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Sectoral resilience through learning in networks and GVCs: A historical perspective on the food-processing and clothing industries in Poland

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ABSTRACT

This paper investigates how inter-organizational learning in networks and global value chains (GVCs) has contributed to resilience in Poland's food processing and clothing industries. The Polish economy has been widely accepted as resilient since Poland's transition from a planned to a market economy. Through drawing on the regional resilience literature, this paper develops a network-oriented framework of sectoral resilience that integrates network evolution, inter-organizational learning in networks, and the role of history. It uses unique primary data from the period of Poland's abovementioned transition (1989–2001), which is complemented with secondary data on the networking activities of Polish firms in the two abovementioned sectors between 2004 and 2018. In turn, the firms' interactive learning is found to function as an important contributor to their path-dependent network trajectories and resilience. Moreover, knowledge networks and GVCs present different dynamics in terms of their effects on learning and result in uneven sectoral resilience. Learning from knowledge spillovers and by interacting with the co-existence of adaptation- and adaptability-related network characteristics has guided both the studied sectors towards developing short-term adaptive capacity for path-extension and sustainability. Learning from advanced science and technology (S&T) and education regarding exclusive adaptability-related network characteristics has driven Poland's food-processing industry's path-evolving long-term capability to be fully resilient.

1. Introduction

Our world is currently living through unprecedented changes due to a pandemic, political turbulences, and the attendant economic shocks. Given such continued economic shocks, scholarly interest in resilience of firms and economies has increased. However, the current understanding of this concept is fuzzy and varies according to different schools of thought. The conventional view of resilience considers it simply as a 'bounce back' from the crises or shocks in an economy (Hill et al., 2008; Briguglio et al., 2009; Fingleton et al., 2012; Iacobucci and Perugini, 2021). Yet others argue that resilience is not just about 'bounce back' but, more importantly, concerns 'adaptation and adaptability' (Simmie and Martin, 2010; Pike et al., 2010; Boschma, 2015; Martin and Sunley, 2020).

Notably, the resilience of firms and economies is also viewed as path dependent; in other words, their 'history matters' (Boschma, 2015). While the literature largely associated path dependence often utilizes concepts like 'lock-in' and 'continuity,' novel evolutionary perspectives stress the capacity of developmental trajectories for 'ongoing change' and, hence, a 'path-dependent evolution' (Martin, 2010). Moreover, Boschma (2015) asserts that the networks of an economy serve as a useful background to understand resilience. Consequently, we argue that the analysis of the historical legacy of networking and the concomitant successful learning outcomes are important to understand the path dependence of both existing and new developmental trajectories that may promote resilience. These trajectories are closely related to the way in which firms learn from their networks (Lema et al., 2018; Figueiredo et al., 2020) and how path dependence (through the adaptation and adaptability of networks) is associated with different learning modes.

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We build on and advance this line of research by specifically focusing on how inter-organizational learning in knowledge networks and global value chains (GVCs) can contribute to building sectoral resilience. We integrate inter-organizational learning into an understanding of the role of networks in building resilience by operationalizing the attendant notions of adaptation and adaptability, using the historical data of networks. We then examine the effects of these networks on inter-organizational learning. Specifically, we focus on the low- and medium-technology (LMT) sectors of food-processing and clothing in Poland.

Poland appears to be a highly idiosyncratic case, having been singled out for displaying resilience at national and regional levels throughout recent economic crises (Bogdan et al., 2015; Sensier et al., 2016; Piatkowski, 2018). More broadly, the extant literature illustrates how the relocation of manufacturing in LMT sectors occurs, from Western Europe to Central and Eastern European countries (CEEC) (Yoruk, 2004; Pickles et al., 2006), not only altering the structure and dynamics of these industries but also generally influencing their pace of change in CEECs (Heidenreich, 2009). Therefore, these industries function as 'carrier industries' to the new knowledge and technology created by high-tech industries and sciences (von Tunzelmann and Acha, 2005; Mendonca, 2009). Additionally, LMT industries offer ample opportunities for inter-organizational learning through networks and with regard to the accumulation of technological innovation capability (Figueiredo and Cohen, 2019; Figueiredo et al., 2021). In terms of resilience, these traditional industries are prone to 'lock-in' to a path with a suboptimal level of growth (Pike et al., 2010; Hassink, 2010). In fact, the evolutionary approach to 'lock-in' regarding path-dependency is related to the way in which past legacies—industrial, technological, or network—weaken the capabilities to access new knowledge and learn, in turn constraining regions and industries within rigid trajectories (Boschma and Lambooy, 1999). Therefore, we postulate that the nature of networking and learning behavior of Polish LMT firms during a major change (i.e., Poland's economic transition years), has a significant bearing on the creation of path dependence through the adaptation and adaptability of these networks, which shapes Poland's resilient economy today (cf. Martin and Sunley, 2006).

Based on an empirical analysis of the Polish food-processing and clothing industries, we use unique primary data collected during Poland's economic transition period (1989–2001), which is complemented with secondary data on the networking activities of innovative firms in its food-processing and clothing industries between 2004 and 2018, in order to explore the capacity of these activities to generate new growth paths in the long run. Hence, our analysis is not only longitudinal—spanning from 1989 to 2018—but also chronological, with respect to network evolution. Our primary data analysis examines the following: how the selected Polish firms have learned from their foreign and domestic partners within networks and GVCs, and what characteristics of networks and GVCs have played a major role in the different learning mechanisms.

This study contributes to the existing literature on resilience in three main ways. First, this study is the first of its kind to establish the link between resilience and the concepts of networks and learning that are widely discussed in the resilience literature (Boschma, 2015). Second, the empirical approach of this study is the first to incorporate historical data analysis into the examination of resilience and is able to implement an evolutionary perspective in assessing path dependence. Third, this study provides empirical evidence regarding the resilience of specific industries associated with their path-dependent industrial development trajectories, in the context of network evolution (i.e., developing and dissolving networks) (Gluckler, 2007; Boschma, 2015), network structure, and their benefit in learning from these networking relations, from the perspective of adaptation and adaptability (Pike et al., 2010; Boschma, 2015; Hu and Hassink, 2020). As a result, we find that the path-dependent network trajectories of the two studied sectors have developed differently, creating uneven sectoral resilience.

This paper is structured as follows: Section 2 presents the paper's theoretical background. Section 3 details the research methods used. Section 4 presents the results of our analyses. Section 5 provides a discussion of our findings. Finally, Section 6 provides the concluding remarks.

2. Theoretical background

2.1. The concept of resilience

Recent economic crises, in particular the global financial crisis of 2008 and the more recent COVID-19 pandemic, have encouraged scholarly interest in the concept of resilience (Bristow and Healy, 2014; Boschma, 2015; Capello et al., 2015; Martin and Sunley, 2015; Gong et al., 2020). The traditional equilibrium-based view on resilience considers it as an entity's short-term ability to rapidly recover from external shocks, i.e., economic crises, pandemics, or natural disasters. Accordingly, the initial conditions and the relevant sequence of events play no role in establishing a stable equilibrium (Gluckler, 2007). In contrast, the evolutionary perspective to resilience, which we adopt in this paper, argues that in addition to the ability to 'bounce back' to a steady state after being exposed to shocks, the capacity of a region/economy/industry to chart new growth paths and sustain long-term development is essential to its resilience (Simmie and Martin, 2010; Pike et al., 2010; Boschma, 2015).

However, there is a lack of consensus on and difficulties in measuring resilience in general (Sensier et al., 2016). Indeed, Martin and Sunley (2020) argue that resilience as a concept requires development and consolidation with regard to how it should be conceptualized and measured, what its determinants are, and how it links to patterns of long-run growth. In this regard, the equilibrium-based approach to resilience widely utilizes the level of real output and employment to quantify 'economic' resilience across European nations and regions (Fingleton et al., 2012; Briguglio et al., 2009; Hill et al., 2008). Yet, from an evolutionary perspective, the operationalization of 'regional' resilience—that is embedded in a region's industrial, network and institutional structures—is more complex and, consequently, remains less developed as a concept (Boschma, 2015). Hence, the applicability of frameworks proposed by the evolutionary approach to resilience remains limited.

In understanding and measuring regional resilience, Boschma (2015: 743) recommends retaining the idea of 'path-dependence' while also integrating 'historical legacy,' since these are the keys to understanding growth paths. Perez (2016) also stresses the role of history in shaping the future of an economy, as future events are not independent of a certain sequence of past events; therefore, evolutionary change may be a function of path-dependence (Gluckler, 2007). While path-dependence refers to the resources, capabilities, and experiences inherited from previous paths, its major role is manifest as a mechanism that stimulates the recombination of these inherited assets and conditions to determine what changes can be made and how multiple future paths can be created (Stark and Bruszt, 2001; Martin, 2010). Pursuing these ideas, Martin (2010: 32–33) proposes a path-dependent industrial evolution, proposing two outcomes: 'path as movement to a stable state' and 'path as a dynamic process.' The former results in continuity and stability without much change in firm structures, networks, and knowledge, akin to the 'lock-in' effect that makes 'the industry highly prone to shifts in markets, to the rise of more productive (or cheaper) competitors elsewhere and to atrophy, even decline' (p. 33). In contrast, the latter promotes incremental and endogenous change, allowing a renewal of networks, knowledge, and technologies within an industry to create path-dependent and path-evolving industrial development trajectories.

2.2. The role of networks and inter-organizational learning in resilience

Networking behaviors have implications on the performance of firms

and sectors (Hauknes and Knell, 2009). Networks are based on interconnectedness and strong mutual dependence in the coordination of activities and resources between nodes, with explicit gains from the pooling of the resources of the involved partners (Powell, 1990; Hakansson and Lundgren, 1995; Huggins and Johnston, 2010; Huggins et al., 2012). Moreover, evolutionary approaches to networks focus on firms' interest in acquiring, combining, creating, and exploiting technology, knowledge, and capabilities (Coombs and Metcalfe, 2000).

Connected to networking, inter-organizational learning is a dynamic and complex process that allows firms to access, acquire, and absorb knowledge from external actors within their networks, providing a significant capacity to change routines and to build new capabilities (Nelson and Winter, 1982; von Hippel, 1988; Freeman, 1991; Powell et al., 1996). Experts have firmly established that networks enhance organizational learning by letting firms, through formal and informal interactions, access the ideas, resources, and knowledge of other organizations whose activities may be complementary or competitive in nature (Hamel, 1991; Powell et al., 1996; Janowicz-Panjaitan and Noorderhaven, 2008).

GVCs also draw on similar themes to the networks literature. GVCs are typically based on hierarchical and asymmetric relationships between a lead firm and its local suppliers, where the former exercises control over the network resources and decision-making activities (Gereffi, 1999; Humphrey and Schmitz, 2004; Gereffi et al., 2005; Ernst, 2007). GVCs can, therefore, play a significant role in the knowledge transfer to and the creation of learning opportunities for supplier firms, by providing access to both the supply/production and the demand/distribution sides of a value chain. To this end, GVCs involve a series of exchanges of information, resources, products, and services among suppliers, producers, and customers over a period of time, including specifications of the terms and responsibilities of each partner (Ernst, 1997, 2008; Gereffi et al., 2005; Belderbos and Grimpe, 2020).

While involvement in a variety of interactions might enhance the learning of firms, the ways in which they learn from their networks may differ according to the type and nature of an inter-organizational relationship (cf. Boschma, 2015; Huggins et al., 2012). Indeed, the extant literature highlights the importance of interaction between firms, through networks and GVCs, for 'learning from knowledge spillovers' (Miremadi et al., 2019; Tajoli and Felice, 2018; Gunther, 2005; Audretsch et al., 2004). Trading relationships promote knowledge spillovers through 'learning by interacting' with upstream suppliers, downstream customers, users, and other complementary firms and organizations either in or related to a given industry (von Tunzelmann and Wang, 2007). In addition, formal interactions with suppliers of technology and skills (e.g. universities, or specialized consulting or intermediary firms for international technology transfer), as well as advances in science and technology (S&T) achieved by the work of actors such as research institutes and laboratories, may also promote the learning of firms (Ranga and Etzkowitz, 2013).

Given the fact that resilience necessitates a path-dependent industrial development trajectory in the context of network evolution, both the adaptation and adaptability of development paths via past networking and learning activities are crucial (Gluckler, 2007; Pike et al., 2010; Boschma, 2015; Hu and Hassink, 2020). Adaptation refers to '*a movement towards a pre-conceived path in the short run*, characterized by strong and tight couplings between social agents in place.' On the other hand, adaptability is defined '*as the dynamic capacity to effect and unfold multiple evolutionary trajectories*, through loose and weak couplings between social agents in place that enhance the overall responsiveness of the system to unforeseen changes' (Pike et al., 2010: 4, italicization by authors for emphasis).

Similarly, Hu and Hassink (2020) view adaptation as '*path-extension*' (by maintaining the existing functions of a system/industry) and adaptability as '*path-evolving*' (by transforming into new development paths). To date, these two concepts have been viewed as a trade-off. Yet, scholars increasingly stress the importance of viewing them as interrelated; therefore, both are deemed important in promoting resilience (Boschma, 2015; Hu and Hassink, 2020). To operationalize adaptation and adaptability, based on Fleming et al. (2007), Boschma (2015) contends that at the regional level, resilience can be achieved with network structures that host co-existing embedded/dense relations, which harbor 'control' and promote the 'efficiency' of collective behavior (adaptation) and loose relations, in turn stimulating 'openness' and 'access to external knowledge through short pathways' (adaptability). Knowledge interactions within these local/international or dense/loose relations can also be mixed in order to develop resilience through 'efficiency' and 'local clustering' (adaptation) along with 'novelty' (adaptability) (Boschma and Frenken, 2010). In fact, network structures can lead to resilience through adaptation or adaptability when inter-organizational learning is regarded as an outcome of networking.

Yet, at the firm level, inter-organizational learning is not necessarily an automatic outcome of the interaction between partners. Such learning depends largely on the way that the dyadic tie in networks is built to exert **control**, along with improving the **efficiency** of a network experience as well as the choice of partners and the nature of their relationship, in order to ensure a level of **openness** in the given network.

The component of **control** in such networks is related to whether a firm or a partner proactively initiates a relationship and whether the interactions are arranged between individuals or groups of people throughout the relationship, either formally or informally (Gulati, 1998; Hakansson and Snehota, 1995; Gulati and Gargiulo, 1999). The component of **efficiency** is related to how long such a relationship continues with the same partner. Finally, the level of **openness** of such networks are related to the entities with whom a firm partners (foreign or domestic organizations) and shift based on whether knowledge flows unilaterally (from one partner to the other) or mutually. Certain characteristics of a network, such as the initiation, continuity, formality, the geographical origin of the partner, and the direction of knowledge transfer, inform the structure of a network, its level of control, efficiency, and openness.

To elaborate, first, initiating a relationship shows a partner's willingness to share its knowledge and allows knowledge spillovers. However, if a firm is inclined towards preventing unintended knowledge transfer through a high degree of control in a relationship (utilizing strict coordination), its partner may be confined to being a passive learner, only learning from what is shared rather than from what it can explore (i.e., adaptation) (Hamel et al., 1989; Inkpen, 1998; Tatikonda and Stock, 2003; Schmitz, 2006). On the other hand, when a firm initiates a relationship, it is considered to be motivated by an active learning intention or to have strategic goals related to accessing the complementary capabilities of the right partner that will add value to its own operations (i.e., adaptability) (Lane and Lubatkin, 1998; Gluckler, 2007).

Second, formality relates to the level of control within networks. Formal networks are determined, coordinated, and arranged contractually in order to facilitate personnel exchange, teamwork, secondment, teams and task forces, meetings and organized personal contact, arranged visits among partners, organized training, technical consultancies, and standard machinery transfer for activities, with immediate effect on the given networking relationship (i.e., adaptation) (Ernst and Kim, 2002; Pak and Snell, 2003; Huggins et al., 2012). In contrast, informal relationships between individuals and within groups of people with common professional interests and specializations may happen spontaneously, as and when needed. Those relationships enhance the flow of tacit knowledge and create positive externalities for product development, provide technical advice for problem-solving in production processes, and facilitate knowledge spillovers with long-term effects on capability development (i.e., adaptability) (Pak and Snell, 2003; Dahl and Pedersen, 2004; Janowicz-Panjaitan and Noorderhaven, 2008).

Third, the stability of relationships enables the exchange of richer and more complex knowledge (Hakansson and Johanson, 1988; von

Hippel, 1988; Simonin, 1997; Tatikonda and Stock, 2003). Such '*continuous relationships*' develop trust and enhance knowledge transfer between partners by reducing uncertainty. At the same time, they may limit a firm to the knowledge and expertise of only the trusted partners, eventually hampering its search for knowledge (i.e., adaptation) (Gulati, 1995). However, learning opportunities do not decrease as the continuity of a relationship reduces (Hakansson et al., 1999), even though occasional and one-off relationships might signify weak ties and opportunistic responses for short-term gains (Granovetter, 1973). Therefore, in the long term, these relationships can boost a firm's capability to absorb knowledge, allow access to a diverse range of knowledge and expertise, and gradually develop a variety of its capabilities, as they promote learning and adjustment to challenging shocks and ensure efficiency in the newly developed networks (i.e., adaptability).

Further, types of partners are also important for adaptation. For example, a foreign partner may enhance learning opportunities by allowing access to wider sources of knowledge that are more up-to-date and state-of-the-art (Cassiman and Veugelers, 2002; Hagedoorn and Duysters, 2002; Gentile-Lüdecke and Giroud, 2009; Eapen, 2012; Lee et al., 2016). For instance, GVCs are considered to contribute widely to a firm's knowledge base in this sense (Ernst and Kim, 2002; Schmitz, 2004; Pietrobelli and Saliola, 2008). Conversely, domestic partners may represent access to more homogenous sources of knowledge (Grabher, 1993; Asheim and Isaksen, 2002; Boschma, 2015; Lee et al., 2020).

Finally, adaptability may be influenced by the direction of knowledge transfer within a network and the cognitive proximity of the partners involved (Freeman and Hagedoorn, 1994; Johnston, 2022). In this respect, bi-directional knowledge transfer may signal close cognitive proximity whereby mutual learning is warranted through similarities and complementarities in the knowledge bases of partners (i.e., adaptation) (Mytelka, 2001). On the other hand, uni-directional knowledge transfer paradoxically means less learning as one partner holds more knowledge than the other (Mowery et al., 1996); yet, in the long term, the partner at the receiving end benefits more from such a transaction by gaining new capabilities, e.g. through technology purchase, licensing, subcontracting, reverse engineering etc. (i.e., adaptability) (Hagedoorn and Sedaitis, 1998; Belderbos and Grimpe, 2020). Table 1 provides a summary of how adaptation and adaptability are operationalized in examining network characteristics to influence inter-organizational learning and, thereby, achieve resilience.

In sum, we argue that resilient firms and sectors are those that learn from their networks and can build path-evolving development trajectories. In this light, we conduct a dynamic analysis, using historical data to understand how inter-organizational learning in networks create a path dependence through adaptation and adaptability and how this process shapes network evolution that might influence sectoral resilience over time.

Table 1
Link between network structure, characteristics, and adaptation and adaptability for resilience and inter-organizational learning.

Network structure	Network characteristic	Network characteristic leading to learning and resilience through		Learning
		Adaptation	Adaptability	
Control	Initiator of the network	The partner	The Polish firm	- From Knowledge spillovers - From Advances in S&T and education - By Interacting
	Level of formality in the network	Formal	Informal	
Efficiency	Continuity of the network	Continuous	Occasional and One-off	
Openness	Geographical origin of the partner	Domestic	Foreign	
	Direction of knowledge flow	Bi-directional	Uni-directional	

3. Research design and methods

3.1. Sample and data

Our analysis used unique primary data on Poland's food-processing and clothing sectors for period 1989 to 2018. Given the longitudinal nature of our analysis, our research design utilized two types of data: (i) primary historical data that covered Poland's economic transition period (when it shifted from a command economy to a capitalist economy) between 1989 and 2001, and (ii) secondary data on Poland's post-transition period, between 2004 and 2018, starting from its accession to the European Union (EU) and the consequent developments. Table 2 provides a snapshot of these data by time scales, data types, indicators, data sources, and aspects of resilience.

In both the food-processing and clothing industries of Poland, large domestic brand manufacturers with >500 employees were studied.

Notably, at the time of interviews in 2001, 78 food-processing and 46 clothing Polish-owned firms were registered with the Polish Embassy in London.[1] The primary data sample in this paper included eight firms from each sector, representing 10 % and 17 % of the total populations of Poland's large food-processing and clothing firms, respectively. These firms were confined to specific market niches before Poland's transition and they stayed in these markets throughout its transition years. Some of the food-processing firms operated as subcontractors to foreign retailers at home, while others exported their products to world markets. The clothing firms typically functioned as subcontractors to lead firms in GVCs. Reportedly, none of them exported their products at that time.

The data for this study were collected through face-to-face semi-structured interviews during visits to Poland in May and November 2001. The interview questions focused on detailing each dyadic tie and the concomitant learning that occurred through cooperation. The interviews identified ties with stakeholders such as: i) technology and raw material suppliers, ii) customers/buyers/end-user firms, iii) downstream distributors/users/other actors, iv) competitor and complementary firms in the same industry, v) universities and public or private research institutes/laboratories, vi) consultants, consulting firms, export/intermediary agencies, design agencies, human resource or advertising agencies, and vii) the Polish Chamber of Commerce, other industrial organizations/associations, and governmental institutions.

31 interviews with core firms and 19 interviews with 10 public and private organizations were conducted; the latter helped triangulate multiple sources of the same evidence and ensured data reliability. These interviews took place with managers/key informants who had knowledge of their firms' current and past relationships. Each interview lasted for at least 4 h, excluding the time taken to visit the production site and for conversations with operations managers; the latter served as multiple informants who enabled double-checking and minimization of the possibility of common method bias, while increasing the reliability of our results.

Based on the content analysis of these interviews and subsequent coding through analytical iterations (Larsson et al., 1998), a dataset of 467 dyads comprising 16 large Polish firms during Poland's transition period (1989–2001) was constructed (Table 3).

3.2. Model specification and measures

Given that capturing the complex and dynamic nature of inter-organizational learning is not an easy task and that resilience as a concept also requires the longitudinal analysis of trajectories (Bristow

[1] www.polishemb-trade.co.uk/Home_en/Main_en.htm (accessed October–November 2000). There was no available online resource containing the complete register of all firms in the two studied industries in Poland at the time.

Table 2
Characteristics of the analyses by time scales, data types, indicators, data sources, and aspects of resilience.

Time scale	Data type for analysis	Indicator	Categorical attributes of indicator	Source of data	Resilience aspect
Transition period (1989–2001)	Primary data	Network type	Knowledge networks Production and distribution networks Arm's length relations	Interviews with firms in food-processing and clothing sectors in Poland	Networks-and learning-based resilience through adaptation and adaptability
		Initiator of the network	The firm The partner		
		Formality of the network	Informal Formal		
		Continuity of the network	Continuous Occasional/Regular Once		
		Geographical origin of partner	Foreign Domestic		
		Direction of the knowledge flow	Uni-directional Bi-directional		
		Inter-organizational learning mechanisms	Learning from knowledge spillovers Learning from advances in S&T and education Learning by interacting No learning		
Post-transition period (2004–2018)	Secondary data	Innovative enterprises engaging in all types of networks		CIS	Network evolution and sectoral resilience
		Networks by partner in innovative enterprises		CIS	
		Production growth		EUROSTAT	
		Employment growth		ILO	
		Share of value added in manufacturing		EUROSTAT	
		Export growth		EUROSTAT	

Table 3
Basic characteristics of the dataset.

	Number of firms	Total number of dyads	% in total dyads	Average number of dyads per firm	Number of dyads (min/max)
Food-processing	8	195	41.8	24.4	10/44
Clothing	8	272	58.2	34.0	22/47
Total	16	467	100	29.2	10/47

and Healy, 2020), this research used a mixed methods approach (Creswell and Clark, 2007; Greene, 2007; Teddlie and Tashakkori, 2009). Specifically, we followed Larsson et al. (1998), who advocated in favor of conducting longitudinal and in-depth case studies and, subsequently, transferring qualitative data into quantitative variables through rigorous coding for statistical analysis to deliver generalizable results (see, for example, Ariffin, 2010; Yoruk, 2011; Peerally and Cantwell, 2012). Methodologically, this paper used a 'concurrent nested' design method (Creswell, 2003), where multinomial logistic regression (MLR) (Hosmer and Lemeshow, 2000; Borooah, 2002) was the primary method of quantitative analysis while sample formation and data collection were conducted via qualitative research methods.

Indeed, MLR allowed the use of categorical data for the predicted probabilities in estimate (risk ratio) interpretation, defined as the probability of one outcome to the probability of a reference outcome (Borooah, 2002). MLR was particularly suitable for our dependent variable, which was a choice indicator with unordered categories (Agresti, 1990). Furthermore, in model building and robustness checks, the strategies and tests suggested by Hosmer and Lemeshow (2000) were strictly followed.

We specified our final model as follows:

$$\begin{aligned}\mathrm{Log}\,[Pr\,(\mathrm{EXTLEARN} = &\text{Learning from knowledge spillovers}\\ &/\text{Learning from advances in S\&T and education}\\ &/\text{Learning by interacting})\\ &/Pr\,(\mathrm{EXTLEARN} = \text{No learning})\,]\\ &= \alpha_{j0} + \beta_{jk}\,(\text{Knowledge network}, \text{Foreign partner}, \text{Firm initiator}, \text{Continuous dyad}, \text{Occasional dyad}, \text{Informal dyad},)\,/\theta_{jI}\,\mathrm{INDUSTRY}\,/\varepsilon_{ij}\end{aligned}$$

MLR estimations from the above equation resulted in three (log) risk-ratio equations (the results gathered by these models are presented in Table 4). The variables were constructed as follows:

Dependent variable. *External Learning Mechanisms (EXTLEARN)* represented the learning mechanisms employed in a specific inter-organizational relationship by a given Polish firm. Here, we

Table 4
Multinomial logit estimation of learning mechanisms (full specification).

	Model 1a		Model 1b		Model 1c	
Dependent variables	Learning from knowledge spillovers		Learning from advances in S&T and education		Learning by interacting	
Explanatory variables	Coeff.	RRR	Coeff.	RRR	Coeff.	RRR
Network type						
Knowledge network vs. Arm's length relations	1.01**	2.99	2.12***	8.34	−0.55	0.58
Production & distribution network vs. Arm's length relations	0.66	1.07	−1.71**	0.18	2.07***	7.90
Initiator in network						
Firm as the initiator vs. Partner as the initiator	−0.67**	0.51	1.43***	4.19	−0.17	0.84
Continuity in network						
Continuous relations vs. One-off relations	1.08***	2.93	−1.38***	0.25	0.72*	2.05
Occasional relations vs. One-off relations	0.58	1.79	−0.27	0.76	0.32	1.37
Formality in network						
Informal relations vs. Formal relations	2.10***	8.19	0.53	1.69	0.62	1.85
Geographical origin of the partner						
Foreign vs. Domestic	0.88**	2.42	0.27	1.31	0.99***	2.68
Direction of the knowledge flow						
Uni-directional vs. Bi-directional	−0.37	0.69	1.72***	5.58	0.49	1.63
Industry						
Food-processing vs. Clothing	0.17	1.18	0.71*	2.04	0.54	1.72
Constant	−0.93	0.39	−3.13***	0.04	−2.18***	0.11
No. of observations	467					
Log Likelihood	−249.65					
LR Chi-Square	401.43					
Degrees of freedom	27					
Prob. > Chi-Square	0.000					
Pseudo R2 (McFadden)	0.317					

Reference category for dependent variable 'No learning.' Restricted specification by backward elimination method. Omitted variables: PERIOD in full specification model. RRR = Relative risk ratio.
*** $p < .01$.
** $p < .05$.
* $p < .10$.

adopted Malerba's (1992) taxonomy for learning from external sources and constructed a categorical variable comprising the following: 1) learning from knowledge spillovers, 2) learning from advances in S&T and education, 3) learning by interacting, and 4) no learning. This variable was constructed by capturing the routes through which knowledge was transferred during each dyadic interaction. Moreover, information was sought from the interviewees as to whether any learning had indeed occurred during the above relationship and, if so, whether they had gained any new knowledge in the relationship in addition to their prior knowledge. If an interviewee was able to illustrate the new knowledge gained with specific examples, we classified the ways this knowledge was gained into our categories of learning. Appendix A presents selected observations drawn from our interviews for each learning mode that was employed during dyadic interactions.

Independent variables. Independent variables captured the firms' adaptation and adaptability, as per Table 1. *Network type (NETWORK)* represented the domain the dyadic tie was embedded in. The extant literature identified three main types of networks where dyadic ties existed: 1) production and distribution networks (i.e., GVCs), 2) knowledge networks, and 3) arm's length relations. Capturing the variations in the degree of embeddedness of relationships (arm's length versus knowledge networks and GVCs) enhanced our understanding of the role of trust, resource sharing, joint problem-solving, and knowledge transfer in networks (Gulati, 1999; Brass et al., 2004); (the illustrations of networks observed within these networks are presented in Appendix B). *Initiator of the network (INITIATOR)* established whether the given firm itself or its partner had initiated the relationship. *Formality of the network (FORMALITY)* determined whether the particular contact was based on arrangement and/or agreement by the top-level managers (i.e., formal and manager-approved) or based on contacts among individuals, particularly in the form of individual interaction, to build and maintain a personal relationship with other individuals such as scientists, engineers, or middle-level managers in the partner organization (i.e., informal and employee-driven). *Continuity of network (CONTINUITY)* was defined as the frequency of a firm's relationship with the same partner. It captured whether the relationship involved either of the following: 1) continuous cooperation (i.e., uninterrupted cooperation since the start of the relationship); 2) occasional cooperation (i.e., relationships occurring at irregular or infrequent intervals, when needed by the firm or the partner, on an annual basis, e.g. those with public research institutes, for tests/accreditation or technical fairs, conferences, symposiums); or 3) a one-off cooperation (i.e., relationships terminated after one instance of cooperation, e.g. technology acquisition packages). *Geographical origin of the partner (GEORIGIN)* differentiated whether a firm's partner was of foreign or domestic origin. Domestic partners were classified as Polish-owned organizations, whereas foreign partners referred to organizations located in other countries (independent foreign/global suppliers and buyers/customers, or those involved in the GVCs), universities, research institutes, as well as those created through inward foreign direct investment (FDI). In fact, FDI played an important role in transitioning the two studied sectors into market economies and was one of the major instruments used to create a learning effect on indigenous firms (through spillovers). It took the following forms: 1) strategic investors in indigenous firms or 2) multinational enterprises operating in Poland with their own GVCs. Finally, *Direction of knowledge flow (DIRECTION)* identified whether knowledge and resources flowed uni-directionally or bi-directionally between partners.

Further, descriptive statistics were presented as chi-square tests of independence, due to the nature of the categorical variables (Appendix C). After the models were run, we eliminated the possibility of high multicollinearity by controlling for standard errors of the variables that were greater than '2' (Tabachnick and Fidell, 2007; Petrucci, 2009). In their networks, food-processing firms learned from advances in S&T and

Table 5
Interpretation of network and learning analysis results in the light of adaptation and adaptability for resilience[a].

Network structure	Network characteristics	Learning from knowledge spillovers	Learning from advances in S&T and education	Learning by interacting
	NETYPE	Knowledge networks**	Knowledge networks***	Production networks***
			AL (vs. prodn. nets)**	
Control	INITIATOR	The partner*	The firm***	
		Adaptation	Adaptability	
	FORMALITY	Informal***		
		Adaptability		
Efficiency	CONTINUITY	Continuous***	One-off (vs. cont.)***	Continuous*
		Adaptation	Adaptability	Adaptation
Openness	GEORIGIN	Foreign partner**		Foreign partner**
		Adaptability		Adaptability
	DIRECTION		Uni-directional***	
			Adaptability	
	INDUSTRY		Food-processing*	

[a] Based on the operationalization of network characteristics in relation to the adaptation and adaptability aspects of resilience in Table 1.
*** $p < .01$.
** $p < .05$.
* $p < .10$.

education (34.4 %), from knowledge spillovers (28.2 %), and by interacting (23.6 %). The majority of learning in clothing firms' networks, on the other hand, occurred via interacting in 40.8 % of the dyads and via knowledge spillovers in 25.7 % of them (Appendix C).

4. Findings

4.1. Networks and inter-organizational learning during Poland's transition years

This section presents our findings based on the analysis of primary data regarding how network characteristics influenced inter-organizational learning in Poland's food-processing and clothing sectors during the transition years (1989–2001). Table 4 reports our estimations from a multinomial logistic regression of the full specification model (all indicators are available in the model).[2] In the MLR model identified above, α_{j0} are the coefficients for 'no learning'; hence, the log risk ratio is α_{j0} for ties that are formal, one-off arm's length relations with a domestic partner where the relationship was initiated by the partner. In all three models in Table 4, under these conditions, the probability of no learning compared to the probability of learning from spillovers, from advances in S&T, or by interacting is found to be higher ($\alpha_{j0} < 0$). Thus, in the following sections, we elaborate on the conditions that underlie the probability of outcomes for different learning mechanisms compared to the probability of a 'no learning' outcome.

4.1.1. Learning from knowledge spillovers

The estimation results from Model 1a identify five characteristics as being crucial to improving a network's risk ratio of resulting in learning from knowledge spillovers: involvement in knowledge networks, involvement in continuous relations, involvement in informal relations, the partner initiating the relationship, and the partner being foreign.

The firms' likelihood to learn from spillovers in a knowledge network was almost three times higher (RRR = 2.99) than those in an arm's length relationship, being twice as high with foreign partners compared to domestic ones (RRR = 2.42), 50 % higher when the relationship was initiated by the partner rather than the firm (RRR = 0.51), almost three times higher in continuous relations (RRR = 2.93), and eight times higher in informal relationships compared to those in formal relationships (RRR = 8.19). Importantly, no significant difference between the food-processing and clothing sectors was observed in this regard.

To summarize, foreign partners were the main source of learning from knowledge spillovers through the informal and continuous relations that they initiated. For food-processing firms, inward FDI into the Polish market[3] fostered technological and organizational change through (un)intended spillovers (Ernst, 1998; Szymanski et al., 2007). Linkages with foreign input suppliers and retailers present in the Polish market facilitated access to the newest food products and the associated processing technologies, leading to new product development. Evidently, the development of local/regional/national value chains of some large Polish clothing firms, in tandem with their involvement in GVCs since the early 2000s, was also a spillover effect from the GVCs (Yoruk, 2002). Knowledge spillovers in GVCs manifested in the improved capabilities of the involved Polish firms, e.g. in reorganizing their production lines to optimize efficiency, and in their ability to self-upgrade technologically and organizationally (Yoruk, 2019).[4] In fact, clothing multinational corporations (MNCs) entering the Polish market set up distribution channels in cooperation with large Polish firms whose local knowledge was exchanged with foreign knowledge spillovers on marketing, distribution, and brand management strategies (Yoruk, 2002).

4.1.2. Learning from advances in S&T and education

The results from Model 1b identified five characteristics as important for improving a network's risk ratio with regard to generating learning from advances in S&T and education: involvement in knowledge networks rather than arm's length relations, involvement in arm's length relations compared to GVCs, involvement in one-off relationships, the instance of the firm initiating the requisite relationship, and operating in the food-processing sector.

The firms' learning from advances in S&T and education was eight times more likely to occur in knowledge networks when compared to that occurring in an arm's length relationship (RRR = 8.34) and 20 %

[2] The full and restricted specifications gave the same results.

[3] These were given through upstream/downstream partners of Polish food firms within the value chain, or through a strategic investor in the Polish food firms, or through MNC food manufacturers.

[4] For instance, participation in GVCs by lead firms enabled Polish clothing firms to access knowledge directly through training, on-the-job, by the foreign technicians sent by these lead firms to work with personnel responsible for CAD and to supervise the production process and ensure the quality of the end-product (Pickles and Smith, 2011; Yoruk, 2004). While these technicians were present throughout a formally set relationship between a Polish clothing firm and a lead firm, long-term stays of these technicians allowed informal knowledge exchange at every level of the former. For instance, the technicians taught Polish employees how to complete a particular task or how to use a particular machine they had brought for a specific sewing type; they provided advice with machinery purchase and helped with problem-solving in matters unrelated to their company's products.

more likely to occur in arm's length relations than in GVCs (RRR = 0.18). The likelihood of one-off relationships resulting in learning from advances in S&T was higher by 25 % compared to continuous relations resulting the same (RRR = 0.25); also, a one-off relationship was four times more likely to yield learning from S&T when the firm had initiated the relationship (RRR = 4.19). Food-processing firms were twice more likely to exploit learning from advances in S&T and education compared to clothing firms.

In sum, food-processing firms displayed a greater technological orientation than clothing firms. These firms proactively sought cutting-edge knowledge and advanced technologies, initially to rapidly modernize production processes, and later to develop new products for internal and prospective export markets. So, they varied their sources of scientific and technological knowledge through one-off relations (such as turnkey technology acquisition packages, traditional links with specialized food-processing faculties in national universities, joint projects with foreign and domestic public research institutes,[5] and foreign consultants[6]).

4.1.3. Learning by interacting

The estimation results from Model 1c identified three characteristics as crucial for improving a dyad's risk ratio of leading to learning by interacting: involvement in GVCs, working with a foreign partner, and cooperating continuously with the partner. Indeed, firms were eight times more likely to learn by interacting in GVCs compared to learning via arm's length relations (RRR = 7.90), almost three times more likely to learn from their foreign partners (RRR = 2.68), and twice more likely to learn in continuous relations (RRR = 2.05).

During Poland's economic transition period, firms in both sectors were involved in GVCs led by foreign firms. As GVCs were established with a long-term view, they built trust and certainty that facilitated the transfer of up-to-date knowledge among partners, provided periodical training to improve the quality of end-products, and helped in capability development to acquire, share, and transfer knowledge.[7]

4.2. Networks, inter-organizational learning, and resilience from the perspective of adaptation and adaptability

We postulate that the differences in the resilience developed by food-processing and clothing industries after Poland's economic transition might be linked to the experiences they gained, the content and the structure of the networks each of them were involved in during transition years, and the way they learned through the networks and experiences. The results of our multinomial logistic regressions highlight how network structures and characteristics developed through adaptation and adaptability affected learning and played a key role in developing the foundations of resilience during Poland's transition years (Table 1). Table 5 provides a synthesis of these findings.

Learning from knowledge spillovers was associated with knowledge networks while learning by interacting was strongly associated with GVCs. These results were similar for both Poland's food-processing and clothing sectors and yet presented a mix of adaptation and adaptability. GVCs offered openness through foreign links but their continuity led to a 'lock-in' effect that reduced the firms' enthusiasm to search for new knowledge (making them settle for short-term solutions to challenges). In addition to ensuring openness through foreign links, knowledge networks fostered spillovers through informal links that warranted inter-personal relations due to weaker control over a given relationship. While knowledge spilled over through continuous links due to trust, it also confined a firm to the knowledge possessed by the same partner for a long time. Moreover, the partner initiating the relationship determined the extent to which it shared its knowledge.

Possibly due to its more technology-oriented nature, Poland's food-processing sector was distinguished from its clothing sector, with its sole focus on learning from advances in S&T and education, whose associated network characteristics all represented adaptability. This learning mechanism was strongly associated with knowledge networks and arm's length relations. The food-processing firms actively initiated the relationships leading to this learning mechanism, indicating their strategic intent to learn. Moreover, knowledge was transferred from the partner to the Polish firm, since the parties did not share cognitive proximity (through one-off relations) that warranted access to a diverse range of knowledge. Therefore, this learning mechanism, if adopted in networks, could enable the access to up-to-date, state-of-the-art knowledge and secure long-term adaptability when successfully integrated into a firm's capabilities.

In sum, our analysis revealed that historical learning practices from knowledge spillovers and by interacting were driven by co-existing adaptation- and adaptability-related network characteristics that guided both the studied sectors towards short-term adaptive capacity for path sustainability. However, for 'adaptation to enable adaptability' (cf. Hu and Hassink, 2020) to ensure a strong long-term resilience, learning from advances in S&T (associated exclusively with adaptability-related network characteristics) would be required. Most importantly, learning from advances in S&T was found to be an outcome of knowledge networks and arm's length relations. In that sense, Poland's food-processing sector was singled out for being able to establish these kinds of relationships during the nation's transition years.

The next section concerns the following: whether the findings from our historical data analysis predicted the state of network evolution in the years following Poland's transition for the two studied sectors, and whether these were reflected in the sectoral economic performance indicators in relation to sectoral resilience.

4.3. Shifting network structures after transition

To complement the regression analysis presented in Section 4.1, this section examines sector-level statistical data to assess the resilience of Poland's food and clothing sectors after its economic transition years.

The economic transition appeared to be a decisive turning point for Polish firms, with the emergence of a variety of networks and a jump in the number of relationships for all network types in the late 1990's. Evidently, networking was at its highest level by the end of the economic transition and just before Poland's accession to the EU in 2004. Fig. 1 shows that by 2004, as high as 40 % and 30 % of innovative enterprises were engaging in networking in Poland's food-processing and clothing sectors, respectively, suggesting that these firms had ventured into and were exploiting many types of cooperation. However, maintaining these relationships was a challenge, as from 2006 onwards the rate of collaboration in the food-processing and clothing firms started to decline (with a more prominent decline in the clothing sector). By 2018, about

[5] For instance, a Polish juice producer firm in our sample collaborated with a domestic research institute to develop a new process of producing a non-allergenic ingredient and to understand the impact of vitamin use in its juices on pregnant women.

[6] For example, an independent foreign consultant, with whom the Polish meat-processing firm in our sample was put in touch by their foreign strategic investor, provided constant advice and support through frequent physical visits to the breeding sites and via email. Moreover, the consultant-initiated collaborations with foreign research and advice centres, which was new to the Polish firm, and also enabled the firm to revive the upstream-sector animal husbandry regionally, by supporting Polish farmers with the knowledge acquired from these foreign partners while securing its domestic supply chains.

[7] For example, the Polish shirt producer in our sample was granted its licence by a lead firm, to use a particular production technique that guaranteed the production of high-quality shirts at the same standards as those of the lead firm. On this basis, the Polish firm won the Gold Medal of the Poznan International Fair in Autumn 2000 (Poznan Fair Magazine, 2001). This lead firm also got involved in the purchase of machinery and the training of engineers, technicians, additionally providing advice on production, management, and financing to the Polish firm.

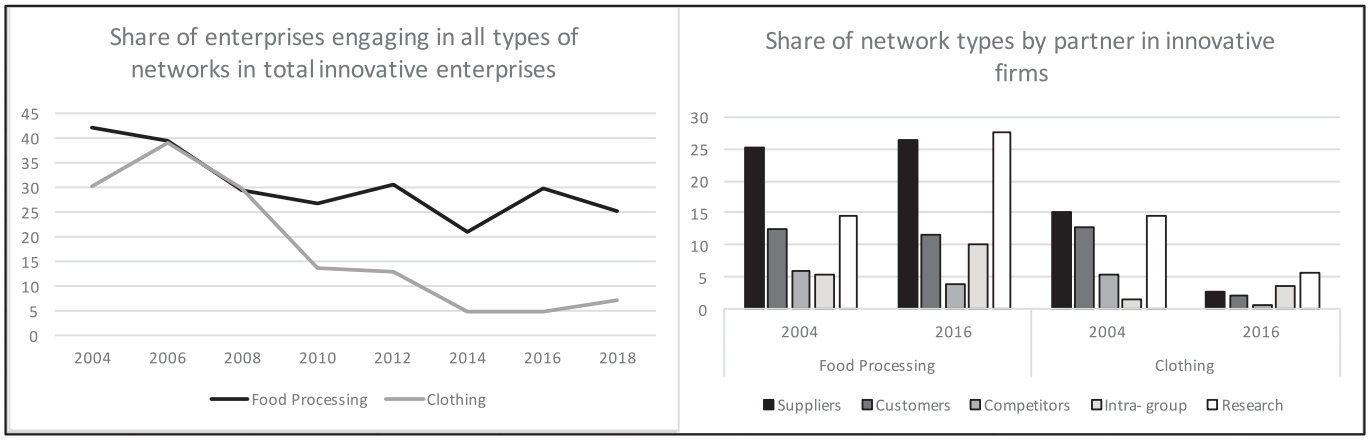

Fig. 1. Enterprises engaging in all types of networks; network type by partner among innovative enterprises in Poland's food-processing and clothing sectors.
Source: Community Innovation Survey.

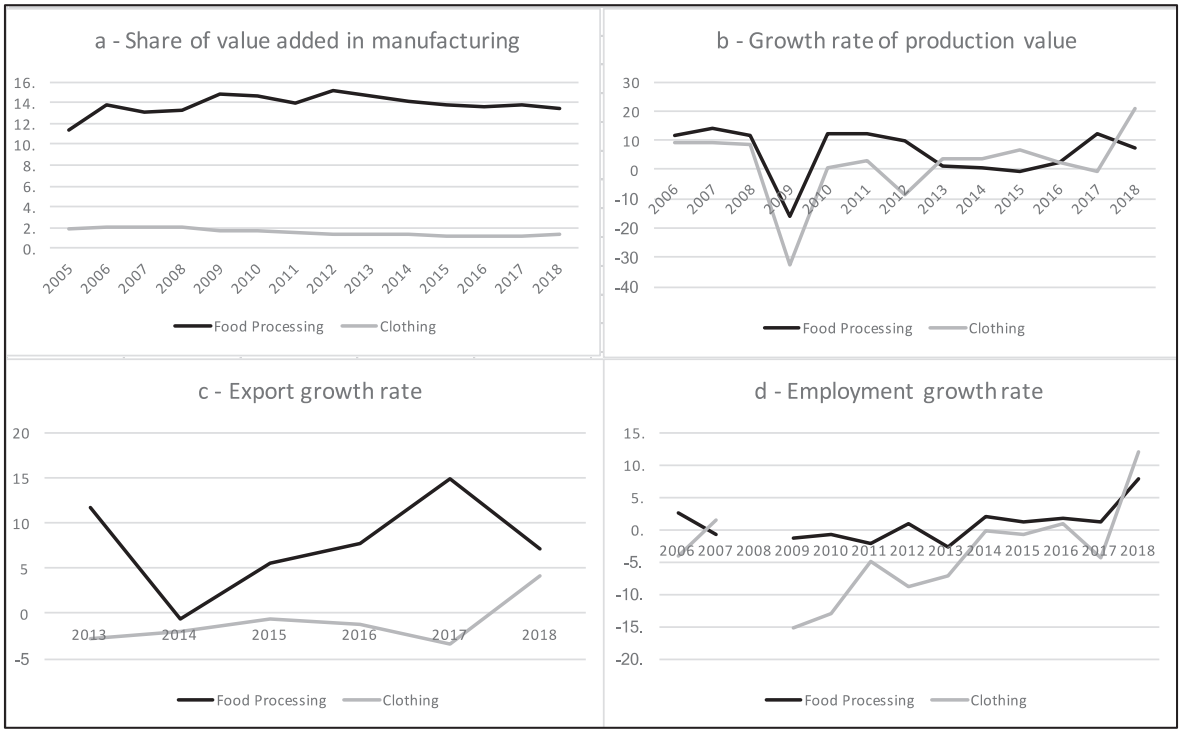

Fig. 2. Selected post-transition indicators for Polish food-processing and clothing sectors (%).
Source: EUROSTAT and ILO.

25 % of innovative food-processing firms were engaging in any type of network, while this rate was only 7 % in Poland's clothing sector. Although the density of links was found to be decreasing in both sectors, the food processing sector retained more than half of its links over time.

The trend in after-transition statistics for networking activities in both the studied sectors confirmed the findings of our historical data analysis. In the food processing sector, the characteristics of knowledge networks and arm's length relations established during the transition period were conducive to adaptability and promoted learning modes that allowed the internalization of knowledge acquired from external sources. The food-processing firms also maintained most of these relationships after transition even as they made new links with research partners. Importantly, these links were made in addition to the GVCs that the food sector firms were already involved with. The clothing sector, on the other hand, relied only on GVCs during Poland's economic transition. Crucially, this interaction and the associated learning was not conducive to the successful internalization of knowledge acquired from GVCs (due to the nature of governance in GVCs; Gereffi et al., 2005). Moreover, after the transition, the clothing sector firms lost most of their GVC relationships (which moved to lower-cost countries overseas) as well as other types of networks.

After Poland's transition, discrepancies between the two studied sectors were visible in other sector-level statistics pertaining to performance; Fig. 2 elaborates on a few selected economic indicators which are considered important for assessing resilience in the conventional view. First, the share of the food sector in manufacturing value-added closely followed the overall performance of the Polish economy between 1994 and 1999–2000, even mirroring the recessions that occurred in this period. This indicated the susceptibility of this sector to economic instability within the country, particularly due to its strong reliance on

domestic demand. However, during the 2008 global recession, this sector's production growth quickly bounced back and its employment growth rate was maintained (Fig. 2b and d), partly due to lower reliance on export markets. While Polish food exports increased in the years following the nation's transition (due to relatively lower product prices and production costs),[8] the food sector was never as export-oriented as the clothing sector. In particular, from 2014 onwards, this sector displayed consistently high export growth rates while the highly export-oriented clothing sector's export rate was found to be declining (Fig. 2c).

5. Discussion

Motivated by the desire to understand how learning through GVCs and networks may contribute to the building of sectoral resilience, this paper explores how changes in network structure and characteristics over time develop resilience in Poland's food-processing and clothing sectors. In particular, our analysis identifies the concomitant role of inter-organizational learning mechanisms, in relation to their capacity to create path dependence through adaptation and adaptability in a historical context (i.e., during Poland's economic transition years, that were particularly beset with uncertainties about what the future would hold for Polish businesses).

We report three major findings. First, the path-dependence of network evolution, the network structure/characteristics, and the successful inter-organizational learning in these networks play important roles in defining resilience. Second, sectoral resilience is positively influenced by inter-organizational learning mechanisms associated with networks that are adaptable in nature. Third, Poland's food-processing and clothing sectors, despite being exposed to similar transitional shocks and being considered as LMT process-intensive sectors, widely differ in terms of developing resilience. Therefore, our findings explain how network evolution and inter-organizational learning in these networks create path dependence and affect long-term resilience in Poland's food-processing sector but not in its clothing sector in the periods under study.

During Poland's transition period, food-processing firms coped with unprecedented changes by maintaining their domestic knowledge and production links and relying on them as sources of knowledge in learning new skills. This approach manifested in their future networking activities that were deliberately targeted at accessing new resources and knowledge, learning about advances in S&T, and developing new capabilities, which eventually led to the development of stronger resilience in Poland's food-processing sector (rather than its clothing sector).

Our primary historical data analysis regarding the impact of network characteristics on inter-organizational learning identified an interplay between adaptation and adaptability, confirming their importance in facilitating evolutionary changes (Boschma, 2015). At the same time, the results also suggest that this is not sufficient to assure long-term sectoral resilience. This analysis distinguished Poland's food-processing sector from its clothing sector, in light of the former's strategic focus on learning from advances in S&T and education, whose associated network characteristics represented adaptability. Regarding GVCs' effect on Poland's clothing sector, we observed that adaptation undermined adaptability, possibly hindering long-term resilience.

We explain these differences in sectoral resilience through the path-dependent evolution of the two Polish industries' networks and the inter-organizational learning that was shaped by particular network characteristics (Martin, 2010). We observe 'path as a dynamic process' in Poland's food-processing sector, wherein the extensive use of knowledge networks and the focus on cooperation with research partners enabled learning from new advances in S&T and allowed strong adaptability. Scientific capacity in fields closely related to its food sector (e.g. chemistry, agriculture, and plant and animal science) was either historically strong or has significantly progressed after Poland's economic transition, leading to an increase in comparative advantage in the food sector (Radosevic and Yoruk, 2013). As an extension, the kinds of network characteristics that shaped the networks of food-processing firms during Poland's transition years not only contributed to the structural transformation of its food-processing sector (Gurgul and Lach, 2018) but also enhanced the food-processing firms' learning capabilities to create a path-evolving industrial development that made them sail through any external shock to which they were exposed. Indeed, the knowledge networks and short-term arm's length relations in the Polish food processing sector became sources of dynamic efficiency and allowed bottom-up learning (Boschma and Lambooy, 1999), increasing the sector's ability to overcome crises and follow a sustained growth path. In this sense, the roles of these networks in other countries (Johnston, 2020) as well as the importance of firm heterogeneity (Martin and Sunley, 2015) remain acknowledged. Plus, in terms of involvement in and benefits from GVCs, the path that Poland's food-processing sector took remains consistent with the assertion by Lee et al. (2018) about a local-global interface in networking and acquisition of knowledge. Indeed, during the early years of Poland's economic transition, food companies engaged in GVCs, progressively learned from their foreign links, and then managed to localize and further improve their externally acquired knowledge by increasing their linkages with domestic partners in terms of research relationships.

The historical evolution of networks in Poland's clothing sector sheds some more light on our understanding of resilience. This sector, at first, was lured by the stability and continuity provided by the GVCs, with clothing firms abiding by the GVC governance in return for access to the knowledge and technology of lead firms (both in terms of learning by interacting and via knowledge spillovers). As the GVCs grew into a dominant form of production, contrary to food-processing firms, the clothing firms abandoned their national production system and focused solely on these foreign linkages. During Poland's transition years, the clothing sector's national and local linkages were weakened and even dissolved, engendering a network failure or misalignment (von Tunzelmann, 2004). Nevertheless, the efforts of some large clothing firms to revive these national/local linkages through the GVC governance system served as a 'path-extension' (Hu and Hassink, 2020), merely shifting the clothing sector from experiencing the 'lock-in' effect of GVCs to experiencing the 'lock-in' effect of domestic/regional linkages (Simmie and Martin, 2010). Consequently, the clothing firms became more adaptive with respect to the preconceived path of establishing relationships within the GVCs or in a similar system (Simmie and Martin, 2010), thus becoming less resilient and more vulnerable when the GVCs were dissolved. Hence, the development trajectory of Poland's clothing sector was shaped by the decreasing density of networks, passive learning, and the 'lock-in' of low-value activities, since the internalization or localization of knowledge could not be sustained with research partners anymore (Lee et al., 2018). In other words, Poland's clothing sector never moved beyond GVCs; furthermore, they kept losing both foreign and domestic linkages over time and settled on the 'path as movement to a stable state' (Martin, 2010).

6. Conclusion

This paper examines adaptation and adaptability as markers of the resilience of inter-organizational networks in Poland's clothing and food processing industries. Our study, the first to empirically bridge the concepts of networks and resilience through inter-organizational learning, significantly advances existing research by demonstrating that different learning mechanisms under different settings of network characteristics may result in uneven sectoral resilience. We incorporate inter-organizational learning into our analysis from a historical

[8] Gorzelak (2009) reported that the confectionery industry grew 15 % in 2009 (with one of the confectionery companies, also in our sample, growing in value) and the food exports continued to increase during the 2008 global recession.

perspective, in order to reflect on the dynamics of firms' learning processes and to capture the impact of path dependence on resilience. Our findings on inter-organizational learning in networks, involving two different paths with distinctive outcomes for sectoral resilience, confirm that 'history matters' in explaining sectoral resilience (Martin, 2010; Boschma, 2015). In addition, our study underscores that the path-dependent network trajectory of a sector is an outcome of both the sector's network evolution over time and the learning that is achieved within these networks. This finding extends our understanding by showing that sectoral resilience, which resides in a sector's ability to develop new growth paths, is a by-product of inter-organizational learning that is shaped by network characteristics. Consequently, this study contributes to the evolutionary approach to resilience by providing empirical evidence on how path dependence defines sectoral resilience from a network perspective.

Furthermore, our findings address the discourse on the trade-off between adaptation and adaptability (Boschma, 2015; Pike et al., 2010; Hu and Hassink, 2020). We argue that both adaptation and adaptability-related network characteristics can co-exist in some learning mechanisms (e.g. cases that involve learning from knowledge spillovers and learning by interacting, which apply to both the Polish sectors under study), contribute to short-term adaptive capacity for path sustainability, and potentially set the background for long-term adaptability towards path-generating transformation (Hu and Hassink, 2020). Yet, achieving long-term adaptability to accommodate shocks and develop sectoral resilience (i.e., adaptation enabling adaptability; Hu and Hassink, 2020) requires adopting learning mechanisms that target state-of-the-art knowledge wherever it exists. Such learning is exclusively associated with adaptability-related network characteristics (i.e., learning from advances in S&T and education), and in this regard, Poland's food-processing sector—showing a strong sectoral resilience—serves as an exemplary case.

In light of our observations, we conclude that from the perspective of networks and learning, sectoral resilience is not solely shaped by the historical legacy of a country but is also impacted by the path-dependence created by the firms in its economic sectors, through their network evolution, structure and characteristics, and the way they learn via these inter-organizational interactions. Our findings reveal that network-based path dependence might cause problems of adjustment in one sector while boosting another sector to develop sectoral resilience.

Reinforced by adaptability-related network characteristics, a particular choice of inter-organizational learning helped Poland's food-processing sector improve its networks (through cumulative processes of learning since the nation's economic transition years) and develop new paths after the transition every time it was exposed to external shocks, enabling this sector to sustain a long-term ability for adaptability and resilience. On the contrary, the decline of Poland's clothing sector was not inevitable; however, this sector's adaptive capacity (i.e., emulating GVCs at home) stayed focused on local factors, which diminished its learning ability and hindered its capacity to undergo necessary restructuring processes in response to external shocks/structural changes (Boschma and Lambooy, 1999).

Finally, while our paper contributes important new insights on sectoral resilience, it is not without limitations (that can pave the way for further research). As per our research design, the type of learning indicator is a choice indicator without implications or any kind of ordering. However, different levels of learning may exist under each broad type of learning, e.g. low, medium, or high levels (Fiol and Lyles, 1985; Figueiredo, 2002; Bell and Figueiredo, 2012). In fact, the content and degree of learning are important but qualitative and thus are difficult to quantify (Lyles, 1988; Larsson et al., 1998). Despite these limitations, we encourage further research to develop and utilize these measures. Additionally, such studies should seek to incorporate the institutional environment into their analysis, in order to examine the extent to which the co-evolution of firms and industries may occur. For instance, future studies can examine LMT process-intensive sectors during major economic changes—during COVID-19, Brexit (for the United Kingdom) and back-to-back economic shocks—to compare their responses and resilience in different contexts. Finally, we call for further explorations of resilience as a concept within the context of the co-evolution of learning and capability frameworks.

CRediT authorship contribution statement

Deniz E. Yoruk: Conceptualization, Investigation, Data curation, Methodology, Project administration, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Supervision. **Esin Yoruk:** Conceptualization, Methodology, Formal analysis, Data curation, Writing – review & editing, Visualization. **Paulo N. Figueiredo:** Conceptualization, Methodology, Writing – review & editing, Supervision. **Andrew Johnston:** Conceptualization, Methodology, Writing – review & editing, Supervision.

Data availability

Data will be made available on request.

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Appendix A. External learning modes and exemplifications

Learning modes	Descriptive examples based on observations from this research
Learning by knowledge spillovers	- Strategic investor's supportive activities in managerial, technical, technological and/or scientific matters - Cooperation with sister companies' research/product development units for product or process development
Source of knowledge: From production	- Managerial and technical harmonisation after merger with a horizontally-related firm, - Participation in conferences, seminars, scientific meetings arranged by universities or industrial organizations such as the Chamber of Commerce
(e.g. activities of competitors and other horizontally-related firms such as parent and sister companies)	- Interactions at a personal level in trade shows, fairs and exhibitions where competitors and horizontally-related firms participate - Distribution licensing of a brand of a foreign horizontally related firm - Visits to production plants of the partner or technology supplier companies before the transfer of technology - Training by the global buyers and their technicians situated within the firm - Technical assistance by the representative of foreign partner located in the firm for a certain time to guide the production processes and training provided to recipient firm's employees to improve the firm's production and technical capabilities to the desired advanced level required by the foreign partner

(*continued on next page*)

(*continued*)

Learning modes	Descriptive examples based on observations from this research
Learning by interacting	- Subcontracting of a complementary firm for production purposes or of raw material suppliers (such as farmers in the food industry with whom extensive scientific training is undertaken by the firm to introduce new advanced S&T techniques)
Source of knowledge: From consumption (e.g. upstream suppliers or downstream costumers in technology and market domains)	- Technical training by raw material supplier firm as to how to make use of its product in different ways - Projects with design firms, consulting firms for adapting and improving technical, organizational and managerial processes, for problem-solving - Organizational and managerial training outside the company by consulting firms and universities - Marketing agencies before launching a new product to the market - Market or product-related demands and feedbacks of wholesalers or hypermarkets - Feedback loops between the firm and its supplier and customer - Observing the products, a foreign customer requested to be produced and the associated production processes it taught
Learning from advances in S&T	- Transfer of new-to-firm technologies - Technical training during technology transfer
Source of knowledge: From search 'supply' (e.g. suppliers of technology and skills such as universities, research labs and consultancy)	- Licensing of new-to-firm or state-of-the-art process technology - Contracting research to the university, research institutes or labs for a new ingredient, product, or process development - Participation in advanced training and/or postgraduate programs for technical, technological or scientific improvements by universities - Hiring skilled people, consultancy services for international technology transfer - Participation in research projects run by the university as an 'application' partner - Joint projects with consulting firms for quality management to get specific certifications and/or for IT-related managerial training - Contacts with academics at the universities for problem-solving and trouble-shooting - Presence at the firm of post-graduate students and post-doctoral fellows as part of their degree work or joint projects

Appendix B. Categorisation of networks observed in this research

Network type	Description of inter-organizational networks observed in this research
Arm's length relations	- Machinery and equipment purchases - Technology purchases in the form of R&D contract and licensing - Contracting of R&D activities to universities and research labs - Intermediary agents (e.g. for finding customers, improving marketing and distribution) - Market research agents - Participation in fairs and exhibitions - Participation in conferences, seminars and symposiums - Cooperation with human resource development and recruitment agencies, advertisement agencies, design agents, consulting firms, industry associations, Chambers of Commerce, etc.
Distribution (and marketing) networks	- Cooperation / strategic alliance in distribution with competitor, distributor or complementary firms - Licence agreement for marketing and distribution - Franchising; cooperation between wholesaler/retailers and the firm's sales representatives (in the form of feedback for product improvement and/or development, training, etc.)
Production networks	- Subcontracting (outward processing, OEM), contract manufacturing - Licensing for production - Cooperation with competitors, customers, suppliers (e.g. training, technical and organizational assistance and advice, etc. for attribute or component pricing system), with complementary firms in the industry (e.g. for new product and process manufacturing), with sister firms and strategic investor
Knowledge networks	- Knowledge relationships with other firms (such as sister firms, strategic investor firms, supplier firms, user firms, complementary firms, etc.) in product and process improvement and/or development, quality improvement, scientific advice, experimentation, etc. - Cooperation with universities, public and private research institutes, R&D laboratories, technology suppliers, etc. (e.g. for new product and process development, access to new advances in S&T, technological improvements of production processes) - Relationships developed with individuals who obtain specialized knowledge based on personal acquaintance - Firm visits and observation (e.g., among partners) - Relationships based on technical and organizational assistance, advice and training (e.g. from technology suppliers, raw material suppliers, universities, design agents, consulting firms, industry associations, Chambers of Commerce) - Relationships with consulting firms for re-organization of the production process, product-market strategy development - Cooperation with universities, consulting firms, etc. for training in business functions, planning, and design and technology management.

Appendix C. Descriptive statistics

	Both sectors			Food-processing sector			Clothing sector			Pearson Chi-Square Test (Asymp. Sig. 2-sided): INDUSTRY vs (VARIABLE)
	Count	%	Chi-square test (Asymp. Sig.)	Count	%	Chi-square test (Asymp. Sig.)	Count	%	Chi-square test (Asymp. Sig.)	
Sample size	467	100		195	41.8		272	58.2		
External learning modes (EXTLEARN)			0.000***			0.000***			0.000***	0.000***

(*continued on next page*)

(*continued*)

	Both sectors			Food-processing sector			Clothing sector			Pearson Chi-Square Test (Asymp. Sig. 2-sided): INDUSTRY vs (VARIABLE)
	Count	%	Chi-square test (Asymp. Sig.)	Count	%	Chi-square test (Asymp. Sig.)	Count	%	Chi-square test (Asymp. Sig.)	
Learning from knowledge spillovers	125	26.8		55	28.2		70	25.7		
Learning from advances in S&T	109	23.3		67	34.4		42	15.4		
Learning by interacting	157	33.6		46	23.6		111	40.8		
No learning	76	16.3		27	13.8		49	18.0		
Network type (NETWORK)			0.000***			0.000***			0.000***	0.000***
Knowledge nets	141	30.2		103	52.8		38	14.0		
Production nets	180	38.5		36	18.5		144	52.9		
Distribution nets	40	8.6		14	7.2		26	9.6		
Arm's length relations	106	22.7		42	21.5		64	23.5		
Network initiator (INITIATOR)			0.000***			0.000***			0.002***	0.079*
Firm	292	62.5		131	67.2		161	59.2		
Partner	175	37.5		64	32.8		111	40.8		
Network formality (FORMALITY)			0.000***			0.000***			0.000***	0.028**
Informal	110	23.6		36	18.5		74	27.2		
Formal	357	76.4		159	81.5		198	72.8		
Network continuity (CONTINUITY)			0.000***			0.000***			0.000***	0.012**
Continuous	245	52.5		103	52.8		142	52.2		
Occasional	90	19.3		48	24.6		42	15.4		
One-off	132	28.3		44	22.6		88	32.4		
Geographical origin of partner (GEORIGIN)			0.002***			0.519			0.000***	0.000***
Foreign partner	267	57.2		93	47.7		174	64.0		
Domestic partner	200	42.8		102	52.3		98	36.0		
Direction of the knowledge flow (DIRECTION)			0.000***			0.000***			0.000***	0.338
Uni-directional	383	82.0		156	80.0		227	83.5		
Bi-directional	84	18.0		39	20.0		45	16.5		

*** $p < .01$.

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