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The transformation of global value chains in the age of Covid-19 and Digitization

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Abstract

Almost everyone on the globe had to adjust to new conditions as a result of Covid-19 in conjunction with digitization. Contact and entry limitations damaged global business, trade and social connections. In addition, there is an increasing impact of digitization in supply chain. Regarding these disruptions current publications emphasize that global value chains are transforming to become more resilient. This study analyzes potential factors that might increase resilience in such a dynamic environment. The research is based on a quantitative empirical study to test the formulated hypotheses. The research questions were investigated trough a survey with logistics professionals. Two hypotheses were established as significant throughout the study. These are the robustness and responsiveness of global value chains, which have a substantial impact on their resilience. Both are determined direct or indirect by digital technologies. The complexity of global value chains had no discernible effect on the resilience of the system. A structural equation model is used to analyze the data's processing. This is achieved via a hypothesis model. As a result, major implications on global value chains' resilience can be found.

Keywords: Global Value Chains; Covid-19; Pandemic; Transformation; Quantitative Research

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1. Introduction

The value chain is a term that refers to the entire set of activities that firms and employees engage in to bring a product from conception to end-use and beyond. A value chain's activities can be concentrated within a single firm or dispersed across multiple firms. Globalization has generally resulted in the activities that comprise a value chain being carried out in global inter-firm networks [1].

There are numerous compelling reasons for firms to participate in GVCs during normal times. To begin, it is frequently the case that imported intermediate goods and services are less expensive than equivalent inputs sourced domestically. These cost advantages may be the result of lower labor and other costs in foreign locations, but they may also be the result of differences in climate (for example, in food production) and natural resources. Second, there may be insufficient productive capacity in the domestic economy to supply the required inputs in sufficient quantity or sufficient quality. Third, diversifying global sourcing not only mitigates unsystematic risks for firms but also increases their resilience to supply chain disruptions. Firms that rely entirely on domestic inputs are vulnerable to local disruptions such as epidemics, strikes, hurricanes, food shortages, and terrorist threats. Finally, consumers appreciate the expanded choice of goods provided by foreign sources [2].

The Covid-19 pandemic has highlighted the global value chain's flaws. To begin, expatriate workers and/or a large number of persons involved in the physical delivery of commodities may be directly affected by the virus or may be denied entry into the country. This will obstruct the GVCs' effective operation. Second, international air travel has been significantly restricted. Thirdly, social isolation and other health screenings result in border delays. Fourth, many businesses (and governments) have faced shortages of critical goods and services as a result of international suppliers prioritizing domestic consumers. Finally, but certainly not least, the pandemic has intensified many people's long-standing skepticism of free trade [3]. The pandemic of Covid-19 has created a supply and demand shock in several countries. Directly and indirectly, production, consumption, and trade patterns have been impacted by lockdowns and social distancing measures. Factory closures in China, Europe, the United States, and elsewhere have resulted in a decline in exportable goods supply and disruption of global value chains (GVCs) [4]. Covid-19-shock is fundamentally unique in comparison to other pandemic shocks [5].

The pandemic has clearly demonstrated the vulnerability of global value chains, which raises the question of how global value chains can be made more resilient [6]. Against this backdrop, the paper seeks to contribute to the body of literature on what effects the Covid-19 crisis will have on global value chains and how they will change due to the new requirements that arose with the pandemic, such as [7],[8], [9], [10], [11], [12], [13].

The following section summarizes the findings from the literature and presents the hypotheses that have been proposed, as well as the conceptual model. In section 2.2, our quantitative study and data collection technique is described in more detail. Section 2.3 elaborates the quantitative research methodology and a discussion of data analysis.

2. Research Design and Method

The following chapter explains our conceptual model and the methodology used in this study. One of the papers empirical contribution consists of a quantitative survey of the transformation of global value chains in the age of Covid-19, where our proposed hypotheses are examined.

2.1. Conceptual Model

For the analysis of the transformation of global value chains, the influences of various constructs were examined with the use of a hypothesis model. Figure 1 illustrates the influences of the various determinants on the research

question. In the hypothesis model, the dependent variable is the increased resilience of global value chains. Twelve hypotheses were identified. See Fig. 1.

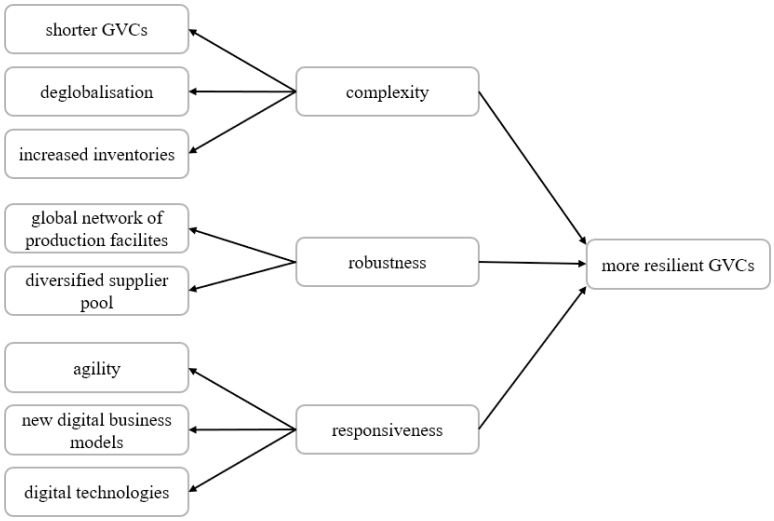


Figure 1. Conceptual Model

Resilience

Covid-19 has unveiled vulnerabilities of global value chains, for instance when essential goods such as medical supplies could not be made available when they were needed. Therefore, the demand for more resilient value chains has become more elucidated [14]. In case of a disruption, a resilient value chain can remain in its original stable situation or can reach a new secure state. Therefore, resilience can also be described as the ability of a value chain to face disruptions [15]. Of course, a resilient value chain alleviates the effects of any future challenges [16].

H1: GVCs should become more resilient.

Complexity

By their nature, global value chains are very complex, as they can also be described as global production networks. They consist of strategic partners, specialized suppliers, and customer bases that are scattered across the globe [17]. Due to their structure, complex value chains can be more vulnerable to disturbances like Covid-19 [18].

H2: To increase resilience in GVCs, they should become less complex.

Shorter global value chains

The longer value chains are, the more costly the shipment of goods can become in case of a delay, which can motivate companies to concentrate production [19]. The increased volatility and uncertainty that is experienced since the outbreak of Covid-19 could lead to shorter GVCs [20].

H3: To increase resilience in GVCs, they should be shorter.

Deglobalization

Due to the Covid-19 crisis, international dependencies and vulnerabilities are reevaluated [14]. Since the negative effects of globalization could be limited by deglobalization, many countries are already focusing their attention inwards [21].

H4: To increase resilience in GVCs, they should be more local.

Just-in-Time

The lean and globalized structure of GVCs was specifically exposed to disruptions due to the coronavirus [22]. For instance, many healthcare providers had introduced inventory management systems based on just-in-time supply, due to which the growing demand for personal protective equipment could not be met since the suppliers are used to steady demand [23]. Even though it might be costly, increase inventory in a highly volatile environment can be predicted [20].

H5: To increase resilience in GVCs, inventories should be increased.

Robustness

"Organizational resilience is the ability of organizations to anticipate, avoid, and adjust to shocks in their environment" [24]. A robust value chain, often supported by an efficient use of digital technologies, is able to withstand a disruption [8]. Therefore, the robustness of a value chain, that avoids it from being damaged, is essential to value chain resilience [15].

H6: To increase resilience in GVCs, they should be more robust.

A global network of production facilities

Bonadio et al. quantified the role of global supply chains in terms of GDP. They found out that renationalizing in supply chains harmed the GDP since eliminating exports increases reliance on domestic inputs. Lockdowns in one's own country would directly affect manufacturing [25]. Global value chains and production diversity can also help organizations build resilience [26].

H7: To increase resilience in global value chains, a global network of production facilities is necessary.

Diversifying the supplier pool

A global industrial network allows value chains to be flexible. Low interruption costs arise from strong adaptability. Diversification of products, markets, or supply sources is commonly used to increase flexibility [27]. For example, redundancy among suppliers or production locations can ensure resilience. Businesses with diversified suppliers and a global manufacturing network can adjust output in the case of a disaster [13].

H8: To increase resilience in GVCs, supplier pools should be diversified.

Responsiveness

The management of change and the return to the previous level of performance after a disruptive event can be achieved either reactively or proactively [28]. In other words, value chain resilience is not only the capability to recoup, it is also the ability to prepare its adaptation to new circumstances and lessen future disturbances [17]. The use of digitization, in particular digital technologies and business models, plays also a major role in here. Hence, a resilient value chain can respond accordingly after a shock [8].

H9: To increase resilience in GVCs, they should be more responsive.

Agility

Businesses must respond fast to changing client needs as well as disruptive environmental changes. Agility is critical for survival in such tumultuous and volatile environments [29]. As a result, we might consider agility to be a

defining characteristic of resilience. Resilience is the capacity to anticipate and adapt to unforeseen events, to disrupted operations, and recover from them while maintaining desired levels of operational continuity; agility is the capacity to do so fast [30].

H10: To increase resilience in GVCs, organizations and business processes should be more agile.

Digital business models

Digital services and technologies like Blockchain [32] will continue to challenge company structures. The current study offers strategies for firms to ride this wave and not just survive but grow post-Covid-19 [21]. Through the most effective use of digitization, new business models can be formed. This insight is critical for small and medium-sized businesses, in particular when it comes to doing daily operations during the Covid-19 pandemic. Digitization enables businesses to create new products and services and, additionally, it results in a more resilient value chain [31].

H11: To increase resilience in GVCs, new digital business models should be adopted by companies.

Digital technologies

The existing research argues that technology can aid to make value chains safer and more predictable through a reciprocal supply of planning relevant data [38]. This makes the entire supply network more adaptable and responsive [32]. Digital technologies enable risk management to be carried out efficiently, regardless of the length or complexity of value chains [13].

H12: To increase resilience in GVCs, digital Technologies should be implemented to boost risk management capabilities.

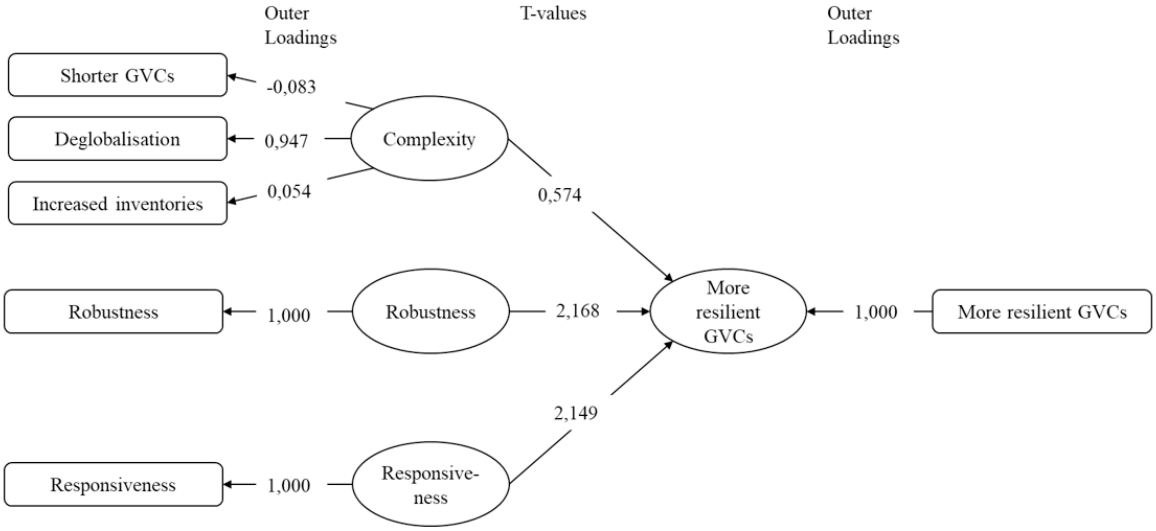
2.2. Data Collection

The questionnaire was derived from the hypotheses frame. The quantitative survey examined the conceptual model with the help of a web-based online survey using the open-source software LimeSurvey. The study surveyed experts in the field of logistics. For this reason, the requirement for participation in the study was a relevant professional experience in the logistics environment. After a detailed pretest, the final survey was conducted in the period from 22.01.2022 to 13.02.2022. During the survey period, 238 responses were collected. The survey was conducted in the German-speaking countries of Germany, Austria, and Switzerland as well as in Georgia. All items of the questionnaire were rated by the respondents with a 5-point Likert scale (1 = Completely agree, 2 = Rather agree, 3 = Neither agree nor disagree, 4 = Rather disagree, 5 = Completely disagree). The 5 different expressions of the scale can be used to investigate the impacts of the determinants. In total, participants rate 13 statements. After cleaning the data and eliminating the incomplete questionnaires, the number of participants in the study is n=111. At the beginning of the questionnaire, all socio-demographic data are collected.

2.3. Data Analysis and Results

Structural equation modeling is used to analyze the collected data from the quantitative study. With the help of SmartPLS, the related influences and effects of the different variables on the research question can be estimated. This system enables the data collected to be examined and validated concerning the research question. It can then be deduced whether and to what extent the hypothesis and the theoretical model are confirmed by the collected data [33]. Structural equation modeling is seen as the second generation of multivariate analysis to provide greater insight into the analysis of the various relationships. Through the measurement model, the latent variables are validated, and the structural equation model explores the relationships between the latent variables and the research model [34].

After evaluating the empirically collected sample with n=111 complete records using the SmartPLS analysis tool, two of the hypotheses are found to be significant. Figure 2 displays the results of the evaluation. The structural equation model of this study consists of three constructs. For “robustness” and “responsiveness”, the individual items are applied due to the quality of the indicators used. After the results are evaluated, different versions for each construct are tested and the version with the highest quality is selected.



The illustration in figure 2 shows the T-values of the structural equation model. These values can be used to validate the structural model and to analyze the relationships between the selected determinants (constructs) and the dependent variable (Resilience of GVC). The illustration in figure 2 also shows a measurement model with the outer loadings. Commonly, the size of the outer loading is also known as indicator reliability. The required minimum level of the outer loadings of all indicators to be statistically significant is 0.708 or higher [36].

The coefficient of determination R2 for the model is given as 0.025. According to Chin, this value is considered weak. R2 is considered "weak" at a value of 0.19, "moderate" at 0.33, and "substantial" at 0.66. It should be noted that these values, however, cannot be applied to all models and are accordingly adjusted depending on the application [35].

The analysis in SmartPLS based on the hypothesis model shows significant influence for two of the three examined constructs on the resilience of global value chains.

We proposed in hypotheses 2, 3, 4 and 5 an increase of the resilience via less complex GVC. That means shorter and more local value chains as well inventories should be increased. Figure 2 shows that our findings disprove these hypotheses. The outer loadings of two single items don’t reach the significant thresholds; consequently, the construct "complexity" doesn’t show a significant impact with the T-value of 0,566 and a P-value of $p > 0,1$ [36].

Figure 2: Structural equation model with SmartPLS.

Hypothesis 6, 7 and 8 stated that GVCs should be more robust, a global network of production facilities is required and supplier pools should be diversified to increase resilience. The data analysis supports these hypotheses. With a T-value of 2,111 and a P-value of $p < 0.05$, the construct "robustness" has a highly significant influence on GVCs' resilience.

Hypotheses 9 to 12 suggested that in order to increase GVC resilience, they should be more responsive, organizations and business processes should be more agile, companies should adopt new digital business models, and digital technologies should be implemented. The results of SmartPLS support these hypotheses. With a T-value of 2,183 and a P-value of <0.05, the construct "responsiveness" also has a highly significant influence.

A more detailed description of the evaluations is listed in the following Table 1.

Table 1. Results of the Structural Equation Modelling

Determinants	Original Sample Path Coefficients	Sample Mean	Standard deviation	T-tatistics	P-values
Complexity	0,085	0,078	0,149	0,574	0,566
Responsiveness	0,219	0,223	0,102	2,149	0,032
Robustness	0,218	0,211	0,101	2,168	0,030

The table shows that the constructs "responsiveness" and "robustness" have excellent T-values and P-values. In addition, the values for path coefficient (original sample and sample mean can also be classified as good. The two constructs "responsiveness" and "robustness" reach values > 0.2 in both columns. Here, the indicator reliabilities are measured for the items used. Accordingly, the external weights have high significance and are of high quality [37]. This means that the constructs can be confirmed in their significance. However, construct "complexity" has insufficient T-values and P-values and thus, doesn't show significance.

For the present study, a reflective model is chosen. This means that the indicator variables reflect the latent variable. Appropriate measures of fit for reflective measures include composite reliability (CR), Cronbach's alpha (CA), and average variance extracted (AVE). All three coefficients for the internal consistency are calculated and shown in Table 2. Since, the constructs "responsiveness" and "robustness" are used as single item determinants, CR, CA and AVE are at 1.0. As already mentioned, the single item constructs were used, as the indicators of "responsive" and "robustness" describe the respective construct as weaker than the general single items. The reason for the weaker scores is the correlation of the undergirding indicators.

Table 2. Quality Criteria for the SEM.

Determinants	Cronbach's Alpha (CA)	Composite Reliability (CR)	Average variance extracted (AVE)
Complexity	0,330	0,287	0,302
Responsiveness	1,00	1,00	1,00
Robustness	1,00	1,00	1,00

A threshold value of > 0.7 is required for Cronbach's alpha. This is not achieved for "complexity". The Composite Reliability and the average variance extracted also indicate poor reliability for this construct.

In summary, the structural model of this study has the medium quality and two of the variables have a significant influence on the resilience of global value chains. In further research projects in this field, care should be taken to ensure that the indicators describe a construct as completely possible and therefore with higher quality.

It is worth noting that the majority of experts have years of professional expertise. There is, however, a small group of 24 individuals with fewer than three years of job experience. In addition to that, a global value chain is essential for 92 percent of participants' companies, with only one person disagreeing that value chains are important for the organization. Another significant finding of the study is that 99 percent of experts agree that Covid-19 has disrupted global value chains, implying that future global value channels would need to be more resilient.

3. Conclusion

The results of this study show that two determinants have a large impact on the resilience of global value chains in the age of Covid-19 and digitization. The determinants are “robustness” and “responsiveness”. According to these findings, the structure of global value chains must be adapted to changed conditions of global business, trade and social connections. Robust and responsive global value chains can achieve better resilience. The influence of digitization plays a major role here, direct via digital technologies and business models or indirect via global networks. Furthermore, it is shown that a lower complexity of global value chains has no relevance in terms of resilience.

The study has revealed interesting aspects concerning resilience and thus the transformation of global value chains. But some limitations need to be mentioned. First, the survey was conducted predominantly in German-speaking countries. Only a few Georgian participants were invited to the study. In order to be able to apply the results globally, further countries should be included. Furthermore, it would be interesting to know if country-specific or region-specific results can be identified. This could be researched in a further study. Another limitation is the number of 111 participants surveyed. Since this is an empirical study in the form of quantitative research, this limitation must be considered. In addition, there is a limitation regarding the correspondence between the indicators and the constructs. For the construct “robustness” and “responsiveness” the general single items are used because they couldn´t be described correctly by the indicators. These limitations indicate that further studies on the topic may be necessary.

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