfredi-Sánchez 2021). Cities working within democratic regimes can often contest national agendas and direction by crafting their policy initiatives when legally capable and proxying that through their global city status. In contrast, cities working within undemocratic regimes can transform into vessels to advance national policy directives onto the global stage via their global city status (Chan 2016; Leffel 2021). As further part of their ambitions, global cities can mobilise their resources to advance the institutions, organisations, and infrastructure which are driving recent city-to-city efforts: philanthropic capital, state and commercial investment, telecommunications networking, transportation infrastructure, and noteworthy figures are already concentrated in global cities and can therefore be mobilised by city actors to enter into civic linkages through pre-existing connections and centrality of exchanges (Balbim 2016; Acuto, Kosovac, and Hartley 2021; Manfredi-Sánchez 2021). These initiatives touch on many action areas, yet the nature of global city influence in city-to-city action from the initial modern

iterations still lingers. Economic and capital interests often hold high value in these strategies and overlap with political and governance strategy, leading to many acting at the city level for foreign market entry, investment attraction, and capital mobilisation (Leffel 2021). However, there are a few key policy areas where the recent majority of global urban governance work has been conducted.

2.2.2 Global urban governance of climate change

Although the role of cities on the international stage has been developed in almost all policy areas, it is in climate governance where cities have been the most prevalent in recent years (Bulkeley and Schroeder 2012; Leffel 2021). Notably, since the 2014 Non-State Actor Zone for Climate Actions and the ensuing 2015 UNFCCC COP 21 in Paris, the inescapably growing presence of cities in this realm has given rise to an entirely new typology of a "post-Paris" governing of climate change by city actors (Gordon and Johnson 2017; Aust 2018; Leffel 2021). 'Cities' and their actors have been increasingly categorised as example contributors to more bottom-up approaches to climate adaptation, mitigation, and resilience strategies through urban development and are gaining traction and scholarly attention (Gordon 2013; Creutzig et al. 2020). This trend follows the modern shift of urban governance in aligning itself with sub-national problem-solving and the devolution of state capabilities in mitigating ongoing crises which impact urban spaces more than others, especially in the alarming case of climate change facing cities (Bulkeley, Broto, and Edwards 2015; Knieling and Klindworth 2016; Goh 2019). Transnational actors have played an increasingly core part in global environmental politics since the mid-twentieth century through international organisations, civil societies, and supranational governmental institutions (Castells 2008; Bulkeley, Broto, and Edwards 2015; Hale 2020). Advancements in communication technologies and economic infrastructure have re-scaled the movements and issues in urban spaces, enabling cross-border activism spearheaded by civil society organisations and advocacy networks sharing resources and information. Since global environmental issues often surpass the legal capacities of individual countries, ecological governance has had a demonstrable need to be undertaken beyond the common conceptualisation of the sovereign lawmaking nation-state (Hale 2020). This governance is often done through the prism of corporate strategies, privileging technocratic management and interests through market differentiation, risk management, and business pool pressures working through neoliberal organisations such as the World Trade Organization, United Nations, and European Union (Castells 2008; Bulkeley and Schroeder 2012; Bulkeley, Broto, and Edwards 2015; Hale 2020).

Nonetheless, non-state transnational climate governance complements state-born initiatives by filling regulatory gaps, working beyond the nation-state diplomatic sphere, and constructing polycentric action at different scales and with varying scopes (Gordon and Johnson 2017; Hale 2020). City-to-city action has been instrumental in organising and mobilising non-state transnational actors, particularly in the climate and environmental governance realm (Amul and Shrestha 2015; Groen 2022). City actors are uniquely positioned to attract international organisations and climate finance through economic centrality, networks and connecting infrastructure prevalence, and global status (Pillay and Potgieter 2017; Groen 2022). The circular momentum of needing to and therefore attracting non-state transnational environmental actors and finance emphasises cities' ability to govern transnational climate policy: cities and city actors can, thus, influence multiple levels of climate governance, guide and direct climate policy knowledge, and blend the divide of state and non-state actors and public and private authority (Bulkeley and Schroeder 2012; Aust 2018). Therefore, the relevant status of cities within globalisation shifts, their ability to weave new movements of global urban governance, and renewed pushes to surpass national-level gaps in addressing environmental issues have seen them systematically usurp transnational climate governance from the traditional state-level action, even if not entirely recognised by the realm of international relations and diplomacy (Aust 2015; Gordon and Johnson 2017; Aust 2018; Smeds and Acuto 2018; Creutzig et al. 2020). City actors often require considerable effort to mobilise these resources and involve high-tier actors in various sectors (Heijden et al. 2018).

Certain cities have, therefore, been more capable of assembling climate governance strategies than others, especially if they are less connected than other cities — politically, economically, or socially (Johnson, Schroeder, and Toly 2015). Yet, specialised climate-centred policy and action networks have emerged between cities as the most effective and popularised method of city-level action and diplomacy in urban climate governance (Betsill and Bulkeley 2007; Bouteligier 2012; Goh 2019). Though an increasing amount of works contest the romanticised portrayal of cities as saviours in the current climate adaptation literature, as cities remain beholden to multi-level governance, the growing role of cities in climate governance remains prominent and an integral facet of the sphere (Knieling and Klindworth 2016; Heijden et al. 2018).

2.2.3 The role of city networks

City actors have largely self-organised to achieve efforts of urban climate governance through inter-city action, city-to-city action, international organisations, and direct partnerships, which can be categorised as varying types of city networks — i.e. trans-national municipal climate networks (TMCNs) (Bulkeley and Schroeder 2012; Balbim 2023). Current research attributes the root and rise of these TMCNs to globalisation processes found driving capital flows, information exchange, and the theme of the commons in the prevailing climate adaptability paradigm (Lee 2013; Haupt, Zevenbergen, and Herk 2020). Multiple studies exist on the nature of these networks and provide ways to identify and sort them categorically. These frameworks include the division of different typologies of networks: domestic, regional, and global, and various modalities of their organisation: multilateral or institution-led (Lee and Jung 2018). A broader scope also seeks to identify the different functions and capabilities of these networks, which can vary tremendously based on their stated goals and ambitions (Cortes et al. 2022): information exchange, networking, lobbying and funding, research, standards and commitments provision, and monitoring and certification (Lee and Jung 2018); or networking between individuals (Heikkinen 2022), shared experiences and transfer of knowledge (Haupt, Chelleri, et al. 2019), and the promotion of their projects and work (Haupt, Zevenbergen, and Herk 2020). In specific studies of interurban climate networks in Europe, multiple underlying philosophies contribute to cities' participation within the networks and their degree of enrolment, ranging from socioeconomic to political. Post-industrial cities often use peer-to-peer networking to promote their economic and political position and use these networks for strategic manoeuvres (Mocca 2017; Heikkinen et al. 2020). Cities with advanced economies composed of robust technological innovation sectors and a highly skilled workforce are more likely to participate in the networks as a reflection of a proactive approach towards connection building (Keiner and Kim 2007; Lee 2013; Heikkinen et al. 2020).

Although current research has not necessarily correlated the political leanings of local governments to participation within TMCNs, civic bodies with a centre-left and left-leaning tradition are more likely to align with the sustainable development goals paradigm on which the majority of the networks are predicated (Mocca 2017; Cortes et al. 2022). Additionally, cities that exhibit a greater willingness to join these networks often belong to multiple networks already. Multimembership may indicate a path-dependent attitude influenced by positive past experiences — particularly within the European context. Environmental quality, however, has no apparent link with cities' propensity to enrol in climate networks (Mocca 2017; Woodruff 2018). More recent work currently aims at bridging the gap of knowledge on whether TMCNs have real, measurable impacts within the member cities; however, that body of literature remains incomplete (Lee and Jung 2018; Gordon and Johnson 2018; Bertoldi et al. 2018; Heikkinen et al. 2020; Heikkinen 2022; Fünfgeld 2015; Grant, Leffel, and Johnson 2023; Smeds and Acuto 2018). Although these city networks undoubtedly act as powerful forums, capital mobilisers, and learning platforms, the full achievement of their headline goals including reducing greenhouse gas emissions from cities, achieving carbon neutrality, and meeting the common goal of limiting global temperature increase to 1.5°C compared to pre-industrial levels is incredibly nuanced to isolate and evaluate

even in broad correlation studies (Bertoldi et al. 2018; Grant, Leffel, and E. Johnson 2023; Nguyen, Davidson, and Coenen 2020; Betsill and Bulkeley 2007; Bouteligier 2012).

Existing geographies

An imbalance in the geographic position of better-connected cities complements imbalanced knowledge-sharing processes by creating or highlighting existing leading cities. Multiple cases emphasise the overrepresentation of smaller, regional metropolises and medium-sized cities within these networks and, in some cases, the absence of more traditional, financially dominating global cities (Keiner and Kim 2007; Heikkinen 2022). Betsill and Bulkeley (2004, 2007), in studies across multiple networks, have shown that a majority of local governments grow more engaged in climate networks and deepen their connections when financial and political resources are at play, particularly in the case of legitimisation and growing multi-level governance over the subject and knowledge when considered as spaces of network action. Focusing on the role of cities as strategic sites for the concentration of knowledge, ecological governance, and institutions of the initiatives of transnational actors, Bouteligier (2012) later reaffirmed these findings through an analysis of the networks as operators within cities in expanding the role of certain cities in tackling the climate crisis.

Initial research into city climate networks by Keiner and Kim (2007) attributed the phenomenon to various potential causes, including that "they are more easily able to redirect priorities to sustainability issues, while global cities are often confronted with a battery of other issues and larger inflexible governments, and they are better attuned to local conditions essential for the effective implementation of sustainability measures" (p. 1393), that "developing countries offer the greatest potential in terms of return on an investment in outreach and are strangely represented, to some extent supposedly incredibly well, to another extent not at all" (ibid., pp. 1393), and that some cities may not be members of the numerous networks that they perhaps host. These potential causes provide initial evidence as to the potential of climate networks to globalise and stratify the participation of certain cities, particularly when taken together with the organisational structures of certain TMCNs actively working to divide cities based on various criteria, membership elitism, and circles of friendly cities (Lee 2013; Bertoldi et al. 2018; Mocca 2018).

2.3 Global urban governance of climate change and the global city

2.3.1 Global cities and global governance

As it has been developed, the global city theory and related literature on global city formation have lacked the compounding elements of global urban governance and urban climate governance. Instead, the foundational theories on the growth and expansion of particular cities as global actors and the shifting dynamics they create between different urban localities are deeply intertwined with information networks, capital flows, and economic centrality disconnected from newer trends of global urban governance (Sassen 2002; Bulkeley and Schroeder 2012; Johnson, Schroeder, and Toly 2015). Yet, the shifting ambitions being compounded by these developments are increasingly including the production of urban governance and the export of local development solutions to global problems, turning many cities into mobilisers of policies beyond neoliberal economic networking (Amul and Shrestha 2015; Chan 2016; Balbim 2023). As global urban governance evolves from its roots in conventional state-centric diplomacy to embrace a networked and collaborative governance approach, city actors are playing increasingly crucial roles as network builders and conduits for the centralisation of urban governance power (Gordon 2013; Gordon and Johnson 2017; Acuto, Kosovac, and Hartley 2021; Manfredi-Sánchez 2021). From redefining the scope and scale of transnational action in problem-solving contexts to leveraging soft power and networked governance structures, cities are increasingly asserting themselves not only on the global scale but between each other as power dynamics between city actors flourish

in the new translocal urban governance movement (Antrobus 2005; Balbim 2016; Dietrichsen and Niekerk 2017; Mocca 2018; Goh 2019; Gordon 2019). The phenomenon of cities competing among each other while globalising their urban governance initiatives, mobilising their policy ambitions and knowledge, and being, in turn, globalised by the networks they are partaking in — particularly in climate and environmental initiatives — reflects the theories initially put forward on global city formation and construction (Sassen 2002; Camagni 2006; Bouteligier 2012; Davidson, Coenen, Acuto, et al. 2019).

The interlink between global cities and global urban governance outside of the dominant financial and capital flows paradigm showcases how city actors are constructing new typologies of connectivity and influence within and between traditional circuits (Goh 2019; Leffel 2021; Lee 2015). Transitioning from the capital accumulation and facilitation perspectives underlying original global city formation and increasingly integrating the fundamental features of social structure and relationships of power and experience, the pivoting to urban climate governance provides a new development in global city theory (Knieling and Klindworth 2016; Jakobi, Loges, and Haenschen 2023). As cities in global urban climate governance become seen as fully-fledged actors rather than nodes and spaces affected by membership within networks, they provide an additional facet to explore in global city formation theories (Bouteligier 2012; Johnson, Schroeder, and Toly 2015). Since global cities are inherently specialised in the task of centralising international organisations, connective infrastructure, mobilising capital, and acting as conduits in the dominating climate adaptation paradigm of techno-managerial market intervention, climate governance is a defining characteristic of the modern, diplomatically competitive, governance-leading global city (Davidson, Coenen, Acuto, et al. 2019; Gordon 2019). Though the notion of global cities as centres of capital, trade, and transnational economic centrality remains sound and a widely-accepted definition, the inclusion of urban governance characterised through climate governance via TMCNs may benefit the evolution of the global city theory in a world where climate change and transnational adaptation strategies are taking centre stage (Johnson, Schroeder, and Toly 2015; Lee 2015). Without the need to completely reconceptualise or abandon current ideas of global city formation, incorporating academically-pervasive trends of cities' growing role in climate change and how they achieve such may yield new results in the conceptualisation of the most competitive and leading cities as the demands of competition shift as well.

2.3.2 The gap between TMCNs and global city formation

Beginning again with Keiner and Kim (2007) and followed by Lee (2013), Mocca (2017), and Acuto and Leffel (2020) as an update, some work has been done on mapping TMCN member cities, both globally and constrained to various geographies. In these cases, the mapping and correlation work remains a binary, Boolean statistical method that considers every city membership through ingroups and outgroups. Between works, mainly Lee (2013) and Acuto and Leffel (2020), this is done under the concept of cities as spaces for the actions of networks rather than cities as the actors within the networks, as Woodruff (2018) pays particular attention to. In all current systematic analyses, correlation studies, and city connectivity analyses, the position of a city within the networks it is part of is not categorically analysed. Therefore, there is no systematic study of the stratification of city membership within climate networks in line with the discussed conceptualisation of networks, global cities, and city hierarchies. Exploration by Mocca (2018) and Haupt, Zevenbergen, and Herk (2020) notes that both 'leading' and 'lagging' cities participate in the same networks under a qualitative analysis of select cities or select networks, finding that frontrunners often participate by boasting their achievements to novice cities learning from perceived environmentally studious peers. The knowledge exchange within the highlighted networks has been depicted as asymmetric, even in inter-urban networks within the same continent, under a general assumption that some cities are leading the climate networks. In line with the conceptualisation of global cities and networks put forward by Sassen (2002) and Castells (2002, 2005), certain cities appear to dominate over others by driving the network through itself as a powerful node, exerting its accrued influence or being looked to by comparatively smaller

or weaker actors. In these anecdotal cases, past studies found certain dominating cities in leadership positions to cluster in particular geographic or economic strata, which differ from the traditionally financially dominant cities (Camagni 2006; Keiner and Kim 2007; Mocca 2018; Aust 2018).

The systemic statistical research predicated on equal, horizontal membership between cities within the same network is an operational circumstance disproven by stratified knowledge sharing, policy development, agenda setting, and capital mobilisation practices within numerous high-profile climate networks (Betsill and Bulkeley 2004; Bouteligier 2012; Coenen, Davidson, and Gleeson 2019; Kosovac et al. 2021). Applying an extension of the logic utilised in the construction of a dominant city hierarchy between global cities via integration in global economic flows, the depth and level of participation or integration that a city holds within a climate network should reflect the position of the city as an actor and node in the global web of TMCNs. A city which is a member of the same networks as another but to a more substantial degree through participation in network leadership structures rather than simple entry-level congresses could, therefore, be construed as having a deeper level of connection, one resembling its position as a globalised or globalising city reflective of global city formation.

Hence, a statistical comparison and profiling of participation characteristics taking into consideration a non-binary depth of city membership in TMCNs would depict the current disposition of cities in TMCNs in a way that allows the construction of theories and hypotheses concerning the ability of member cities to influence one another, comparable to the flows of global city formation. Understanding that the hierarchy of global cities is derived from the theory that globalisation has stratified geographic locations through the influenceability of network flows, the idea of leadership through deep connection within networks rather than simply high nodal connectivity between networks has grounds as a facet of contemporary city hierarchy formation. If a global city manifests itself as the most complex and significant hub within the internal system — as defined by links binding it to other cities with direct tangible effects on global affairs — then the links and the depth of cities' connectivity within TMCNs are a potential grounds for the construction of a different perspective on city hierarchy. Evaluating the depth of connectivity as opposed to solely the binary membership of cities in TMCNs may, therefore, provide insight into how cities as actors are globalising within the climate adaptability paradigm, the cities leading such initiatives, and the potential for such to reflect a more nuanced view of global city formation.

3 METHODOLOGY

The following section overviews this study's foundational theories and principal methods. An initial introduction to the theoretical framework and conceptualisation of this study's line of inquiry of how cities' differing degrees of integration in trans-national municipal climate networks contributes to global city formation and why cities assume these positions is provided. A walkthrough of the methods by which this study seeks to resolve the question is then presented, including how data will be collected and analysed. Lastly, a concession of the limitations of the study's methods is described. As identified in the review of current literature, a substantial sphere of qualitative research into TMCNs exists, supplemented by a narrower body of research on systematic, quantitatively-drawn conclusions on the stratification occurring within and among the networks. This study follows a quantitative methods approach grounded in a hybrid validity-realism perspective to achieve its goal of a systematic review of city hierarchies within TMCNs and the reasons behind their emergence in a generalised manner.

3.1 Theoretical framework

3.1.1 Epistemological and ontological means

This study utilises a hybrid critical realist and positivist approach in line with Campbellian critical realism, as opposed to a strictly Bhaskarian critical realist or Comtean-Durkheim positivist lens. The previous review of literature highlights that cities' memberships in TMCNs and the variety of typologies in which their participation manifests have concrete observable effects in the real-world manifestation of the networks, their interactions, and the exchange of policy and capital. Equally highlighted is the broad uncertainty with which the dynamics of cities' reasons for their participation and effects of the networks in globalising cities are distinguished. Aspects of global urban governance further investigate observable, real debates and actions made in largely open and promoted spheres. However, these dynamics may equally result from obfuscated, invisible, or unknown forces that cannot be directly or easily identified and investigated, potentially hindering the generation and testing of theories within a broadly critical realist perspective.

In essence, the conditions of the development of TMCNs and the varying depths of cities' membership within them are real social responses affected by real social situations. Therefore, any analysis of such would create a social construction of city membership typologies and reasons. In line with Bhaskarian critical realism, the objective reality of cities' memberships in TMCNs is constrained to a partial understanding by the social context in which they occur (Price and Martin 2018). However, a positivist approach to the critical realist perspective allows a better formulation wherein a generalised model of the observable, real world can be constructed via rigorous research methods and iterative evidence (Mckelvey 1999). Naturally, this model will not create an absolute, universal understanding, but a critical evaluation, and additional improvements can make an increasingly accurate and reliable theory (ibid.). The Campbellian critical realism perspective allows this study to generate a generalised model and test hypotheses within an objective, observable reality. Yet, it acknowledges such limitations and stresses the critical evaluation of future refinement without discarding the invisibilities that may affect it.

3.1.2 Research framework

This study's theoretical framework is predicated on three distinct steps: the varied depths of cities' memberships in TMCNs, the hierarchies which emerge from such memberships as a contributing facet to global city formation, and the reasoning for the variance in memberships leading to certain cities emerging as command-and-control centres. The conceptual framework of the line

of inquiry can be represented as a flow diagram of the steps the study takes to mobilise the reviewed theories to conceptualise the dynamic between TMCN membership and global city formation vis-à-vis TMCN membership hierarchies. Figure 1, below, illustrates the theoretical framework in its distinctive parts and the literature mobilised to draw each step.

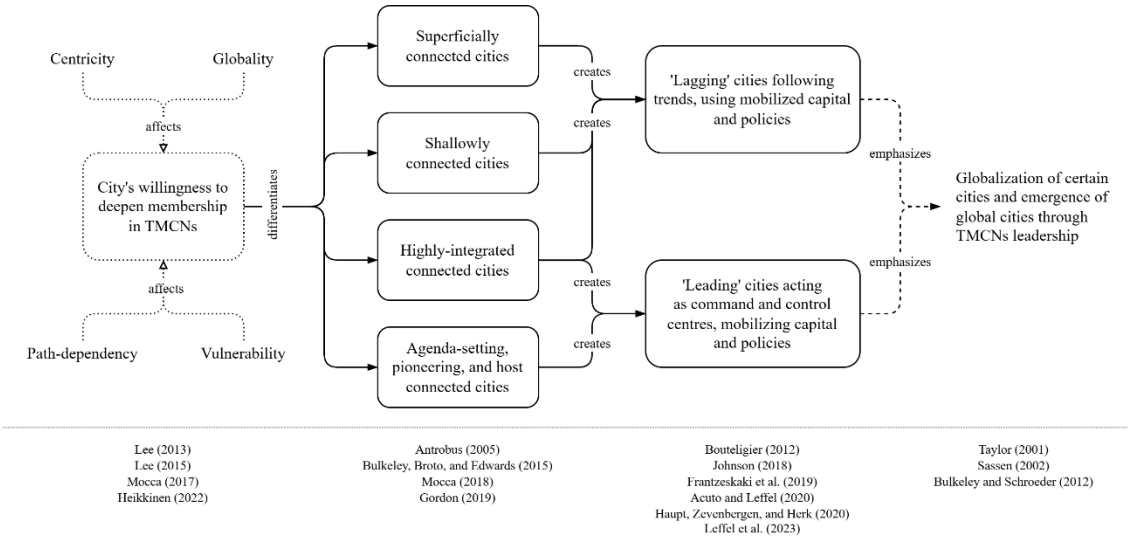


Figure 1. The study's theoretical framework diagram and associated literature.

In previous literature, Lee (2013), Mocca (2017), and Heikkinen (2022) have identified that multiple factors contribute to a city's decision to join a TMCN or join additional ones, including already being large global cities, perceived vulnerability to climate change effects, historically positive experiences and left-leaning political coalitions generating path-dependence, and broader elements of centrality within governance schemes. These provide the underlying foundation for the reasons for cities' memberships in TMCNs, which will be used as parallel contextual pieces for cities' depth of membership. These broad elements will, constructed with multiple component indicators, comprise the four principal categories of factors potentially contributing to cities' membership depth decision-making: centricity, vulnerability, globality, and path-dependency.

These four factors manifestly contribute to the readily observed variance in cities' integration into the networks, as identified by Bulkeley, Broto, and Edwards (2015), Mocca (2018), and Gordon (2019). The varied typology of cities' integration will be utilised as the basis for constructing cities' depth of integration within TMCNs, whereby more connected cities in leadership roles are identified as more deeply connected, and less connected cities in observer roles are identified as less deeply connected. Consequently, a divide can be drawn in emerging command and control centres actively mobilising and globalising the networks versus following, globalised cities. The phenomenon has been observed by — among others — Bouteligier (2012), Acuto and Leffel (2020), and Leffel et al. (2023), providing a necessary stepping stone in validating the dynamic between deeply-integrated and shallowly-integrated cities within the networks as a component of the inequalities present within global city theory. Ultimately, these elements — the factors which affect cities' depth of membership, the different strata of integration it contributes to, and the distinction of command-and-control centres created — emphasise the emergence of global cities among TMCNs at the core of the study.

Inductive versus deductive

This study utilises both an inductive and deductive reasoning approach in its investigation. The first step, inductive, generates conclusions on cities' depth of memberships through membership and integration patterns, predicated on observing cities' status within the TMCNs they are

member of. This will generate the overarching depth of memberships for member cities and resolve the second and third steps of the theoretical framework through concrete observable realities — hence the full lines and connections in Figure 1. The second step, deductive, aims to draw specific conclusions by testing contributing factors to cities' membership depths as hypotheses for the reasoning of greater or lesser interconnection and globalisation. This will make predictions on which factors contribute to global city formation through TMCNs to answer why some cities are emerging as command-and-control centres within TMCNs over others — represented as the dotted connections in Figure 1. The order is a product of the research steps, in which the variances in TMCN memberships and leading cities are inducted in a bottom-up approach before the potential reasoning behind the variances can be deducted.

3.1.3 Scope and definitions

The primary scope of this study is twofold: the trans-national municipal climate networks themselves and the member cities as actors of globalisation with different will within them. Both are defined within the context of the study's needs and interpretation rather than as holistic understandings of the concepts to establish an objective, categorical use of the two objects of study. This study has no bounds in terms of geographic area of study or case study, seeking instead to gather as many component objects of study as possible to draw generalisable conclusions with as much reinforcing data as possible.

Trans-national municipal climate networks

The transnational municipal climate networks — TMCNs — or networks, are defined in the study as transnational, internationally-acting city-to-city and peer-to-peer networks which have a focus or are otherwise oriented towards policy mobility and exchange, best practices sharing, and fostering executive action on climate change, sustainability, adaptation, resilience, emissions reduction, net-zero goals, and other related initiatives. Bilateral agreements between two cities are not considered networks for this study, nor are regional networks operating within a single nation-state or networks with mandatory membership structures as part of state-sponsored programmes. Continental networks, such as networks operating solely within the European Union, South America, Africa, etc., are considered as geographically bounded cross-border networks. Networks predicated on a single annual meeting or conference are also included. An emphasis is placed on active networks, as defined by Lee and Jung (2018), which is the focus of the principal data collection. Only networks with voluntary membership initiation systems are considered, although this does not exclude networks with membership requirements or thresholds for specific membership levels. Recent debate on the narrow scope of transnational municipal networks versus broader "city networks" has emerged concerning the scope of rising state-initiated, but not necessarily state-led, city networks, a handful of which cross national boundaries (Acuto and Leffel 2020; Grant, Leffel, and Johnson 2023). For this study, which emphasises city-formed, city-led initiatives as a characterisation of city globalisation, state-led or initiated networks are still considered if they fulfil the previous criteria.

Significant places

The 'cities' are defined as broadly analogous units with a general interpretation of defined urban units. Metropolitan urban areas are considered under a single banner of the central urban concentration in which it lies, in the case of individually-participating subdivisions and component urban units, dependent on the politico-administrative system under which it operates — e.g. "London" as the Greater London levels. The list of cities used as objects of study is primarily derived from the networks to which they are member, with any degree of membership they hold condensed to a single unit in the case of multi-level membership at the same level — e.g. "London" assuming the highest level of connection of Greater London, the City of London, the Greater

London Authority, or its main borough. Although many networks include devolved municipal authorities, counties and subdivisions, regional governmental offices, and intercity partnership programs as members, only single units of the direct city unit or regional subdivision are considered. Government and representative organisations are not regarded as objects of study. In cases where the component parts of a general city entity may hold membership without the rest of the parts of the unit, membership is generalised, and the entire unit will be included as an object of analysis. All scales and levels of cities — from megacities to villages — are included as objects of study. The study does not include non-urban units such as rural parishes and agricultural districts.

3.2 Research design

3.2.1 Data collection

Three principal datasets were gathered for the study. First, the list of the TMCNs serving as objects of study according the established definition was compiled. Basic characteristics of each TMCN, including their internal structure, host location, and founding elements, would also be included. Second, the complete list of all cities that are members of the compiled TMCNs was generated. Basic characteristics of each city, including its location and population, would also be included. Third, the indicators component of the four factors contributing to city membership depth in TMCNs — centricity, vulnerability, globality, and path-dependency — were identified and compiled. Due to the limited scope of readily available data covering the wide range of TMCN-member cities, most indicator components would come from national rather than city-level statistics.

The networks

A wide range of sources was used to generate the list of TMCNs studied, notably drawing from available pre-existing compilations of TMCNs. Acuto and Leffel (2024)'s "city networks membership dataset" was used as a foundational dataset from which a basic list of popular and recognisable TMCNs was available from 2017 data. As the dataset was not up to date and included inactive networks or lacked newly founded networks, it was supplemented by identified networks from the Global Cities Hub (2024)'s International City Networks Directory and the Urban Climate Change Research Network (2020)'s Climate Action Networks and Organizations list. Additionally, the UNFCCC Cities Race to Resilience (2024) programmes' partner finder dashboard was used to identify relevant networks to include in the study. A handful of additional networks were identified from the European Environment Agency Climate-ADAPT (2018a)'s list of networks, drawn from connections between observed networks or gathered from additional material during relevant coursework.

To narrow down the generated list of networks to solely those which were currently active, the same method as Lee and Jung (2018) was employed. The recency of their activities and whether they still appeared active in the last few years was gauged by looking through the websites of each TMCN, their recent publication and news postings, social media pages, and any recent references to each TMCN. Additional characteristics of each TMCN were gathered by analysing their websites, publications, legal documents, and public information to collect a wide set of relevant attributes, including:

- The name of each network and its abbreviation.
- The founding year of each network.
- The headquarters or office location(s) of each network.
- The central geography of each network — e.g. global, EU, continental, regional, etc.

- The main topic or action area of each network — e.g. general climate and environment, sustainability or SDGs, water, disaster risk or resiliency, energy, net-zero goals, food sustainability, etc.
- The primary activity type of each network — e.g. knowledge exchange, technical assistance, funding, etc.
- The leadership type of each network — i.e. institution-led or multilateral.
- The membership type of each network — e.g. equal partnership, executive secretariat, rotating board, steering committee, single leader, etc.
- The membership criteria of each network — e.g. commitment signing, policy necessities, population thresholds, etc.
- The membership fees of each network.
- The funding source of each network — e.g. funding by membership fees, grant-derived funding, institutional funding, etc.
- The founding members of each network.

These characteristics served as an object of comparison between each TMCN to identify the different typologies of membership and internal stratification present among them and draw trends and conclusions. Central to the analysis of the depth of city membership were the founding member cities of each network and the founding year of each network, as these can be further used to match the initiating cities of each network. For a handful of TMCNs, the founding members were not directly available, and the membership fee rules were too loose or subjective (pay-as-you-go schemes) to provide an accurate overview of the standard fee procedures. Otherwise, the complete list of characteristics was compiled for each network. The list of members of each network was then utilised to generate the list of cities studied.

The cities

The principal source for the list of studied cities was derived from the list of each network's member cities, partner cities, and founding and hosting cities — in the case that the latter did not figure as member cities themselves, which was a recurring case. The heterogeneous fashion in which each TMCN displayed or publicised its list of members meant multiple methods were used to draw the list of member cities from the networks. A few networks conveniently provided a formatted table of their members, others provided unformatted lists that needed copying and parsing, and some only had online tables that required a web scraping Python script to collect and compile the list. In all cases possible, the membership year of each city was included, which was completely inaccessible for about half of the identified networks. The internal membership level of each city, whenever differentiated in multi-level membership TMCNs, was compiled for each city in a simple scheme of observer or non-voting member, full regular member, or elevated member in some leadership position or greater capacity than a regular member.

Each city was paired with a unique identifier to track the cities between TMCNs and identify unique members (as networks in different languages used different localisations of the same city name at different instances — e.g. Vienna, Wien, Vienne, etc.). This process entailed geocoding all named places through the Google Maps API and using a fuzzy matching Python script to identify the same places, complemented with a manual review of unmatched locations. During the process of condensing the list of cities to unique cities, places that did not meet the criteria outlined in the scope and definitions were discounted, and different levels of the same urban place were merged and cleaned. Additional characteristics of each member city were gathered from the World Cities Database (Pareto Software 2024), including:

- The common name of each city.
- The country in which each city is located and its ISO 3166-1 alpha-2 and alpha-3 codes.
- The UN-designated M49 region and sub-region location of each city.
- The coordinates of each city's location.

- The population of each city, both territorial and metropolitan population.

Additional characteristics of each city were gathered to fulfil the indicators, which are listed in the following section.

To complement the list of cities derived from the identified and studied TMCNs, all cities listed in the last two editions of The World According to GaWC's World Cities publications (2022, 2024) are included as an additional object of comparison to test the capital flows model of global city formation against the developed TMCNs model. As the memberships of TMCNs fluctuate over time and the cohort of cities in leadership positions may be on a rotating or temporary basis, the gathered list provides only a snapshot of memberships in November of 2024. Numerous previously-member and future-member cities of the identified TMCNs do not figure in the dataset due to the temporal nature of TMCN membership, which is outside the scope of this study.

The indicators

To gauge the effects of the identified factors on city's membership depth in TMCNs, the same four broad categories of factors are used: centricity (C), vulnerability (V), globality (G), and path-dependency (P). These four categories are each composed of multiple indicators, or variables, of factors potentially contributing to city membership depth, derived from similar studies and findings reviewed in the current literature. Across the four categories, 39 indicators are identified and congruently labelled: C1 to C6, V1 to V20, G1 to G3, and P1 to P10. Each indicator is derived from a particular source of existing data or the product of the collected data, particularly to generate city-level statistics, as datasets operating at the city scale are not readily available for the wide variety of factors tested, so it is common to substitute it with national-level statistics (Lee 2013). A breakdown of the 39 identified indicators, the reasoning behind their inclusion, their datasets, and sources, follows.

The centricity (C) indicators gauge the power, or central prominence or importance, a city has as a place, distinct from any globalised phenomena operating within its urban space. Testing the size of a city, its productive output, how central it is to its home state, and the relative weight of the city in the national and internal sphere, these indicators represent the most basic level of investigation as to what factors of size, national importance, and productivity contribute to the potential of city's membership depth in TMCNs. A more populous city, a high-output city, or a socioeconomically or politically important city may have a different membership depth tendency than a less populous city, a lower-output city, or a less politically relevant city. The factor of a city's share within its home nation may additionally highlight places which are more integrated into TMCNs. See Table 1, below, for the list of centricity indicators.

Table 1. The centricity attributes, their units, scales, ranges of values, and dataset source(s).

NO.	NAME	UNIT	SCALE	RANGE	SOURCE
C1	City population	number	city	10 - 37M	Pareto Software (2024)
C2	Capital status	national (3), administrative (2), minor (1)	city	0 - 3	Pareto Software (2024)
C3	National GDP	2022 current USD	national	59B - 26T	World Bank Group (2022c)
C4	GNI per capita PPP	2022 current USD	national	890 - 123K	World Bank Group (2022d)
C5	City GDP	2022 current USD	city	400K - 1.8T	city population × GNI per capita PPP
C6	City GDP per cent	percentage	city	0 - 100	city GDP ÷ national GDP

The vulnerability (V) indicators gauge a city's susceptibility to climate change's effects and its ability to adapt to, react to, or counter the externalities of climate change. Numbering 20

indicators, the vulnerability category is the most populated list, representing half of the total list of indicators, as a substantial number of factors with a high variety in their implications may affect a city's vulnerability to climate change. Consequently, as the object of study is primarily climate-focused networks, vulnerability factors come under increased focus for their potentially greater impact on a city's depth of membership in TMCNs. See Table 2, below, for the list of centricity indicators.

The list of vulnerability indicators can be further grouped into sets of variables. Firstly, the factors contributing to or resulting from climate change, including greenhouse gas emissions and air pollution. Secondly, the aspects related to energy production and the energy transition, including energy consumption and renewable energy output. Third, other environmental factors affecting climate-related attributes, including the coastal placement of a city and average precipitation. Fourth, a city's development level, potentially impacting its ability to respond to climate change, including HDI statistics, life expectancy, prevalence of informal housing, and UN-recognised development states such as LDC, LLDC, and SIDS. Finally, various indices from various institutions gauging a place's susceptibility to climate change effects and the performance of particular areas in addressing the threats of climate change.

Table 2. The vulnerability attributes, their units, scales, ranges of values, and dataset source(s).

NO.	NAME	UNIT	SCALE	RANGE	SOURCE
V1	Total greenhouse gas emissions excluding LULUCF	Mt CO2e	national	0.001 - 16K	World Bank Group (2023a)
V2	Total greenhouse gas emissions excluding LULUCF per capita	t CO2e	national	0.06 - 84.71	World Bank Group (2023b)
V3	City GHG emissions	Mt CO2e	city	0.001 - 335	city population × total greenhouse gas emissions excluding LULUCF per capita
V4	National energy consumption per capita	BTU	national	649K - 81M	The World Factbook (2023)
V5	City energy consumption	BTU	city	1T - 5.4Q	city population × national energy consumption per capita
V6	National inequality-adjusted HDI	coefficient	national	0 - 100	United Nations Development Programme (2022a)
V7	National planetary pressures-adjusted HDI	coefficient	national	0 - 100	United Nations Development Programme (2022b)
V8	Life expectancy at birth, total	years	national	55 - 87	World Bank Group (2023c)
V9	Coastal status	true/false	city	0 - 1	≤10 km from the coast, from GIS plotted points
V10	Proportion of urban population living in slums, informal settlements	percent	national	0 - 100	UN-Habitat (2022)
V11	Average precipitation in depth	mm per year	national	18 - 3240	World Bank Group (2021a)
V12	PPM2.5 air pollution, mean annual exposure	micrograms per cubic meter	national	4.9 - 85	World Bank Group (2020b)
V13	Renewable energy consumption	percentage of total final energy consumption	national	0 - 100	World Bank Group (2020a)

V14	Climate Change Performance Index 2025	factor	national	0 - 100	Burck et al. (2024)
V15	Climate Risk Index 2025	factor	national	0 - 100	Adil et al. (2025)
V16	Climate-driven INFORM Risk index	coefficient	national	0 - 10	Disaster Risk Management Knowledge Centre (2022)
V17	Children's Climate Risk Index	coefficient	national	0 - 10	UNICEF (2021)
V18	UN-attributed Least Developed Country (LDC)	true/false	national	0 - 1	Statistics Division of the United Nations Secretariat (1999)
V19	UN-attributed Landlocked Developing Country (LLDC)	true/false	national	0 - 1	Statistics Division of the United Nations Secretariat (ibid.)
V20	UN-attributed Small Island Developing State (SIDS)	true/false	national	0 - 1	Statistics Division of the United Nations Secretariat (ibid.)

The globality (G) indicators gauge a city's interconnectedness in existing globalisation institutions and phenomena in a more specific way than the centrality indicators. These are predicated on two prominent institutions, the EU and the OECD, representing highly globalising tools of developed countries. The EU in particular has a strong stance on networking cities and multiple city networks, including TMCNs, which operate within its framework, potentially strongly affecting the ability, willingness, and capacity for cities in EU member states to integrate within TMCNs. Additionally, the GaWC dataset on focal cities within the web of finance networks is included as a strong object of comparison, as one of the dominant perspectives and investigations of global city formation through the lens of capital mobility. For additional comparisons, the cities delisted in GaWC's 2022 and 2024 dataset publications are included, as they are nonetheless noteworthy contributors to the globalisation phenomenon through financial flows. See Table 3, below, for the list of centricity indicators.

Table 3. The globality attributes, their units, scales, ranges of values, and dataset source(s).

NO.	NAME	UNIT	SCALE	RANGE	SOURCE
G1	GaWC ranking 2022 and 2024	unlisted, delisted, Sufficiency to Alpha++	city	0 - 13	Globalization and World Cities (GaWC) research network (2022 and 2024)
G2	OECD member	true/false	national	0 - 1	OECD (2024)
G3	EU member	true/false	national	0 - 1	European Union (2024)

The path-dependency (P) indicators gauge the effect of pre-existing choices and historical trends that cities have followed in shaping the depth of their memberships in TMCNs. As tendencies in climate action, networking, and globalisation tend to follow reproducing trends and existing willingness to engage with the topic of climate change, adaptation, and the TMCNs themselves, these indicators may highlight elements that affect the continuity of past decisions and events in cities' depth of membership in TMCNs. Numbering 10 indicators, the path-dependency category represents the second-largest one after vulnerability, for similar reasons that they likely represent the most influential components of a city's willingness to deepen membership in TMCNs. See Table 4, on next page, for the list of centricity indicators.

The list of path-dependency indicators can be further grouped into sets of variables. Firstly, derived from the collected data, the number of networks a city has founded or hosted is likely linked with a greater tendency to interact with the web of TMCNs and deepen membership into the wider network. Second, existing governance structures that show a willingness to address climate change may be linked with a city's willingness to integrate in the form of existing environmental plans, a sympathetic governing coalition, extensive natural protection, or an existing state party

to the Kyoto Protocol. Thirdly, a high prevalence of climate-intensive economic activity and a greater reliance on those sectors may affect a city's participation in TMCNs, such as through different shares of their GDP stemming from land use, industry, or oil production.

Table 4. The path-dependency attributes, their units, scales, ranges of values, and dataset source(s).

NO.	NAME	UNIT	SCALE	RANGE	SOURCE
P1	Networks hosted	count	city	0 - 40[2]	from data
P2	Networks founded	count	city	0 - 40[2]	from data
P3	Environmental plan presence	true/false	city	0 - 1	various
P4	Governing party	(Far-)right, centrist, (far-) left	city[3]	-2 to +2	various
P5	Agriculture, forestry, and fishing, value added	percentage of 2022 GDP	national	0 - 100	World Bank Group (2022a)
P6	Industry including construction, value added	percentage of 2022 GDP	national	0 - 100	World Bank Group (2022b)
P7	Terrestrial and marine protected areas	percentage of total territorial area	national	0 - 100	World Bank Group (2023a)
P8	Total natural resources rents	percentage of 2021 GDP	national	0 - 100	World Bank Group (2021b)
P9	Kyoto Protocol Annex 1/B ratifier	true/false	national	0 - 1	UNFCCC (2024)
P10	OPEC and OPEC+ member	true/false	national	0-1	OPEC (2024)

The cases of environmental plan presence and identifying the governing party of the cities are limited to the top 95th percentile of the most integrated cities, to provide a manageable sample which must be collected individually for each city. The data for the presence of environmental plans is based on available information through website analysis of each city in early 2025, based on whether each city has or has recently had an environmental plan, climate action plan, sustainability plan, net-zero plan, or a related initiative. For the governing party, the same data collection method is utilised to generalise the political leaning of the ruling institutions of each city on a scale of far-right, to right, centrist, left, to far-left. This classification is based on the predominant political orientation of each city's local government over the past two decades. Many cities have naturally experienced shifts in political leadership during the reviewed timeframe, but the listed leaning reflects the overall trend during that period. For cities where specific information was not readily available, the classification is based on the general political tendencies of the region, or, in rare cases, the country. The single-axis, basic typology of the political leanings is not meant to provide an in-depth analysis of the political institutions of each city, but rather to offer a basic object of comparison which may contribute to membership depth in TMCNs.

3.2.2 Data analysis

The performed data analysis is two-fold. The first part systematically maps and quantifies the membership depth of all identified cities across every identified TMCN. This is accomplished through the creation of a grading mechanism which scores the depth of cities' connectivity per network and collectively in total. The second part maps the indicators' effect on cities' willingness to deepen membership depth. This is done through the proxy of the indicators, which, via a

[2] The maximum theoretical number of networks a city can found or host, see the results section for additional details.

[3] Where available; otherwise, on a regional or national scale.

regression analysis, will test the degree to which each indicator can predict the depth of a city's membership in TMCNs.

Membership grade and index

A Membership Grade was derived for each city across all networks. Such a grade represents the depth of a city's integration within a particular network and is assigned to every city for every network, even if a city is not a member of that network. The grade is a simple number constructed through a point scheme depending on a city's level of integration, leadership position, and structural contributions to a particular network, or lack thereof. Table 5, below, details the breakdown of the Membership Grade assembly and value of the awarded points. In practice, a city that is not a network member will have a Membership Grade of 0, while a city that is in a leadership position, a founder of that network, and a host of that network will have the maximum Membership Grade of 6. The additional points for founding cities (+1) and host cities (+2) can still be earned by cities not members of that network. So, it may be possible for a city to be a former founding member or a non-member city hosting the network without earning any points as a member.

Table 5. Breakdown of the Membership Grade.

POINTS	SIGNIFICANCE
0	Non-member or former-member city.
1	Observer, non-voting, or not a full member city.
2	Full, regular, voting member city.
3	Leading, executive board-sitting, agenda-setting, or secretariat or president member city.
+1	An additional point if the city is included in the list of initial founders of the network.
+2	An additional point if the city hosts the network's headquarters, office(s), annual convention, or conference.

From a city's Membership Grade across every network, the Membership Index (TMCNMI) is compiled. Each identified city has a single score in the Membership Index, representing the depth of its connection and level of integration within the whole TMCN network web. The Membership Index is calculated simply as the sum of its Membership Grade in every identified network. Therefore, a city's maximum theoretical score in the Membership Index is six times the number of identified networks. As it is inherently impossible for a city to reach the top score, the Membership Index does not need to be normalised or converted to a coefficient out of 1. If any of the cities not derived from network membership in the data collection among the added ones of the GaWC datasets do not hold membership in any network, nor host or have founded any networks, then it will have a Membership Index of 0, as will any city not listed in the final dataset. A further Membership Index Degree is developed in which each city's Membership Index is divided by the number of networks in which they are members to gauge the average Membership Grade they hold. A Membership Index Degree of 2.00 indicates that, on average, a city simply holds full, ordinary membership in every network in which it is a member. In contrast, a value greater than 2.00 indicates that a city typically has a greater than typical integration with the networks in which it is a member.

Indicators regressions

The Membership Index will serve as the basis for a regression analysis alongside the 39 indicators, effectively acting as the dependent variable. Inherently, a linear correlation regression analysis does not prove a cause-and-effect relation between the indicators and the depth of cities' membership in TMCNs (the Membership Index variable) and only provides a correlation between the compared variables. Nonetheless, using linear regression as a proxy can enable

conclusions to be drawn on the patterns of membership depth and factors contributing to that depth to discern any relationships between the indicators and membership. To narrow the results of the regressions and uncover more significant trends, multiple regressions are performed to account for and control for certain variables most likely to affect the independence of each city's indicators and Membership Index. Particularly, analysing the most integrated cities and those globalised in other ways will account for certain biases drawn from, for example, the prevalence of geographically bounded networks in the EU or among UN development initiatives. Table 6, below, details the twelve regressions performed and the reason for each.

Table 6. List of the regressions, their scope, and reasoning.

NO.	SCOPE	SIGNIFICANCE
A	All listed cities	All cities in the database to utilise the maximum number of available data points to draw conclusions.
B	Membership Index > 2	Only the cities with a Membership Index greater than 2, testing those that are more than a regular member of a single TMCN.
C	Membership Index 90th percentile	The cities that comprise the 90th percentile of the Membership Index, testing the highly integrated cities.
D	Membership Index 99th percentile	The cities that comprise the 99th percentile of the Membership Index, testing the most integrated cities.
E	EU-member country	Only EU-member country cities, testing the impact of globalisation through EU membership, to compare its effects on globalisation via the TMCNs.
F	Non-EU-member country	Non-EU-member country cities, testing the impact of globalisation through EU membership, to compare its effects on globalisation via the TMCNs.
G	OECD-member country	Only OECD-member country cities, testing the impact of globalisation through OECD membership, to compare its effects on globalisation via the TMCNs.
H	LDC-designated country	Only Least Developed Country-designated cities, testing the impact of extreme precariousness and the lowest development level.
I	GaWC-ranked city	Only GaWC-ranked cities, testing the impact of globalisation through financial flows, to compare its effects on globalisation via the TMCNs.
J	Networks hosted > 0	The cities that host one or more networks, testing the central centres of activity acting as nodes in the TMCNs.
K	Networks founded > 0	The cities that have founded one or more networks, testing the pioneering cities involved in the creation of the TMCNs.
L	Membership Index Degree > 2.00	Only the cities with a Membership Index Degree greater than 2, testing the cities with the deepest average integration in the TMCNs in which they are a member.

Following the creation of both the Membership Grade and Membership Index, and the ensuing regressions, conclusions will be drawn and discussed on the results of the disposition, typology, and hierarchy of the cities' membership depth in TMCNs and the indicators which parallel greater or lesser depth. A basic statistical review of the Membership Index, a physical map of the identified cities, and a list of the most deeply integrated cities are additionally generated.

3.2.3 Limitations

Apart from the inability of the regression analyses to draw concrete conclusions on the links between the centricity, vulnerability, globality, and path-dependency indicators with the depth of city memberships in TMCNs vis-à-vis the Membership Index, the data collection and analysis are affected by two other prominent limitations. First, the definition of a city's degree of integration within each TMCN as an elevated position or formal leadership role may not fully capture

the informal dynamics, invisible relations, and personal networking which contribute to a city's stature within each TMCN and the network of TMCNs. Analysing the inner workings of each TMCN to gauge the cities which are actually active within their leadership roles or active in a leadership capacity outside of formal leadership positions may allow a more nuanced and therefore representative definition of city leadership within TMCNs. Furthermore, some cities which are full members may also be passive members, not contributing to the activities of the network or engaging in the globalising effects of TMCNs, which could not be deciphered without a rigorous review of every member in every network, a considerable undertaking outside the scope of this study.

A second prominent limitation is the lack of temporal scope in the collected data, preventing more profound conclusions from being drawn about the shifting dynamics of city membership in TMCNs and the elevated positions of cities within them. As the number of member cities in each TMCN fluctuates, certain cities may join or leave a particular TMCN at certain moments or assume different roles. The political affiliation of a city's ruling institutions also fluctuates over time and may affect the degree to which a city is willing to integrate within the web of TMCNs at different points in time or cause them to leave outright or join different TMCNs. Additionally, as seen in the literature review, many TMCNs are organised with a rotating or temporary leadership positions structure in which members are elected, serve terms, or rotate responsibilities. Therefore, the collected data, analysis, and study provide only a snapshot in time of the TMCNs and their members, rather than definitive conclusions on the matter for every point in time.

Within the analysis, the 39 indicators are only grouped within four broad categories; they do not combine their component indicators into a broader, composite indicator — e.g. a single 'centricity' coefficient taking together all C1 to C6 indicators. Simply averaging the component indicators into a single coefficient would yield inconclusive and misleading results for two reasons. First, the trend of each variable does not necessarily align with the others in the same category. For example, the path-dependency variable of OPEC and OPEC+ member country (P10) may show a negative correlation, compared to the Kyoto Protocol Annex 1/B ratifier country variable (P9), which may show a positive correlation. Simply averaging the two would not produce any meaningful result and would likely necessitate that the range for P10 be changed from false = 0 and true = 1 to false = 0 and true = -1 to align the values of the categories. Numerous other variables in the different categories may share this necessity, such as V13 Renewable energy consumption, V14 Climate Change Performance Index 2025, and P5 and P6 on the percentage of national GDP derived from climate change-contributing sectors. Second, a simple averaging of raw correlation coefficients may lead to inaccurate results when the sample size differs or when comparing different units, variables, and datasets, as is the case in this study (Fisher 1992).

Correctly deriving a composite result of the indicators in each category would necessitate transforming each independent indicator using Fisher's z-transformation, after any necessary reversal of the coefficient to align with the broader hypotheses, averaging the z-transformed values, then inversing the mean z-value of each categorical composite back into a correlation coefficient (Fisher 1992). To maintain the specificity of the study's investigation of contributing factors to city membership depth without oversimplifying the four categories, and due to the amount of time such statistical manipulation would require to perform on all four categories across all twelve performances, the transformations were not performed and a composite indicator for each category was not derived in this study. Nonetheless, it may prove beneficial to perform such in the future.

4 RESULTS

This section provides a comprehensive sample of the breadth of gathered and analysed data of the thesis. Similar to the data collection process, three main sets of findings are presented: the assortment of identified networks taken as objects of study and their characteristics, member cities, and internal stratifications; a high-level analysis of the Membership Grade and Membership Index generation for every city and the cities with the most pronounced scores in both; and, as the most considerable accumulation of data in the study, the regression analyses performed among the four groups of 39 indicators against the complete list of cities and, subsequently, varying sets of cities. The most significant results are reviewed in the section, including the correlations of note among the regressions, while the full detailed results are available in the appendices.

4.1 Networks and members

4.1.1 Identified networks

Following the first step of data collection, 54 TMCNs were identified as relevant according to the definitions established in the scope. Of the 54 networks, 14 were no longer active, including, for example, completed temporary URBACT projects of the EU. The resulting 40 TMCNs used as the foundation for the analysis do not represent an exhaustive list, but all networks which have a significant enough presence within the current climate change regime and include general networks which have a substantial climate or environment-related topic area, even if it may not represent their sole activity area. The resulting web of networks consists of a broad map of actors covering multiple geographies and internally organised in different yet parallel ways. Only for one of the networks, Leading Cities, could appropriate data on their members not be collected, as it is considered member-only, proprietary information. In the case of the United Cities and Local Governments (UCLG) umbrella organisation, the direct membership of the network was identified as mainly consisting of national-level city networks with few direct city memberships. Three UCLG sections — Asia-Pacific, Eurasia, and Middle East and West Africa — are directly composed of cities and were observed separately, while the main UCLG body was observed for its congressional panel of leading cities through its Presidency and World Secretariat. Table 7, on next page, lists all TMCNs included in the study and their characteristics.

A little over half of the 40 compiled TMCNs have a completely global scope. In contrast, 18 networks have a more restricted topic geography, ranging from continental organisations and regional networks to those linked with pre-existing bodies, namely the EU and UN. A third of the TMCNs were founded before 2000, another third appeared between 2010 and 2020, and four began in the last five years. Most networks founded after 2000, particularly those emerging from 2010, have a narrower climate-related scope, while the broader, global, general networks tend to be the longest-running. Around a third of the identified networks are general-purpose city networks with a sub-topic of climate-related activities, while the remaining TMCNs are oriented explicitly towards climate-related activities. Among those, there is a wide variety of action areas which TMCNs target. These can be grouped into a few loose themes: (a) energy, net-zero, and emissions; (b) mainstream sustainability, SDGs, and adaptation; (c) flooding, water management, and disaster risk; (d) food sustainability and the natural environment; and (e) transportation and mobility. These broad themes are non-exhaustive, and, naturally, many networks have overlapping topic areas that may reach beyond these, as climate change is an intersectoral phenomenon. Networks that focused exclusively on public health, cultural management, finance, or the architectural built environment were not studied unless they specifically touched on climate-related phenomena.

Table 7. Overview of the networks identified and included in the study.

ABBREVIATION	NETWORK	YEAR FOUNDED	CITIES	HEADQUARTER(S)	GEOGRAPHY	ACTIVITY AREA	STRATIFICATION
B40	B40 Balkan Cities Network	2021	68	Istanbul, Turkey	Balkans	General	Secretariat
BCN	Barcelona Challenge for Good Food and Climate	2021	24	Barcelona, Spain	Global	Food sustainability	Steering committee
C40	C40 Cities Climate Leadership Group	2005	96	London, U.K.	Global	Climate change	Steering committee
C4F	Cities4Forests	2018	94	Washington D.C., U.S.	Global	Nature / environment	Secretariat
CCCI	Cities and Climate Change Initiative	2008	44	Nairobi, Kenya	Global South	Disaster-related	None
CDC	Connecting Delta Cities	2018	17	Rotterdam, Netherlands	Global	Water-related	Steering committee
CFM	Cities for Mobility	2006	322	Stuttgart, Germany	Global	Mobility / transportation	Secretariat
CITYNET	CityNet	1987	94	Seoul, South Korea	Asia-Pacific	Climate change	Secretariat
CLIMALL	Climate Alliance	1990	1,770	Frankfurt, Germany	Europe	Climate change	Executive board
CNCA	Carbon Neutral Cities Alliance	2014	22	Copenhagen, Denmark	Global	Net-zero / emissions	None
CWN	CitiesWithNature	2018	312	Cape Town, South Africa	Global	Nature / environment	Secretariat
ENCIT	Energy Cities	1990	132	Besançon, France	Europe	Energy transition	Executive board
ESC	IDB Emerging and Sustainable Cities Program	2012	61	Washington D.C., U.S.	Latin America	Climate change	None
EUROCITIES	Eurocities	1986	209	Brussels, Belgium	Europe	General	Executive board
GCA	Green Cities Accord	2020	110	Brussels, Belgium	Europe	Climate change	None
GCOM	Global Covenant of Mayors for Climate & Energy	2016	11,534	Brussels, Belgium	Global	Energy transition	Executive Board
GPM	Global Parliament of Mayors	2016	136	The Hague, Netherlands	Global	SDGs	Steering committee
ICLEI	ICLEI - Local Governments for Sustainability	1990	1,043	Bonn, Germany	Global	SDGs	Executive board
IDB	IDB Cities Network	2017	251	Washington D.C., U.S.	Americas	General	None
LEADCIT	Leading Cities	2008	10	Boston, United States	Global	General	None
MCR2030	UNDRR Making Cities Resilient 2030	2020	1,659	Geneva, Switzerland	Global	SDGs	Secretariat
MEDCITIES	Mediterranean Cities Network	1991	74	Barcelona, Spain	Mediterranean	SDGs	Executive board
MERCO	Mercociudades	1995	386	São Paulo, Brazil Montevideo, Uruguay	Latin America	General	Executive board
METROPOLIS	World Association of Major Metropolises	1985	149	Barcelona, Spain	Global	General	Executive board

MUFPP	Milan Urban Food Policy Pact	2015	311	Milan, Italy	Global	Food sustainability	Steering committee
NCN	Nordic City Network	2018	11	Malmö, Sweden	Scandinavia	SDGs	Executive board
NZC	NetZeroCities	2019	111	Paris, France	Europe	Net-zero / emissions	Steering committee
OASC	Open and Agile Smart Cities	2015	150	Brussels, Belgium	Global	Smart cities	Executive board
POLIS	Polis	1989	89	Brussels, Belgium	Europe	Mobility / transportation	Executive board
RCN	Resilient Cities Network (formerly 100RC)	2019	99	Singapore, Singapore New York City, U.S. Mexico City, Mexico	Global	General	Steering committee
U20	Urban20	2017	61	Barcelona, Spain London, U.K. Buenos Aires, Argentina Paris, France	G20	Climate Change	Steering committee
UBC	Union of the Baltic Cities	1991	73	Gdańsk, Poland	Baltic Sea	General	Executive board
UCLG	United Cities and Local Governments	2004	365	Barcelona, Spain	Global	General	Secretariat
UCLG-ASPAC	UCLG-Aspac	2004	126	Jakarta, Indonesia	Asia-Pacific	General	Executive board
UCLG-EURASIA	UCLG-Eurasia	2004	101	Kazan, Russia	Central Asia	General	Executive board
UCLG-MEWA	UCLG-MEWA	1987	185	Istanbul, Turkey	Middle East & West Africa	General	Executive board
UNGC	United Nations Global Compact	2001	42	Melbourne, Australia	Global	SDGs	Secretariat
URBOCE	UrbanOcean	2019	17	Washington D.C., U.S.	Global	Water-related	Steering committee
WECP	World Energy Cities Partnership	1995	30	Houston, Texas	Global	Energy transition	Executive board
WEGO	World Smart Sustainable Cities Organization	2010	134	Seoul, South Korea	Global	General	Executive board

Apart from outliers like the Global Covenant of Mayors for Climate & Energy (GCoM), ICLEI - Local Governments for Sustainability, UNDRR's Making Cities Resilient 2030 (MCR2030), and Climate Alliance, the vast majority of TMCNs have between 10 and 400 members, with an average of about 130 members per TMCN. ICLEI is the fourth-most populated network, while MCR2030 and Climate Alliance hold about 1,700 members as the third and second-highest membership networks. GCoM, with 11,534 members included in the study, is the largest direct-membership TMCN — as UCLG's direct membership is relatively low despite its high accumulation of indirect member cities and local governments. Among these members, most TMCNs have a singular headquarters site from which the network operates, which in some cases differs from the geography of that network's activities. For example, IDB's Emerging and Sustainable Cities Program operates in South and Latin America but is headquartered in Washington, D.C. Certain UN and EU-led TMCNs are also de facto headquartered in Brussels or Geneva and Nairobi, where the organisations are located without necessarily including those cities as members or within their target geography. Nonetheless, a diverse range of primary TMCN seat cities is observed as the central headquarters of each network. These include prominent and classical international hosting cities — London, Seoul, Washington D.C., Barcelona, Brussels, Geneva — and less classical or atypical host cities — Stuttgart, Houston, Melbourne, Jakarta, Gdańsk. Several networks have non-permanent or unfixed headquarters cities, particularly those which are not institution-led or do not have a fixed secretariat. In these cases, the 2024 host city is identified as the network leader — namely for B40 and U20, in which the leader is the yearly or biannually rotating conference host. Reproducing the list of host cities in a different year would lead to different results.

Network stratifications

Almost all 40 studied TMCNs have some internal stratification in leadership structures or membership levels. Only six networks, 15% of those studied, have an equal membership structure and do not have some sort of stratification. Only a few of the 85% with an internal hierarchy system have different, distinct membership levels. C40 and Eurocities have the strictest membership classifications with population requirements to attain the highest levels of membership and partnership or observer classes for cities which do not meet the criteria to join. The Union of the Baltic Cities (UBC) interestingly created an observer membership level for Ukrainian cities as an extension of the Baltic Sea-region network to support municipalities affected by the 2022 Russian invasion, as a show of support and due to the strong relations from the Polish, Baltic nations, and Finnish leadership of the network with Ukraine's circumstances. Eight networks are multilateral establishments directly between members, and the 32 others are institution-led by a parent or structural organisation such as an NGO, coordinating secretariat, international institution, or governing body. Six networks entirely rely on a single member city to bear all network responsibilities, including leadership and funding. These may be rotating host cities for annual conferences or elected cities — as for the B40 and U20 — or predicated on the single founding and coordinating city — as for Cities for Mobility (Stuttgart), the Nordic Cities Network (Malmö), the World Energy Cities Partnership (Houston), and the Barcelona Challenge for Good Food and Climate network and Milan Urban Food Policy Pact.

Although other networks have various distinctions in memberships from working groups, subnetworks, and reporting versus non-reporting participants, the most common is the existence of a leadership structure via a secretariat, steering committee, or executive board, present in the 85% of networks with an internal stratification. In most cases across the studied TMCNs, the steering committees are elected or appointed permanent groups, secretariats are semi-permanent or voluntary positions, and executive boards are elected, rotating, non-permanent leadership groups. Like the case of rotating host cities, fixed-term, elected leadership positions create a fluctuating leadership environment within each TMCN. Reproducing the list of leadership cities at a different time, particularly those in executive boards or other non-permanent positions, would therefore yield different results.

4.1.2 Member cities

Across all 40 studied TMCNs, 22,168 discrete city memberships were identified, trimmed to 16,021 unique cities between all TMCNs. An additional 19 GaWC-listed cities not members of any networks were added, for a total of 16,040 cities in the study. Together, the 16,040 cities make up 2.32 billion people, about 30% of the world population, across 186 countries and territories. The unique cities represent nearly all major states, dependencies, and recognised or semi-recognised territories — i.e. Palestine, Kosovo, and Taiwan. Only a handful of significant places are not represented within the TMCNs, namely Bahrain, Brunei, Eritrea, Greenland and the Faroe Islands, Turkmenistan, and the Democratic People's Republic of Korea. Apart from the European continent with the highest density, a few places represent the most substantial concentrations of TMCN member cities. These include Belgium, Brazil, and Germany, which have over 500 member cities; Austria, which has over one thousand; Spain, which has over two thousand; and Italy, which has over four thousand. Geographically, Armenia, Bangladesh, Hungary, Lebanon, and Moldova have some of the densest concentrations of networked cities. Thirty territories have a single city member to TMCNs, around one hundred territories have more than ten city members to TMCNs, and twenty-three territories have more than one hundred city members to TMCNs. Figure 2, below, provides a map of all 16,040 unique cities identified in the study.

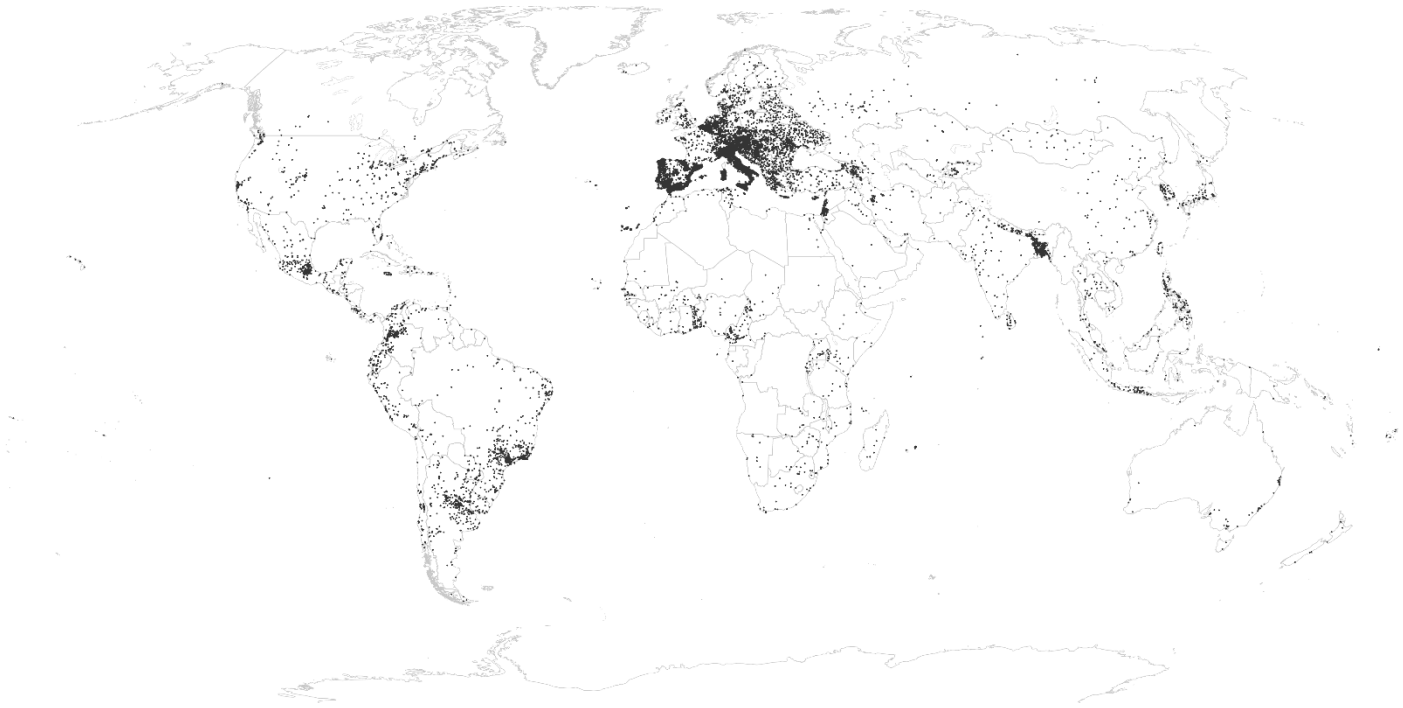
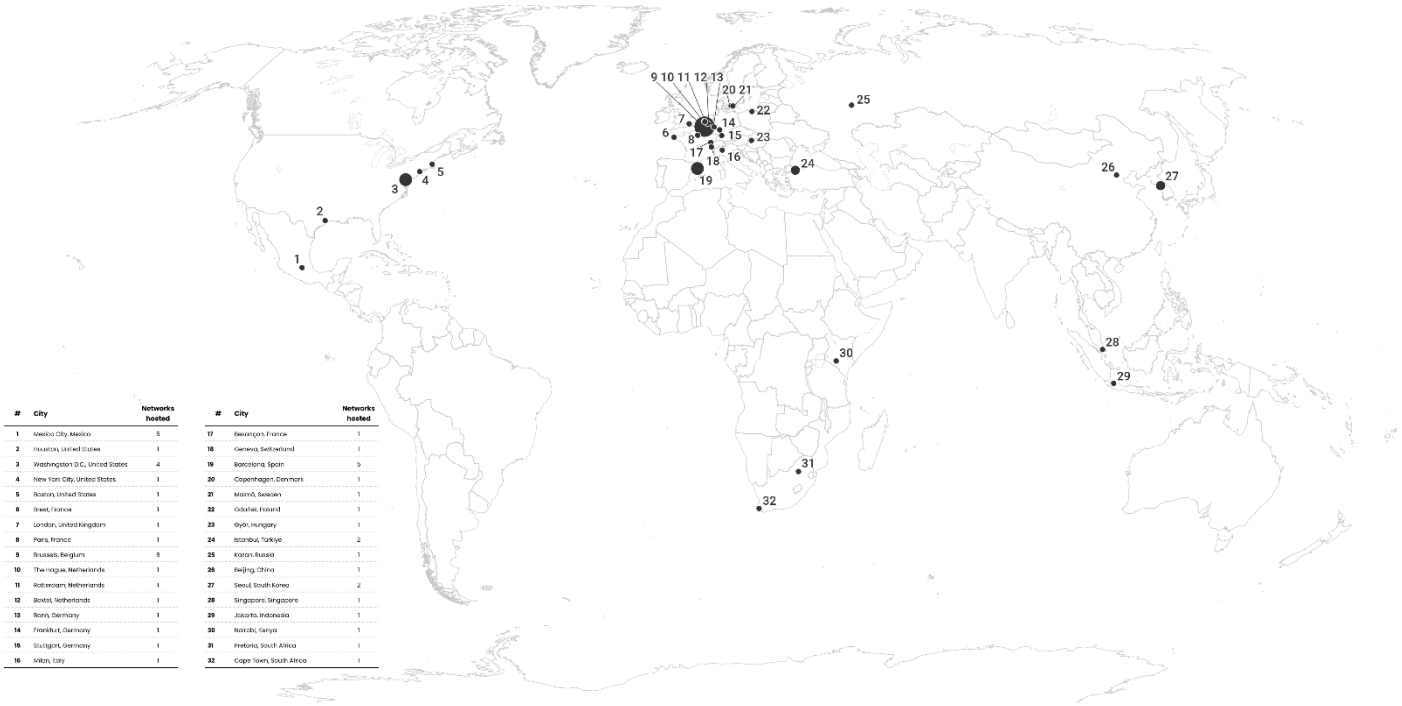


Figure 2. Map of all cities identified in the study.

14,138 cities, over 88%, are members of a single TMCN, creating an average of 1.25 TMCN memberships per city. Among the rest, 1,902 cities are members of two or more TMCNs; 854 of three or more; 325 of five or more; 58 of ten or more; and eight cities are members of fourteen or more TMCNs — Barcelona, Helsinki, Istanbul, Jakarta, Lisbon, Paris, Rio de Janeiro, and Rotterdam. Barcelona, a member of 20 TMCNs, is the city with the most memberships. Among all cities, 392 have acted as founders of one more TMCN, of which 44 cities have participated as founders of two or more TMCNs, and 15 have founded three or more. Only three cities have acted as founders of more than four TMCNs: New York City and Melbourne as founders of five TMCNs, and Barcelona as a founder of seven. A parallel, though narrower, trend emerges in cities that host TMCNs, with only 32 cities of 16,040 hosting one or more networks. Only three cities host more than three TMCNs: Washington, D.C., as the host of four, Barcelona as the host

of five, and Brussels as the host city of eight different TMCNs — namely, European-centric ones or EU-led networks. Figure 3, below, provides a map of the 32 TMCN-hosting cities.



#	City	Networks hosted
1	Mexico City, Mexico	5
2	Houston, United States	1
3	Washington D.C., United States	4
4	New York City, United States	1
5	Boston, United States	1
6	Brest, France	1
7	London, United Kingdom	1
8	Paris, France	1
9	Brussels, Belgium	8
10	The Hague, Netherlands	1
11	Rotterdam, Netherlands	1
12	Boxtel, Netherlands	1
13	Bonn, Germany	1
14	Frankfurt, Germany	1
15	Stuttgart, Germany	1
16	Milan, Italy	1

#	City	Networks hosted
17	Besançon, France	1
18	Geneva, Switzerland	1
19	Barcelona, Spain	9
20	Copenhagen, Denmark	1
21	Malmö, Sweden	1
22	Gdańsk, Poland	1
23	Győr, Hungary	1
24	Istanbul, Türkiye	2
25	Kazan, Russia	1
26	Beijing, China	1
27	Seoul, South Korea	2
28	Singapore, Singapore	1
29	Jakarta, Indonesia	1
30	Nairobi, Kenya	1
31	Pretoria, South Africa	1
32	Cape Town, South Africa	1

Figure 3. Map of all cities which are host to one or more TMCN.

The 16,040 identified cities represent a wide range of places and characteristics. Places as large as the 37 million inhabitants of Tokyo's metropolitan population to smaller towns of a few thousand inhabitants cast a wide diversity of sizes and capacities, with member cities having an average population of around 200,000. By GNI, the member cities account for USD 73 trillion in GDP, about three-quarters of global GDP, and 18 thousand Mt of CO2, half of global yearly CO2 production. Around 16%, 2,623, of cities are located on the coast; four thousand are regional, administrative, or national capitals, of which 183 are national capitals — corresponding to a dozen UN member or non-member observer states not being represented within TNCMs. Almost a thousand cities are in designated least developed countries, land-locked developing countries, or small island developing states. Comparingly, nearly 12,000 member cities — almost three-quarters — are in OECD member countries, of which 10,800 are in EU member countries, two-thirds of the identified cities. Slightly more than 12,000 cities are in IPCC Kyoto Protocol Annex I and Annex B countries, compared to around one thousand cities in OPEC and OPEC+ participating countries, just 0.06%.

4.2 Membership Index

4.2.1 Overview

Scaling the depth of member cities' participation among the web of TMCNs by the Membership Grade for each network and the summed Membership Index yields a wide range of different depths of integration. Ranging from 1 to 66, out of a theoretical maximum of 240 (highest Membership Grade of 6 × 40 TMCNs), with an average Membership Index of 2.6. The mean jumps to 6.8 when only cities with more than one TMCN membership are included, as the average Membership Index Degree between all cities is 2.00. Most cities have a Membership Index of only 2, representing the equivalent of a single regular membership in one network, with only

2,165 cities having a Membership Index greater than 2. A Membership Index of 5 or greater puts a city in the 90th percentile, populated by one thousand cities; a Membership Index of 15 or greater enters the 99th percentile with 143 cities; and the top fifteen cities representing the 99.9th percentile have a score of 30 or greater. Figure 4, below, maps all cities by Membership Index.

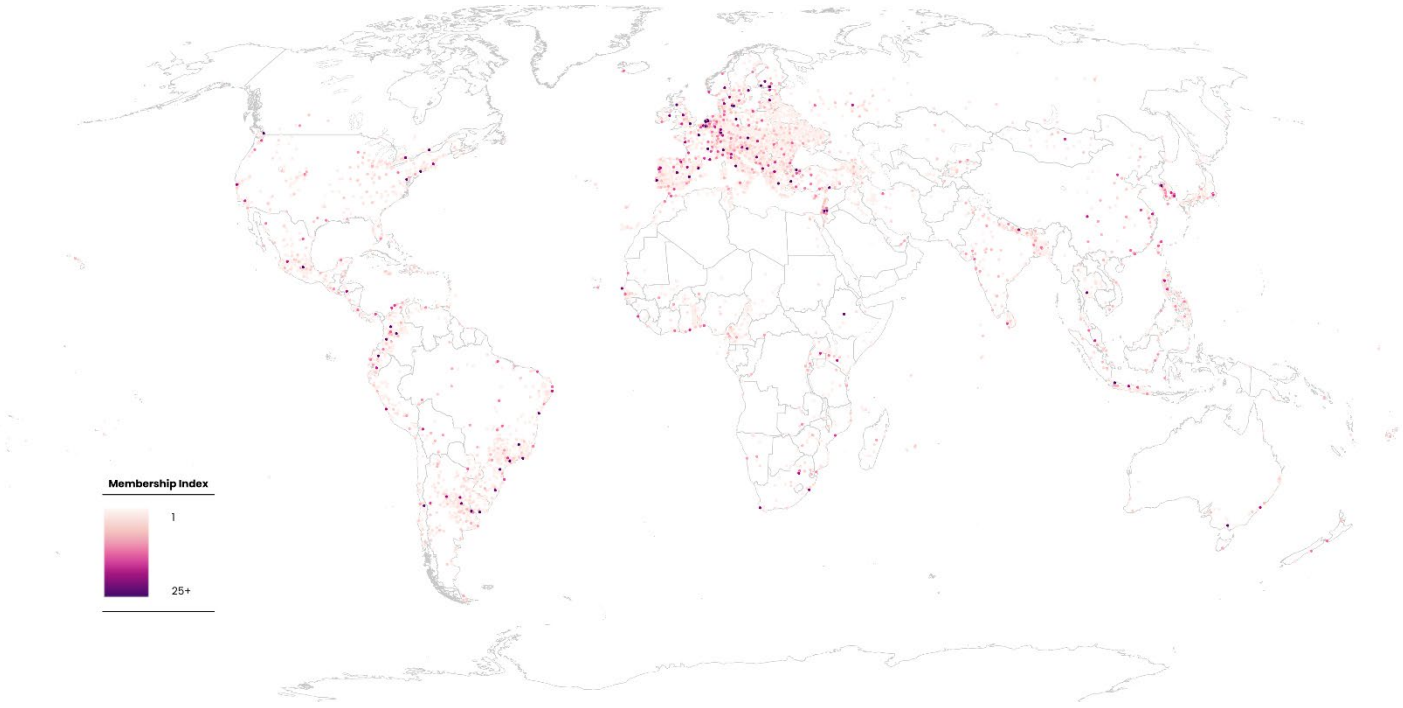


Figure 4. Map of all cities identified in the study by Membership Index.

The average Membership Index of 2.6 demonstrates a heavy skew by the most integrated cities with a Membership Index greater than 2, representing only 13% of the 16,040 cities in the dataset. Additionally, a mean Membership Index Degree of around 2.00 among all member cities effectively shows an average Membership Grade of 2 for every TMCN to which a city is a member. As two is the default Membership Grade for a typical member city, it shows a broad, across-the-board shallow integration into the web of TMCNs for all but the top percentiles of member cities. Further, among the 2,165 cities with a Membership Index greater than 2, 1,600 of them — nearly three-quarters — also have a Membership Index Degree of 2.00 or less, indicating an even smaller group of cities with a Membership Index and high Membership Index Degree. The small group of most-integrated cities effectively hold up the results on city integration, indicating the presence of a select handful of powerful, highly integrated cities acting between the networks.

4.2.2 Deepest-integrated cities

The 90th percentile of cities by Membership Index represents the 997 most-integrated cities in TMCNs across 138 countries and territories. Characterised by a Membership Index of 5 or greater, they additionally represent more than half of the population of all TMCN member cities, around 1.4 billion people, for a much more populous average of 1.5 million inhabitants. The geographic diversity of the 90th percentile follows similar trends to the overall spread of all networked cities, with a high concentration in Europe and Latin America, but lower density in Sub-Saharan Africa and West and Central Asia. A handful of countries, such as Belgium, Lebanon, the Netherlands, Nepal, and South Korea, retain a high density of member cities at this level of integration. Despite the relative prominence of European member cities in the 90th percentile of TMCN integrated cities, Argentina, Brazil, Türkiye, and the United States have the most cities in

the 90th percentile — followed only then by France, Germany, Italy, and Spain — while mainland China, Colombia, India, Mexico, and South Korea also factor highly, showing a lack of considerably distinct Global North bias. Figure 5, below, maps the 997 cities of the 90th percentile of the Membership Index.

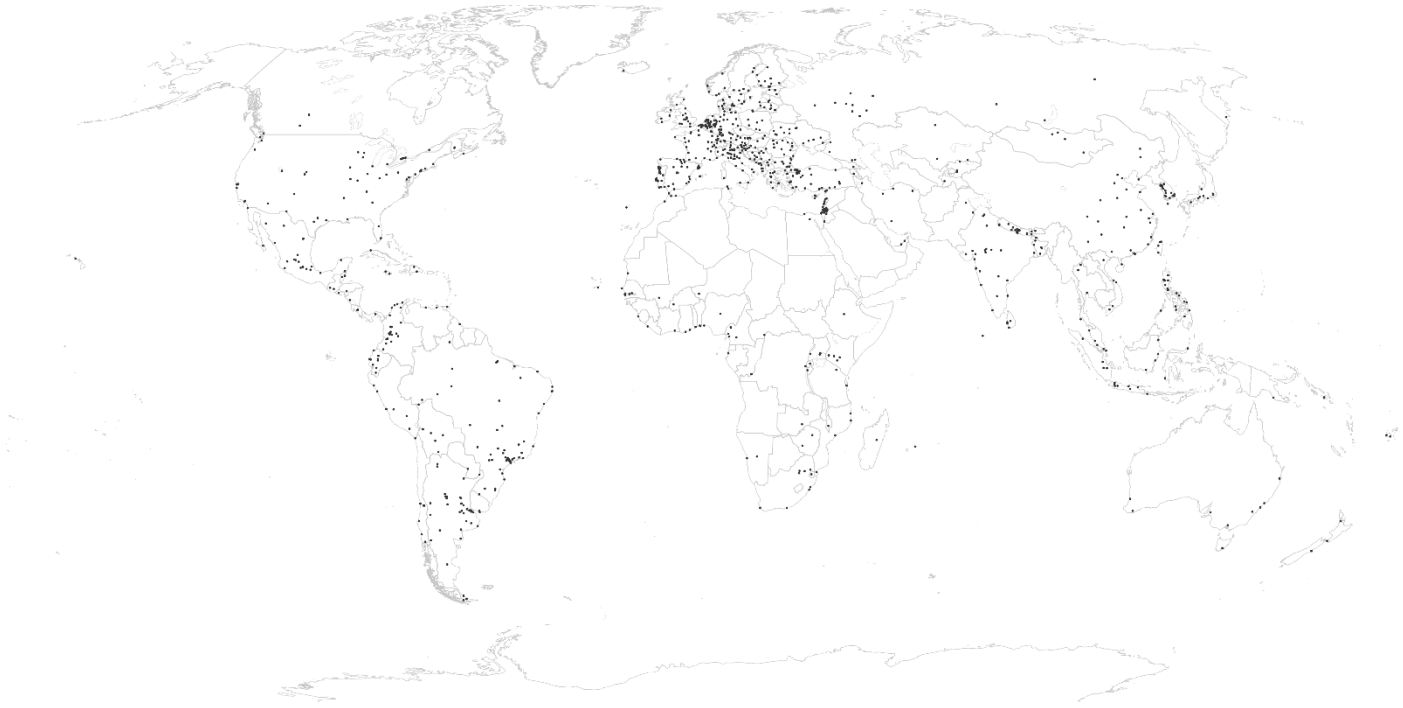


Figure 5. Map of the 90th percentile of cities by Membership Index.

The 143 cities that comprise the 99th percentile of integration into TMCNs by Membership Index provide additional insights into the typology of membership depth in the 40 networks. A geographical balance emerges among the top cities, with few appearing in the same countries — only 28 countries have more than ten 99th percentile cities, led by Brazil with 62 and Argentina, Türkiye, and the United States with more than 40, indicating little pervasive Global North-South divide. With a mean Membership Index Degree of 2.25 and a handful of cities with a Membership Index Degree of less than 2.00, the depth of membership in each network to which cities at that level are integrated remains influenced by the number of networks in which a city is a member. At these levels, the 143 cities still make up half a billion inhabitants with an increasing average of four million residents, and nearly all are some sort of capital or administrative centre, while slightly less than half are coastal cities, and almost two-thirds are in OECD member countries.

A closer look at the highest-scoring cities by Membership Index provides further details on the variety of integration patterns that cities demonstrate between TMCNs. The thirty-five deepest integrated cities by Membership Index score 25 or higher, but have a broad range of Membership Index Degrees, number of networks founded and hosted, and capture a wide geographic area — despite a narrower range of membership counts. Among the top thirty-five listed cities, the number of cities' memberships to TMCNs ranges from 9 to an outlier of 20, and the Membership Index Degrees range from 1.70 to 3.14. The top thirty-five most integrated cities also show a wide geographic range, balanced between Global North and Global South. Only seven countries are home to more than one city in the top thirty-five: Colombia, France, Italy, the Netherlands, Spain, and Türkiye, with Brazil hosting the most at three cities. Table 8, on next page, lists the thirty-five cities with the highest Membership Index and the breakdown of their scores.

Table 8. List of the thirty-five deepest integrated cities by Membership Index.

CITY	MEMBER-SHIP COUNT	MEMBER-SHIP INDEX	MEMBER-SHIP INDEX DEGREE	NETWORKS FOUNDED	NETWORKS HOSTING
Barcelona, Spain	20	66	3.14	7	5
Brussels, Belgium	13	44	2.75	1	8
Paris, France	17	43	2.26	4	1
Seoul, South Korea	13	38	2.71	2	2
Rotterdam, Netherlands	14	37	2.64	3	1
Istanbul, Türkiye	14	37	2.64	1	2
São Paulo, Brazil	13	35	2.50	2	0
Rio de Janeiro, Brazil	14	35	2.33	2	0
Jakarta, Indonesia	14	34	2.43	2	1
Milan, Italy	12	33	2.75	3	1
London, United Kingdom	12	32	2.46	4	1
Mexico City, Mexico	13	32	2.46	3	1
Lisbon, Portugal	15	32	2.13	2	0
Montevideo, Uruguay	11	30	2.50	0	0
Helsinki, Finland	15	30	2.00	0	0
Buenos Aires, Argentina	11	28	2.33	3	0
Athens, Greece	12	28	2.33	1	0
Rome, Italy	13	28	2.15	2	0
New York City, United States	10	27	2.25	5	1
Lyon, France	12	27	2.25	3	0
Utrecht, Netherlands	12	27	2.25	2	0
Belo Horizonte, Brazil	11	27	2.25	1	0
Quito, Ecuador	11	27	2.25	1	0
Berlin, Germany	12	27	2.08	3	0
İzmir, Türkiye	13	27	2.08	1	0
Vienna, Austria	11	26	2.36	0	0
Madrid, Spain	12	26	2.17	2	0
Vancouver, Canada	10	25	2.50	3	0
Zagreb, Croatia	12	25	2.08	1	0
Medellín, Colombia	11	25	2.08	0	0
Bogotá, Colombia	13	25	1.92	0	0
Melbourne, Australia	9	24	2.67	5	0
Malmö, Sweden	9	24	2.67	2	1
The Hague, Netherlands	9	24	2.67	2	1
Montréal, Canada	10	24	2.40	2	0

Cases of interest

Barcelona stands out as the top-scoring city by Membership Index and member of the most TMCNs at 20 concurrent memberships. Among the top thirty highest cities by Membership Index, it also has the highest Membership Index Degree at 3.14, built on a high integration depth in almost every network to which it is a member, as demonstrated by its hand in founding seven different TMCNs and hosting the offices or headquarters of five. Combining a high membership count and number of elevated positions within each membership, a large number of founded networks, and a high amount of hosted networks, Barcelona utilises every studied strategy to deepen its membership, hence earning an outlier score in the Membership Index. In contrast, the narrowly competing second- and third-highest-scoring cities of Brussels and Paris draw their high Membership Index scores from different trends. Second by Membership Index, Brussels is, however, fifth by its number of TMCN memberships, far beyond the 20 and 17 of Barcelona and Paris, with only 13 memberships. Most of Brussels' integration within TMCNs is not drawn from elevated network positions or a helping hand in founding networks, but as the most popular host city for the headquarters and offices of eight different networks. Paris, meanwhile, draws its score from a high number of memberships, deep member integration into each network across the board, and extensive fostering of TMCNs without a strong role as a host.

These patterns of differently derived Membership Index scores continue across many of the most deeply integrated cities. Rotterdam and Istanbul, with a Membership Index score of 37, derive their scores oppositely from the same number of memberships, with Rotterdam acting as founder for multiple TMCNs and Istanbul as host for an equally valuable number. Comparably prominent global cities such as London and New York, with 12 and 10 memberships, respectively, are not the most integrated into the TMCNs. While New York specialises in helping as a founder of networks, the second most behind Barcelona with five, London takes on more elevated leadership positions within the networks it is a member of, while neither serves as a particularly prominent TMCN host city. Certain cities like Rio de Janeiro and Lisbon also perform well in the Membership Index, but with comparably more memberships than those around them. Helping to found a few networks, they are, however, more connected with a higher number of memberships as the foundation of their scores, rather than being deeply integrated into a smaller pool of networks, as is common with other high-scoring cities. Meanwhile, cities such as Helsinki, Bogotá, and Medellín draw their score almost entirely from a high number of regular membership connections to many TMCNs, essentially becoming integrated by low, yet broad, participation.

Not listed in Table 8 are two additional cities of interest: Besançon, France, and Stavropol, Russia. Both are relatively low-tier cities within their home countries — Besançon with a population under 300,000 and Stavropol with around 400,00 — yet both have the highest Membership Index Degree at 4.00. In the case of Stavropol, it attains a Membership Index score of only 4, in the 87th percentile, as it is only member of one network as an elevated and founding member. Meanwhile, Besançon is a member of only two networks for an ultimate Membership Index of 8, in the 96th percentile. Despite this, it is a significant node among the web of TMCNs as the founding, host, and a leading city of Energy Cities, as well as holding an elevated position in GCoM. From these, Besançon, like Stavropol, manages to 'punch above its weight' and, despite a low level of overall connections, shows the depth of integration they have as centres of specific networks' operations, which is reflected in their comparatively high Membership Index scores. Cases like these are reproduced frequently in places where membership depth significantly extends beyond membership count. Malmö, Melbourne, Stockholm, and The Hague stand out in the top fifty highest-scoring cities for having a relatively low membership count TMCN memberships and yet a high Membership Index score of 23 to 24 from deep connections to the networks to which they are members, as founders and hosts. Boston, Frankfurt, and Stuttgart similarly reproduce this trend with fewer connections to TMCNs among the top one hundred highest-scoring cities by Membership Index from their roles as hosts and leaders of comparably few networks.

4.3 Regressions

4.3.1 Overview

The twelve regressions were then performed to generate insights into patterns of membership depth among the series of 39 centricity, vulnerability, globality, and path-dependency indicators. Ultimately, each regression and component indicators utilised a varying number of datapoints due to gaps in the original datasets. In some cases, the information in the dataset is not available for every city, country, or territory, depending on the level of detail of the original dataset, the places that the source recognises, or the transferability from constructed indicators — e.g. for city GDP as a factor of GNI × city population, if a place is missing one of the two variables. Additionally, the relevance and significance of the constructed indicators will not be analysed as intensely as other indicators due to the heavy reliance on the population factor, which may simply replicate the correlation of population. In some cases, controlling for one factor may yield zero datapoints in an attribute, in which case the coefficient data and significance are not available, nor relevant — e.g. there are no developing countries in the OECD, so controlling for OECD membership produces no results for the developing country indicators, etc. The results of the linear regressions' correlation coefficients and their significance are detailed in the following part, including any noteworthy results. For all twelve regression analyses, a table of the tested indicators, correlation coefficients, number of datapoints, and relative significance is provided alongside an accompanying explanation of the tested bounds and results of note.

Interpreting the varied substantiality of the correlation coefficient's significance can be done by general categories of scores in a ladder format, both for positive and negative correlations, which show inverse patterns of the same relationship. A higher positive correlation coefficient from the regression analysis shows a relationship whereby a higher indicator value is linked to deeper integration vis-à-vis a higher Membership Index. Conversely, a higher negative correlation coefficient shows that a lower indicator value is linked to deeper integration, or it can be construed as a higher indicator value being related to shallower integration depth through a lower Membership Index. A correlation coefficient of zero or near-zero demonstrates no relationship whatsoever, signifying that there is no link between an indicator value and higher membership depth. Generally, for this study's results, a value of zero or ±0.01 indicates no relationship; a coefficient of ±0.02 to ±0.05 indicates a small, narrowly significant link; a value of ±0.06 to ±0.14 indicates a weak link; a value of ±0.15 to ±0.25 indicates a minor link; a value of ±0.26 to 0.34 indicates a moderate link; ±0.35 to ±0.49 indicates a perceivable or observable link; ±0.50 to 0.69 indicates a pronounced, recognisable link; ±0.70 to ±0.89 is a substantial link; and, ±0.90 to ±1.00 is a direct, incredibly significant relationship. Further significance depends on the specific indicator, as they may be broad national statistics or already-generalised indices. Additionally, the number of tested datapoints may affect the relative noteworthiness of the results, with both an overabundant dataset of tens of thousands of points or an overly narrow dataset of just a handful of points may skew results.

4.3.2 Regression results

Regression A: all listed cities

The first regression includes all cities identified in the dataset. Including all cities generates a look at the broad linkages between membership depth vis-à-vis the Membership Index and the tested attributes. Apart from the indicators of environmental plan presence (P3) and governing party (P4), which are only available for the 95th percentile of cities, all other indicators are tested against the full breadth of available data for the whole list of cities. Across all four indicator groups, few distinguishable relationships exist between city TMCN integration depth and elements of centricity, vulnerability, globality, and path-dependency. Specific indicators, however,

show the most pronounced links, particularly those that otherwise affect a city's role in a broader context. Table 9, on below, details the correlation coefficients and their interpretation.

Table 9. Regression analysis results for regression A, testing all listed cities.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.46	n=14,330	Between all cities, there is a perceivable link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.42	n=16,021	Between all cities, there is a perceivable link between deeper TMCN integration and higher capital status.
C3	National GDP	+0.04	n=15,981	Between all cities, there is little to no link between deeper TMCN integration and higher national GDP.
C4	GNI per capita PPP	-0.10	n=15,980	Between all cities, there is a weak link between deeper TMCN integration and lower national GNI per capita PPP.
C5	City GDP	+0.46	n=14,300	Between all cities, there is a perceivable link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.39	n=14,300	Between all cities, there is a perceivable link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	+0.10	n=15,885	Between all cities, there is a weak link between deeper TMCN integration and higher national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	+0.04	n=15,885	Between all cities, there is little to no link between deeper TMCN integration and higher national per capita GHG emissions.
V3	City GHG emissions	+0.41	n=14,237	Between all cities, there is a perceivable link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	-0.01	n=16,005	Between all cities, there is little to no link between deeper TMCN integration and lower national energy consumption per capita.
V5	City energy consumption	+0.40	n=14,316	Between all cities, there is a perceivable link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	-0.10	n=15,797	Between all cities, there is a weak link between deeper TMCN integration and a lower national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	-0.12	n=15,768	Between all cities, there is a weak link between deeper TMCN integration and a lower national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	-0.13	n=16,009	Between all cities, there is a weak link between deeper TMCN integration and lower national life expectancy.
V9	Coastal status	+0.12	n=16,021	Between all cities, there is a weak link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	-0.01	n=4,585	Between all cities, there is no link between deeper TMCN integration and a lower national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	+0.06	n=15,938	Between all cities, there is a weak link between deeper TMCN integration and higher national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	+0.07	n=16,000	Between all cities, there is a weak link between deeper TMCN integration and higher national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.05	n=16,003	Between all cities, there is a weak link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	-0.02	n=13,948	Between all cities, there is little to no link between deeper TMCN integration and lower national performance in climate change mitigation on the Climate Change Performance Index.

V15	Climate Risk Index 2025	-0.13	n=15,910	Between all cities, there is a weak link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.
V16	Climate-driven INFORM Risk index	+0.10	n=15,993	Between all cities, there is a weak link between deeper TMCN integration and higher national climate-driven risk on the Climate-driven INFORM Risk index.
V17	Children's Climate Risk Index	+0.09	n=15,867	Between all cities, there is a weak link between deeper TMCN integration and higher national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	+0.02	n=16,021	Between all cities, there is a weak link between deeper TMCN integration and being located in an LDC-designated country.
V19	UN-attributed Landlocked Developing Country (LLDC)	+0.03	n=16,021	Between all cities, there is a weak link between deeper TMCN integration and being located in an LLDC-designated country.
V20	UN-attributed Small Island Developing State (SIDS)	+0.03	n=16,021	Between all cities, there is a weak link between deeper TMCN integration and being located in an SIDS-designated country.
		GLOBALITY INDICATORS		
G1	GaWC ranking 2022 and 2024	+0.56	n=16,021	Between all cities, there is a pronounced link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	-0.12	n=16,021	Between all cities, there is a weak link between deeper TMCN integration and being located in a non-OECD member country.
G3	EU member	-0.18	n=16,021	Between all cities, there is a minor link between deeper TMCN integration and being located in a non-EU member country.
		PATH-DEPENDENCY INDICATORS		
P1	Networks hosted	+0.37	n=16,021	Between all cities, there is a perceivable link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.58	n=16,021	Between all cities, there is a pronounced link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	+0.03	n=588	Between all cities, there is little to no link between deeper TMCN integration and the existence of a civic environmental plan.
P4	Governing party	-0.04	n=588	Between all cities, there is little to no link between deeper TMCN integration and a right-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	+0.12	n=14,576	Between all cities, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	+0.06	n=14,576	Between all cities, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	-0.01	n=16,003	Between all cities, there is little to no link between deeper TMCN integration and a lower amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	+0.09	n=15,979	Between all cities, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	-0.15	n=16,021	Between all cities, there is a minor link between deeper TMCN integration and being located in a non-party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	+0.05	n=16,021	Between all cities, there is little to no link between deeper TMCN integration and being located in an OPEC or OPEC+ member country.

Cities that are more populous (C1) or have a national, regional, or administrative capital status (C2) show a strong tendency to be the most integrated cities with higher Membership Index scores. Overall, vulnerability indicators show minimal relationships with city TMCN integration,

apart from some among the group of development-related indicators, such as those testing HDI score (V6 and V7) and life expectancy at birth (V8), which have a minor pattern of higher Membership Index scores among cities in places with lower HDI scores and life expectancy. Yet, there is little link between membership depth and UN-designated development states. Despite these, the plurality of indices demonstrates disparate information. There is little to no relationship between well-performing climate change policy countries and city membership depth (V14), though there is a minor correlation between countries at higher risk of climate change and city membership depth (V15). The globality indicators have the most pronounced links among all cities. The GaWC ranking of a city (G1) is deeply correlated with the TMCN integration of a city, with the highest GaWC-ranked cities having some of the highest Membership Index scores. Contrastingly, being located in an OECD or EU member country (G2 and G3) shows a notable, negative relationship wherein cities in the OECD or EU tend to have lower integration. This is likely due to the high number of EU cities integrated at the surface level with only a single ordinary membership to a single network, which may skew the results. Among the path-dependency indicators, there are strong linkages between city integration depth and the number of hosted (P1) or founded networks (P2). Cities that have found more networks tend to be the most integrated, while those that host more networks also tend to be better integrated, though to a lesser extent. National lack of partyship to the Kyoto Protocol (P9) additionally tends to be linked with a deeper integration, which is similarly skewed as the OECD and EU indicators for the same reason.

Regression B: Membership Index > 2

The second regression particularly considers the cities with a Membership Index greater than two. Effectively excluding most of the dataset to focus on the couple of thousand cities that are more than a regular member of a single network to appropriately discount the surface-level integrated cities that are geographically and characteristically linked. Apart from the indicators of environmental plan presence (P3) and governing party (P4), which are only available for the 95th percentile of cities, the whole suite of indicators is tested for all cities with the qualifying Membership Index. Overall, there are few significant links between the four groups of indicators, which tend to follow the same patterns as the overall list of cities. However, a few indicators emerge as the strongest correlation with membership depth. Table 10, in Appendix D, details the correlation coefficients and their interpretation.

Similar to the overall results, more populous cities (C1) and cities with a capital status (C2) tend to be among the most integrated cities with a Membership Index greater than two. The vulnerability indicators show no strong links with TMCN integration depth among the most integrated cities. Coastal proximity (V9) and higher precipitation (V11) appear to have a small pattern with higher integration but remain comparably low. Among the indices, the Climate Risk Index (V15) has the most pronounced relationship, demonstrating a negative link between increased climate risk and membership depth. All other vulnerability indicators show little to no link with near-zero or zero correlations across the board. Among the globality indicators, the GaWC ranking (G1) is once more resoundingly linked with membership depth — a higher GaWC ranking tied with a higher Membership Index score. The other globality indicators of OECD and EU membership (G2 and G3) show no clear links with membership depth. Among the path-dependency indicators, a higher number of hosted networks (P1) and founded networks (P2) shows a clear relationship with deeper TMCN integration. Networking hosting is more linked with membership depth among the higher Membership Index cities than the general list of cities, representing the increased value of being a host city in the Membership Index. However, being a founding city remains strongly linked and is one of the few path-dependency variables with a significant correlation. Among the indicators, national HDI scores (V6 and V7), PPM2.5 air pollution (V12), proportion of the national GDP from agriculture (P5), and OPEC and OPEC+ membership (P10) show a distinct correlation of 0.00 with absolutely no relationship or discernible patterns with membership depth among cities with a Membership Index of more than 2.1

Regression C: Membership Index 90th percentile

The third regression selects only the 90th percentile of cities by Membership Index. Reducing the selection of cities to only the top thousand enables looking at the patterns among the most deeply integrated group of cities to narrow down the potential trends for those with a Membership Index of 5 or higher. Within this grouping, around half of the cities are included in the dataset for the indicators of environmental plan presence (P3) and governing party (P4), while all other indicators are tested in full. This regression shows much more pronounced patterns for a handful of indicators, which draw significant links with the depth of integration of the ten per cent most integrated cities. Table 11, in Appendix D, details the correlation coefficients and their interpretation.

For the top one thousand cities, indicators of higher population (C1) and capital status (C2) have a less pronounced, though still significant, relationship with deeper integration. Compared to the analysis of all cities (regression A) and cities with a Membership Index greater than two (regression B), the first two centricity indicators appear to have a diminishing relationship with integration as the pool of cities narrows to only the most integrated. At the scale of the 90th percentile, higher national income (C4) also has a stronger relationship, showing that cities in richer countries tend to have deeper integration. Certain clearer relationships among the vulnerability indicators also appear at this scale. GHG emissions (V1 and V2) have no relationship with deeper membership, while HDI statistics (V6 and V7) show a positive correlation with cities in more developed countries tending to be more deeply integrated. Meanwhile, among the induced, precarity of national situations related to climate change (V16 and V17) show an emerging negative relationship wherein cities in countries more at risk are not as integrated, made clear in the 0.00 correlation with the Climate Risk Index (V15). City's higher GaWC ranking (G1) strongly correlates with higher city membership among the globality indicators. In contrast to regressions A and B, EU and OECD membership aligns more with deeper integration in the top ten per cent of cities by Membership Index. The number of networks hosted (P1) and founded (P2) are again tightly linked with deeper memberships in the path-dependency indicators of the top one thousand cities, while other factors arise as correlating elements. Particularly, inverse tendencies appear between the share of national GDP drawn from agriculture (P5) or natural resources (P8) and the proportion of protected national territory (P6), in which the former have a minor tendency to be related to lower integration and the latter with deeper integration.

Regression D: Membership Index 99th percentile

The fourth regression selects the top 99th percentile of cities by Membership index, a small set of 143 cities, to test the four groups of indicators among the deepest levels of membership integration and any trends in the scale of membership among the top percentiles. Within this group, the narrowest scale of data is available for all cities, and all variables are tested, except for a city's presence in an UN-attributed Small Island Developing State (V20), as no cities in the 99th percentile are located in an SIDS. This regression, looking at the narrowest degree of integration and highest Membership Index scores, sees the most prominent relationships between the indicators and depth of integration compared to the preceding three regressions, mimicking some of the significant trends identified in the regression of the 90th percentile (regression C). Table 12, in Appendix D, details the correlation coefficients and their interpretation.

In the top 99th percentile of most integrated cities, higher population (C1) and higher capital status (C2) are much less significant than for all cities (regression A) and small groups of high-Membership Index cities (regression B and regression C), however, they are still weakly linked with deeper integration. In this narrow group of cities, national GDP (C3) takes on an inverse relationship compared to GNI (C4), in which higher national GDP is slightly linked with higher integration depth, while higher national income is more strongly linked with deeper integration, showing a tendency for high GDP per capita cities to be more integrated. Much more pronounced

correlations emerge in the vulnerability indicators as well. A tendency for cities in lower GHG-producing countries (V1) to be more deeply integrated appears in the top percentile alongside those with lesser PPM2.5 air pollution (V15). Across multiple indicators, cities in more developed countries and countries with lower climate risks are also much more significantly linked with a higher Membership Index, as seen in — comparably — very high negative correlations between integration depth and HDI scores (V6 and V7), life expectancy (V8), prevalence of precarious housing (V10), between risk indices (V16 and V17), and being in designated underdeveloped countries (V18 and V19). Globality indicators maintain the trends set forward in the 90th percentile (regression C) of a still-significant but slightly less directly linked GaWC ranking indicator (G1) and strengthening relationship between being in an OECD (G2) and EU (G3) country with a higher Membership Index. Considerably stronger patterns further emerge in the path-dependency indicators, as networks hosted (P1) and founded (P2) have a very pronounced effect on the Membership Index at this level. In the top percentile, a relationship additionally emerges between greater integration depth and the presence of an environmental plan (P3) and a left-leaning governing party (P4), being the first strong links between these indicators and membership depth. The share of national GDP derived from agriculture (P5), industry (P6), and natural resources (P8) also shows a strong negative trend as membership integration deepens, linking slightly more service economies with a higher Membership Index.

Regression E: EU-member country

The fifth regression is performed only among cities in the 27 EU member countries. Controlling for EU membership by selecting only cities present in the EU allows stronger conclusions to be drawn from the distinction of cities which are present in EU-only TMCNs, which are numerous. As EU cities may skew the overall regressions through a higher natural proliferation due to the globalising nature of the supranational organisation, they still represent nearly two-thirds of the entire list of cities. All indicators from the four categories are tested against EU-member cities, except for EU membership (G3), Kyoto Protocol Annex 1/B ratifier (P9), and OPEC and OPEC+ membership (P10), as all EU cities are in the EU, in Annex 1/B party states, and not in OPEC member countries. The indicators of UN-designated LDC, LLDC, and SIDS (V18 through V20) are also not tested, as no EU member country is designated as an LDC, LLDC, or SIDS. Distinct results appear when analysing only European cities, possibly due to being skewed by a large number of single-membership cities, roughly 80% of the ten thousand cities. Table 13, in Appendix D, details the correlation coefficients and their interpretation.

For EU cities, centricity elements of higher population (C1) and higher capital status (C2) are greatly linked with deeper integration, showing the relationship of populous, capital cities tending to have the highest Membership Index scores. In contrast, where they play a larger role in the narrower selection of cities, national GDP (C3) and national income (C4) have little to no relationship with integration depth, despite having a broad range of national economic performance across the organisation. Vulnerability indicators similarly have less pronounced relationships, though some trends do form. Compared to the global scale, EU countries and the cities within them fit into a narrow range of development levels and risk, which is demonstrated by the weak linkages between vulnerability indicators and a higher Membership Index. Overall, elements such as lower PPM2.5 pollution (V12) and lower climate risk indices (V15 through V17) align with higher integration, whereas GHG emissions (V1 and V2) have nearly no relationship with membership depth. Globality indicators show that GaWC rankings are highly linked, with higher GaWC-ranked cities in the EU being the most integrated to a high degree. By path-dependency, there are less clear patterns among EU-only cities outside direct network paths. Hosting TMCNs (P1) is pronouncedly linked with deeper integration, though founding networks (P2) appears to be one of the most deeply linked strategies for EU cities' Membership Index.

Regression F: Non-EU-member country

The sixth regression, the inverse of regression E, selects all cities not located in EU member countries, about five thousand cities in total. As with the previous regression, controlling for EU membership among the identified cities can provide a better comparison by excluding the cities globalised by the EU's institutions and the high number of TMCNs that work solely on the European continent or within the EU framework. All indicators apart from EU membership are tested, as none of the cities in non-EU member countries are in the EU. Overall, the correlations across the four categories show distinctly different relationships from the EU-only regression, with less significant results. Table 14, in Appendix D, details the correlation coefficients and their interpretation.

For non-EU cities, centricity elements see a lower significance, though not absent, than those in the EU (regression E). Higher population (C1) holds a detectable relationship with higher integration, while higher capital status (C2) has a lesser link with higher Membership Index. Similar to EU cities, national GDP (C3) and income (C4) have little relationship with integration depth, though higher GNI has a slightly stronger tie with higher Membership Index. Non-EU cities have different links than EU cities in terms of vulnerability elements, with multiple national-scale indicators such as average precipitation in depth (V11), PPM2.5 air pollution (V12), climate change performance (V14), and youth climate precarity (V17) having zero relation with membership depth and a handful of other having little to no detectable links. UN designations for LDC, LLDC, and SIDS (V18 through V20) additionally have no distinct relationship with integration depth; however, non-EU cities have a relatively notable link between being located on the coast (V9) and deeper membership. Among globality indicators, the GaWC ranking continues to play a central role as higher-ranked cities tend to be more integrated with a higher Membership Index. Like the vulnerability indicators, path-dependency attributes also have very weak relationships with membership depth among non-EU cities, with indicators such as share of the national GDP stemming from agriculture, industry, and natural resources (P5 through P8) having zero or near-zero links. Among network integrations, network hosting (P1) has a much weaker relationship among non-EU cities than EU cities, likely stemming from the geographic layout of host cities being concentrated in Europe — nearly 60%. Likely related, there is a stronger link between the number of networks founded by non-EU cities and their Membership Index.

Regression G: OECD-member country

The seventh regression is performed only among cities in the 38 OECD member countries. Controlling for OECD membership by selecting only cities present in the OECD allows stronger conclusions to be drawn from the distinction of cities being globalised by the cooperative organisation, and with a notably higher level of development and economic integration. Though cities globalised by factors such as OECD membership may skew the overall regressions from higher globalisation through different entities, they still represent about 12,000 cities, about three-quarters of the dataset. Among OECD members, there are no countries designated as LDC, LLDC, or SIDS (V18 through V20), so those indicators cannot be tested, nor can OECD membership itself (G2), though all other indicators are fully tested. Differing trends from solely EU-member cities — almost all of which are in the OECD themselves — appear, with some stronger links for certain indicators among larger variances. Table 15, in Appendix D, details the correlation coefficients and their interpretation.

For OECD cities, city population (C1) also has a pronounced relationship with membership depth, though less than EU member cities (regression E), with a similar degree of linkage as higher capital status being highly correlated with deeper membership depth. The economic centricity of a city has a lower to no relationship with membership depth; however, among the high-tier economic performance of OECD countries, national income levels (C4) do not have any relationship with membership depth. Slightly different attributes are more significant among the

vulnerability indicators for OECD cities, namely the minor link between higher GHG emissions (V1 and V2) and higher membership integration. Certain performative elements, such as a lower planetary pressures-adjusted HDI score (V7) and lower life expectancy (V8), as well as being a coastal city (V9), are linked with a higher Membership Index. Globality indicators are a very pronounced link with deeper membership integration as well; a higher GaWC ranking (G1) is closely linked with a higher Membership Index score in a notable way. However, EU membership (G3) relates to a lower depth of integration, likely due to the prevailing skew of low-depth, low-connection EU cities reappearing among the large population of cities. Among path-dependency indicators, the number of founded (P2) and hosted (P1) networks continued to be well linked with deeper membership, with a relationship closely resembling that of European cities (regression E). There is also a small relationship between a city's national share of GDP derived from agriculture, industry, and natural resources (P5, P6, and P8) and a higher membership depth, and an inverse link of non-partyship to the Kyoto Protocol Annex 1/B being tied with reduced membership depth.

Regression H: LDC-designated country

The eighth regression is performed only with cities in UN-designated Least Developed Country (LDC) countries, totalling a very narrow portion of the overall dataset, with 575 cities. Controlling for the most precarious context of a city's location allows for greater distinctions to be be drawn about the context of how significantly less globalised cities in higher risk environments are integrated into the web of TMCNs. Among LDC country cities, numerous indicators are not present, including: the Climate Change Performance Index (V14), OECD and EU membership (G2 and G3), and Kyoto Protocol Annex 1/B partyship (P9), as no cities are considered in the climate performance index nor are in OECD or EU countries. Additionally, no cities in LDC countries are host to any network, so the number of networks hosted (P1) cannot be tested, alongside the LDC location itself (V18). Many indicators across all four groups are significantly linked to LDC country cities' level of integration, demonstrating different engagement patterns from other regression variables. Table 16, in Appendix D, details the correlation coefficients and their interpretation.

For LDC-designated country cities, higher city population (C1) and higher capital status (C2) continued to be linked with higher membership depth, however, to a reduced degree than for OECD (regression G) and EU (regression E) member country cities. Starkly different from almost all other groups of cities, there is a detectable relationship between lower national GDP (C3) and lower national income (C4) with deeper membership integration. Distinct trends also appear among the vulnerability indicators, in which cities in countries with lower overall GHG emissions (V1) and per capita energy consumption (V4) tend to be better integrated, similar to cities in places with lower HDI scores (V6 and V7) and life expectancy (V8). Conversely, cities on the coast (V9) are linked with higher membership depth. However, those in places with lower precipitation are linked with lower membership depth, demonstrating a pattern of coastal cities in dry environments being better integrated. Though countries in the predominantly Global South context of LDC-designated countries are not scored in the climate performance index, an observable trend is found among cities in countries with higher rates of renewable energy consumption (V13) with higher Membership Index scores. Yet, across the indices, there is a small link between lower climate-related risks and deeper membership among cities in LDC countries. Among the globality indicators, only the GaWC ranking of cities (G1) is tested, which shows a perceivable link with higher membership once more, though it connects only a handful of low GaWC-ranked cities among LDC countries. Among path-dependency indicators, no cities in LDC-designated countries host any networks, yet, there is a demonstrable pattern between higher numbers of founded networks (P2) and deeper integration to about the same degree as other groups of cities. There is additionally a bias among cities with higher portions of national GDP derived from agriculture (P5) and natural resources (P8), but a lower portion from industry (P6), with deeper membership. Although many of these indicators mimic the trends of developing countries in

general, the controlling variable of solely analysing LDC-designated countries highlights the trends precisely among cities in developing countries.

Regression I: GaWC-ranked cities

The ninth regression only tests cities with a GaWC ranking 2024 of sufficiency or above, or those delisted in 2024 from the 2022 sufficiency levels. Controlling for only GaWC-ranked cities allows for more significance results to be obtained about the globalisation of cities within the context of existing globalisation trends to identify trends within the globalised cities any differences which may rise from differing patterns of globalisation than, for example, OECD (regression G) and EU (regression E) membership. In total, around 300 listed cities are tested against all indicators. As GaWC ranking has been consistently identified as a linked element in all previous regressions, the correlations among solely GaWC cities are substantially more significant and produce trends both in parallel and opposition to earlier results. Table 17, in Appendix D, details the correlation coefficients and their interpretation.

In GaWC-ranked cities, the previous trends in the centricity attributes are much less prevalent, as higher city population (C1) and notably higher city capital status are much less significantly linked with higher membership depth. Also breaking from other trends, cities in more economically potent countries (C3) are heavily tied to shallower membership integration. Distinct trends also appear among the vulnerability indicators, in which elements classically tied with higher environmental impact, including higher GHG emissions (V1), higher per capita emissions (V2), higher energy consumption (V4), and higher pollution (V12), are linked with lower membership depth. However, higher development in the form of higher HDI (V6 and V7) has a positive relationship with higher Membership Index. Conversely, lower national climate-related risk among the indices (V15 through V17) is linked with higher membership and better climate performance (V14) or national renewable energy-derived energy consumption (V13) is heavily tied with deeper membership. In globality, there is notably not a complete link between higher GaWC membership (G1) and higher integration into the web of TMCNs, indicating that among GaWC-ranked cities, the GaWC score is only partially linked with the most deeply integrated cities. Additionally, EU membership (G3) has a notable relationship with integration depth, wherein higher GaWC-ranked EU cities are moderately more integrated. Among path-dependency indicators, the higher number of hosted networks (P1) and founded networks (P2) has one of the most distinct links with higher membership depth, especially in the number of hosted networks which is more prominent in GaWC-ranked cities than other groups of cities outside the highest percentile (regression D). Economic factors further show a bias towards the kinds of developed, advanced economies of GaWC cities with a perceivable pattern of lower percentages of national GDP derived from agriculture (P5), industry (P6), and natural resources (P8) and higher membership depth.

Regression J: Networks hosted > 0

The tenth regression tested cities with one or more TMCNs exclusively, a very narrow group of 32 cities. Analysing the handful of cities which host networks can enable conclusions to be drawn between the four categories of indicators and cities' tendency to be more integrated into the web of TMCNs, in this case partially predicated on being a host to more networks. Among the group of host cities, there are no cities located in UN-designated LDC or LLDC countries, so those indicators cannot be tested (V18 and V19). Overall, there are few distinct trends linked with host cities' membership depth, though some attributes are intensified compared to other top-scoring groups of cities, such as the highest percentiles (regressions C and D). Table 18, in Appendix D, details the correlation coefficients and their interpretation.

Between host cities, centricity attributes follow similar trends as other narrower testing scopes of cities, where higher city population (C1) and higher capital status (C2) have detectable links with

higher membership depth, but to a lesser extent than when analysing a large sample of cities. Additionally, both higher national GDP and GNI (C3 and C4) show a weak negative link with greater membership integration. Regarding vulnerability, many indicators have little to no relationship with higher membership depth, including risk and performance indicators (V10 to V16). Higher GHG emissions (C1 and C2) again show a slight trend to lower membership depth. Interestingly, higher planetary-adjusted HDI (V6) demonstrate a much stronger relationship with deeper integration than inequality-adjusted HDI (V7), highlighting a trend in more planetary values-confined places to be deeper integrated, while, at the same time, cities in SIDS (V20) have a notably lower Membership Index score. Among globality indicators, a higher GaWC ranking (G1) continues to be well linked with higher membership integration to a similar extent as cities in the top percentiles (regression C and D). Interestingly, there is an observable relationship between location in an OECD member (G2) country and higher integration, in contrast to other results denoting a stronger relationship usually among EU member countries. In path-dependency attributes, the relationship between higher numbers of hosted (P1) and founded (P2) networks with higher membership depth is greatly intensified, with the latter being the strongest correlation among all results. There is a stronger link between a host city having an environmental plan (P3) being more deeply integrated, and a contrasting trend of being in a country with a lower share of protected territory (P7) and being more integrated.

Regression K: Networks founded > 0

The eleventh regression, comparable to regression J, exclusively tests cities that have acted as founders in at least one TMCN, 392 cities in total. Selecting the smaller proportion of cities involved in the formation of the networks can allow the analysis to generate results on which elements may be linked with the most integrated cities that act as founders, one of the principal ways cities may rise above common trends. For this regression, all indicators across the four groups are tested; however, only a portion of founder cities are present within the 95th percentile of Membership Index, so not all cities have data on environmental plan presence (P3) and governing party (P4). Overall, although the trends are slightly more significant than for ghost cities (regression J), all but a few remain relatively weak. Table 19, in Appendix D, details the correlation coefficients and their interpretation.

Between founder cities, the top centricity indicators remain significant, as in the previous regressions. Higher capital status (C2), though, is more deeply linked with higher membership than in other regressions, and the relationship between GDP and GNI with integration depth parallels others that do not necessarily align. Among the vulnerability indicators, a minor relationship exists between higher GHG emissions (V1 and V2) and higher energy consumption (V4) with increased membership depth. Interestingly, water elements have a more prominent link as the greater link between proximity to the coast (V9) and higher average national precipitation (V11) with higher membership depth is more pronounced. Among the indices, there is a broad range of patterns with no clear alignment, though there is a notable link between a lower country climate risk index (V15) and higher membership. Within the globality indicators, a higher GaWC ranking (G1) remains prominently linked with higher membership depth, more so than in host cities (regression J). In contrast to host cities, the subsequent two globality indicators have an inverted relationship, with cities in non-EU countries (G3) being more integrated. Yet, there is little relationship between OECD membership (G2) and TMCN integration depth. Among path-dependency attributes, a higher quantity of hosted (P1) and founded (P2) networks are closely linked with cities' higher Membership Index, although not to the same level as for host cities. Other elements of path dependence have very little or extremely weak relationships apart from city location in a Kyoto Protocol Annex 1/B country, which is notably tied with a lower degree of integration.

Regression L: Membership Index Degree > 2.00

The twelfth regression tests cities with a Membership Index Degree greater than 2.00. Effectively, the final regression tests cities have an average Membership Grade in every network of higher than two, which is a wide set of cities in every category and not necessarily in the top percentiles, but which have interesting integration patterns beyond simple membership. In total, 562 cities are tested in this category against all indicators of the four categories. Testing these cities separately enables relationships to be detected among the cities with the deepest integration rate per TMCN. Across the indicators, a high variety of patterns emerge between indicators with a broad range of implications, with only a few links standing out. Table 20, in Appendix D, details the correlation coefficients and their interpretation.

For cities with a Membership Degree Index greater than two, similar significances are derived as the previous two regressions with network hosts (regression J) and network founders (regression K), in which city population and capital status (C1 and C2) are positively linked with deeper membership depth, to a similar degree. Similarly, economic centricity indicators have little to no consistent relationship with a higher Membership Index score. The globality indicators maintain the pattern — namely of founder cities — with a slightly reduced set of links across indicators, but consistent weak negative significance for OECD (G2) and EU (G1) membership and strong trends following higher GaWC membership (G1). Path-dependency elements also replicate a similar trend of closely-linked higher numbers of hosted and founded networks (P1 and P2) with higher membership, with more hosted networks having a stronger relationship. Other indicators of path-dependency have fluctuating relationships with a general trend reproduced in city location in a Kyoto Protocol Annex 1/B country, being somewhat linked with lower membership depth. Overall, the results for the regression of high-Membership Index Degree cities parallel those of host and founder cities.

5 DISCUSSION

The following section discusses the results of the previous section, expanding upon their signification, their meaning, and the conclusions and implications which can be derived from the data analysis. The section begins with commentary on the networks and member cities observed from the first portion of the data analysis, including the sorts of cities observed within the web of TMCNs and the different forms of integration each takes. A review of the patterns of indicators' relationships with city membership depth is then discussed, including an interpretation of the quantitative results of the previous section. The discussion concludes with the implications of the results on global city formation through the emergence of global cities within TMCNs, parallels such hold with established global city theory, and the departures it may take from those theories.

5.1 Typologies of networks and city memberships

5.1.1 TMCNs' hierarchies

The results of the review of the TMCNs' varied structures show that almost all networks have an internal stratification or hierarchy system within their structure through a select group of cities which act as decision-makers, steerers and guiders of the network, funding sources, or policy and agenda setters. In most cases, this phenomenon manifests in two predominant ways: the secretariat and the steering committee, with many networks having both. The secretariat is the institutional or pragmatic arm of leadership through which the treasury, communications, and organisation are managed, either devolved to separate roles for different members or assigned to a collective organisation. The steering committee is the executive, guiding body of the network wherein a select minority sit as board members, panellists, leaders of working groups, or advisors in a typically horizontal committee system. Commonly, the steering committee and secretariat will share a collective presidential member who guides the overall nature of the network. In almost all cases, there is a democratic or rotational component to the structure whereby the positions of the executive elements are elected to their roles or rotate the roles among each other. This creates a substantially more inclusive leadership structure, particularly when incorporating democratic values of horizontal decision-making. However, the select minority of cities that hold these positions, even on a rotating basis, create an inherent clique of leadership that maintains an elevated status across elections and, in some instances, recreates itself between observed networks. As the web of TMCNs has considerable overlap, cities in one leadership role tend to be in other leadership roles in different networks or within joint ventures of multiple networks. The instances where a single city holds all responsibilities within a network further particularly stress these hierarchical structures, either rotating those responsibilities in the case of the U20 and B40 or being the de jure and de facto embodiment of the network in the case of CFM and the WECP.

The near-total prevalence of internal stratifications within TMCNs — 85% of all studied networks, the remaining being completely organisation-led endeavours orchestrated through third-party institutions such as the EU, UN, or IDB — creates an imbalance in the supposedly peer-to-peer connections of the member cities, with focal members becoming the dominant information brokers and strategic mobilisers across the array of TMCNs. This compounds the findings by Mocca (2017, 2018), Haupt, Zevenbergen, and Herk (2020), and Leffel et al. (2023) of asymmetrical exchanges among networked cities highlighted by a selection of dominant cities reproducing their policies across different scales and places to peripheral, shallowly-integrated cities. The phenomenon of unequal exchanges predicated on central nodes of control and globalisation that are globalising peripheral areas through network connectivity is a staple of global networks and global cities (Sassen 2002; Castells 2002, 2005). As such, the consistent emergence of hierarchical structures within TMCNs drives globalisation trends and the globalisation of certain members by the globalised cities' roles within TMCNs, as information, policy exchange, technical assistance, funding, and other network activities are driven through specific nodes within and

between networks. From the spread of the networks, it is additionally observable that the trends of asymmetric performance extend beyond Global North-South divides into trends of North-North and South-South exchanges among networks geographically concentrated in developed places, such as the EU, or less developed places, such as UN-heralded networks targeting knowledge exchanges among developing countries. This further implies a dynamic that does not simply reflect classical development trends and divides but also creates new patterns of exchanges in specific climate contexts, e.g., along equatorial or hemispheric climate areas rather than merely geographies of capital flows.

5.1.2 Genres of integrated cities

The results of the identified cities holding network memberships reveal four main findings: there is a vast geography of member cities which is unequal at the highest levels of integration, there is a European and Latin American bias in city memberships, there is a Global North bias among host cities, and there is a bias of financially integrated cities among the highest TMCN membership depths. The 16,021 unique cities with membership in at least one studied TMCN are spread across the world and almost every single country and territory, and have a wealth of different shapes, sizes, cultures, and developments, ranging from megacities to small towns. However, not all are as deeply integrated into the web of TMCNS, particularly in city classes, whereby certain cities are mainly present in the highest Membership Index percentiles. Smaller cities are notably not prevalent among the most integrated cities, as are cities in Asia, the Middle East, and Africa, due to a bias for larger European and American cities. Such bias is more pronounced in the complete pool of cities where Spanish, Italian, German, Austrian, Moldovan, Ukrainian, and Benelux cities figure much more frequently than other geographies, creating a Euro-centric general layout.

However, European cities do not tend to be more integrated than the other geographies, as a high proportion of networked European cities are shallowly integrated, which contrasts with the much more prominent Euro-centric views created by solely investigating binary membership, as, for example, Leffel et al. (2023) have put forward. There remains, however, a Global North and particularly European bias for the host locations of the TMCNs, where three-quarters of host cities are in the Global North, and most of those are on the European continent. Furthermore, the top selection of most integrated cities reflects the most economically integrated and powerful cities, particularly in international finance and capital flows. Of the top half of the thirty most integrated cities from Table 8, almost all are Alpha cities under the GaWC rating. Though it is not a direct equivalency of hierarchy — as, by TMCN Membership Index, London and New York City, for example, figure relatively low — they are nonetheless very well integrated and closely follow other Alpha+ or Alpha cities which are among the most deeply integrated, most powerful nodes of the TMCN web of networks.

These broad trends have multiple implications. First, a bias among European cities demonstrates the effect of existing globalising phenomena in continuing to globalise and privilege certain places over others, emphasising the findings of Mocca (2017), Antrobus (2005), and Bulkeley, et al. (2003) where institutions such as the EU, but also the UN and IDB, leverage TMCNs to transmit, apply, and circulate sustainability and climate-related policy as an active policy mobility tool. It additionally parallels earlier findings from Leffel et al. (2023) and Lee (2015), and others that global cities in financial circles are considerably more active in TMCNs than their peripheral counterparts. However, the results of this study provide a caveat to a potentially simplistic view of simply better connected global cities by marking the most deeply integrated, less financially-globalised cities through a more nuanced description of their degree of integration. In this sense, the different types of most-integrated cities trend away from classical global cities and bigger-city dynamics due to the relatively shallow integration of Asian cities, particularly megacities such as Beijing, Shanghai, Tokyo, Bangkok, Mumbai, Saigon, etc. The prevalent concentration of European and Latin American cities among the most integrated ones over other geographies

highlights the peculiarities of TMCNs' dynamics and the geographies they target and concentrate their activities within.

5.1.3 Heterogeneity of integration forms

Among the most integrated cities with the highest Membership Index, each city's manifestation of deep integration is relatively unique and predicated on a variety of integration strategies and relationships with the web of TMCNs. Cities such as Barcelona are comprehensively integrated with many memberships, elevated positions across the board among those memberships, being a founder of many networks, and hosting multiple networks. Other cities, such as Brussels, are deeply integrated not solely because of their quantity of membership but by being the most prominent host city with the most networks located within it; compared to Paris, Seoul, Rotterdam, or Istanbul which weave together different levels of membership, varying numbers of hosted networks, and a wide range of foundational partyship to various networks. This phenomenon is consistently replicated as the number of connections a city has vis-à-vis the number of memberships it holds is not the sole indicator of deeper integration, as many cities with fewer or differing membership counts are present in the same categories of the Membership Index. These differences create varying patterns of integration across cities: some prioritising host privileges and integration — i.e. Brussels and Istanbul; others acting as major pioneers, frequently involved in developing new networks — e.g. Paris, Rotterdam, New York, London, and Melbourne; certain cities predicating their entire membership depth on direct connections — e.g. Helsinki, Vienna, and Salvador; a handful focusing on deep membership and integration into only a small pool of networks, rather than across multiple ones — e.g. Malmö, Stockholm, Boston, and Frankfurt; and a select few employing a combination of all strategies — i.e. Barcelona and Seoul. The wide variety of techniques and different forms of integration into the TMCNs reflect an evolving, incredibly diverse and dynamic approach to TMCN formation, activities, and relationships between cities as each play to their strengths, utilise existing frameworks and networking, and approach TMCN membership in different internal, economic, political, and diplomatic ways.

The heterogeneity of cities' integration into TMCNs illustrates two critical points and subsequent implications: first, differing propensities and methods for cities to integrate, and second, the value of a beyond-binary analysis of participation in TMCNs. The diverse patterns of integration reflect the differing wills of cities and their positions within the networks as pioneering forces, nodal links, or connecting entities across networks, further complexifying the discussion by Mocca (2017), Heikkinen et al. (2020), and Leffel et al. (2023) on cities' and officials' willingness and reasons to integrate into TMCNs investigated by adding a facet of widely varying degrees of integration beyond simple membership. It additionally implies that cities with different ambitions, therefore adopting different patterns of integration, are likely to apply those to differently focused networks, adding to Cortes et al. (2022) and Kern and Alber's (2009) discussion on the heterogeneity of TMCNs' activities and purposes by formalising the concept of different approaches cities take to join different networks. The other key implication of the diversity of integration patterns is the complexification of membership beyond in-groups and out-groups, wherein cities with a range of integration depth also have a range of capabilities and capacities to act within the networks. When Acuto and Leffel (2020) and Leffel et al. (2023) studied their dataset of network memberships and used a binary conceptualisation of membership, they drew conclusions based on more connections equating a greater capability to affect the web of networks. However, the divergent patterns of integration that cities take on have been found to add an additional facet of integration degree predicated on differentiable ways in which cities can affect the web of networks. The smaller cities with a slim number of memberships that, however, are the founders of a large proportion of the networks they are members of identified in this city — e.g. Rotterdam, Melbourne, etc. — highlight the necessity of a more complex and comprehensive conception of TMCN membership.

5.2 Patterns in depth of membership

5.2.1 Indicators

Centricity indicators

Across the different regressions, a city's population (C1) and its capital status (C2) being higher both have a pronounced relationship with deeper integration into the web of TMCNs. This trend is more present in the broader array of cities, including all cities, EU cities and non-EU cities, and when controlled only for cities that act as founders or hosts. It is less prevalent among a narrower scope of high-ranking cities, particularly in the 90th and 99th percentiles of the Membership Index. National GDP (C3) has little trend with membership depth and fluctuates considerably among different groups of cities. Its stronger relationship is among LDC-designated country cities and GaWC-ranked cities, among which high GDP negatively correlated with deeper membership. Likewise, though less pronounced, cities in the 99th percentile of the Membership Index and those that founded networks tend to have a lower national GDP. GNI (C4) follows a similar variety of integration patterns, which infrequently parallels the trends of national GDP. Among the top percentiles of the Membership Index, higher GNI is weakly linked with deeper integration, an opposite relationship from national GDP.

The calculated indicators of a city's GDP as a factor of a city's population and GNI (C5) and a city's GDP percentage as a proportion of city's GDP from the national GDP (C6) often closely mimic the correlation coefficient of population with Membership Index due to the bias of city population in the calculation, which diminishes its value as an indicator. However, the parallel is broken in some sets of cities where a significant difference can be observed. Among the 99th percentile of cities by Membership Index, deeper integration has a correlation coefficient with a city's higher GDP percentage of half that of a city's higher raw GDP, as well as among GaWC-ranked cities and cities which host at least one network, indicating that the cities most integrated among those groups are linked with a lower share of national GDP — or that they represent a smaller share of population within their country. Overall, higher population and capital status elements of centricity are linked with higher membership depth. In contrast, higher national GDP and GNI have little trend with deeper membership, apart from a couple of negative links.

These findings show that deeply integrated cities tend not to be very highly populated, and, at the highest levels, are not major capital cities, indicating a bias for more regional metropolises with a potentially greater degree of flexibility and administrative capacity that is not tied to territorial management. This reflects the findings from Lee (2013) and Knieling and Klindworth (2016) on studying similar factors concerning simple city membership, with the addition of the diminishing prevalence of high population and high capital status among the most integrated cities. Further, the most integrated cities are often not located in the biggest economies and wealthiest countries, mimicking the same trends as basic membership integration. The most deeply integrated cities with a higher Membership Index score are infrequently megacities and among the expansive economies of China and the United States, but rather large non-capital cities. This differs from earlier membership-first cities from Keiner and Kim (2007) and Mocca (2017), which have found mid-sized and regional cities to be more connected in the past when accounting for integration solely through the number of memberships. Nonetheless, the relatively poor performance of the centricity indicators' alignment with deeper membership implies that factors of population, capital status, and economic performance are not major predictors of deeper TMCN integration. Alternatively, they may be components of other factors among the indicators, influencing elements such as administrative capacity, the flexibility of policy (re)orientation, and intervention priorities (Lee 2013).

Vulnerability indicators

National GHG emissions (V1) and GHG emissions per capita (V2) have few distinct impacts on deeper membership integration. Though higher GHG emissions are relevant in deeper membership, the much stronger negative link among LDC-designated countries nullifies the relationship by introducing a bias for more developed countries, which is exemplified by the moderate link between lower overall GHG emissions and deeper integration among the top percentiles of cities by Membership Index and host cities. In most cases, per capita emissions closely follow the trends of total emissions, with the notable exception of the 99th percentile, in which there is little to no relationship, while there is a moderate relationship between lower national GHG emissions and deeper integration. Across the board, per capita energy consumption (V4) has little to no relationship with any of the groups of cities, apart from following development trends and a pronounced link between lower consumption and deeper integration among host cities. Like the other calculated indicators, a city's GHG emissions as a product of population and national per capita GHG emissions (B3) and a city's energy consumption as a factor of its population and national energy consumption per capita (B5) closely mirror the correlation with city population and are therefore frequently nearly identical.

High-level development indicators of inequality-adjusted HDI (V6), planetary-pressures adjusted HDI (V7), and life expectancy (V8) follow similar patterns, with planetary-pressures adjusted HDI often showing an intensified version of the relationship. Overall, higher development is linked with deeper membership at the highest levels, apart from founding cities, which show a trend of deeper membership among lower development places. UN designations of Least Developed Country (V18), Land-locked Developing Country (V19), and Small Island Developing States (V20) have a prevalent weakly negative relationship with deeper membership, whereby deeply-integrated members are not present in UN-designated developing places. Such a relationship is less intense among network founders but is incredibly prevalent among host cities and high Membership Index cities.

A city's placement on the coast (V9) has a weak general relationship with deeper integration, ranging from little to moderate relationships without any pronounced relationship among any sets of cities. Other indicators of precarity, including the proportion of the national population living in poor housing conditions (V10), the average national annual rainfall (V11), and exposure to PPM2.5 air pollution (V12), have fluctuating relations between different groups of cities. In the top percentiles of cities by Membership Index, however, there is a pronounced link between lower rates of the three and deeper membership, while there is no link among host cities. Across the board, the share of national energy consumption derived from renewable energy sources (V13) also has little link with deeper membership. The three risk indices — national risk posed by climate change (V15), exposure to climate-related risks (V16), and exposure of youth to climate-intensified risks (V17) — have broadly negative correlations in which places at lower risk are the ones which are most deeply integrated, particularly among the top percentiles of the Membership Index and LDC-designated cities. The index for national performance in addressing climate change (V14), though, has few links with deeper membership across the different sets of cities.

Generally, these findings exemplify that a city's degree of climate-related vulnerability is not closely linked with deeper TMCN membership, effectively demonstrating that more vulnerable cities are not more deeply integrated. Instead, cities in more developed countries with better climate response performance, high HDIs, and lower contributions to climate externalities tend to be more deeply integrated. A few of these factors likely stem from the relationship between the relative weight of larger megacities, such as those in Asia, on global emissions and their relatively shallow TMCN integration. Nonetheless, these results mimic previously investigated trends from Lee (2013; 2015), Mocca (2017), and Heikkinen et al. (2020) that greater environmental risk and climate change vulnerability have little correlation with higher memberships, paralleling the result of membership connections in membership depth. Though the aforementioned investigations

have found that cities in developing countries are increasingly becoming members of TMCNs, the findings of this study's analysis of membership integration of cities in LDC, LLDC, and SIDS countries demonstrate that those cities are not deeply integrated, even if they are increasingly connected. These findings imply that other factors outside vulnerability are more connected with cities' propensity to be deeply integrated, and that the cities which may be inclined to join networks as learners and receivers of knowledge, policies, and technical assistance are not deeply integrated compared to the more robust and developed mobilising cities.

Globality indicators

Indicators of other globalising factors have the most pronounced and significant relationships with membership of depth of any of the four categories. A city's GaWC ranking has the strongest overall relationship on membership depth, ranging from +0.41 to +0.66 for an average of +0.54 across all regressions. In broader analyses of more cities, a higher GaWC ranking is more pronouncedly linked with deeper membership vis-à-vis a higher Membership Index score; however, that effect is diminished in higher percentile cities. Strongest among high Membership Index Degree cities and founder cities, it is not as direct a link among host cities as among GaWC-ranked cities. City partnership with globalising institutions such as the EU (G3) and OECD (G2) shows a pronounced relationship with membership depth, albeit in multiple ways. As there are a substantial number of shallowly integrated cities in the EU and subsequently in the OECD, an analysis of large sets of cities shows a relationship between non-membership in the EU and OECD and deeper integration. This relationship is inverted when analysing narrower sets of deeply-integrated cities with high Membership Index scores, where EU and OECD membership are linked with deeper integration. Yet, among host cities, OECD membership is more strongly linked with deeper integration, while EU membership is perceivably linked with lesser integration among founder cities.

The globality indicators provide the most significant link with deeper integration: more financially global cities are nearly consistently the most integrated cities, with a higher Membership Index score. Though this presented itself in the list of the most integrated cities, predominantly composed of GaWC Alpha-ranked cities, it is further found in a more linear link across the board, with cities with a higher GaWC rank consistently being those with a higher Membership Index. These findings parallel those of Lee (2013) and Leffel et al. (2023), which found that global cities have more connections. However, the findings here illustrate a complex relationship wherein financially global cities tend to be more deeply integrated, yet to an imperfect degree. Among the most integrated cities, there is a diminishing link between a higher GaWC ranking and a higher Membership Index, indicating that the most financially globalised cities are not the most integrated but generally tend to be better integrated compared to lower-ranked cities. This is seen in the list of cities with the highest Membership Index, which is an imperfect composition of the GaWC podium. Meanwhile, other globalising institutions of OECD and EU membership indicate that cities in developing countries tend to be slightly more integrated and serve more often as host cities. In contrast, due to the plethora of shallowly integrated, EU membership is not indicative of deeper integration.

Path-dependency indicators

Among all regressions, the path-dependency indicators of the number of hosted networks (P1) and founded networks (P2) have the strongest relationship with membership depth. Across all tested groups, a higher number of hosted networks and founded networks is linked with deeper membership, increasing among narrower sets of cities. As these two metrics are an integral and significant component contributing to calculating the Membership Index, the result is not unexpected. Yet, there is a pronounced trend of founding cities to be more integrated across the board. For the 95th percentile of Membership Index cities for which data was gathered, the presence of a green or environmental plan (P3) and the political leaning of the civic government (P4) seldom

have a prominent relationship with deeper city membership. A few exceptions emerge in the 99th percentile cities where an existing green plan is notably linked with deeper membership, and a left-leaning government is also moderately so, which reappears among host cities.

Among prominent economic sectors derived from the percentage of national GDP contributed to by agriculture, forestry, and fishing (P5), the percentage contributed to by industry and construction (P6), and the percentage contributed to by natural resources extraction (P8), there are substantial fluctuations between the different groups of cities. Among increasing Membership Index percentiles, there is a stronger relationship between lower percentages of the GDP derived from the three sources and deeper integration, while other groups see a far less prevalent link. The proportion of the national territory in which a city lies that is protected land or marine areas (P7) also has little to no observable trends among the different regression groups. National partyship to the Kyoto Protocol's Annex 1/B (P9) or the OPEC organisation (P10) has widely varying trends, likely due to the combined EU signatory party to the agreement and the lack of European members in OPEC or OPEC+. Overall, there is a slight trend for cities in Kyoto Protocol Annex 1/B places to have deeper membership apart from founder cities, which have an opposite tendency, while there is no observable link between OPEC membership and membership depth.

These results demonstrate that, overall, cities which found networks are consistently likely to found more and be more deeply integrated, which is, to a lesser extent, also the case among host cities. This is perceivably true across different assortments of cities and other facilitating structures such as global organisations. Additionally, more integrated cities tend to be in places with developed, service and financial economies, rather than those predicated on primary goods and industry. However, this trend is not present among founder, host, and high Membership Index Degree cities that more commonly align with the less developed economic factors or more agrarian and industrial economies. This parallels somewhat Mocca (2017)'s findings that post-industrial cities tend to have more network connections. However, it differs in the extent of its applicability, as, when accounting for membership depth, it is not reproduced among host and founder cities. Mocca's and, additionally, Lee's (2013, 2015) studies found similar results on the propensity for particular government political leanings and the existence of a civic environmental or green plan on a city's tendency to have more network connections, finding that it had a perceivable positive relationship. However, the tendency is less prevalent when accounting for membership depth, particularly for the relative impartiality of government leaning's relationship with deeper membership. Further, whereas Leffel et al. (2023) have found that cities in countries which ratify more environmental agreements and have a stronger climate governance response have more memberships, a different trend appears when accounting for membership depth as path-dependency attributes such as ecological protection and partyship to the Kyoto Protocol Annex 1/B are not performative indicators for deep integration. These trends imply that more integrated cities with a higher Membership Index score tend to be proactive founders and hosts in developed economies without an incredibly pronounced disposition to other pro-environmental tendencies.

5.2.2 Global cities

The roster of the most integrated cities and the trends found among the indicators with membership depth showcase that the most significant pattern of integration among the TMCNs is for generally global cities to be more integrated and have a higher Membership Index score. Among the roster, a substantial proportion of the most integrated cities are GaWC-ranked Alpha cities, representing the most financially globalised cities on the web of APS firms acting as telecommunication and mobility centres. Among the indicators, the factors that have the most pronounced relationship with deeper integration are also a city's GaWC ranking, in addition to consistently high development, large developed economies, and greater administrative capability. At the same time, the most integrated cities tend not to be those at greater risk from climate change-related externalities, the most significant contributors to climate change, nor those with a greater

predisposition to climate action. The typology of the most integrated cities, being global cities by other metrics such as economic integration, is similar to the findings of studies on simple membership connections that have also found that global cities have more connections, whereby this study extends this implication to membership depth as well (Lee 2013; Acuto and Leffel 2020; Leffel et al. 2023).

However, the relationship is not exact and is more nuanced than earlier studies have found. Less prevalent, not traditionally-global cities factor highly among the most integrated cities, while the traditionally top global cities of London and New York figure less prominently. Further, global cities in geographies such as Asia figure particularly poorly among the TMCNs, indicating that, although global cities are more integrated, not all global cities are deeply integrated, nor are the most integrated cities necessarily all the most global cities. This distinction and deviation have broad implications for how cities are globalising among the TMCNs, particularly on the directionality or temporality of cities' globalisation through TMCNs. Namely, it stresses the dynamic of whether cities joining TMCNs are inherently global and so TMCN membership is a symptom of their globality, or if, partially through TMCN membership, they are becoming more globalised by the inherent nature of the networks.

5.3 Global city formation

5.3.1 Materiality

The varying typologies of network hierarchies, the heterogeneity of cities' integration within them, and the patterns in the integration among TMCNs vis-à-vis differing levels of integration observed and analysed through the Membership Index satisfy this study's line of inquiry of how cities' different degrees of integration in TMCNs contribute to global city formation. These key results — internal stratification among TMCNs, a plurality of cities' integration strategies within TMCN memberships, and the consistent trend of globally connected, economically advanced and developed, while not necessarily more vulnerable cities being more connected — parallel many of the factors put forward by Hall (1996), Castells (2002), Sassen (2002, 2005), and Bulkeley and Schroeder (2012) in global city literature. Chiefly, the internal stratification among TMCNs contributes to the emergence of nodes and the expansion of facilitating spaces of knowledge-sharing and capital mobility; the variety of TMCN integration methods harnesses the production of focal points and specialisations of cities' roles; and the indicative trends of the most integrated cities in the web of TMCNs perpetuate the emergent roles of knowledge-based economies. However, although many of these factors parallel classical global city formation, the role of path-dependency from existing centralisations of telecommunication and capital hubs is not inherently present within the globalisation phenomenon among TMCN-integrated cities to the same extent.

Nonetheless, the results of the study clearly illustrate that the diverse degrees of integration that cities have in TMCNs select key points within the networks to act as nodes that globalise other cities via imbalanced, asymmetric connections, as globalising cities by constructing key roles beyond participation — or lack thereof —, and as extensions of the broader realm of globalising cities and global cities. The presence of incongruent city globalisation and the emergence of global cities in the web of TMCNs stresses the evolution of global cities beyond financial circles and capital exchanges as leveragers of their central roles and telecommunication and mobility capacities into global urban governance, non-state action in climate change, city diplomacy, and emerging trends of municipalist action. The notable divergences, perhaps more so than the parallels, additionally complexify the evolution of global city formation and the global city phenomenon by highlighting new and different spaces for emerging roles beyond the heretofore prevailing arrangement of global cities. The materiality of global city formation among TMCN membership, in both its replication and deviation from prevailing global city conceptualisation, has notable implications for the study of global cities, the governance of climate change and its

relevant actions, and the conception of TMCNs by enlarging the scope of globalising forces, creating new and stratified circuits of knowledge exchange and action, and elevating the discussion on the integration of cities in TMCNs.

5.3.2 Parallels

The globalising nature of the TMCNs and their variably integrated member cities reflects three core tenets of global city formation: the emergence of nodes and command-and-control centres, the specialisation of spaces and cities, and the engagement of advanced and developed economies. The specificity of the TMCN web's selection of more deeply integrated cities as those with elevated memberships entailing greater authority, decision-making power, and agenda setting highlights particular spatial units with considerably more sway within the TMCNs and a greater ability to assert their dominance or guide the flow of exchanges and activities of the network. The emergence of these nodes as command-and-control centres through deeper memberships is consistent with Sassen (2002) and Castells (2005)'s conceptualisation of deeply-integrated, linked spaces in which new dynamics of political operations, transnational networking, and the formation of trans-local communities and identities of climate response manifest in trans-territorial centres. Information and communication technologies central to TMCNs' operations as circuits of information exchange for political mobility and remote programming has seen nodes emerge to act as facilitators and coordinators of these exchanges, stoking the formation of global cities among the most-deeply integrated member cities' enhanced positions across networks — explicitly developed by the TMCNs' operations management. This recurrent pattern of internal stratification is grounded in the corporate, technocratic management marked by market differentiation, risk management, and business pool pressure working through neoliberal organisations that further highlight nodes of global exchanges and seek to create specific coordination centres (Castells 2008; Bulkeley and Schroeder 2012; Bulkeley, Broto, and Edwards 2015).

These coordination centres then effectively specialise the role of cities, which is reflected in TMCNs by the distinct patterns of integration that cities demonstrate. Although technological advancements reduce the necessity of geographic proximity for many needs, they nonetheless highlight the centrality of certain cities as hubs of connectivity that emphasise horizontally integrated governance processes in which specific spaces specialise in particular roles (Hall 1996; Castells 2002). Among TMCNs, these roles include proximity and centrality to other institutions, instruments, and networking capabilities — such as the centrality of Brussels as a host city despite its superficial network participation — delineating different categories and types of integration. The heterogeneity of integration patterns and genres of integrated cities resembles different roles of cities and their specialisation within TMCNs, reproducing global city formation. Furthermore, the selection of more integrated cities among the analysed indicators mimics the economic transition from agriculture and industry to knowledge-based, service-oriented economies relying on the development of information and communication technologies and mobility centrality, as seen in the trend for Alpha cities in more developed economies to be better integrated (Sassen 2002, Sassen 2005). It further characterises the integration of cities as a post-industrial phenomenon among re-specialising cities rather than one of integration as a result of greater vulnerability from climate change effects or a prevailing desire to engage with climate change, as Mocca (2017, 2018) has found among individual cities.

5.3.3 Divergences

Despite the multiple parallels of wider global city formation that persist within TMCNs, there is a notable absence of the path-dependent characteristics that form the broader assortment of global cities. As reviewed in the literature, Sassen (2005), Castells (2002), and Hall (1996) note that the shifts in contributing factors to global city are most prominently occurring in historically and geopolitically significant cities where colonial power, trade, industry, transportation, and concentration of knowledge are cornerstones of the circuits of exchanges, decision-making power, and

nodal predisposition of those cities. Essentially, historically significant spaces continue to amass influence by re-specialising, leveraging existing concentrations of resources and technological capabilities, and utilising local conditions beyond economic power. However, these tendencies are not wholly reproduced among global cities in TMCNs. Among the genres of integrated cities, though Alpha cities factor prominently, global cities from Asia are almost always absent: Hong Kong, Singapore, Beijing, Shanghai, Dubai, Tokyo, Mumbai, Riyadh, Delhi, Saigon, etc., with Seoul and Jakarta as the notable exceptions. Whereas these absent cities are considered classical global cities shaped by their role as concentrators of resources, power, and capabilities, they appear not to be integrated among TMCNs nor globalising through urban climate change governance. This disparity highlights one of the most significant distinctions of global city formation through TMCNs: the relative geographic concentration in Europe and Latin America. So, although Leffel et al. (2023) have remarked, the most global cities may have more TMCN connections, they are not necessarily the most integrated, and a biased selection of global cities occurs within deeper TMCN integration.

There are a few reasons why this relative geographic partiality may be the case, stemming from earlier discourse on the simplified model of the patterns of membership connections. Mocca (2017, 2018) has found that the cooperative attitude of 'serial joiners' may be influenced by the path-dependence of experiences in TMCNs, where positive past experiences are notably correlated with more connections. This may also be the case, where the geographic concentration of networks in the European and Latin American context creates more networks for cities to join and therefore more opportunities for better experiences and deeper memberships. Mocca also found that many cities join to elevate their profiles or become learning cities, so less integrated cities may have a lesser willingness or need to elevate their profiles and brand themselves as climate change-involved cities. The seminal study by Keiner and Kim (2007), which found different results at the time but offers still relevant explanations, attributes the phenomenon to the possibility that certain global cities are more easily able to re-specialise than others that have grown rigid in their financial roles within increasingly inflexible governments. Additionally, cities in the Gulf States and the Middle East, or manufacturing hubs, may be less inclined to integrate into TMCNs due to their roles as significant direct and indirect contributors to climate change and how intertwined their economies are with processes contributing to climate change. Further state rigidity, authoritative national control, and a lesser ability for those cities to enter into city-to-city agreements, as opposed to national financial deregulation and capital attraction, may play a part in the tendency to integration into TMCNs.

6 CONCLUSION

The ultimate section consists of the concluding remarks of this study and a summary of its significant components and critical functions. A synopsis of the key findings is provided for the three main arms of inquiry, from there a résumé of the contributions to the line of inquiry is compiled alongside the contribution of the developed research method to the broader field. Elements of future research are then discussed, including potential improvements to the methodology to continue to test TMCN integration and avenues for further exploration of the significance of the results. The section then concludes with parting remarks on the study as a whole and conclusions on the field.

6.1 Key findings

6.1.1 Typologies of TMCNs

This study has found that TMCNs consistently adopt stratifying governance structures with demarcated leadership positions, often with a democratic or popular flair. 40 TMCNs were identified as active, international, climate-related, city-to-city networks across a broad range of geographies and enrolling many networked cities, from 10 to over 10,000 members, covering 30% of the world population between 186 countries and territories. Most cities are members of a single network, and a select hundred or so cities function as founders and hosts of the TMCNs. All but a handful of the studied TMCNs were led by some sort of secretariat or steering committee, frequently with an executive board or presidential city running the two. In infrequent cases, a single city will be the guiding figure for all network activities and bear all responsibilities, which, like the consistently multilevel leadership system, stresses the asymmetric exchanges within the networks. Further, the select minority of cities that hold elevated positions, even on a rotating or electoral basis, create an inherent clique of leadership that maintains higher status across elections and, often, consistently so between networks. As the TMCNs overlap, cities in one leadership role tend to be in leadership roles in other networks. The unequal exchanges, predicated on central nodes of control and globalisation, drive the networks' activities through specific centres of coordination that work horizontally across the networks.

The typologies of hierarchically-organised coordination structures with a diversity of horizontally integrated governance systems reflect the formations of global cities. This recurrent pattern of internal hierarchy is rooted in the technocratic management schemes many of the networks are partial to as neoliberal organisations, further highlighting select nodes of global exchanges as they seek to create specific coordination centres for their cross-border activities. As spaces become rescaled and new dynamics of political operations, circuits of exchanges, and the formation of trans-territorial communities, in this case emerging from TMCN climate-related activities, take shape among the stratified structures of the networks, certain cities emerge as nodes to facilitate and coordinate these exchanges, stoking the formation of global cities among the most-deeply integrated member cities. These trends of asymmetric performance also extend beyond Global North-South divides and create North-North and South-South exchanges among networks with specific geographic bounds, such as the EU, or less developed places, such as UN-led initiatives between developing countries. Trends extending beyond the North-South divide imply a dynamic that does not simply reflect classical development trends but creates new contextually-specific patterns of exchanges.

6.1.2 Membership index

Through the development of the TMCN Membership Index, this study has found a wide variety of ways by which cities integrate into the web of TMCNs, and which cities are the most integrated

into the studied TMCNs. Ranging from 1 to 66 (out of a theoretical maximum of 240), with an average Membership Index of 2.6, most cities have a Membership Index of only 2, equivalent to a single regular membership in one network. The 90th percentile comprises one thousand cities with a Membership Index of 5 or greater, and the 99th percentile is populated by 143 cities with a Membership Index of 15 or greater. Fifteen cities with a Membership Index of 30 or greater compose the 99.9th percentile of integration. The geographic composition of the 90th percentile of most integrated cities, following similar trends to the whole assortment of networked cities, is concentrated around Europe and Latin America, with a lower density in Sub-Saharan Africa and Asia. Among the top-scoring cities by Membership Index, the number of memberships ranges from 9 to an outlier of 20 and a wide range of membership depths in each network, highlighting the diversity of integration approaches. Some cities host many networks, sometimes without membership; others are major pioneers frequently involved in founding new networks; a few cities work directly with high membership counts but shallow integration in those networks; and a select few employ all those trends. The diversity of integration forms demonstrates the dynamic and contextual approaches to TMCN formation, activities, and civic relationships that cities employ based on their strengths, existing frameworks, and internal principles.

The tendency for TMCNs to create central nodes as facilitators and coordinators, evolving into command-and-control centres, is further demonstrated among the different ways cities integrate into TMCNs. Though technological capabilities and increased transportation mobility reduce the need of geographic proximity for many needs, the value afforded by the centrality of specific spaces to the institutions on which the TMCNs are built, draw from, or utilise, combined with the partially horizontal structure of the networks, sees cities specialise their roles within the networks. These specialised roles include proximity to institutions, such as the centrality of Brussels, the placement and location of international conferences, such as Paris and Seoul's role, or continuous facilitators of network development and financing, such as Barcelona and Istanbul. Member cities' specialisations within their integration into TMCNs reproduce the specialisations found in global city formation, and the incapability or unwillingness of other cities to specialise may be a reason why they are not as deeply integrated. The variety of activity types among TMCNs additionally contributes to cities' varying levels of integration between networks, as network-city specialisations and particular activity types attract certain cities over others for economic, political, cultural, or geographic reasons.

6.1.3 Patterns of cities' membership depth in TMCNs

By the testing of 39 compiled variables across the four elements of centricity, vulnerability, globality, and path-dependency as indicators of deeper integration into TMCNs vis-à-vis a higher Membership Index, this study has found that a narrow set of variables have a positive relationship with deeper membership. Performed over twelve different regression analyses testing sets of cities to control for other globalising factors, development levels, and more, the presence of a developed, advanced economy and greater administrative capabilities were most related to deeper membership. Indicators such as contributions to climate change, air pollution, indices for climate change risks, coastal status, and other vulnerability attributes had little pronounced relationship with deeper integration, as did, in most cases, the relative performative size and wealth of the economies in which a city is situated. Path-dependency variables such as the civic government's political leaning, the existence of a green plan, or national partyship to binding international environmental agreements also had no distinctive correlation with membership depth. Among the perceivably linked indicators, those with the most pronounced relationship with deeper integration are a city's GaWC ranking, high national HDI scores, location in a developed economy with lower GDP contributions from agriculture and industry, and higher capital status.

The categorisation of the most integrated cities as global cities by other metrics, such as economic integration, is similar to findings from past studies, which use the number of connections as a basis for comparison, with this study extending such implications to membership depth to a

similar assortment of cities. This reflects the economic transition to knowledge-based, service-oriented economies utilising information and communication technologies found in global cities, as the list of most deeply integrated cities is highly populated by Alpha cities with developed economies. It additionally generally characterises member cities' integration as a post-industrial economic and perception trend, rather than one of vulnerability or climate engagement, as also seen in other studies. However, this trend is not completely reproduced, as many economically-integrated cities do not figure as deeply integrated and have significantly lower TMCN Membership Index scores despite being Alpha cities or otherwise globalised cities. Even though those absent cities are traditional concentrations of resources, power, and capabilities, they are not integrating within TMCNs and taking on strong roles in urban climate governance. The relative geographic concentration of integrated cities and disparity in integrating cities are the strongest distinctions of global city formation through TMCNs.

6.2 Contribution

6.2.1 Research framework

The conceptual framework of this study and the subsequent research approach used to derive the results from applying the framework differ from previous studies, allowing new conceptualisations of TMCNs to be reached. Whereas previous studies have been based on theorising TMCN membership as essentially horizontal, with a greater number of connections as the defining factor in global TMCN leadership (Lee 2013; Goh 2019; Leffel et al. 2023), this study instead considers TMCN integration through the prism of membership strata and the internal hierarchies found within TMCNs' governance and leadership structures. This allows entirely new conclusions to be drawn about how cities integrate differently as TMCN members, the roles they take on within TMCNs, and the patterns of leadership that emerge between different networks. Moving past the binary of ingroups and outgroups, this study utilises the possibility of investigating membership depth and the specialised roles of cities within TMCNs to draw conclusions about how cities are globalising themselves and each other with greater nuance and a more robust understanding of the complexity of globalisation. In turn, this has allowed this study to investigate and analyse patterns of integration and trends between membership depth and relevant indicators to draw new, more developed understandings of why cities integrate into city networks and the role of TMCNs in the formation of global cities.

In doing so, through the methods it has used, this study further contributes to the field of TMCN research with the most significant sample of analysed cities to date. The compilation of the TMCN and city dataset of 16,041 unique urban places (from over 18,000 locations in total) represents a substantial update from the heretofore most complete dataset of 10,343 cities from late 2017 utilised in very recent, cornerstone studies (Leffel et al. 2023; Acuto et al. 2024). Incorporating the rapid evolution of TMCNs since the American exit and re-entrance to the COP 21 Paris Agreement, the COVID-19 pandemic, the outbreak of war in Ukraine and Gaza, the development of the European Green Deal, and more into a new, more detailed, and broader list of TMCNs provides strong avenues for further research and a new temporal step for future research (for comparisons of the number of connections to the 2017 study). With that dataset, this study provides a critically lacking broad, systematic, quantitative analysis of TMCNs and city membership, which has been called for amid the overreliance on smaller-scale, narrow-scope, ungeneralisable studies that feature prominently among TMCN studies (Busch 2016; Acuto and Leffel 2020; Jakobi, Loges, and Haenschen 2023). By providing a systematic analysis of a large sample of TMCNs and cities, this study creates generalisable conclusions about the nature of city globalisation through TMCNs and furthers the debate on global urban climate governance with extensive data.

6.2.2 Global city theory

This study provides insights into global city theory and global city formation within TMCNs, which has previously been lacking due to the conceptualisation of TMCNs as, first and foremost — and occasionally solely —, products and symptoms of global city formation rather than contributing factors. By resituating global city formation as a product of TMCN formation and development, this study draws conclusions about the interaction between global cities and TMCNs in a more meaningful and thorough way. This has allowed this study to find how cities' integration in TMCNs reflects and deviates from classical global city formation and the arrangement of financially globalised cities, generating new insights on the evolution and globalisation of cities in the face of an urban climate crisis and the growing trend of global urban climate governance and management. Analysing global city formation from within TMCN memberships contributes a new angle to global urban climate governance in the complexifying network society. Additionally, it contributes these new angles to overall global city theory and the debate on global city formation by adding a new facet to cities' globalisation: the city-to-city networks. Conceptualising TMCNs and other city networks as not solely products but contributing factors to city globalisation further characterises and develops the emerging trends in globalisation into a relatively capital-focused global city theory that is beginning to show its age among global evolutions in neoliberalism and capitalist governance.

6.3 Future research

6.3.1 Refinement of the Membership Index

Future research should focus, in part, on improving the Membership Index and methods utilised in this study. Additional work should be done to define further and test the point scheme of the per-network Membership Grade and subsequent Membership Index beyond the 0-3 and +1-3 system implemented in this study. As seen in the analysis, a large portion of the Membership Index remains predicated on the number of connections a city has to TMCNs and skews the Membership Index Degree to a value of 2.00, which may be challenging to conceptualise in descriptive terms. A scoring system more weighted towards one, with observer and non-voting member cities earning a score of 0.5 and full members a full one, while enabling two levels of stratification among networks for a score of two and three, may lend itself to more descriptive results. Additionally, testing an element of cities' actual validity of integration may be beneficial to determine whether they are truly active within their roles. Certain cities, which may be complete members, may be in periods of lull in participation or simply not interact with the network outside of receiving communications, denoting a lower level of inclusion despite an otherwise full membership. Differentiating between actively participating and passively connected cities would further substantiate the value of the Membership Index and the conceptualisation of not simply binary participation. At scale, for example, for a dataset of the size used in this study and for the multi-thousand-strong networks, this may be difficult to accomplish systematically but may be possible for smaller selections of cities.

Moreover, future studies would benefit tremendously from a temporal dimension of study. This study provides only a snapshot of TMCNs and cities' membership in late 2024, not an ultimate truth about the composition of TMCNs. Over the next couple of years, many TMCNs will see a rotation in their leadership, many cities will likely have internal political and socioeconomic shifts affecting their participation in TMCNs, and new networks will appear and develop. Replicating this study in the future will yield new insights about the evolving and dynamic nature of city membership in TMCNs by analysing which cities remain in elevated positions, which ones step down or step up, and which cities join more TMCNs. Further, including for analysis within the Membership Index the role of cities as conference hosts, where many TMCNs have yearly conferences in different places, would provide a better overview of the role of host cities outside

static spaces. Systematically performing this analysis on a regular basis would generate a wealth of new data and information about the dynamic sphere of TMCNs' leadership and the evolution of global cities among and outside them.

6.3.2 Qualitative perspective

A critical mass of information that this study did not collect is the qualitative dimension of membership depth, that is, the unquantifiable relationships of cities with membership depth and TMCNs. Document analysis, policy review, interviews, and surveys among the most integrated cities in TMCNs would yield significant insights about the political and personal networking facets related to deeper TMCN membership. Particularly, the cases of Barcelona, Brussels, Paris, Seoul, Rotterdam, Istanbul, and the opposite cases of London and New York City looked at more closely for the nature of the unquantified links and relationships they hold with TMCNs is likely to yield new insights about the specific stances of civic leaders to TMCNs — e.g. the proactivity of Barcelona; the role of city diplomacy in more authoritarian regimes — i.e. the current case of Istanbul; the impact of shifting leadership — i.e. the departure of Michael Bloomberg as mayor of New York City and subsequent city leadership's transition among TMCNs; the role that the location of international (climate-related) conferences sponsored by the nation-state has in the centrality of cities in TMCNs — i.e. for Paris and Seoul; the interplay between institution locations and TMCN office locations, especially in cities which are not members themselves — i.e. the case of the EU and Brussels, and more. The qualitative lens has also been lacking in many of these cities, as TMCN research has focused on specific case studies outside of the most connected or most deeply integrated cities, which, following the identification of those by this study, now have significant relevance in future studies (Amul and Shrestha 2015; Kosovac et al. 2021; Heikkinen 2022).

6.3.3 Impacts of membership depth

Furthermore, the effect of cities' deeper integration into TMCNs on their urban fabric, response to climate change, and internal development should be studied. There is persistent academic investigation about the effectiveness and actual impact of TMCNs on combating climate change, with little concrete results on whether they contribute to overall GHG emissions, the net-zero and energy transition, and the development of sustainability projects more than nominal civic attention and budgetary capabilities (Gordon and Johnson 2018; Dumała et al. 2021; Grant, Leffel, and Johnson 2023). Nonetheless, evaluating what deeper membership integration implies on the ground for the most deeply integrated cities compared to more shallowly integrated cities would further discussions about the validity of the activities of TMCNs and their impact on cities' role in climate change and the role of TMCNs inside cities, rather than simply between them. Gauging the relationship between deeper integration and city climate and sustainability activities systematically — by the number of climate-related projects involved in TMCNs — and in more specific qualitative case studies — by asking civic leaders and partners how deeper integration manifests in day-to-day projects and capabilities — would generate new insights about the role of TMCNs in cities' response to climate change.

6.4 Final remarks

This study sought to highlight the evolution of global city theory and global city formation in the context of emerging city diplomacy and global urban climate governance through trans-national municipal climate networks by utilising the prism of diverse membership depth in cities' integration into TMCNs. To do so, it posed the research questions of how cities' differing degrees of integration in TMCNs contribute to global city formation, and why cities assume these positions. In answering these questions, this study deviated from the heretofore binary conception of TMCN membership by analysing the stratifications in city memberships and the relative vertical

hierarchy they represent. By collecting a complete dataset of TMCN membership data for over 16,000 cities and calculating the degree of integration of every city, it has found that TMCNs consistently employ governance structures and create leadership roles which stratify cities by their roles in steering bodies, secretariats, executive boards, and presidencies to make selections of more integrated cities. Through heterogeneous patterns of integration evoking specialisations in roles, techno-managerial governance structures, and a reliance on developed, knowledge-based information economies and technologies to integrate themselves, it was found that cities that integrate deeper reflect many aspects of global city formation.

Yet not all classically global cities are deeply integrated into TMCNs. Further, the most integrated cities tend not to be those with the highest predisposition to risks and adverse effects of climate change, nor necessarily those with better existing addresses to climate change. This implies an evolution or selection bias in city globalisation among TMCNs wherein city climate networks are globalising new and different urban spaces in emerging ways not necessarily complicit with traditional global city formation but certainly linked with the same root phenomena. These findings have implications for the continued rescaling of space found in global cities within the context of the ongoing climate crisis, an intensely urban challenge, by creating new leaders and global hierarchies in urban climate governance. As cities are increasingly recognized as the ground-zero for adaptation and resilience initiatives in the face of the global challenge of climate change, they take on new roles in climate governance, generating a global urban climate governance system. Within this system — predicated on city-to-city knowledge exchanges and circuits of power in policy mobility, technical knowledge, and social, political, and economic capital — also arises asymmetric and incongruent exchanges between networked cities, generating power hierarchies and globally uneven flows between dominating, central cities and peripheral urban localities of the trans-territorialized response to climate change.

Overall, this study makes contributions to the conceptualisation of TMCN membership beyond the simple binary of member versus non-member to more accurately reflect the gradient of membership depth, integration, and internal power hierarchies forming among TMCNs. Further, it fills the gap of large-scale, systematic analysis with up-to-date data, which has been lacking in TMCN research. With this novel toolset and research framework, this study has been able to contribute to the sparse, but more often absent, link between city-to-city exchanges within the network economy and global city theory. Limited by the temporal scope of the data, this study provides only a snapshot of TMCNs and a broad, generalised analysis predicated on primarily quantitative data, unable to reflect the hidden and informal connections between cities. Future studies should therefore concentrate on refining the methods used, including the temporal scope, and qualitatively analysing the interplay of cities' integration in TMCNs. Additionally, although the scope of this study is that of trans-national municipal climate networks, recent calls have been made to broaden the field of research to all trans-national municipal networks (Leffel et al. 2023; Acuto, Pejic, et al. 2024). The framework of this study applies to this call as well, capable of being replicated for the greater global web of all city-to-city networks as cities become increasingly valuable and resourceful actors in the international sphere and to each other in the face of waning nation-state action in the face of climate change, inequality, and justice.

APPENDIX A References

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APPENDIX C Maps

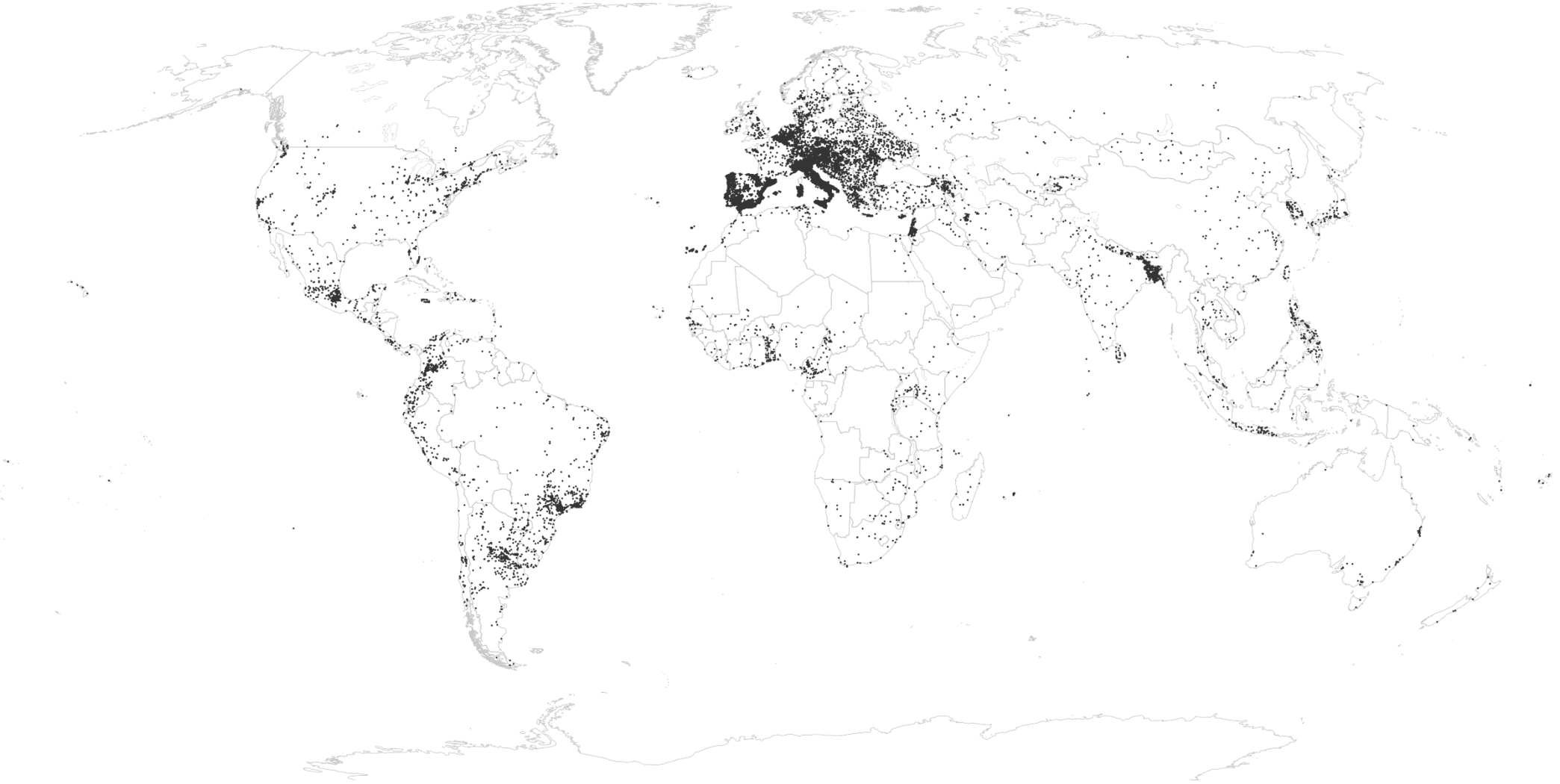

Figure 2. Map of all cities identified in the study.

#	City	Networks hosted
1	Mexico City, Mexico	5
2	Houston, United States	1
3	Washingston D.C., United States	4
4	New York City, United States	1
5	Boston, United States	1
6	Brest, France	1
7	London, United Kingdom	1
8	Paris, France	1
9	Brussels, Belgium	8
10	The Hague, Netherlands	1
11	Rotterdam, Netherlands	1
12	Boxtel, Netherlands	1
13	Bonn, Germany	1
14	Frankfurt, Germany	1
15	Stuttgart, Germany	1
16	Milan, Italy	1

#	City	Networks hosted
17	Besançon, France	1
18	Geneva, Switzerland	1
19	Barcelona, Spain	5
20	Copenhagen, Denmark	1
21	Malmö, Sweden	1
22	Gdańsk, Poland	1
23	Győr, Hungary	1
24	Istanbul, Türkiye	2
25	Kazan, Russia	1
26	Beijing, China	1
27	Seoul, South Korea	2
28	Singapore, Singapore	1
29	Jakarta, Indonesia	1
30	Nairobi, Kenya	1
31	Pretoria, South Africa	1
32	Cape Town, South Africa	1

Figure 3. Map of all cities which are host to one or more TMCN.

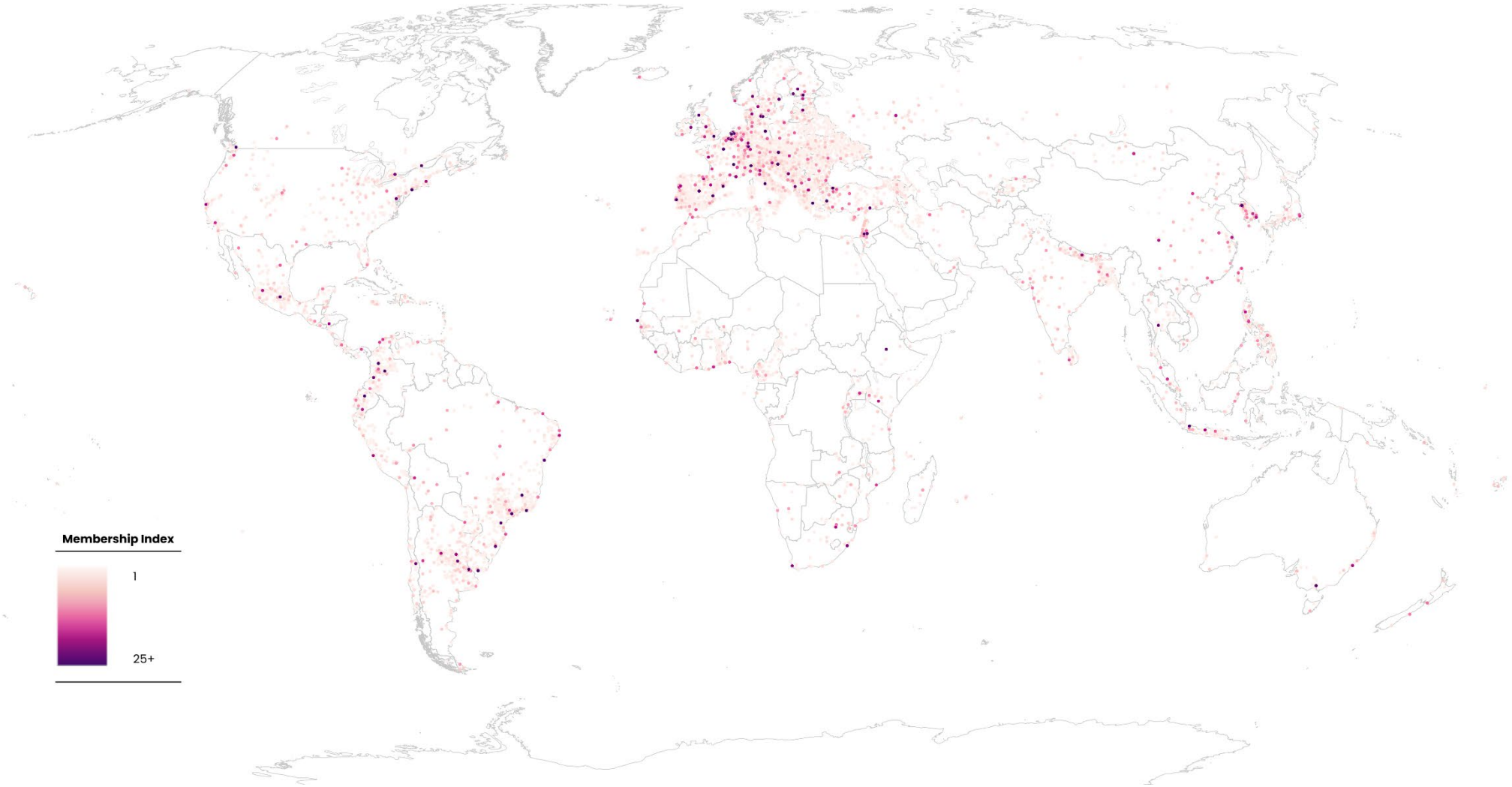

Figure 4. Map of all cities identified in the study by Membership Index.

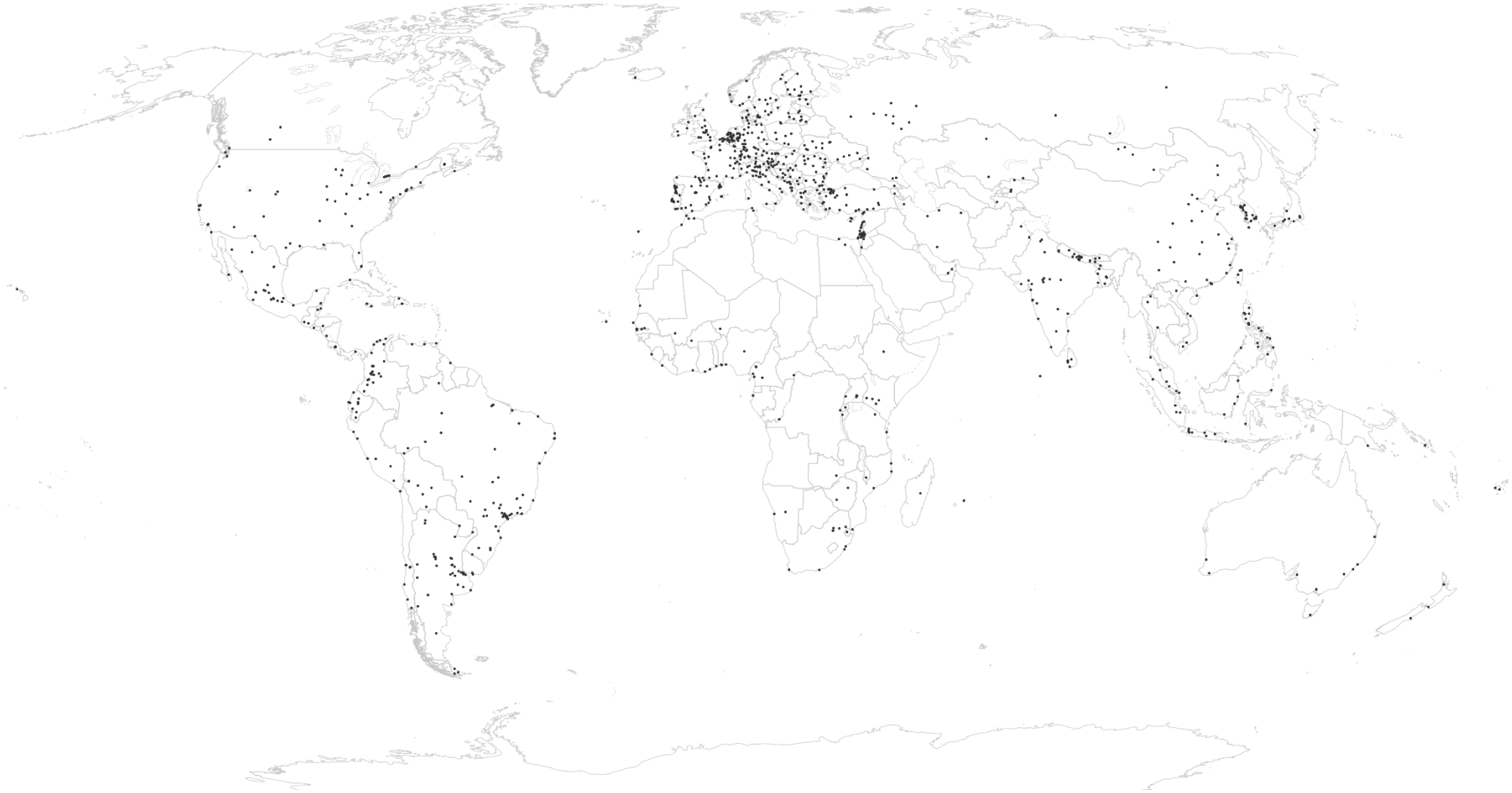

Figure 5. Map of the 90th percentile cities by Membership Index.

APPENDIX D Regression results

Table 9. Regression analysis results for regression A, testing all listed cities.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.46	n=14,330	Between all cities, there is a perceivable link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.42	n=16,021	Between all cities, there is a perceivable link between deeper TMCN integration and higher capital status.
C3	National GDP	+0.04	n=15,981	Between all cities, there is little to no link between deeper TMCN integration and higher national GDP.
C4	GNI per capita PPP	-0.10	n=15,980	Between all cities, there is a weak link between deeper TMCN integration and lower national GNI per capita PPP.
C5	City GDP	+0.46	n=14,300	Between all cities, there is a perceivable link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.39	n=14,300	Between all cities, there is a perceivable link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	+0.10	n=15,885	Between all cities, there is a weak link between deeper TMCN integration and higher national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	+0.04	n=15,885	Between all cities, there is little to no link between deeper TMCN integration and higher national per capita GHG emissions.
V3	City GHG emissions	+0.41	n=14,237	Between all cities, there is a perceivable link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	-0.01	n=16,005	Between all cities, there is little to no link between deeper TMCN integration and lower national energy consumption per capita.
V5	City energy consumption	+0.40	n=14,316	Between all cities, there is a perceivable link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	-0.10	n=15,797	Between all cities, there is a weak link between deeper TMCN integration and a lower national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	-0.12	n=15,768	Between all cities, there is a weak link between deeper TMCN integration and a lower national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	-0.13	n=16,009	Between all cities, there is a weak link between deeper TMCN integration and lower national life expectancy.
V9	Coastal status	+0.12	n=16,021	Between all cities, there is a weak link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	-0.01	n=4,585	Between all cities, there is no link between deeper TMCN integration and a lower national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	+0.06	n=15,938	Between all cities, there is a weak link between deeper TMCN integration and higher national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	+0.07	n=16,000	Between all cities, there is a weak link between deeper TMCN integration and higher national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.05	n=16,003	Between all cities, there is a weak link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	-0.02	n=13,948	Between all cities, there is little to no link between deeper TMCN integration and lower national performance in climate change mitigation on the Climate Change Performance Index.
V15	Climate Risk Index 2025	-0.13	n=15,910	Between all cities, there is a weak link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.

V16	Climate-driven INFORM Risk index	+0.10	n=15,993	Between all cities, there is a weak link between deeper TMCN integration and higher national climate-driven risk on the Climate-driven INFORM Risk index.
V17	Children's Climate Risk Index	+0.09	n=15,867	Between all cities, there is a weak link between deeper TMCN integration and higher national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	+0.02	n=16,021	Between all cities, there is a weak link between deeper TMCN integration and being located in an LDC-designated country.
V19	UN-attributed Landlocked Developing Country (LLDC)	+0.03	n=16,021	Between all cities, there is a weak link between deeper TMCN integration and being located in an LLDC-designated country.
V20	UN-attributed Small Island Developing State (SIDS)	+0.03	n=16,021	Between all cities, there is a weak link between deeper TMCN integration and being located in an SIDS-designated country.
		GLOBALITY INDICATORS		
G1	GaWC ranking 2022 and 2024	+0.56	n=16,021	Between all cities, there is a pronounced link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	-0.12	n=16,021	Between all cities, there is a weak link between deeper TMCN integration and being located in a non-OECD member country.
G3	EU member	-0.18	n=16,021	Between all cities, there is a minor link between deeper TMCN integration and being located in a non-EU member country.
		PATH-DEPENDENCY INDICATORS		
P1	Networks hosted	+0.37	n=16,021	Between all cities, there is a perceivable link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.58	n=16,021	Between all cities, there is a pronounced link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	+0.03	n=588	Between all cities, there is little to no link between deeper TMCN integration and the existence of a civic environmental plan.
P4	Governing party	-0.04	n=588	Between all cities, there is little to no link between deeper TMCN integration and a right-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	+0.12	n=14,576	Between all cities, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	+0.06	n=14,576	Between all cities, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	-0.01	n=16,003	Between all cities, there is little to no link between deeper TMCN integration and a lower amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	+0.09	n=15,979	Between all cities, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	-0.15	n=16,021	Between all cities, there is a minor link between deeper TMCN integration and being located in a non-party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	+0.05	n=16,021	Between all cities, there is little to no link between deeper TMCN integration and being located in an OPEC or OPEC+ member country.

Table 10. Regression analysis results for regression B, testing cities with a Membership Index greater than 2.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.40	n=2,031	Among cities with a Membership Index greater than 2, there is a perceivable link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.38	n=2,165	Among cities with a Membership Index greater than 2, there is a perceivable link between deeper TMCN integration and higher capital status.
C3	National GDP	-0.02	n=2,154	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and lower national GDP.
C4	GNI per capita PPP	+0.01	n=2,153	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and higher GNI per capita PPP.
C5	City GDP	+0.42	n=2,020	Among cities with a Membership Index greater than 2, there is a perceivable link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.34	n=2,020	Among cities with a Membership Index greater than 2, there is a perceivable link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	+0.01	n=2,110	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and lower national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	-0.01	n=2,110	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and higher national per capita GHG emissions.
V3	City GHG emissions	+0.36	n=1,990	Among cities with a Membership Index greater than 2, there is a perceivable link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	+0.01	n=2,159	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and higher national energy consumption per capita.
V5	City energy consumption	+0.35	n=2,026	Among cities with a Membership Index greater than 2, there is a perceivable link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	0.00	n=2,082	Among cities with a Membership Index greater than 2, there is no link between deeper TMCN integration and national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	0.00	n=2,070	Among cities with a Membership Index greater than 2, there is no link between deeper TMCN integration and national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	+0.02	n=2,160	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and higher national life expectancy.
V9	Coastal status	+0.11	n=2,165	Among cities with a Membership Index greater than 2, there is a weak link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	+0.01	n=1,232	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and a higher national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	+0.07	n=2,137	Among cities with a Membership Index greater than 2, there is a weak link between deeper TMCN integration and a higher national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	0.00	n=2,155	Among cities with a Membership Index greater than 2, there is no link between deeper TMCN integration and national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.04	n=2,157	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	+0.04	n=1,696	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and higher national performance in climate change mitigation on the Climate Change Performance Index.
V15	Climate Risk Index 2025	-0.06	n=2,118	Among cities with a Membership Index greater than 2, there is a weak link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.

V16	Climate-driven INFORM Risk index	-0.01	n=2,153	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and lower national climate-driven risk on the Climate-driven INFORM Risk index.
V17	Children's Climate Risk Index	+0.01	n=2,090	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and higher national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	-0.01	n=2,165	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and being located in a non-LDC-designated country.
V19	UN-attributed Landlocked Developing Country (LLDC)	-0.02	n=2,165	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and being located in a non-LLDC-designated country.
V20	UN-attributed Small Island Developing State (SIDS)	-0.04	n=2,165	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and being located in a non-SIDS-designated country.
		GLOBALITY INDICATORS		
G1	GaWC ranking 2022 and 2024	+0.55	n=2,165	Among cities with a Membership Index greater than 2, there is a pronounced link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	+0.02	n=2,165	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and being located in an OECD member country.
G3	EU member	-0.02	n=2,165	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and being located in a non-EU member country.
		PATH-DEPENDENCY INDICATORS		
P1	Networks hosted	+0.42	n=2,165	Among cities with a Membership Index greater than 2, there is a perceivable link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.49	n=2,165	Among cities with a Membership Index greater than 2, there is a perceivable link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	+0.03	n=588	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and the existence of a civic environmental plan.
P4	Governing party	-0.04	n=588	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and a right-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	0.00	n=1,990	Among cities with a Membership Index greater than 2, there is no link between deeper TMCN integration and the proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	+0.04	n=1,990	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and a higher proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	+0.03	n=2,157	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and a higher amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	-0.01	n=2,154	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and a lower proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	-0.04	n=2,165	Among cities with a Membership Index greater than 2, there is little to no link between deeper TMCN integration and being located in a non-party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	0.00	n=2,165	Among cities with a Membership Index greater than 2, there is no link between deeper TMCN integration and being located in an OPEC or OPEC+ member country.

Table 11. Regression analysis results for regression C, testing cities in the 90th percentile of the Membership Index.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.37	n=960	Among cities in the 90th percentile of Membership Index, there is a perceivable link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.37	n=667	Among cities in the 90th percentile of Membership Index, there is a perceivable link between deeper TMCN integration and higher capital status.
C3	National GDP	-0.01	n=990	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and lower national GDP.
C4	GNI per capita PPP	+0.09	n=990	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and higher GNI per capita PPP.
C5	City GDP	+0.39	n=953	Among cities in the 90th percentile of Membership Index, there is a perceivable link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.30	n=953	Among cities in the 90th percentile of Membership Index, there is a moderate link between deeper TMCN integration and nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	-0.03	n=971	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and lower national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	0.00	n=971	Among cities in the 90th percentile of Membership Index, there is no link between deeper TMCN integration and national per capita GHG emissions.
V3	City GHG emissions	+0.32	n=940	Among cities in the 90th percentile of Membership Index, there is a moderate link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	+0.05	n=994	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and higher national energy consumption per capita.
V5	City energy consumption	+0.31	n=957	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	+0.07	n=953	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and a higher national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	+0.08	n=951	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and a higher national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	+0.10	n=993	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and higher national life expectancy.
V9	Coastal status	+0.09	n=997	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and higher placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	-0.03	n=585	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and lower national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	+0.02	n=985	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and higher national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	-0.08	n=991	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and lower national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.02	n=992	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	+0.06	n=781	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and higher national performance in climate change mitigation on the Climate Change Performance Index.

V15	Climate Risk Index 2025	0.00	n=974	Among cities in the 90th percentile of Membership Index, there is no link between deeper TMCN integration and national climate change risk on the Climate Risk Index.
V16	Climate-driven INFORM Risk index	-0.09	n=990	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and lower national climate-driven risk on the Climate-driven INFORM Risk index.
V17	Children's Climate Risk Index	-0.06	n=961	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and lower national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	-0.02	n=997	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and being located in a non-LDC-designated country.
V19	UN-attributed Landlocked Developing Country (LLDC)	-0.03	n=997	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and being located in a non-LLDC-designated country.
V20	UN-attributed Small Island Developing State (SIDS)	-0.07	n=997	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and being located in a non-SIDS-designated country.
		GLOBALITY INDICATORS		
G1	GaWC ranking 2022 and 2024	+0.51	n=997	Among cities in the 90th percentile of Membership Index, there is a pronounced link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	+0.10	n=997	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and being located in an OECD member country.
G3	EU member	+0.09	n=997	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and being located in an EU member country.
		PATH-DEPENDENCY INDICATORS		
P1	Networks hosted	+0.45	n=997	Among cities in the 90th percentile of Membership Index, there is a perceivable link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.58	n=997	Among cities in the 90th percentile of Membership Index, there is a pronounced link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	+0.03	n=588	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and the existence of a civic environmental plan.
P4	Governing party	-0.04	n=588	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and a right-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	-0.07	n=931	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and a lower proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	-0.03	n=931	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and a lower proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	+0.06	n=992	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and a higher amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	-0.07	n=990	Among cities in the 90th percentile of Membership Index, there is a weak link between deeper TMCN integration and a lower proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	+0.05	n=997	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and being located in a party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	-0.01	n=997	Among cities in the 90th percentile of Membership Index, there is little to no link between deeper TMCN integration and being located in a non-OPEC or OPEC+ member country.

Table 12. Regression analysis results for regression D, testing cities in the 99th percentile of the Membership Index.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.28	n=142	Among cities in the 99th percentile of Membership Index, there is a moderate link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.15	n=143	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and higher capital status.
C3	National GDP	-0.09	n=142	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and lower national GDP.
C4	GNI per capita PPP	+0.12	n=142	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and higher GNI per capita PPP.
C5	City GDP	+0.26	n=141	Among cities in the 99th percentile of Membership Index, there is a moderate link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.12	n=141	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	-0.12	n=141	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and lower national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	+0.01	n=141	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and higher national per capita GHG emissions.
V3	City GHG emissions	+0.18	n=140	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	+0.08	n=143	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and higher national energy consumption per capita.
V5	City energy consumption	+0.19	n=142	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	+0.15	n=141	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and a higher national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	+0.18	n=141	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and a higher national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	+0.17	n=142	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and higher national life expectancy.
V9	Coastal status	-0.01	n=143	Among cities in the 99th percentile of Membership Index, there is little to no link between deeper TMCN integration and non-proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	-0.22	n=69	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and a lower national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	-0.09	n=142	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and lower national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	-0.15	n=142	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and lower national PPM2.5 air pollution.
V13	Renewable energy consumption	-0.06	n=142	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and a lower proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	+0.08	n=121	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and higher national performance in climate change mitigation on the Climate Change Performance Index.

V15	Climate Risk Index 2025	-0.06	n=142	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.
V16	Climate-driven INFORM Risk index	-0.16	n=142	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and lower national climate-driven risk on the Climate-driven INFORM Risk index.
V17	Children's Climate Risk Index	-0.16	n=141	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and lower national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	-0.08	n=143	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and being located in a non-LDC-designated country.
V19	UN-attributed Landlocked Developing Country (LLDC)	-0.11	n=143	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and being located in a non-LLDC-designated country.
V20	UN-attributed Small Island Developing State (SIDS)	n/a	n/a	n/a
		GLOBALITY INDICATORS		
G1	GaWC ranking 2022 and 2024	+0.44	n=143	Among cities in the 99th percentile of Membership Index, there is a perceivable link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	+0.17	n=143	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and being located in an OECD member country.
G3	EU member	+0.14	n=143	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and being located in an EU member country.
		PATH-DEPENDENCY INDICATORS		
P1	Networks hosted	+0.57	n=143	Among cities in the 99th percentile of Membership Index, there is a pronounced link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.57	n=143	Among cities in the 99th percentile of Membership Index, there is a pronounced link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	+0.23	n=143	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and the existence of a civic environmental plan.
P4	Governing party	+0.12	n=143	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and a left-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	-0.14	n=133	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and a lower proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	-0.14	n=133	Among cities in the 99th percentile of Membership Index, there is a minor link between deeper TMCN integration and a lower proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	+0.01	n=142	Among cities in the 99th percentile of Membership Index, there is little to no link between deeper TMCN integration and a higher amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	-0.12	n=142	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and a lower proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	+0.13	n=143	Among cities in the 99th percentile of Membership Index, there is a weak link between deeper TMCN integration and being located in a party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	+0.03	n=143	Among cities in the 99th percentile of Membership Index, there is little to no link between deeper TMCN integration and being located in an OPEC or OPEC+ member country.

Table 13. Regression analysis results for regression E, testing cities in EU-member countries.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.66	n=10,138	Among cities in the EU, there is a pronounced link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.44	n=10,803	Among cities in the EU, there is a perceivable link between deeper TMCN integration and higher capital status.
C3	National GDP	-0.01	n=10,803	Among cities in the EU, there is no link between deeper TMCN integration and national GDP.
C4	GNI per capita PPP	+0.01	n=10,803	Among cities in the EU, there is no link between deeper TMCN integration and GNI per capita PPP.
C5	City GDP	+0.66	n=10,138	Among cities in the EU, there is a pronounced link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.42	n=10,138	Among cities in the EU, there is a perceivable link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	-0.02	n=10,803	Among cities in the EU, there is little to no link between deeper TMCN integration and lower national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	0.00	n=10,803	Among cities in the EU, there is no link between deeper TMCN integration and national per capita GHG emissions.
V3	City GHG emissions	+0.67	n=10,138	Among cities in the EU, there is a pronounced link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	+0.04	n=10,803	Among cities in the EU, there is little to no link between deeper TMCN integration and higher national energy consumption per capita.
V5	City energy consumption	+0.66	n=10,803	Among cities in the EU, there is a pronounced link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	+0.05	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and a higher national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	-0.02	n=10,803	Among cities in the EU, there is little to no link between deeper TMCN integration and a lower national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	-0.06	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and lower national life expectancy.
V9	Coastal status	+0.08	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	-0.03	n=979	Among cities in the EU, there is little to no link between deeper TMCN integration and a lower national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	-0.05	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and lower national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	-0.09	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and lower national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.05	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	+0.10	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and higher national performance in climate change mitigation on the Climate Change Performance Index.
V15	Climate Risk Index 2025	-0.08	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.
V16	Climate-driven INFORM Risk index	-0.05	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and lower national climate-driven risk on the Climate-driven INFORM Risk index.

V17	Children's Climate Risk Index	-0.06	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and lower national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	n/a	n/a	n/a
V19	UN-attributed Landlocked Developing Country (LLDC)	n/a	n/a	n/a
V20	UN-attributed Small Island Developing State (SIDS)	n/a	n/a	n/a
		GLOBALITY INDICATORS		
G1	GaWC ranking 2022 and 2024	+0.63	n=10,803	Among cities in the EU, there is a pronounced link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	-0.02	n=10,803	Among cities in the EU, there is little to no link between deeper TMCN integration and being located in an OECD member country.
G3	EU member	n/a	n/a	n/a
		PATH-DEPENDENCY INDICATORS		
P1	Networks hosted	+0.45	n=10,803	Among cities in the EU, there is a perceivable link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.63	n=10,803	Among cities in the EU, there is a pronounced link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	-0.08	n=191	Among cities in the EU, there is a weak link between deeper TMCN integration and the lack of a civic environmental plan.
P4	Governing party	-0.01	n=191	Among cities in the EU, there is no link between deeper TMCN integration and civic government leaning.
P5	Agriculture, forestry, and fishing, value added	0.00	n=10,803	Among cities in the EU, there is no link between deeper TMCN integration and the proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	-0.05	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and a lower proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	+0.07	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and a higher amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	+0.09	n=10,803	Among cities in the EU, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	n/a	n/a	n/a
P10	OPEC and OPEC+ member	n/a	n/a	n/a

Table 14. Regression analysis results for regression F, testing cities in non-EU-member countries.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.50	n=4,211	Among cities not in the EU, there is a perceivable link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.34	n=5,237	Among cities not in the EU, there is a moderate link between deeper TMCN integration and higher capital status.
C3	National GDP	+0.02	n=5,197	Among cities not in the EU, there is little to no link between deeper TMCN integration and higher national GDP.
C4	GNI per capita PPP	+0.04	n=5,196	Among cities not in the EU, there is little to no link between deeper TMCN integration and higher GNI per capita PPP.
C5	City GDP	+0.46	n=4,181	Among cities not in the EU, there is a perceivable link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.35	n=4,181	Among cities not in the EU, there is a moderate link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	+0.06	n=5,101	Among cities not in the EU, there is a weak link between deeper TMCN integration and higher national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	+0.03	n=5,101	Among cities not in the EU, there is little to no link between deeper TMCN integration and higher national per capita GHG emissions.
V3	City GHG emissions	+0.44	n=4,118	Among cities not in the EU, there is a perceivable link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	+0.04	n=5,221	Among cities not in the EU, there is little to no link between deeper TMCN integration and higher national energy consumption per capita.
V5	City energy consumption	+0.41	n=4,197	Among cities not in the EU, there is a perceivable link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	+0.03	n=5,009	Among cities not in the EU, there is little to no link between deeper TMCN integration and a higher national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	+0.03	n=4,983	Among cities not in the EU, there is little to no link between deeper TMCN integration and a higher national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	+0.02	n=5,225	Among cities not in the EU, there is little to no link between deeper TMCN integration and higher national life expectancy.
V9	Coastal status	+0.14	n=5,237	Among cities not in the EU, there is a minor link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	-0.03	n=3,614	Among cities not in the EU, there is little to no link between deeper TMCN integration and a lower national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	0.00	n=5,153	Among cities not in the EU, there is no link between deeper TMCN integration and national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	0.00	n=5,215	Among cities not in the EU, there is no link between deeper TMCN integration and national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.02	n=5,219	Among cities not in the EU, there is little to no link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	0.00	n=3,159	Among cities not in the EU, there is no link between deeper TMCN integration and national performance in climate change mitigation on the Climate Change Performance Index.
V15	Climate Risk Index 2025	0.03	n=5,123	Among cities not in the EU, there is little to no link between deeper TMCN integration and higher national climate change risk on the Climate Risk Index.
V16	Climate-driven INFORM Risk index	-0.06	n=5,208	Among cities not in the EU, there is a weak link between deeper TMCN integration and lower national climate-driven risk on the Climate-driven INFORM Risk index.

V17	Children's Climate Risk Index	0.00	n=5,082	Among cities not in the EU, there is no link between deeper TMCN integration and national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	-0.04	n=5,237	Among cities not in the EU, there is a weak link between deeper TMCN integration and being located in a non-LDC-designated country.
V19	UN-attributed Landlocked Developing Country (LLDC)	-0.01	n=5,327	Among cities not in the EU, there is little to no link between deeper TMCN integration and being located in a non-LLDC-designated country.
V20	UN-attributed Small Island Developing State (SIDS)	+0.01	n=5,237	Among cities not in the EU, there is little to no link between deeper TMCN integration and being located in an SIDS-designated country.
			GLOBALITY INDICATORS	
G1	GaWC ranking 2022 and 2024	+0.51	n=5,237	Among cities not in the EU, there is a pronounced link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	+0.03	n=5,237	Among cities not in the EU, there is little to no link between deeper TMCN integration and being located in an OECD member country.
G3	EU member	n/a	n/a	n/a
			PATH-DEPENDENCY INDICATORS	
P1	Networks hosted	+0.31	n=5,237	Among cities not in the EU, there is a moderate link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.54	n=5,237	Among cities not in the EU, there is a pronounced link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	+0.04	n=397	Among cities not in the EU, there is a weak link between deeper TMCN integration and the existence of a civic environmental plan.
P4	Governing party	-0.08	n=397	Among cities not in the EU, there is a weak link between deeper TMCN integration and a right-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	0.00	n=4,688	Among cities not in the EU, there is no link between deeper TMCN integration and the proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	+0.01	n=4,689	Among cities not in the EU, there is little to no link between deeper TMCN integration and a higher proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	0.00	n=5,218	Among cities not in the EU, there is no link between deeper TMCN integration and the amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	-0.02	n=5,195	Among cities not in the EU, there is little to no link between deeper TMCN integration and a lower proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	0.00	n=5,237	Among cities not in the EU, there is no link between deeper TMCN integration and being located in a party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	-0.03	n=5,237	Among cities not in the EU, there is little to no link between deeper TMCN integration and being located in a non-OPEC or OPEC+ member country.

Table 15. Regression analysis results for regression G, testing cities in OECD-member countries.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.50	n=11,091	Among cities in OECD states, there is a pronounced link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.45	n=11,972	Among cities in OECD states, there is a perceivable link between deeper TMCN integration and higher capital status.
C3	National GDP	+0.06	n=11,972	Among cities in OECD states, there is a weak link between deeper TMCN integration and a higher national GDP.
C4	GNI per capita PPP	0.00	n=11,972	Among cities in OECD states, there is no link between deeper TMCN integration and GNI per capita PPP.
C5	City GDP	+0.47	n=11,091	Among cities in OECD states, there is a perceivable link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.55	n=11,091	Among cities in OECD states, there is a pronounced link between deeper TMCN integration and a lower nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	+0.07	n=11,972	Among cities in OECD states, there is a minor link between deeper TMCN integration and higher national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	+0.09	n=11,972	Among cities in OECD states, there is a minor link between deeper TMCN integration and higher national per capita GHG emissions.
V3	City GHG emissions	+0.43	n=11,091	Among cities in OECD states, there is a perceivable link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	+0.08	n=11,969	Among cities in OECD states, there is a minor link between deeper TMCN integration and higher national energy consumption per capita.
V5	City energy consumption	+0.42	n=11,088	Among cities in OECD states, there is a perceivable link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	-0.01	n=11,972	Among cities in OECD states, there is little to no link between deeper TMCN integration and a lower national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	-0.09	n=11,972	Among cities in OECD states, there is a weak link between deeper TMCN integration and a higher national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	-0.09	n=11,972	Among cities in OECD states, there is a weak link between deeper TMCN integration and lower national life expectancy.
V9	Coastal status	+0.11	n=11,972	Among cities in OECD states, there is a weak link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	-0.04	n=1,832	Among cities in OECD states, there is a weak link between deeper TMCN integration and a lower national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	+0.04	n=11,972	Among cities in OECD states, there is a weak link between deeper TMCN integration and a higher national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	-0.02	n=11,972	Among cities in OECD states, there is little to no link between deeper TMCN integration and lower national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.01	n=11,972	Among cities in OECD states, there is little to no link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.

V14	Climate Change Performance Index 2025	-0.01	n=11,898	Among cities in OECD states, there is little to no link between deeper TMCN integration and lower national performance in climate change mitigation on the Climate Change Performance Index.
V15	Climate Risk Index 2025	-0.13	n=11,969	Among cities in OECD states, there is a weak link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.
V16	Climate-driven INFORM Risk index	+0.04	n=11,972	Among cities in OECD states, there is little to no link between deeper TMCN integration and lower national climate-driven risk on the Climate-driven INFORM Risk index.
V17	Children's Climate Risk Index	+0.02	n=11,972	Among cities in OECD states, there is little to no link between deeper TMCN integration and lower national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	n/a	n/a	n/a
V19	UN-attributed Landlocked Developing Country (LLDC)	n/a	n/a	n/a
V20	UN-attributed Small Island Developing State (SIDS)	n/a	n/a	n/a
		GLOBALITY INDICATORS		
G1	GaWC ranking 2022 and 2024	+0.61	n=11,972	Among cities in OECD states, there is a pronounced link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	n/a	n/a	n/a
G3	EU member	-0.16	n=11,972	Among cities in OECD states, there is a minor link between deeper TMCN integration and being located in a non-EU member country.
		PATH-DEPENDENCY INDICATORS		
P1	Networks hosted	+0.44	n=11,972	Among cities in OECD states, there is a perceivable link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.63	n=11,972	Among cities in OECD states, there is a pronounced link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	-0.04	n=304	Among cities in OECD states, there is little to no link between deeper TMCN integration and the lack of a civic environmental plan.
P4	Governing party	-0.03	n=304	Among cities in OECD states, there is little to no link between deeper TMCN integration and a right-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	+0.07	n=11,469	Among cities in OECD states, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	+0.05	n=11,469	Among cities in OECD states, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	+0.02	n=11,972	Among cities in OECD states, there is little to no link between deeper TMCN integration and a higher amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	+0.10	n=11,972	Among cities in OECD states, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	-0.07	n=11,972	Among cities in OECD states, there is a weak link between deeper TMCN integration and being located in a non-party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	+0.02	n=11,972	Among cities in OECD states, there is little to no link between deeper TMCN integration and being located in an OPEC or OPEC+ member country.

Table 16. Regression analysis results for regression H, testing cities in LDC-designated countries.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.34	n=274	Among cities in Least Developed Countries, there is a moderate link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.40	n=575	Among cities in Least Developed Countries, there is a perceivable link between deeper TMCN integration and higher capital status.
C3	National GDP	-0.22	n=572	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and lower national GDP.
C4	GNI per capita PPP	-0.20	n=572	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and lower GNI per capita PPP.
C5	City GDP	+0.27	n=272	Among cities in Least Developed Countries, there is a moderate link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.33	n=272	Among cities in Least Developed Countries, there is a moderate link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LU-LUCF	-0.24	n=574	Among cities in Least Developed Countries, there is a moderate link between deeper TMCN integration and lower national GHG emissions.
V2	Total greenhouse gas emissions excluding LU-LUCF per capita	-0.06	n=574	Among cities in Least Developed Countries, there is a weak link between deeper TMCN integration and lower national per capita GHG emissions.
V3	City GHG emissions	+0.31	n=273	Among cities in Least Developed Countries, there is a moderate link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	-0.19	n=575	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and lower national energy consumption per capita.
V5	City energy consumption	+0.26	n=274	Among cities in Least Developed Countries, there is a moderate link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	-0.14	n=539	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and lower national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	-0.15	n=538	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and lower national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	-0.12	n=575	Among cities in Least Developed Countries, there is a weak link between deeper TMCN integration and lower national life expectancy.
V9	Coastal status	+0.16	n=575	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	-0.04	n=575	Among cities in Least Developed Countries, there is a weak link between deeper TMCN integration and a lower national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	-0.17	n=572	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and a lower national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	-0.05	n=575	Among cities in Least Developed Countries, there is a weak link between deeper TMCN integration and lower national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.22	n=575	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	n/a	n/a	n/a
V15	Climate Risk Index 2025	-0.15	n=568	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.
V16	Climate-driven INFORM Risk index	-0.13	n=575	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and lower national climate-driven risk on the Climate-driven INFORM Risk index.

V17	Children's Climate Risk Index	-0.17	n=560	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and lower national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	n/a	n/a	n/a
V19	UN-attributed Landlocked Developing Country (LLDC)	+0.18	n=575	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and being located in an LLDC-designated country.
V20	UN-attributed Small Island Developing State (SIDS)	+0.01	n=575	Among cities in Least Developed Countries, there is little to no link between deeper TMCN integration and being located in an SIDS-designated country.
			GLOBALITY INDICATORS	
G1	GaWC ranking 2022 and 2024	+0.43	n=575	Among cities in Least Developed Countries, there is a perceivable link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	n/a	n/a	n/a
G3	EU member	n/a	n/a	n/a
			PATH-DEPENDENCY INDICATORS	
P1	Networks hosted	n/a	n/a	n/a
P2	Networks founded	+0.52	n=575	Among cities in Least Developed Countries, there is a pronounced link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	+0.02	n=535	Among cities in Least Developed Countries, there is little to no link between deeper TMCN integration and the existence of a civic environmental plan.
P4	Governing party	+0.05	n=35	Among cities in Least Developed Countries, there is a weak link between deeper TMCN integration and a left-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	+0.19	n=568	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and a higher proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	-0.19	n=568	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and a lower proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	+0.14	n=575	Among cities in Least Developed Countries, there is a minor link between deeper TMCN integration and a higher amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	+0.10	n=572	Among cities in Least Developed Countries, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	n/a	n/a	n/a
P10	OPEC and OPEC+ member	+0.03	n=575	Among cities in Least Developed Countries, there is little to no link between deeper TMCN integration and being located in a non-OPEC or OPEC+ member country.

Table 17. Regression analysis results for regression I, testing GaWC-ranked cities.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.25	n=303	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.22	n=306	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and higher capital status.
C3	National GDP	-0.27	n=304	Among GaWC-ranked cities, there is a moderate link between deeper TMCN integration and lower national GDP.
C4	GNI per capita PPP	-0.05	n=304	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and lower GNI per capita PPP.
C5	City GDP	+0.28	n=301	Among GaWC-ranked cities, there is a moderate link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.11	n=301	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	-0.23	n=303	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and lower national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	-0.27	n=303	Among GaWC-ranked cities, there is a moderate link between deeper TMCN integration and lower national per capita GHG emissions.
V3	City GHG emissions	+0.16	n=300	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	-0.22	n=305	Among GaWC-ranked cities, there is a moderate link between deeper TMCN integration and lower national energy consumption per capita.
V5	City energy consumption	+0.15	n=302	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	+0.05	n=294	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and a higher national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	+0.25	n=297	Among GaWC-ranked cities, there is a moderate link between deeper TMCN integration and a higher national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	+0.11	n=305	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and higher national life expectancy.
V9	Coastal status	+0.10	n=306	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	-0.01	n=177	Among GaWC-ranked cities, there is little to no link between deeper TMCN integration and a lower national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	+0.10	n=301	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and higher national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	-0.17	n=303	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and lower national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.19	n=305	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	+0.27	n=251	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and lower national performance in climate change mitigation on the Climate Change Performance Index.
V15	Climate Risk Index 2025	-0.14	n=300	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.
V16	Climate-driven INFORM Risk index	-0.11	n=303	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and lower national climate-driven risk on the Climate-driven INFORM Risk index.

V17	Children's Climate Risk Index	-0.20	n=298	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and lower national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	-0.02	n=306	Among GaWC-ranked cities, there is little to no link between deeper TMCN integration and being located in a non-LDC-designated country.
V19	UN-attributed Landlocked Developing Country (LLDC)	-0.04	n=306	Among GaWC-ranked cities, there is little to no link between deeper TMCN integration and being located in a non-LLDC-designated country.
V20	UN-attributed Small Island Developing State (SIDS)	-0.10	n=306	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and being located in a non-SIDS-designated country.
			GLOBALITY INDICATORS	
G1	GaWC ranking 2022 and 2024	+0.41	n=306	Among GaWC-ranked cities, there is a perceivable link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	+0.12	n=306	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and being located in an OECD member country.
G3	EU member	+0.32	n=306	Among GaWC-ranked cities, there is a moderate link between deeper TMCN integration and being located in an EU member country.
			PATH-DEPENDENCY INDICATORS	
P1	Networks hosted	+0.50	n=306	Among GaWC-ranked cities, there is a pronounced link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.69	n=306	Among GaWC-ranked cities, there is a pronounced link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	-0.08	n=187	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and the lack of a civic environmental plan.
P4	Governing party	-0.03	n=187	Among GaWC-ranked cities, there is little to no link between deeper TMCN integration and a right-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	-0.13	n=248	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and a lower proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	-0.29	n=249	Among GaWC-ranked cities, there is a moderate link between deeper TMCN integration and a higher proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	+0.14	n=304	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and a higher amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	-0.14	n=303	Among GaWC-ranked cities, there is a minor link between deeper TMCN integration and a higher proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	+0.09	n=306	Among GaWC-ranked cities, there is a weak link between deeper TMCN integration and being located in a party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	-0.04	n=306	Among GaWC-ranked cities, there is little to no link between deeper TMCN integration and being located in a non-OPEC or OPEC+ member country.

Table 18. Regression analysis results for regression J, testing cities that host at least one network.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.37	n=32	Among cities hosting one or more networks, there is a perceivable link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.26	n=32	Among cities hosting one or more networks, there is a moderate link between deeper TMCN integration and higher capital status.
C3	National GDP	-0.11	n=32	Among cities hosting one or more networks, there is a weak link between deeper TMCN integration and lower national GDP.
C4	GNI per capita PPP	-0.14	n=32	Among cities hosting one or more networks, there is a weak link between deeper TMCN integration and lower GNI per capita PPP.
C5	City GDP	+0.31	n=32	Among cities hosting one or more networks, there is a moderate link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.13	n=32	Among cities hosting one or more networks, there is a moderate link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	-0.12	n=32	Among cities hosting one or more networks, there is a weak link between deeper TMCN integration and lower national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	-0.15	n=32	Among cities hosting one or more networks, there is a minor link between deeper TMCN integration and lower national per capita GHG emissions.
V3	City GHG emissions	+0.23	n=32	Among cities hosting one or more networks, there is a minor link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	-0.21	n=32	Among cities hosting one or more networks, there is a minor link between deeper TMCN integration and lower national energy consumption per capita.
V5	City energy consumption	+0.15	n=32	Among cities hosting one or more networks, there is a minor link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	+0.03	n=32	Among cities hosting one or more networks, there is little to no link between deeper TMCN integration and a higher national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	+0.20	n=32	Among cities hosting one or more networks, there is a minor link between deeper TMCN integration and a higher national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	+0.17	n=32	Among cities hosting one or more networks, there is a minor link between deeper TMCN integration and higher national life expectancy.
V9	Coastal status	+0.11	n=32	Among cities hosting one or more networks, there is a weak link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	0.00	n=14	Among cities hosting one or more networks, there is no link between deeper TMCN integration and the national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	0.00	n=32	Among cities hosting one or more networks, there is no link between deeper TMCN integration and national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	-0.01	n=32	Among cities hosting one or more networks, there is little to no link between deeper TMCN integration and lower national PPM2.5 air pollution.
V13	Renewable energy consumption	0.00	n=32	Among cities hosting one or more networks, there is no link between deeper TMCN integration and the proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	+0.01	n=32	Among cities hosting one or more networks, there is little to no link between deeper TMCN integration and higher national performance in climate change mitigation on the Climate Change Performance Index.
V15	Climate Risk Index 2025	-0.11	n=31	Among cities hosting one or more networks, there is a weak link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.

V16	Climate-driven IN-FORM Risk index	-0.01	n=32	Among cities hosting one or more networks, there is little to no link between deeper TMCN integration and lower national climate-driven risk on the Climate-driven IN-FORM Risk index.
V17	Children's Climate Risk Index	+0.04	n=31	Among cities hosting one or more networks, there is little to no link between deeper TMCN integration and higher national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	n/a	n/a	n/a
V19	UN-attributed Landlocked Developing Country (LLDC)	n/a	n/a	n/a
V20	UN-attributed Small Island Developing State (SIDS)	-0.23	n=32	Among cities hosting one or more networks, there is a minor link between deeper TMCN integration and being located in a non-SIDS-designated country.
			GLOBALITY INDICATORS	
G1	GaWC ranking 2022 and 2024	+0.53	n=32	Among cities hosting one or more networks, there is a pronounced link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	+0.20	n=32	Among cities hosting one or more networks, there is a minor link between deeper TMCN integration and being located in an OECD member country.
G3	EU member	+0.06	n=32	Among cities hosting one or more networks, there is a weak link between deeper TMCN integration and being located in an EU member country.
			PATH-DEPENDENCY INDICATORS	
P1	Networks hosted	+0.55	n=32	Among cities hosting one or more networks, there is a pronounced link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.75	n=32	Among cities hosting one or more networks, there is a substantial link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	+0.21	n=29	Among cities hosting one or more networks, there is a minor link between deeper TMCN integration and the existence of a civic environmental plan.
P4	Governing party	+0.06	n=29	Among cities hosting one or more networks, there is a weak link between deeper TMCN integration and a left-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	+0.02	n=28	Among cities hosting one or more networks, there is little to no link between deeper TMCN integration and a higher proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	+0.04	n=28	Among cities hosting one or more networks, there is little to no link between deeper TMCN integration and a higher proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	-0.12	n=32	Among cities hosting one or more networks, there is a weak link between deeper TMCN integration and a lower amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	-0.08	n=32	Among cities hosting one or more networks, there is a weak link between deeper TMCN integration and a lower proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	+0.04	n=32	Among cities hosting one or more networks, there is little to no link between deeper TMCN integration and being located in a party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	+0.03	n=32	Among cities hosting one or more networks, there is little to no link between deeper TMCN integration and being located in an OPEC or OPEC+ member country.

Table 19. Regression analysis results for regression K, testing cities that have founded at least one network.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.45	n=384	Among cities which have founded one or more networks, there is a perceivable link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.51	n=392	Among cities which have founded one or more networks, there is a pronounced link between deeper TMCN integration and higher capital status.
C3	National GDP	+0.10	n=391	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and higher national GDP.
C4	GNI per capita PPP	-0.02	n=391	Among cities which have founded one or more networks, there is little to no link between deeper TMCN integration and lower GNI per capita PPP.
C5	City GDP	+0.46	n=383	Among cities which have founded one or more networks, there is a perceivable link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.37	n=383	Among cities which have founded one or more networks, there is a perceivable link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	+0.08	n=387	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and higher national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	+0.05	n=387	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and higher national per capita GHG emissions.
V3	City GHG emissions	+0.43	n=379	Among cities which have founded one or more networks, there is a perceivable link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	+0.05	n=390	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and higher national energy consumption per capita.
V5	City energy consumption	+0.41	n=382	Among cities which have founded one or more networks, there is a perceivable link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	-0.08	n=387	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and a lower national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	-0.16	n=384	Among cities which have founded one or more networks, there is a minor link between deeper TMCN integration and a lower national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	-0.10	n=392	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and lower national life expectancy.
V9	Coastal status	+0.15	n=392	Among cities which have founded one or more networks, there is a minor link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	+0.06	n=171	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and a lower national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	+0.18	n=386	Among cities which have founded one or more networks, there is a minor link between deeper TMCN integration and lower national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	+0.07	n=389	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and lower national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.12	n=390	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	-0.03	n=354	Among cities which have founded one or more networks, there is little to no link between deeper TMCN integration and lower national performance in climate change mitigation on the Climate Change Performance Index.

V15	Climate Risk Index 2025	-0.24	n=387	Among cities which have founded one or more networks, there is a minor link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.
V16	Climate-driven INFORM Risk index	+0.07	n=389	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and higher national climate-driven risk on the Climate-driven INFORM Risk index.
V17	Children's Climate Risk Index	+0.09	n=389	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and higher national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	+0.08	n=392	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and being located in an LDC-designated country.
V19	UN-attributed Landlocked Developing Country (LLDC)	+0.09	n=392	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and being located in an LLDC-designated country.
V20	UN-attributed Small Island Developing State (SIDS)	-0.05	n=392	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and being located in a non-SIDS-designated country.
		GLOBALITY INDICATORS		
G1	GaWC ranking 2022 and 2024	+0.66	n=392	Among cities which have founded one or more networks, there is a pronounced link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	-0.04	n=392	Among cities which have founded one or more networks, there is little to no link between deeper TMCN integration and being located in a non-OECD member country.
G3	EU member	-0.22	n=392	Among cities which have founded one or more networks, there is a minor link between deeper TMCN integration and being located in a non-EU member country.
		PATH-DEPENDENCY INDICATORS		
P1	Networks hosted	+0.50	n=392	Among cities which have founded one or more networks, there is a pronounced link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.62	n=392	Among cities which have founded one or more networks, there is a pronounced link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	+0.02	n=183	Among cities which have founded one or more networks, there is little to no link between deeper TMCN integration and the lack of a civic environmental plan.
P4	Governing party	-0.06	n=183	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and a right-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	+0.08	n=373	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	+0.07	n=373	Among cities which have founded one or more networks, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	+0.03	n=390	Among cities which have founded one or more networks, there is little to no link between deeper TMCN integration and a higher amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	+0.02	n=390	Among cities which have founded one or more networks, there is little to no link between deeper TMCN integration and a higher proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	-0.21	n=392	Among cities which have founded one or more networks, there is a minor link between deeper TMCN integration and being located in a non-party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	+0.01	n=392	Among cities which have founded one or more networks, there is little to no link between deeper TMCN integration and being located in an OPEC or OPEC+ member country.

Table 20. Regression analysis results for regression L, testing cities with a Membership Index Degree greater than 2.00.

NO.	INDICATOR	COEFFICIENT	DATA-POINTS	SIGNIFICANCE
			CENTRICITY INDICATORS	
C1	City population	+0.44	n=536	Among cities with a Membership Index Degree greater than 2, there is a perceivable link between deeper TMCN integration and higher metropolitan population.
C2	Capital status	+0.48	n=562	Among cities with a Membership Index Degree greater than 2, there is a perceivable link between deeper TMCN integration and higher capital status.
C3	National GDP	+0.05	n=560	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and higher national GDP.
C4	GNI per capita PPP	-0.03	n=560	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and lower GNI per capita PPP.
C5	City GDP	+0.43	n=534	Among cities with a Membership Index Degree greater than 2, there is a perceivable link between deeper TMCN integration and higher overall city GDP.
C6	City GDP per cent	+0.39	n=534	Among cities with a Membership Index Degree greater than 2, there is a perceivable link between deeper TMCN integration and higher nationally proportional city GDP.
			VULNERABILITY INDICATORS	
V1	Total greenhouse gas emissions excluding LULUCF	+0.02	n=549	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and higher national GHG emissions.
V2	Total greenhouse gas emissions excluding LULUCF per capita	-0.02	n=549	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and lower national per capita GHG emissions.
V3	City GHG emissions	+0.37	n=526	Among cities with a Membership Index Degree greater than 2, there is a perceivable link between deeper TMCN integration and higher overall city GHG emissions.
V4	National energy consumption per capita	-0.02	n=560	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and lower national energy consumption per capita.
V5	City energy consumption	+0.36	n=534	Among cities with a Membership Index Degree greater than 2, there is a perceivable link between deeper TMCN integration and higher city energy consumption.
V6	National inequality-adjusted HDI	-0.08	n=544	Among cities with a Membership Index Degree greater than 2, there is a weak link between deeper TMCN integration and a lower national inequality-adjusted HDI score.
V7	National planetary pressures-adjusted HDI	-0.10	n=544	Among cities with a Membership Index Degree greater than 2, there is a weak link between deeper TMCN integration and a lower national planetary-adjusted HDI score.
V8	Life expectancy at birth, total	-0.05	n=561	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and lower national life expectancy.
V9	Coastal status	+0.15	n=562	Among cities with a Membership Index Degree greater than 2, there is a minor link between deeper TMCN integration and proximity placement on the coast.
V10	Proportion of urban population living in slums, informal settlements	+0.10	n=286	Among cities with a Membership Index Degree greater than 2, there is a weak link between deeper TMCN integration and a higher national proportion of urban population living in precarious housing conditions.
V11	Average precipitation in depth	+0.19	n=554	Among cities with a Membership Index Degree greater than 2, there is a minor link between deeper TMCN integration and a higher national average yearly precipitation.
V12	PPM2.5 air pollution, mean annual exposure	+0.04	n=558	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and higher national PPM2.5 air pollution.
V13	Renewable energy consumption	+0.11	n=559	Among cities with a Membership Index Degree greater than 2.00, there is a weak link between deeper TMCN integration and a higher proportion of national energy consumption derived from renewable energy sources.
V14	Climate Change Performance Index 2025	+0.04	n=487	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and higher national performance in climate change mitigation on the Climate Change Performance Index.

V15	Climate Risk Index 2025	-0.15	n=551	Among cities with a Membership Index Degree greater than 2, there is a minor link between deeper TMCN integration and lower national climate change risk on the Climate Risk Index.
V16	Climate-driven INFORM Risk index	+0.04	n=558	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and higher national climate-driven risk on the Climate-driven INFORM Risk index.
V17	Children's Climate Risk Index	+0.07	n=548	Among cities with a Membership Index Degree greater than 2, there is a weak link between deeper TMCN integration and higher national climate-related youth risk on the Children's Climate Risk Index.
V18	UN-attributed Least Developed Country (LDC)	+0.03	n=562	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and being located in an LDC-designated country.
V19	UN-attributed Landlocked Developing Country (LLDC)	+0.02	n=562	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and being located in an LLDC-designated country.
V20	UN-attributed Small Island Developing State (SIDS)	-0.06	n=562	Among cities with a Membership Index Degree greater than 2, there is a weak link between deeper TMCN integration and being located in a non-SIDS-designated country.
		GLOBALITY INDICATORS		
G1	GaWC ranking 2022 and 2024	+0.61	n=562	Among cities with a Membership Index Degree greater than 2, there is a pronounced link between deeper TMCN integration and higher GaWC ranking.
G2	OECD member	-0.04	n=562	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and being located in a non-OECD member country.
G3	EU member	-0.14	n=562	Among cities with a Membership Index Degree greater than 2, there is a weak link between deeper TMCN integration and being located in a non-EU member country.
		PATH-DEPENDENCY INDICATORS		
P1	Networks hosted	+0.46	n=562	Among cities with a Membership Index Degree greater than 2, there is a perceivable link between deeper TMCN integration and a higher number of hosted networks.
P2	Networks founded	+0.40	n=562	Among cities with a Membership Index Degree greater than 2, there is a perceivable link between deeper TMCN integration and a higher number of founded networks.
P3	Environmental plan presence	+0.02	n=302	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and the lack of a civic environmental plan.
P4	Governing party	-0.04	n=302	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and a right-of-centre civic government.
P5	Agriculture, forestry, and fishing, value added	+0.07	n=531	Among cities with a Membership Index Degree greater than 2, there is a weak link between deeper TMCN integration and a higher proportion of the national GDP derived from agriculture, forestry, and fishing.
P6	Industry including construction, value added	+0.04	n=531	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and a higher proportion of the national GDP derived from industrial and construction sources.
P7	Terrestrial and marine protected areas	+0.05	n=559	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and a higher amount of nationally-protected terrestrial and marine areas.
P8	Total natural resources rents	0.00	n=560	Among cities with a Membership Index Degree greater than 2, there is no link between deeper TMCN integration and the proportion of the national GDP derived from natural resources.
P9	Kyoto Protocol Annex 1/B ratifier	-0.20	n=562	Among cities with a Membership Index Degree greater than 2, there is a minor link between deeper TMCN integration and being located in a non-party state to the Kyoto Protocol Annex 1/B.
P10	OPEC and OPEC+ member	-0.01	n=562	Among cities with a Membership Index Degree greater than 2, there is little to no link between deeper TMCN integration and being located in a non-OPEC or OPEC+ member country.