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**VALUE CHAINS AND COMPETITIVENESS IN EUROPE:  
A COMPARATIVE STUDY OF  
THE CZECH REPUBLIC AND SWITZERLAND**  
(doctoral dissertation)

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## Declaration

I herewith declare, that I have elaborated the doctoral dissertation entitled *Value Chains and Competitiveness in Europe: A Comparative study of the Czech Republic and Switzerland* independently. All the cited sources including my own works are properly quoted and listed in the bibliography.



In Prague, 06 April 2020

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# Acronyms

AMT	Advanced Manufacturing Technologies
BIT	Bilateral Investment Treaty
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CEEC	Central and Eastern European Countries
CEM	Contract Electronic Manufacturer
CH	Switzerland
CM	Contract Manufacturer
CSA	Country-specific Advantages
CPO	Chief Procurement Officer
CTO	Chief Technology Officer
CZ	Czech Republic
DRAM	Dynamic Random Access Memory
ECG	Electrocardiograph
EOI	Export Oriented Industrialization
ERP	Enterprise Resource Planning
EU	European Union
FDI	Foreign Direct Investment
FTE	Full-Time Equivalent (employee)
FSA	Firm-Specific Advantages
FVA	Foreign Value Added
G7	Group of seven IMF-ranked advanced economies of the world
GCC	Global Commodity Chain
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GPN	Global Production Network
GPO	Group Purchasing Organizations
GVC	Global Value Chain
GMDN	Global Medical Device Nomenclature

GVMN	Global Virtual Manufacturing Network
I6	The Industrializing six countries
IB	International Business
IMN	International Manufacturing Network
IT	Information Technology
MedTech	Medical Technology
MNE	Multinational Enterprise (see also MNC or Multinational Corporation)
MNC	Multinational Corporation (see also MNE or Multinational Enterprise)
NPD	New Product Development
NIC	Newly Industrialized Countries
OEM	Original Equipment Manufacturer (Brand owner)
OECD	Organization for Economic Co-operation and Development
OLI	Ownership-Location-Internalization (Eclectic Paradigm)
OM	Operations Management
POMS	Production and Operations Management Society
PTA	Preferential Trade Agreement
R&D	Research and Development
RCA	Revealed Comparative Advantage
SCM	Supply Chain Management
SLR	Structured Literature Review
SME	Small and Medium-sized Enterprises
TiVA	Trade in Value Added
TNC	Transnational Corporation (used alternately with MNC)
US	United States of America
VMI	Vendor Managed Inventory
WIOD	World Input Output Database
WTO	World Trade Organization

# Introduction

In the early 1980s, consultants announced that certain technical functions - like Logistics – which had until then been considered clerical at best had strategic potential for firms. Coining the term Supply Chain Management, this new way of operating, which coordinated previously independent functions and trading partners, improved cost and service to levels which could not be ignored if firms wanted to remain competitive (Oliver & Webber 1982, Stevens 1989). Ten years later, in 1993, a manager at Hewlett-Packard published a paper in Sloan Management Review, outlining “Effective Supply Chain Management”, describing how uncertainty propagated from firm to firm in an interconnected supply chain. It recommended that suppliers, manufacturers and retailers model the end-to-end system and manage their performance across firm borders (Davis 1993). Ten years later, as globalization progressed, economists observed an explosion of export activity, without a corresponding increase in GDP. Since the comparatively small drop in worldwide tariffs driven by GATT/WTO failed to account for the surge of trade volume, they identified the root cause to be the increasingly prevalent vertical specialization of firms (Yi 2003). The global movement of intermediate (semi-finished) goods, which can cross borders several times between nodes in the value/supply chain, explained the sudden increase in export volume. Six years later, an IB paper evaluated the trade flows of US MNEs in 56 countries to confirm that intra-firm trade had indeed increased, and interpreted this as evidence of value-chain disaggregation (Beugelsdijk et al 2009), and a global division of labour. Economic geographers spoke of a “Global Shift” (Dicken 2015), of production activity as work was outsourced to specialized or lower cost locations. A slew of position papers by international advisory and governing bodies announced that Global Value Chains (GVC)s “*play a catalytic role in development*” (UNCTAD 2013 a, UNCTAD 2013 b, De Backer and Miroudot 2013, OECD 2013, IMF 2013, WTO 2017), although the unequal effects of this development remained a concern to economists, Geographers, and sociologists alike. Politicians took note and began targeting factory location – a key element of network design – for statist intervention, or just old-fashioned protectionism. There is little doubt that the practice of trade, and its consequences have changed profoundly over the decades marked by these intellectual milestones. All of them occurred in the course of my professional career as an industrial engineer, and deserve coherent academic attention.

Porter's original concept of a value chain emphasizes that a finished good like an automobile or a ski jacket is the output of a sequence of tasks which progressively add value until it is ready for consumption. In the past, all the value-adding steps were completed in one, or very few, locations by a single nationally-rooted firm. Globalization, technology, and new business processes have enabled the distribution of these tasks to the most competitive supplier, which can be located anywhere in the world. Take the automobile industry. Volkswagen's glass windshields are produced in France, the leather for its seats in South Africa, brake-locking systems in Germany, electronic components in Japan, and final assembly takes place in Germany, the Czech Republic, China, and Mexico, depending on the model and consumer market. Because instructions, specifications, customs, payments, and any other paperwork can be transmitted electronically at real-time, the owners and governance of these firms can be located anywhere else in the world. Most finished goods today therefore have a colourful biography which has traversed the globe in a step-wise transformation from raw material to consumer product.

The New Globalization's division of labour has earned many metaphors: "*splintering*" (Bhagwati 1984), the "*disintegration*" of production (Feenstra 1998), "*vertical specialization*" (Hummels et al 1998, p.81), the "*de-composition of the corporate core*" (Billington & Kuper 2003), "*slicing up the value chain*" (Dicken 2015). The international trade literature has settled on the term "Fragmentation", proposed by Jones & Kierzkowski in 1990. The many metaphors demonstrate the energy with which multi-disciplinary theory has responded to the new phenomenon. The production function can no longer be reduced to a black box whose output issues from a single nation. If in the past, "*Exports were 'packages' of a single nation's productive factors*" (Baldwin 2014, p.237), today's global division of labour has de-nationalized both industrial sectors and comparative advantage.

This dissertation addresses the new GVC paradigm from the perspective of three distinct stakeholders: the scholars who conceptualize them, the decision-maker in the firm, and the policy-makers in the locations which host them. Each group has its own agenda, objectives, and political interests. Economists, Sociologists, and Geographers seek to explain and, ideally, motivate state-led interventions recently covered under the notion of competitiveness, i.e. long-term capability of an economic system to deliver sustainable and inclusive economic growth. Yet, the behavior and impact of GVCs were not predicted by academics, who are more or less impartial observers who conceptualize it after the fact. GVCs originated in practice, as

individual firms adjusted to cope with the pressures of New Globalization, and their supply chain engineers devised new strategies and processes to deal with the unsuspected effects of the network. For this reason, I claim that an understanding of logistics and supply chain management as a business strategy (and not a technical transaction), are vital to explaining how and why GVCs work as they do. Only by understanding these (often counter-intuitive) effects of the network structure can a stakeholder intelligently design a strategy for profitable engagement.

The objective of this dissertation is to bridge the above mentioned gaps in globalization studies by summarizing the body of GVC knowledge across Economics, Geography, Sociology, International Business (IB), and Operations Management. The study positions itself firmly within the framework of European economic integration, which has received insufficient attention by GVC scholars. To discover possibilities for value creation and enable policy development, it benchmarks two developmentally different, but otherwise comparable, European countries deeply embedded in GVCs: the Czech Republic and Switzerland. In so doing, the thesis addresses two research questions: 1. How to compete as a place and as a firm? And 2. What types of strategy can change the shape of the Smile Curve for the better?

### **Research Question 1: How to compete as a place and as a firm?**

This is divided into several sub-inquiries. Since the location of the firm in the GVC directly impacts the wealth creation or destruction of its geographic location, does that geographic place determine the relative position of the firm in the GVC?

Much of this research potential admittedly emerges from Smile Curve Economics, which distil a number of key facts about contemporary GVC trade. De-verticalization leads to a trade in tasks, which when divided into tangible and intangible work, in turn, leads to differential value capture. Since this process occurs in a geographically-dispersed global factory or production process, the unequal distribution of tasks results in the unequal generation of wealth. As compelling as this explanation may be for what is happening today, the question of whether this trend will continue, and whether all manufacturing will converge in developed countries remains unanswered. The empirical data begs further exploration: manufacturing continues to thrive in high-wage locations like Germany and Switzerland, and design activity is growing in China and other lower-cost countries.

The Smile Curve is therefore powerfully descriptive of many industries, but is it predictive? The answer to this question again will depend upon a subset of other questions: are there production strategies which go beyond the binary option of specializing in *either* high-paying intangible tasks *or* low-paying tangible tasks? Are there combinations of other economic factors, than unit labour cost or wage levels, with which to create sustainable competitive advantage at the levels of firm and geographic location? Baldwin's observation that the Smile was flatter in the golden past of manufacturing delivers indirect evidence that the curve is neither static, nor beyond the influence of its participants. Since single factors are poor candidates for optimization, we come to our second research question:

**Research Question 2: What types of strategy can change the shape of the Smile Curve for the better?**

This question relates less to content than to scope and methodology of the research. The business cases of the extant GVC literature remain predominantly illustrative and based upon observations, with limited firm-level data. The confusion between impersonal, macro forces like comparative advantage, and the personal choices of "*brand bullies*" persists in a literature which traverses (arguably incompatible), levels of aggregation: Macro-> Meso-> Micro. What were the managers thinking when they de-industrialized America? Let us agree that, however tempting it may appear when the developmental outcomes affect the real incomes of communities, personal villainy is a weak scientific argument. When applied to the usually simplified, single factor economic models of production and value appropriation, supply chain theory provides causal explanations based on rational decision-making under the non-intuitive effects of network structure. Although this results in an inescapably mixed methodology (risky when submitting to specialized journals within clearly-demarcated academic disciplines), it avoids spurious speculation on the personal motives of stakeholders, which are then generalized to entire industries or geographic regions. The literature is also dominated by studies of the US (which is not highly-integrated into GVCs), as well as developing countries, predominantly in industries like automaking, textiles, and agriculture. In all cases, the largest firms are assumed to be the most powerful, most possessive of knowledge, and most strategic in their intent. All of this leaves ample room to discover what smaller suppliers are doing to create and capture value in a GVC. Studies of small, globally-active, enterprises in innovative manufacturing industries, in countries which are tightly-integrated into GVCs would provide important insight. It is to these real cases, with a focus on the sunrise Medical

Technology Industry, in Switzerland and the Czech Republic, that we turn our attention in the next chapter.

In view of the GVC literature as it will be presented in this thesis, the research questions which will be addressed are a response to selected theoretical modules. The first is the structural determinism of network governance as it is understood and diffused by economic sociology, and which takes place at a transactional level. GVC theory suggests that location – both in the geographical space and the network configuration – is destiny and upgrading is the only option to secure better economic and developmental outcomes. The options of policy-makers and local regulators are extremely limited, both in the face of buyers that are deemed all-powerful, and by the state, which has little expertise on production and supply chain improvements.

To the best of my knowledge, there has been little attempt to compile, compare, and (where feasible) synthesize the body of GVC knowledge across Economics, Geography, Sociology, and Business Management. There is no serious dialogue between sociologists and Supply Chain Management scholars<sup>1</sup>, although Hau Lee recently recommended just that in an address to the POMS society in 2016. Operations Management scholars realize that they passively remain at the “*receiving end*” (Ferdows 2018 p. 396), of policy and strategy decisions, although it was their work which set in motion many of the geopolitical forces which are the subject of broader GVC debate.

To redress this missed opportunity, one of the key contributions of my dissertation is a literature review across five discrete disciplines. Under normal academic circumstances, this would be considered too broad for a feasible synthesis, and publication in specialized journals. This challenge required particular methodology. The review does not attempt a full synthesis (which would obscure more than illuminate), but follows Sturgeon’s recommendation for a modular approach to theory-building, within a carefully defined scope. Although this does not deliver an exhaustive summary, it nevertheless yields salient and relevant insights. The review of each domain begins with a genealogy - effectively an intellectual history - which narratively traces its development via the most-cited, hence impactful publications, noting the emergence of constructs over time, and the conditions under which these were drafted. A retrospective of

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<sup>1</sup> I actually count Golini and Kalchschmidt’s invited contribution to the latest *Handbook on Global Value Chains* (Ponte, Gereffi, & Raj-Reichert 2019, p.432) as evidence of no serious dialogue at the level of content. In this chapter, the oversimplified role of SCM is simply reinforced as a technical toolbox. It is one of 35 chapters and relegated to a motley section on “Strategy, Innovation and Learning”.



established theory in this form emphasizes the context-dependent nature of intellectual progress, where existing ideas engender new ones. The method is not new. It is common practice to write intellectual histories in genealogy form, with notable GVC examples including Bair 2009, Sturgeon et al 2008, p.8, Baldwin 2012, 2017, Gereffi 2018, pp. 1-17, Gereffi 2019, Ellram & Cooper 2014, pp.8-10, Stevens & Johnson 2016.

In a subsequent step, each genealogy is followed by a structured literature review (SLR) according to Tranfield et al (2013) and Ellram & Cooper (2014), which compiles, where possible, a transparent and reproducible peer-reviewed knowledge base in each field<sup>2</sup>. Like any method, this structured literature review has limitations, including a sampling bias towards published and peer-reviewed work, and the subjectivity of the coding process. Nevertheless, it also proves to be insightful and useful. The alternative method, a systematic review in the scientific empirical tradition (Rousseau et al 2008), proved inappropriate for the predominance of constructivist and grounded research studies by social scientists (like sociologists). In the sociological GVC domains there was no positivist analysis comparable to what is practiced by medical science, whose systematic reviews depend upon statistical meta-analyses to establish unbiased evidence for cause-and-effect questions, or the effect of particular interventions. A more detailed justification of this methodological choice is made in the section on supply chain management, where a significant stream of mathematical modelling coexists with an equally compelling body of qualitative case-based research, making a systematic synthesis of the evidence problematic within the domain itself. In summary, a mixed methodology was deliberately applied to address the heterogeneity of multi-disciplinary GVC research, composed of both constructivist approaches typical to the social sciences, and the more objective scientific methods pursued by both economists and operations researchers.

In its summary, the literature review in Chapter 1 presents a matrix of its research across the following key dimensions:

1. What are the assumptions in this field?
2. What units of analysis are applied?
3. What methodologies are applied?
4. What are the central constructs, paradigm tradition and shifts?

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<sup>2</sup> Technically, this ran queries on both SCOPUS and Google Scholar, with relevant keywords, to select the most influential publications with the highest citation factors. The keywords and top 20 articles for each of the 4 searches are listed in the appendix. After reading each of these articles, major themes and findings were coded.

5. How do these scholars assess the Developmental Effects of GVCs?
6. Which stakeholder audience does this domain address?

Such a tabulation enables the comparison of ontological (what it is), and epistemological (how it knows), aspects of the Economic, Sociological, Geographical, and Supply Chain theories of GVCs. This comparison is arguably one of the main contributions to GVC theory made by this dissertation, because I am convinced that it will enable a more critical and thoughtful application of seminal concepts across disciplines. This is best illustrated by examples. GVC scholarship has become virtually synonymous with the Gereffi model which generalizes a structurally-determined imbalance of power, the dependency of suppliers, and the study of governance to support upgrading in the hierarchical system. Those international Business scholars, who presumably work within capitalist boundary conditions, and apply the GVC heuristics developed by the Gereffi school should bear in mind that the assumption made by this theory is that GVC trade is a form of neo-mercantilism and neo-colonialism. In very few publications does Gereffi openly state his anti-capitalist stance, but I claim that a theoretical position like this should be acknowledged as the context of the logic, to promote transparency, and deter uncritical re-use of constructs.

The comparative literature review reveals that GVCs are much more than this powerful sociological framework. GVCs are also the industrial unbundling and great convergence of world GDP described by Baldwin. GVCs are also what Yeung defines as managerial devices that deploy core competencies of firms at the lowest possible cost, in constant negotiation with their regulatory and territorial stakeholders. According to the real-world experience of supply chain theorists, GVCs are new network structures which accelerate, amplify and distort information and can adapt at a speed that was unthinkable prior to the IT revolution. Structure proves to be destiny but not necessarily the way Gereffi sees it. The structure of the network creates dependencies for the strong as well as the weak, not just for suppliers but also for buyers who must wait for inputs. Vertical dis-integration has ruptured the natural feedback and feed-forward loops which remain intact in a vertically-integrated firm, and these linkages must be re-established within firms to avoid the propagation of uncertainty and waste within the system. While the sociological governance literature generalizes a hierarchical relationship between controlling MNEs and their dependent poor-country suppliers, the practice and theory of SCM suggests that centralized control is neither feasible nor desirable because of the

inefficiencies which are its unintended consequence. Contrary to popular economic wisdom, working with structural co-dependency by developing collaborative processes may be the most rational forms of maximizing rent for all participants.

My comparison of multiple disciplines therefore reveals interesting divergences in theoretical conclusions: GVCs simultaneously promote impoverishment and development of regional economies. GVCs are both a trap and an opportunity for nations and firms. Multinational Corporations (MNCs) from developed nations tend to appropriate more value in a GVC, while these nations de-industrialize and lose GDP shares to developing nations. GVCs are fixed, zero-sum structures dominated by exploitative MNCs as well as evolving systems in which suppliers play an influential and strategic role. Confronted with this series of diametrically opposed claims, what are we to believe, and what of the competing versions can be trusted to advise decision-makers and stakeholders? Consumers, activists, politicians, and scholars alike are justified in asking where and how was your t-shirt made, at whose expense, and to whose benefit (Rivoli 2005)? Is a GVC a form of structural violence or an opportunity to graduate almost instantly from agricultural to industrial levels of productivity? Will all manufacturing work eventually converge to China and transform developed nations into service economies? How does one become that most competitive supplier? In the memorable words of Dicken, the question is an empirical one, which brings me to the content of the Chapter 2.

Of course this dissertation will not attempt to answer all these questions but pursued a more modest research plan focused on competitive strategies within a GVC, applying supply chain theory in particular. The selected combinations of sector (MedTech and precision manufacturing), location (developed nations in Europe), and GVC position (SME suppliers), have not been the subject of previous research. The methodologies are also novel. The second chapter summarizes three publications on GVCs in two small European countries, the Czech Republic and Switzerland, which are deeply embedded in GVCs and display impressive records of growth, in spite of the competitive challenges posed by globalization. The first section examines economic data and selected case studies to study how two European territories compete and fare in a sunrise sector which arguably presents lower barriers to value creation than well-studied sectors like automaking: Medical Technology. Expanding the GVC framework of Gereffi, it identifies additional measures which reveal competitive factors, including the role of firm-level supply chain strategy on GVC performance. The second section drills down to the

firm level with a Design Science project conducted together with a Contract Electronic Manufacturer in Switzerland. It asks how manufacturing can be deployed as a developmental tool in the highest cost location in the world, which is under ongoing pressure to shutter plants and move them to Eastern Europe and Asia. Again, the firm's innovative supply chain strategy reveals unsuspected opportunities in the Global Value Chains in which this small rich-world contract manufacturer is engaged. It is worth emphasizing that especially this case study is the outcome of a two-year Design Science research project with an industrial partner of the ETH Zurich. This immersive and collaborative methodology yields unprecedented access not only to firm-level data, but to the company's managerial logic in the face of changing boundary conditions and decision-making processes.

The third section focuses on the ingenuity of small suppliers and challenge the GVC and IB assumption that these are essentially in a disadvantaged position. When bundled with product sales, the Supply Chain process innovation that creates an assurance of supply for large MNCs proves to be a sustainable source of revenue and growth for this Small and Medium-sized Enterprise (SME). At a conceptual level, the fact that hundreds of MNC-buyers would be willing to continuously pay for the elimination of supply risk, by surrendering operational control and visibility of their inventory management and replenishment orders to their small supplier is evidence of profitable co-dependence within a GVC.

The contribution made by this chapter arguably exceeds the relatively unexplored sector in the developed region of Europe. All three cases suggest that the smile curve can be flattened by the implementation of targeted supply chain strategies that create value from information flows. None of the papers in this chapter confirm the classical economic notion of competing on the basis of lowest price (for the Swiss suppliers hardly an option) while struggling to upgrade in a power deadlock. Supply Chain processes can, however, generate entirely new business models and revenue streams unheard of in the orthodox conceptualization of production vs. services provision. Unlike design or marketing, the value added by supply chain network intelligence and uncertainty management do not even appear on the smile curve. Including them would raise the profile of activities which have the potential to generate new lines of business, and support pragmatic policy development, which is the subject of the final chapter.

Just as I argue for the full disclosure of anti-capitalist or neo-liberal assumptions in the literature, let me conclude by naming the experiences and biases which form me as

a researcher. Originally trained as an industrial engineer, my position as an economist is Smithonian. This adjective can be defined in contrast to a *Keynesian* interventionism, or *Marxist* revolution. The Smithonian position I represent does not endorse uncontrolled free markets (as the Washington Consensus is perceived today), but rather arises from the conviction that the state and the firm each have their own distinct areas of competency. The state remains the guardian of standards, social welfare systems, and institutions, but is less efficient and productive (and less resistant to vested interests of incumbent structures), than the firm at generating innovation and creating value in industries. It will therefore be vital to pragmatically align the interests of the state with those of the firm, which remains an indispensable locus of value creation and strategic agency. I argue for a strong role of the state creating boundary conditions for economic activity: collecting tax to provide education and social welfare, regulating market competition, and building the institutions which support both business and the communities they employ. Unfortunately, the public servants responsible for administering these vital services and institutions, including public prosecutors and judges, are poorly educated in the specifics of the New Globalization. Their expertise seriously lags that of innovative and nimble firms, both big and small, and this knowledge gap undermines the effectiveness of public governance. These learnings are derived from decades of experience as a supply chain manager at an American MNC. I personally witnessed and contributed to the spread and optimization of GVCs, in the course of an industrial career which, coincidentally, began the year that the Berlin wall fell. The political and social disruptions of this era were not lost upon me. As a humanitarian logistician (my other area of research), I am concerned with the fate of real communities exposed to accelerated change in economic and political conditions, the pace of which outstrips social adaptation, and certainly the development of institutions like labour rights, an independent judiciary, safety, and environmental protection. There is plenty of work to be done in coordinating economic and social progress. As an optimist, I see opportunities in the economic integration of Europe, which ended a history of war and contained humanity's most egregious military aggression. It is almost a supply chain insight which underlies the peace project of the single European market: if our economic well-being depends on one another, we will be reluctant to destroy one another. If we collaborate, it is more likely that all of us will be better off in the end. The following GVC research was conducted in the pursuit of this vision.

# 1. Global Value Chains: Research Context across Disciplines

A number of academic domains have generated significant research streams on what this dissertation will call Global Value Chains, a term defined below. To establish a research context, this chapter conducts a structured review, following Ellram and Cooper (2014), of five research domains, each of which makes a distinct and significant contribution to the discourse. The heterogeneity of these disciplines, which range from the social sciences to economics and engineering, makes a synthesis of their literature streams infeasible and risky. Sturgeon observed that *“Because multiple forces of change are always at play, theory, if used in a totalizing manner can obscure as much as it reveals”* (2008, p.2). The complexity of what is happening at a global scale should not, however, deter theory-building across the multiple disciplines. Each of the domains reviewed here may not fully describe or explain the phenomenon of GVCs, but the most impactful elements combine to deliver a wealth of insight. As Global Value Chains become more present in both public and scholarly debate, the growing tendency to refer to neighbouring disciplines, be it Sociology, Economic Geography, Macroeconomics, International Business, or Logistics and Supply Chain Management, is a welcome development. Cross-references can expand the knowledge base upon which both policy-makers and firms make decisions. At the same time, a dialogue between heterogeneous disciplines will be most fruitful when a construct is transferred with a full awareness of its original context, sensitive to potential logical dissonance.

To navigate the pitfalls of interdisciplinary theory-building, this review applies Sturgeon’s *“modular”* approach, which *“identifies one or a few important causal mechanisms that can be used to partially explain and predict outcomes”* (2008, p.2). To deliver meaningful and useful results, this approach must establish a *“clearly defined explanatory scope”* for each stream under review. Each of the following sections therefore makes the intellectual history, analytical methods, and assumptions of its research domain explicit, followed by a comparative summary which emphasizes both points of complementarity as well as divergence. The chapter concludes with a discussion of knowledge gaps, to identify the questions which the present research project will address.

## Definition of a Global Value Chain

The term Value Chain was coined by the economist and management scholar Porter (1985), who unpacked the economic construct of the monolithic production function. He defined the value chain as the range of activities which must be completed to bring a product from its conception to its transformation from input materials, to the final consumption by a paying customer. The value chain makes explicit the iterative and specialized contributions made by each business function, all of which were located in one place under the roof of a single firm in the original Fordist<sup>3</sup>, pre-GVC model of export trade and business operations. With the opening of markets worldwide, and advent of technologies that reduced the cost of moving goods, information, capital, and people, individual value-adding activities could be distributed outside the walls of the lead firm and the borders of the nation in which that firm is located. Vertical disintegration (Feenstra 1998) thus led to the decomposition of the corporate core (Kuper & Billington 2004), as individual functions were either spun off, or closed, in favour of contracts with specialized external suppliers. Many of the value-adding functions have become entire specialized industries, distributed around the globe (Figure 1).

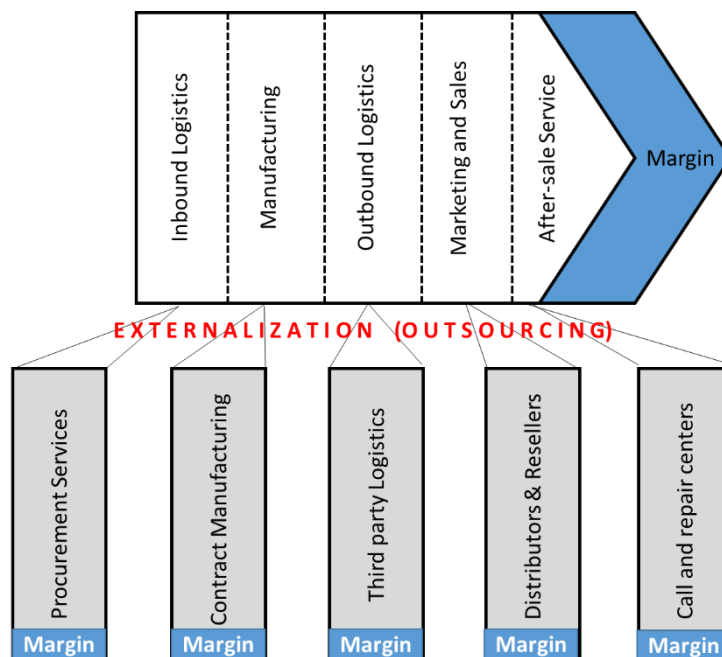


Figure 1: Value-adding Functions of a Firm.

In the vertically-integrated firm, each value-adding function was under one roof. The decomposition of the corporate core (Kuper & Billington 2004) led to the spin-

<sup>3</sup> The Ford Motor Company invented the assembly line and originally owned all of its supply chain from raw material suppliers through to distributors and resellers. In its earliest form, the company was a functionally-integrated production system.

off of individual functions which often became specialized external firms, often in remote international locations. Source: author, based on Porter 1990.

To guide the following review, this research proposes the following definition of a new phenomenon:

A Global Value Chain or GVC is a network of geographically-dispersed, specialized firms which together contribute to the production and delivery of a finished good to its final consumer. Each individual firm is a node in the network, trades in tasks and intermediates across at least one national border, and is remunerated for the incremental value they add to the final sale.

Defined in this way, the GVC addresses the new reality of de-composition (de-verticalization, fragmentation) of the firm, the global dispersion of its activities in a network structure, the collaboration and competitive strategies it develops, its specialization on core competencies, and the distribution of wealth through value creation and capture. As such, it is of interest to the research agendas of sociologists, economists, geographers, industrial engineers, and business scholars. A closer look will reveal a blurring of boundaries: economic geographers, socially responsible and sustainable business theory, supply chain designers and trade economists have all turned their attention to the burgeoning topic. It is not surprising that each academic discipline employs its own terminology to study this type of value-added trade: Global Supply Chain, Global Production Network, Supply Chains, or the Global Value Chains which will be adopted here to represent them all, arguing that each term can be mapped to the above definition (table 1).

Domain	Term	Key references
Macroeconomics	Global Supply Chains	Baldwin school
Sociology	<b>Global Value Chains</b>	Gereffi school
Economic Geography	Global Production Networks (GPN 1.0 and GPN2.0)	Manchester school
International Business	Global Factory	Buckley 2004a
Supply Chain Management	Supply Chains	Multiple

Table 1: Overview of the disciplines which have generated important GVC literature With their respective terminologies. This research will use the term GVC to represent them all. Source: author.



In this literature review, each domain will be described by its particular history of the GVC concept, followed by a structured review of the extant literature. It will thereby distinguish between three possible levels of cause and effect in a GVC (Gereffi 2019, p.196):

1. the *Macro* (global/multinational, or individual nation)
2. the *Meso* (industry and region)
3. the *Micro* (firm-level)

Within these categories, the essential constructs, methodologies, intellectual traditions, respective units of analysis, developmental effects of interest, and policy implications will be made explicit, together with the assumptions generally made during theory-building (Table 3 provides an overview at the conclusion of the chapter). To further facilitate comparison, the key findings of each distinct research domain will be summarized to answer six conceptual questions:

- Q1: What is the global division of labour in the GVC and what determines location choice?
- Q2: What role does the institutional and territorial context play in GVC activity?
- Q3: What effects do GVCs have on social and developmental outcomes?
- Q4: What are the incentives for participating in a GVC rather than be a stand-alone firm?
- Q5: What are the mechanisms of value creation and capture in GVCs?
- Q6: What is the role of managerial agency, and business strategy in GVCs?

## 1.1 The Macroeconomic GVC Literature: A History of Global Trade and Unbundlings

The Macroeconomic Literature studies GVCs as a new paradigm of trade across national borders with particular effects on national productivity. This domain is best represented by the work of Richard Baldwin and his students. Its unit of analysis is the Nation, studied at the Macro or national level, with its primary unit of analysis being the economic rent measured as GDP differentials over time.

This domain of research distinguishes contemporary GVC trade, which began in the 1950s, from forms of international trade in the past. The historical context identifies the

particular conditions under which GVCs emerged to demonstrate how GVCs are contingent upon political, technological, and spatial enablers. The genealogy thus contradicts casual observations of historical continuity, for example, that GVCs are merely “*an extension beyond national borders of the same market forces that have operated for centuries at all levels of human economic activity—village markets, urban industries, or financial centers.*” (IMF 2000). Instead it claims that contemporary GVCs are a departure from previous forms of international trade reaching back to Phoenician merchants or the East India Company which operated within a colonial monopoly established by military force. Helpman (2011) and Baldwin (2017) argue that the international trade of the past consisted of small volumes of luxury goods that cannot be compared to what moves in today’s globally-integrated markets. In order for an international market to qualify as Globalization, three formal criteria must be fulfilled (O’rourke and Williamson 2000 p. 26):

1. a convergence of prices
2. the re-allocation of productive resources
3. the break-up of monopolistic structures.

By analyzing 5 centuries of trade data, O’rourke and Williamson’s study concludes that these three conditions existed for the first time in history in the 19<sup>th</sup> century, during the first industrial revolution<sup>4</sup>. It is happening again now.

The emergence of Global Value Chains is a direct consequence of political transformations that gathered force in the aftermath of the second world war (during which global trade had effectively come to a halt). Postwar devastation arguably “*opened minds to radical changes*” (Baldwin & Wyplosz 2014, 4), and released a hereto unprecedented wave of political liberalization. Emerging economies in Asia dropped tariffs from near 50% to less than 15%, in addition to signing a raft of Bilateral Investment Treaties (BITs) and Preferential Trade Agreements (PTAs) into effect (Baldwin & Gonzales 2013 pp.2-3), which can be interpreted as the “*exchange of sovereignty for participation in international production networks*” (Baldwin 2017, p. 103) The European Union was founded in the same “*climate for radical change*” (Baldwin & Wyplosz 2015, p4), launching the dismantling of trade barriers, which continues

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<sup>4</sup> The fact that they find *no evidence* (sic) of global integration prior to the big bang of Globalization, which coincided with the transport revolution and industrialization of the 1800s, contradicts casual observations of the continuity of global trade to date.

doggedly and with setbacks, until today. Historically, the expansion of the EU's twenty-eight members created a significant internal market with enough diversity and freedom of capital within regions to allow specialization and competition (Altomonte et al 2008). With the fall of communism, newly-open Eastern European countries were dependent upon free trade and FDI inflows from the EU in order to establish functioning market economies. In a textbook example of preferential liberalization, the pressure of the neighbouring internal market motivated each CEEC, in a domino effect, to progressively adopt EU laws and practices, ultimately seeking full membership which was granted by May 2004. Opportunities emerged for manufacturers in the member states as the lower cost of labour in neighbouring regions which operated in the same time zone (unlike Asia or India), and cultural context (many CEECs spoke German), made outsourcing segments of their value chain to CEECs attractive. Analyzing degrees of international fragmentation of production, and intra-European openness in all 28 member states between 2000 and 2009, Ottaviano & Mayer (2007), and Guerrieri et al (2012), conclude that German firms profited from the low wage suppliers in the newly-accessible Eastern European region and *"...the establishment of regionalized production chains is a crucial determinant of Germany's increased export market share in the 2000s"* (Guerrieri et al 2012). Political liberalization continued around the world after the 70s, opening up large markets in Brasil, Russia, India, and China. China offered vast pools of low-cost labour for manufacturing assembly, India the same for business services, based upon a post-colonial Anglophone legacy. With management theory (Prahalad and Hamel 1990), exhorting them to focus on their core competencies and outsource the rest, firms in developed nations were quick to see the advantages of shifting work abroad. Outsourcing often boosted their productivity and lowered the cost of consumer goods like electronics and apparel.

The emergence of GVCs is a direct consequence of technical transformations, which lowered the cost of trade. Comparable to the first Industrial Revolution in which the steam engine and electricity lowered costs of manufacturing and transport, Global Value Chains have been enabled by a drop in the cost of moving goods and information. The shipping container lowered the cost of moving goods to *"a negligible fraction of the total...that makes the postage stamp seem overpriced."* (Caryl 2006, p.46, Levinson 2006 p. 267). An unintended consequence of the surge of investment in internet firms at the turn of the millennium was the installation of glass fibre cable between developed countries and Asia. This lowered the cost of moving information globally. Work could be modularized and transmitted quickly, at low cost, then be

feasibly allocated almost anywhere in the world (Berger 2005, Friedman 2006). The subsequent re-organization of industrial production resulted in a re-distribution of wealth, with material impact on regional developmental patterns.

The Macro-Economic stream explains the emergence of GVCs (which they call Global Supply Chains), as the embodiment of neo-classical principles. The first is Ricardian comparative advantage (Ricardo 1891), in which nations specialize in the industries which exploit their local comparative advantage, made possible by factor endowments. By trading these locally-superior products for goods which other countries produce better, for less, surplus value is created for both sides. At the same time, opening markets to trade from abroad leads to distributional conflicts, as predicted by Heckscher and Olin (1991), because domestic sectors are exposed to competition with exports. According to Helpman (2011, p.58) *“in every country the export-allied specialists gain from trade, while the import-allied specialists lose”* or *“deeper globalization meant a nation would shift more resources from its comparative disadvantage sectors to its comparative advantage sectors”* (Baldwin 2016 p. 172). The accelerated redistributive impact of GVCs is put into historical context as the most recent form of industrial revolution, which implies both social and political disruption. Baldwin defines two consecutive spatial *“Unbundlings”* (Baldwin 2006, 2011, 2012, 2015, 2017) in history. The first industrial revolution in the 18<sup>th</sup> century saw the *“unbundling”* of production from consumption, as steam technology lowered the cost of transport and mechanized production. This led to the regional consolidation of production capacity in the form of factories. As technological breakthroughs like the steam engine and electricity caused the cost of distributing goods to plummet, industrial plants with their economies of scale replaced the less productive artisanal workshops in each village (blacksmith, miller, tailor). Through the subsequent increase in productivity, and drop in consumer prices, the economies of the North experienced growth. The nations in the South re-allocated their resources to agriculture (where they were relatively productive), and stagnated. In this way, the *“First Unbundling”* in the 19<sup>th</sup> century resulted in a *“Great Divergence”* in global economic development and power (Allen 2011 p.32).

According to the Macro-economic school, GVCs (or supply chain trade, to use Baldwin's preferred terminology) triggered the Second Unbundling. Vertical specialization causes work that was previously carried out at a single geographic factory location to be traded and distributed to the most competitive location in the world. (Table 2).

Criterion	First Unbundling	Second Unbundling
When it	Around 1820	Around 1990
Where it	Central Europe	World
Political Trigger	Pax Britannica	Opening of China, Berlin wall falls and opens up former communist countries, Brazil and India liberalize markets
Technological Trigger	Steam power and Railways	Information and Communication technology including glass fiber and internet. Containerization. Modern air travel.
Effect on trade flows	Lower cost of moving goods	Lower cost of moving information and goods and people
Unbundling effect	Production and Consumption no longer had to be co-located.	Individual tasks within the factory and entire production process no longer had to be co-located.
Productivity effects	Economies of scale became possible.	Fragmentation brought Ricardian comparative advantage down to the level of individual tasks. Developing nations can join an existing GVC rather than invest in the entire industrial base, amplifying productive factors, with step changes from agricultural to industrial productivity levels in short periods of time.
Consumer effects	Cost of manufactured goods dropped.	Cost of manufactured goods dropped.
Imbalances	Know-how concentrated in G7 countries because info and people were expensive to move.  Inequality between capital owners and workers leads to social unrest – “Dark satanic mills”.	G7 labour no longer has a monopoly on know-how which is outsourced together with jobs causing degradation in some rich regions and overall gain in poorer ones.  The long-term becomes short term because fragmentation brings competition down to the level of individual task and job. These can shift to more optimal conditions instantly.
Geographic effects	Factory regions were created as the G7 industrialize. The South stagnates.	Factory nations and HQ nations were created. The South, especially China, industrializes. The North and G7 de-industrialize.
GDP effects	G7 share of world GDP increases (Baldwin’s “Great Divergence”).	G7 share of world GDP decreases (Baldwin’s “Great Convergence”). Over 1 Billion people raised out of poverty in developing nations, especially in China.

Table 2: A comparison of the first and second Unbundlings.  
With their effects on regional development. Source: author, based on Baldwin and Allen.

This second Unbundling has a colossal developmental outcome at the level of nation-state, which Baldwin calls “*The Great Convergence*”: the G7 countries have de-industrialized, while the South, particularly China, have rapidly industrialized, tending to equalize world GDP share over time (Figure 2).

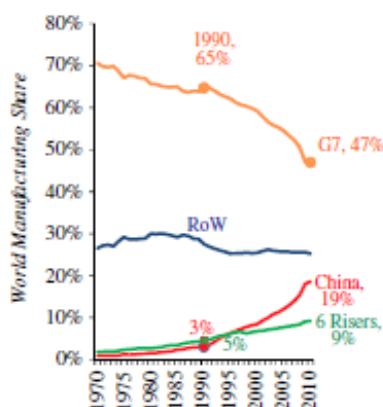


Figure 2: The share of World manufacturing GDP in 2005 measured in USD.  
Source Baldwin & Gonzales 2014, based on UNSTAT data.

By comparing the G7 vs. the I6, Baldwin and Gonzales emphasize that a dramatic “*reversal of fortunes*” (Baldwin & Gonzales 2015 p.4) has occurred. Up until 1980, Globalization had caused an increasing share of global trade to accrue to the G7 economies. After this point, the distribution patterns reversed. This global redistribution of growth and wealth has progressed since the second world war, and differs from national economy to national economy, and from region to region.

Table 2 not only presents the historical evolution of the Unbundlings, but summarizes the disruptive effects of GVCs from the macro view of nation-nation. These arise across several dimensions, principally from the amplifying effects that arise from the international network structure of production and trade. The literature names three disruptive effects: 1) on aggregate economic growth 2) on production factors, and 3) on logistics friction. The G7 nations had slowly built up their own domestic supply chains, industrial base, knowledge base, and social institutions over decades. By comparison, after 1985 GVCs offered emerging economies a singular opportunity to simply *join*, rather than labouriously *build*, an existing industrial base, which instantly increased their productivity from agricultural to industrial levels (Baldwin 2011, p., Baldwin 2017 p. 136). This explains why GVCs are considered to play a “*catalytic*” role for development (UNCTAD 2013 a, p. 23), and why GVCs have created a virtually unprecedented case of lifting nearly a billion people, mostly in China, out of poverty in less than 30 years (Johns

et al. 2015, Baldwin 2016, p. 107, WEF 2014 p. 8, *The Economist* 2013). Although the aggregated national development may be strong in selected nations, the macro-economic scholarship notes that individual regions within growing nations are in decline, and that a dichotomy of Headquarter and Factory national economies has emerged (Krugman 2000, Baldwin 2012). With the exception of Case and Deaton (2015), the differentiated social outcomes are not examined in detail.

GVCs have a second disruptive, amplifying effect: instant access to economies of scale amplifies production factors which would be less significant if they were to stand alone. GVC participation therefore makes it possible to build not only specialized firms, but entire regional clusters upon small increments in skills or knowledge. As a consequence, the traditional aggregated unit of analysis of national sectors (like automobiles or aeronautics), may no longer apply: *“The value chain follows specific commodities and services and encompasses several industries ... specialization is no longer in industries but in specific functions in the value chain.”* (de Backer & Miroudot 2014, p. 8, see Figures 1 and 3). Finished industrial goods, like an airplane (figure 3), no longer necessarily embody a bundle of a single nation’s comparative advantages. Although the brand owner may be headquartered in the U.S., as the example of Boeing illustrates, the Global Value Chain which produces the finished industrial good will make it impossible to define (and target investments in), national sectors like American Aeronautics, because its production value can no longer be allocated to any single national origin. Describing the new nature of international competition, Baldwin claims that *“It is no longer ...Japan versus Germany; it is the Honda-led GVC versus the BMW-led GVC”* (2016 p.146).

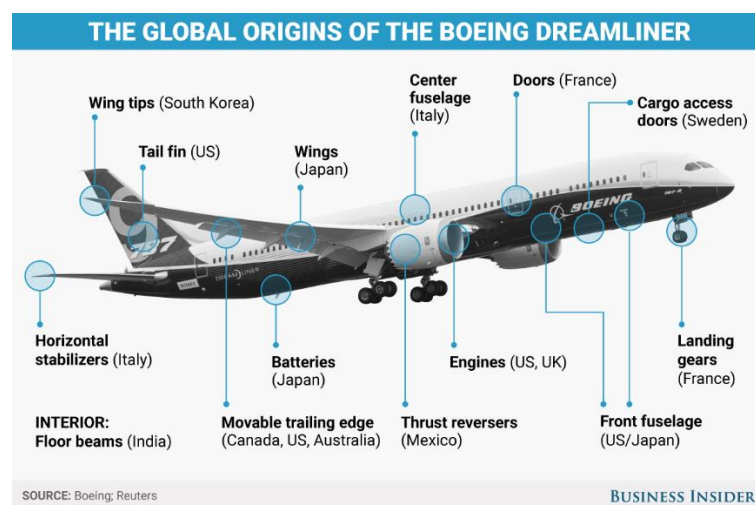


Figure 3: The Global Origins of the Boeing Dreamliner.  
An airplane whose GVC is led by Boeing does not have many components made in the U.S.A. where the brand-owner is headquartered. Source: Business Insider

In the third case identified by the macro-economic literature, amplification applies to the movement of goods within GVCs. Since intermediates in a GVC can cross borders several times, trade protection measures like tariffs magnify costs exponentially: *“in a highly fragmented production process (n=10), ...a 5% tariff leads to a 25% increase in the price of the final good – while a 20% tariff would increase the same price by 160%”* (OECD 2013, p. 90). Reversing this logic reveals the power of integration, since *“Vertical specialization can serve as a propagation mechanism magnifying tariff reductions into large increases in trade”* (Yi 2003 p. 29). A similar increase in logistics friction measured as time and cost of transport has a measurable effect on export trade (Hausman et al 2005).

The Macro-economic stream makes clear recommendations to its stakeholders, mostly the policy-makers who regulate national trade. These include a revision of how exports are measured to avoid double-counting flows which cross borders several times (Koopman 2010), a recommendation to no longer measure export value by measuring Finished Goods at all but the Trade in Value Added, for which new national databases have been created. In general, the cautionary warning against “old paradigm thinking” to manage the economics of the second unbundling which has seen a change in the nature of trade (Baldwin 2014 p.5). It will be much harder for nations to identify sunrise or sunset industries. Because of the fleet-footed and constantly shifting configuration of a global value chain, any investment in industries which at first glance appear to be “national” by traditional definitions, can inadvertently subsidize jobs in other countries (Baldwin 2014 p. 5), and that the application of old instruments to regulate trade and promote domestic industrialization (like tariffs), will have a counter-productive effect of making the inputs to national production more expensive, and local firms instantly less competitive. Since *“all manufacturing nations must import to export”* (Baldwin 2018, p.36) *“protectionism became destructionism”* (Baldwin 2016, p.99).



Based on this review of the macro-economic literature's answers to the 6 core conceptual questions about GVCs are summarized as follows:

Q1: What is the global division of labour in the GVC and what determines location choice?	Comparative advantage has been de-nationalized and takes effect at the level of the task, not the finished good or sector.  Specialization at the level of task will determine the geographic location of the value-adding activity.
Q2: What role does the institutional and territorial context play in GVC activity?	Nations enter into trade agreements and open their borders, exchanging sovereignty for participation rights in GVCs.
Q3: What effects do GVCs have on social and developmental outcomes?	G7 nations are rapidly losing their large portion of world GDP. Emerging nations, especially China, are increasing their share of world GDP. This effectively creates a great (global scale) convergence of wealth and growth.
Q4: What are the incentives for participating in a GVC rather than be a stand-alone firm?	The accelerating effects of the network makes it possible for developing nations to simply join a GVC rather than invest in the decades-long process of building their own industrial base.
Q5: What are the mechanisms of value creation and capture in GVCs?	Trade and specialization, albeit at a much finer degree of resolution as Ricardo imagined the creation of value through comparative advantages. Nations are now turning small increments of productive capacity into entire industries which trade in tasks and intermediate goods.
Q6: What is the role of managerial agency, and business strategy in GVCs?	The rational response to market dynamics assumes competitive behavior at the firm level. Although Managerial agency is not considered in detail, it is not dismissed by this stream.

## 1.2 The Sociological Literature on GVCs: A history of world systems and unequal gains

If the Economist and Management scholar Porter coined the term Value Chain, it is the sociologist Gereffi who coined the term *Global Value Chain*. This originated a new stream of globalization studies which took the sector-specific network (or chain), as a unit of analysis of developmental outcomes in specific locations. This school of GVC research has arguably established itself as the most impactful in the subject, as an increasing number of scholars from multiple disciplines refer to his groundbreaking theory. Richard Baldwin, for example, credits Gary Gereffi personally as “*instrumental in getting economists to view global value chains as something more than foreign direct investments*” (Baldwin 2016, p. 273). Timothy Sturgeon, a collaborator at MIT’s Industrial Performance Center confirms that the Gereffi stream produced a much-needed “*set of tools that...help advance the debate on the shape and trajectory of global economic integration*”. Without these tools and templates, researchers would have only macro-level trade statistics to analyze cross-border inter-firm behaviour and its developmental impact (Sturgeon 2001, p9). Geographers like Coe et al (2008) drafted their GPN construct upon the work of Gereffi’s GVC, and expanded his original conceptualization<sup>5</sup>. Scholars of International Business have begun to grapple with Gereffi’s definition of a GVC, and consider the implications for their domain’s theories of internalization (Strange & Humphrey 2019, Benito et al 2019). Operations managers refer to Gereffi’s seminal work on governance and trade in intermediates to derive consequences for the design of international manufacturing networks (Brennan et al 2015). To present the sociological stream in its specific intellectual context, this section begins with a history of GVC theory, its intellectual roots, assumptions and declared intentions, then summarizes the most salient and generalizable findings. In the course of the review, a notable divergence emerges between the declared agenda (intentions and target audience) of the research, and its empirical outcomes.

The sociological GVC research is motivated by the inequalities which result from globalization. Its study of developmental outcomes chooses to focus on the “*dark side*” of Globalization (Kaplinsky 2000 p.117), to address what they claim to be a persistence of absolute

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<sup>5</sup> The GPN stream will be reviewed in following section.

poverty in a world where economic activity is increasing, but individual returns, mostly in developing countries, are falling. The field ponders the role of global value chains in *“immiserizing growth”* (Gereffi 2018, p.144), and declares it will examine the developments at all levels of the network: *“the individual, the household, the firm, the town, the region, the sector and the nation.”* (Kaplinsky 2000, p.120). In contrast to the *“shallow integration”* of the past, in which finished goods were traded across borders, today’s *“Deep integration”* across national borders is orchestrated by TNCs, who are producing everywhere and consequently control the distribution of activity at any one location. The hypothesis is that these buyers appropriate a disproportionate share of network-wide rents at the expense of local suppliers. The motivation for studying MNCs as the governing agent in *“a hierarchically structured global capitalist economy”* (Gereffi 2018, p.15), is therefore to determine to *“what extent have MNCs supplanted the national autonomy of governments?”* (Gereffi 2018, p.6) and is hence also a political one. The scholarship addresses the policymakers in periphery states which must contend with, and defend themselves against the rival institutional force of MNCs *“which undercut the ability of nation-states to build domestic industries controlled by local firms...[and] which had the power, resources, and global reach to thwart the territorially-based objectives of national governments in both developed and developing countries”* (Gereffi 2005, p.165). The question is how public governance (in the form of statist, Keynesian intervention), should respond.

Two genealogies of the Gereffi domain reveal openly anti-capitalist positions (Bair 2009) which are not always explicit in individual publications. The researchers originally studied what they termed Global Commodity Chains, or GCCs. This built upon Wallerstein’s world systems theory, a branch of sociology which *“drew heavily on earlier critical perspectives of imperialism and capitalist exploitation”* and remains sceptical of the opportunities offered in a modernizing system dominated by core developed countries. Wallerstein’s title implies a systemic view, which would include the strategy of the firm, but its scope is more reductive, investigating production processes across political jurisdictions, and *“complex ‘world-scale’ division of labor marked by phases of expansion and contraction”* (Hopkins and Wallerstein 1986, p. 159). The complexity of these phenomena can be summarized by two key assumptions about scale and the international divisions of labour: the first is that the connective structure of the network determines economic and social outcomes of individual participants. The second key assumption derives from the cited Dependency theory, and which is corollary to structural

determinism. Globalization is viewed as the re-creation of an economic hierarchy in which poor countries are integrated (are essentially co-opted) by rich countries. The resulting dyads of unequal firms *“highlighted the exploitative potential of increased contact between the ‘core’ countries and the ‘periphery’ in the international capitalist system”*. At close quarters, the asymmetry of power will tend to lead to *“the development of underdevelopment’...[because] links to the center were the source of many of the Third World’s problems, rather than a solution”* (Frank 1967, cited in Gereffi 2018, p.3). There are not only barriers to entry into this subjugating system, but once inside, participants experience a kind of entrapment because *“Leaving one structural position implies taking on a new role in the international division of labor, rather than escaping from the system; thus the possibilities for autonomous paths of development are quite limited.”* (Gereffi 2018, p.4).

Conceptualized in this way, sociological GVC theory sees Globalization as a continuum which operates unchanged from the 16<sup>th</sup> century to the present. Its rich-to-poor structure interprets these centuries of imperialist activity as the precursor to GVC trade: the annexation, extraction, and transfer of unprocessed materials (cotton, wheat, spices, and coal), from remote colonies to consumers in developed Europe. State-run monopolies (defended by its military force), like the East India and Hudson’s Bay companies are cast as the antecedents of today’s powerful MNCs. Sociological economics also studies Globalization in terms of its (disruptive) effects on social outcomes, which are *“... greater vulnerability to unfamiliar and unpredictable forces that can bring economic instability and social dislocation, as well as a flattening of culture in the face of well-financed global marketing machines and ‘brand bullies’”* (Gereffi 2005, p.175). No empirical data are provided for observations like the *“flattening of culture”*, the persistence of absolute poverty, or of *“bullying”*, but the choice of language attributes these negative effects of the neo-Colonial world system to the malicious personal intent of its actors.

In the sociological GVC literature, the earliest construct of trade was of Global Commodity Chains, or GCCs, which continued to study the extraction and expediting of bulk goods, as:

*“sets of inter-organisational networks clustered round one commodity of product, linking households, enterprises and states to one another within the world economy. These networks are situationally specific, socially constructed and locally integrated, underscoring the social embeddedness of economic organization”* (Gereffi & Korzeniewicz 1994, p.2).

Extending world systems theory, early GCC research therefore defines the trade network as a social construct, specific to its location. It conceptualizes business practices and structures as forces which produce these social outcomes. This resulted in the influential construct of “*buyer-driven*” commodity chains, that owned no factories, but roamed the world for cheap suppliers. In a later theoretical refinement, this scope was expanded to include manufacturing sectors, with “*producer-driven*” commodity chains, which operated factories abroad.

The anti-capitalist stance is associated with several important assumptions about economic behaviour. According to Gereffi, one of the advantages of the term GVC, instead of FDI or trade volumes, is that it “*allows us to think about ‘incomplete’ firms that have specialized in certain...functions. By focusing on the chain or organizational network as the unit of analysis, interesting questions about power, governance, and dynamics...emerge*” (Gereffi et al. 2001, p.2). Again, the language reveals an important theoretical assumption, that specialized firms are incomplete. By extension, contrary to classical economic principles, it implies that firms and nations which are autark, or self-sufficient in their production capacity, in pursuit of “*escap[e] from the [Wallersteinische world] system...autonomous paths of development*” are both viable and “*complete*”. This social ideal of autonomy is compatible with the interventionist Import Substitution Industrialization (ISI), mostly in Latin America, which was disrupted by the industrial policies associated with the Washington Consensus. In retrospect, GVC participation is made synonymous with Export Oriented Industrialization (EOI), which may be easier to join, but is less advantageous in the long run<sup>6</sup>.

The proliferating case studies and the accumulation of empirical data eventually exerted a mitigating influence on the political anti-market positions of the early GCC studies. Working at MIT’s Industrial Performance Center<sup>7</sup>, Sturgeon et al’s (2008, p.8) genealogy also traces the roots of extant GVC literature to Wallerstein’s world systems theory, then provides a more detailed account of how the questions and units of analysis of the research evolved over time.

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<sup>6</sup> According to Gereffi “...while industrialization under the EOI model became easier and faster (countries could just ‘join’ supply chains by performing specialized tasks, rather than ‘build’ them), it may also be less meaningful. If countries are only engaged in the simplest forms of EOI, such as assembling imported parts for overseas markets in export-processing zones, then they would develop neither the institutions, nor the know-how, nor the consumer markets needed to create and sustain entire industries” (2014, p.16).

<sup>7</sup> The IPC is hosted by the Sloan School of Management and has the motto “*Innovation. Productivity. Competitiveness*”, which suggests less interest in distributional inequality than in firm-level performance. See also <https://ipc.mit.edu/people/timothy-j-sturgeon>, accessed December 2019.

The original GCC concept could not explain the shift from vertically integrated trade, that the buyer-driven model was not adequate for describing the newer forms of network behavior. Furthermore, the notion of “commodity” as undifferentiated products, usually raw materials like crude oil, or bulk agricultural goods, was not generalizable to value-added trade, like electronics or heavy machinery. The refinement of the GCC concept was thus a reformulation to reflect trade practices in post-colonial markets, and modern industrial economies, by focusing *"attention on the main source of economic development: the application of human effort, often amplified by machines to generate returns on invested capital."* (Sturgeon et al 2008, p.10). With this, GCC theory recognized that the governance of trade had shifted from colonial, state-owned monopolies, to firms operating within freer markets. Even as Sturgeon acknowledged modern manufacturing trade, the sociological research continued to prioritize the effects of distributional inequality in those emerging markets which failed to grow in the current wave of globalization. Its research discounted the Asian miracle to maintain a focus upon potentially exploitative, neo-imperialist, practice (Gereffi & Korzeniewicz 1994, Kaplinsky 2000, Kaplinsky & Morris 2001, Gereffi & Fernandez-Stark 2011).

The sociological GVC theory has produced an analytical framework (Gereffi & Fernandez-Stark 2011), which expands theories like transaction cost economics. Its methodology defines four structural dimensions which define GVCs and recommends that these be applied to study any industry-nation dyad:

1. Input-output structures, spanning the transformation of raw materials into finished goods
2. Geographical context
3. Governance structure
4. Institutional context

In wide use today, this framework expands the original buyer- or producer-driven view of international trade, to take a holistic view of the production network in its respective locations. This descriptive framework has been applied extensively to industries in developing countries. The Duke Global Value Chains Initiative website provides a list of journal articles sorted by industry and number of studies in parentheses: Apparel (86), Agriculture (74), Automotive (32), Textiles (27), Coffee (24), Electronics (22), Food (16), Furniture (13), Footwear (12), Fishing (11), Flowers (9), Tourism (9), Manufacturing (8), Retail (8), Forestry (6),

IT/Software (6), followed by 56 classifications of industries, some of which are either sub-categories, or redundant descriptions (like Electronics/Mobile Phones/Telecommunications, Fruit) of the most densely studied, with less than 5 studies each. ([https://globalvaluechains.org/publications?f%5B0%5D=field\\_publication\\_type%3A749](https://globalvaluechains.org/publications?f%5B0%5D=field_publication_type%3A749), accessed March 2019).

To guide the response of public governance to these structures, its declared audience and one of its key stakeholders (besides labour), the research turned its attention to the mechanism of private or firm-led governance as *“a key determinant of upgrading outcomes.”* (Gereffi & Lee 2016, p.26). If language (typified by *“bullies”, “dominance”, “exploitative”,* and *“dependency”*), is any indicator one might expect the assessment of power dynamics to be pre-determined. It is therefore interesting to discover that the grounded research eventually diverges from its original anti-capitalist, neo-imperialist point of departure.

One of its most widely-cited construct categorizes five modes of governance, as a function of explicit coordination and power asymmetry: 1) Market, 2) Modular, 3) Relational, 4) Captive 5) Hierarchy (Gereffi et al 2005, figure 4):

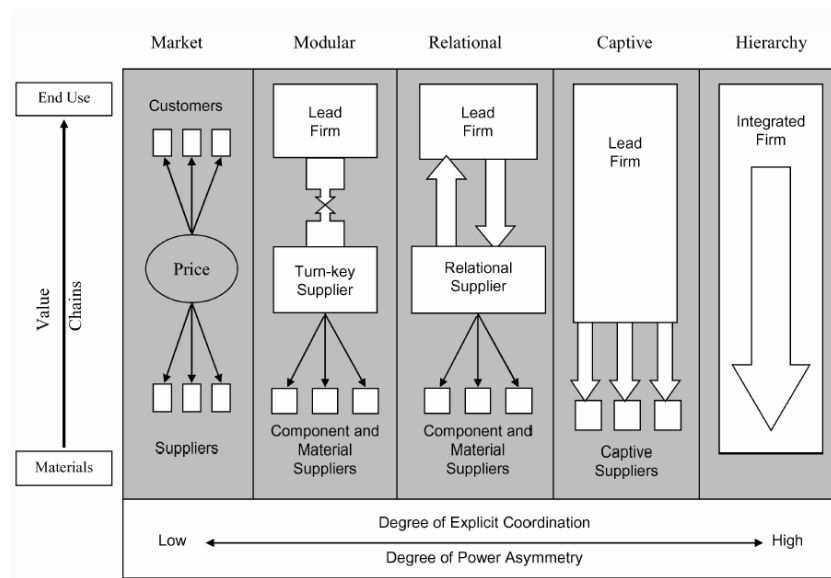


Figure 4: The typology of Governance structures in a GVC in order of explicit coordination and power asymmetry (Gereffi et al 2005)

This GVC governance framework makes several important contributions to the understanding of network operations. First of all it effectively updates the theory of transaction cost economics, whose governance continuum consists of two binary extremes, internal integration and market exchange, and assumes that finished goods are moving between

traders (Williamson 1975). The GVC typology expands this model to include the most significant forms of interaction within a value-adding network in which intermediates are being traded across borders. Second of all, intentionally or not, the model shifted the focus from the state, to the level of firm, generating a theory which predicts how governance will function and adapt should one of the three dependent variables (complexity of transactions, ability to codify requirements to create modularity, supplier capabilities) change. In so doing, it made governance the impersonal function of multiple factors in the system, which may account for its immediate acceptance (Sturgeon 2008, p8) by scholars and practitioners alike.

In effect, the success of the GVC governance archetypes proceeded to divert the theory-building from its original anti-capitalistic and anti-dependency orientation. The GVC theory does not intensively explore social outcomes at the community or family level, nor does it fully explain these through its archetypical power configurations. Instead, it reveals much about how firms interact within a value-adding network, rationally expecting each supplier in a GVC to seek to upgrade their position, and increase their share of rents, which will have positive social outcomes, with *“countries, firms, workers, and many other stakeholders in the global economy ...affected by these shifts”* (Gereffi 2018, p. 142). Again, considering the declared Keynesian position of the research agenda, *“to identify implementable policies to help reduce growing inequality within and between countries and the impoverishing aspects of globalization”* (Gereffi 2018 p. 16), it is noteworthy that the governance typologies they identify are not inescapably skewed in favour of hierarchical control by the TNC. Instead, the range of governance forms are the outcomes of varying degrees of power asymmetry, with captive and hierarchical control comprising only two of the 5 possible archetypes. More than half of all governance types therefore distribute power away from a central buyer. Furthermore, the framework states that the power can shift between parties through knowledge spillovers and strategic agency, which contradicts previous claims of *“deep integration”* (Gereffi 2018, p.142), characterized by centralized control and universal buyer coercion.

The chapter *“The Global Economy”* (Gereffi 2018, pp.137-165), in Gereffi’s own recent genealogy<sup>8</sup> reiterates the researcher’s concern over the power of the TNCs which govern

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<sup>8</sup> Gereffi’s 2018 book, *“Global Value Chains and Development: Redefining the Contours of 21<sup>st</sup> Century Capitalism”* is a collection of the most influential and highly-cited GVC publications, effectively a ready-made structured review of the literature, which benefits from his own frank account of its political agenda. Gereffi personally provides an eloquent and comprehensive review of the intellectual history and influences through which sociological GVC theory emerged in its present form.



GVCs, and may have “*supplanted national governments*” (Gereffi 2018, pp.146), as well as play a role in perpetuating dependency and poverty in the world they have economically integrated (i.e. re-colonized). By pitting the interests and resources of multinational businesses against national governments, this stream of theory imagines a confrontation between private or business-led governance, and public or state-led governance, which justifies the scholarly interest in corrective policy. At the same time, the empirical results concede that the disintegration of the production function has caused the concentrated power of TNCs to diminish (Sturgeon 2008, pp.22-23). The grounded research does not consistently confirm corporate threats to national power and exploitation of firms in the periphery. Instead they provide numerous cases studies of successful industrialization and upgrading by developing nations, like the East Asian NICs “*which are generally taken as the archetype for industrial upgrading among developing countries*”, or the powerful contract manufacturers in the electronics industry (Gereffi 2018, pp.156). Their own evidence does not deter the authors from upholding a consensus that the neoliberal agenda of market fundamentalism has failed to address the most serious problems of development in the world (Gereffi 2005, p.176), because economic upgrading leads to unequal development and does not ensure that social upgrading follows (Barrientos et al 2010). It also does not definitively prove that participation in GVCs systematically “*immiserizes*” growth, although it establishes that standards can function as barriers to both entry and upgrading for suppliers in developing nations (Ponte & Gibbon 2005, Nadvi 2008, Lee et al 2012).

In terms of practical relevance, the sociological literature is the only stream to provide highly-cited heuristic tools like a step-by-step “Primer” to guide stakeholders through the case-by-case analysis of an industry in a particular location (Gereffi & Fernandez-Stark 2011, Kaplinsky & Morris 2001). Its purpose is to methodically assess key aspects of the GVC, its structure, its governance structure, its upgrading options, and what must be done for a sector in a particular location to become or remain competitive. This facilitates the formulation of strategy as firms, activists, and the state can all refer to the Input-Output structure and differentiated activity maps to design precise interventions, or support upgrading. As such, the sociological GVC stream, with its origins in world-systems and dependency theories, has been disproportionately influential in delivering generalizable modules of theory to economically orthodox disciplines (like international business, economic geography, and operations), which do not necessarily share its ideological positions.

Based on this review of the sociological literature on GVCs, the stream's answers to the 6 conceptual questions of this dissertation are listed below:

Q1: What is the global division of labour in the GVC and what determines location choice?	The hierarchical structure of core and periphery is reproduced by global trade led by TNCs/MNEs. Their choice of location is determined by arbitrage of cost, and especially wage levels and standards.
Q2: What role does the institutional and territorial context play in GVC activity?	MNCs are rivals to the power of local governments, although little data beyond the sheer size of these firms are provided as evidence of this confrontation. It is assumed that research must advise public governance to counter the excesses of private governance.
Q3: What effects do GVCs have on social and developmental outcomes?	GVCs do not make all participants rich although a number of developing nations are success stories. There is a concern that developing countries might work their way to the bottom, with diminishing terms of trade and returns to their labour.
Q4: What are the incentives for participating in a GVC rather than be a stand-alone firm?	It is desirable for a national economy to be economically autark, and escape from the world system of dominance and exploitation. Firms should also strive to vertically-integrated in domestic locations, which makes them complete.
Q5: What are the mechanisms of value creation and capture in GVCs?	Five types of governance structures emerge from asymmetries of power, the codifiability of instructions, and the capabilities of suppliers. The empirically-validated GVC governance typology indicates that, contrary to world systems theory and its characterization of MNCs, the relationship is not always hierarchical i.e. dominated by a rich-country buyer.
Q6: What is the role of managerial agency, and business strategy in GVCs?	Managerial agency is not examined in detail. The inter-firm GVC Structure is destiny. The high-level strategy of MNCs is to effectively colonize their poor suppliers and coerce them work themselves to the bottom.

## 1.3 Economic Geography and Global Production Networks

The rise of value creation at a global scale has necessarily brought it to the attention of economic geographers. According to Vlčková:

Economic geography is the study of the location, distribution and spatial organization of economic activities across the world. Economic geography focuses mainly on how and why economic activities differ from place to place.” (Vlčková 2017 p. 8)

A discipline concerned with the relationship between economic activity and location has generated a significant stream of research on the construct of Global Production Chains or GPNs. Although the terminology implies a potentially reductive focus on production only, the stream is critically sensitive to the ideological debates around Globalization and developmental theories, setting itself the task of debunking

... some of the more egregious globalization myths: the world is **not** flat (contra Friedman) / The world is **not** borderless (**contra** Ohmae) / Global corporations do **not** rule the world (**contra** Korten) / Globalization is **not** always good (**contra** the neo-liberal hyper-globalizers) / Globalization is **not** always bad (**contra** the anti-globalizers). (Dicken 2015, p.8, emphasis in original)

To address the complexity of this Globalization, not as a snapshot or inevitable outcome, but “*rather, a complex indeterminate set of processes operating very unevenly in both time and space...continuously in flux*” (p.8) it also declares itself open to dialogue with related fields which include the sociological work on GVCs, Logistics and Supply Chain Management, and of course, the rational Economic logic which remains an integral component of its theory.

The most comprehensive and influential summary of the field is *Global Shift* (Dicken 2015), widely considered a classic both within and beyond the field. In his definition of GPNs, Dicken, a representative of the Manchester school, notes the radical departure from a trading system in which finished goods, capital and people moved between nation-states, to one in which economic activity is distributed, and interacts, around the world. Dicken draws upon a broad range of theoretical views including sociological GVC studies, business studies, and macroeconomic theory, to describe and explain the character and causes for where value is created and why. The monograph acknowledges both the fact that after WWII, “*there has been a relative shift in aggregate terms from developed to developing economies although this should not be over-stated or, indeed taken for granted. Many parts of the world remain, to a greater*

*or lesser degree, disarticulated from the engines of economic growth.”* (Dicken p.36). Economic geography uses the GPN construct to describe, analyze, and explain this shift.

In spite of the undeniable inequalities, the theory is rooted in neoclassical economic rationality, and is not critical of capitalism *per se*. The GPN literature emphasizes the interconnectedness, the grounding of activity in location, the networks of networks of the global production system in which *“Both history and geography matter”* (p.53). For this, it presents empirical evidence, including topologies, case studies and process models. It considers questions ranging from the enabling role of technology in global integration, how technology is replacing certain job classes in certain locations, the role of the TNC as well as that of the state, the root causes of inequality at a global scale, as well as within developing and developed countries. Any explanation refers to empirical evidence, and analysis of its geographic boundary conditions.

GPN theory recognizes the key role that the TNC plays in coordinating and controlling operations in more than one country, but states that this occurs within the macro-structures of the global economy in which these firms are territorially embedded. It is critical of scholarship which perceives large TNCs as rivals to the power of the state and potentially operating outside its regulatory reach. Dicken is reluctant to accept sweeping overstatements of power attributed to any actor in the highly interconnected network:

The popular view tends to see the state as always in a subservient position to the invariably dominant TNC. In fact relationships between TNCs and states are far more complex and ambiguous...[they] are continuously engaged in intricately choreographed negotiating and bargaining processes. On the one hand, TNCs attempt to take advantage of national differences in regulatory regimes (such as taxation or performance requirements, like local content). On the other hand, states strive to minimize such ‘regulatory arbitrage’ and to entice mobile investment through competitive bidding against other states....the outcome of a specific bargaining process is highly contingent. States still have significant power vis-à-vis TNCs...So the claim that states are universally powerless in the face of the supposedly unstoppable juggernaut of the ‘global corporation’ is nonsense; the question is an empirical one. (Dicken pp. 230, 248)

The rebuttal of myth does not mean that the relationship between state and TNC is simple. In fact, that relationship is contentious and shifting. The structure of a GPN is discussed in terms of how value is both created and captured in a particular geographic location. The impact on the environment and the distribution of jobs is also discussed, acknowledging the messy causality of the latter as it is considered in a number of different locations and contexts.

The scholarship on Economic Geography builds upon the widely-cited work of the sociological Gereffi school, its identification of the four fundamental structural components of a GVC, and the 5-fold typology of governance variations which determine the way value is appropriated across location-industry dyads. Like GVC sociological literature, the GPN stream of Economic Geography has its origins in the critique of unequal outcomes in globally integrated economy (Coe et al 2008 p.274). It examines the interrelated levels of macro structures (Institutions of the capitalist market system), in which networks of firms, consumers, labour, and states are embedded, and the uneven distribution of *"goods and bads"* which are the outcomes of "space-time" processes (Coe et al 2008, p.273). But from this point on, the GPN theory parts ways with the Gereffi school. If the sociologists consider the GVC as a social construction which will require state interventions to correct developmental inequalities and power asymmetries, the geographers *"acknowledge both structure and agency as important in shaping GPNs"* (Coe et al 2008, p. 289).

The research of the Manchester school addresses a number of theoretical gaps which they identify in the GVC school, like the static nature of the network, which the GPN construct defines to be continuously evolving, or the fact that the firm is treated as a black box, which eliminates the possibility of firm-level agency striving for competitive advantage. The elimination of differences between firm behaviours results in *"the tendency for GVC/GPN analyses to assume that firms occupying similar positions in production networks will respond in a similar fashion"* (Coe et al 2008 p.278), which is contradicted by empirical observation. GPN theory also acknowledges the key strategic role of logistics, in the study of the configuration, behavior, and causal mechanisms in complex global network.

GPNs which are operated and coordinated by TNC firms, are embedded in the environment, in multi-scalar regulatory systems within states, macro-regional economic arrangements, labour, consumer and civil society. As the scope of activity and number of stakeholders proliferates, the GPN construct is described as a *"contested field"* but immediately qualifies the confrontation that this implies: *"Not only are power relationships between GPN actors not structurally determined but also they are not unidirectional. Each of the major sets of actors in the global economy is involved in both cooperation and collaboration on the one hand, and in conflict and competition on the other."* (Coe et al 2008 p. 288). It is not structure or role allocation in the network which determines the political tension, but a number of other circumstances and strategic choices. The relationships between TNCs and labour can be

combative or cooperative. They are not always of one type and pre-determined. Nor are labour unions without any conflict in the pursuit of their own agendas. Firms are known to both compete and collaborate with one another. For example, the Boeing company supplies components to its archrival Airbus, and Canon delivers printer engines to Hewlett-Packard company. The relationship between TNCs and state regulators can vary as well, and none of these real cases amounts to a paradox. As such, the economic geographers strive for differentiated and dynamic explanations of what they insist is a complex, evolving phenomenon.

According to Yeung & Coe (2014), GPN theory addresses a number of theoretical gaps and logical inconsistencies, some of which were identified by other scholars (Gibbon et al. 2008, Starosta 2010). Because of its empirical content, the GVC stream presents more of a descriptive framework (what they are), rather than a theory of how these observed phenomena came to exist (why they emerged as they are). This underdeveloped sociological theory of “*value, embeddedness, and power*” has resulted in a lack of explanatory or causal analyses of how the three categories predictably interact. The static view of dyadic relationships (buyer-supplier, lead firm-supplier, industry-location), does little to explain variations between GVC structures and outcomes in the same location. Without further conceptualization of how the network operates, five governance archetypes inadequately describe how a lead firm drives the entire chain, because any network can display multiple governance types at various nodes (Gibbon et al. 2008 p.323). Competitive dynamics are not considered by sociological economics at all. The sociological GVC literature addresses only policy-makers, which suggests that these are the only agents in a capitalist system they seek to counteract. The decision-makers in the firm are of no importance for two reasons: the first being structure is destiny, and the second being that the only strategic intent a lead firm can have is single-factor cost reduction. By extension, GVC theory posits that cost arbitrage across global markets would be the only source of value-appropriation and governing power in the network.

To address these gaps, Economic geographers propose a second generation of the GPN theoretical framework, “*GPN 2.0*”, which begins by moving “*away from industry-level generalizations*” (Yeung & Coe 2014 p.4), to multiple actors, and their organizational relationships across locations (Coe et al 2008 p. 272). The GVC’s narrow focus on cost ignores the differentiating effect of the capability of the firm. Claiming that “*Cost reduction alone ... cannot be the fundamental driver of evolving global production networks.*” (Yeung & Coe 2015

p.9), GPN theory proceeds to study the competitive dynamics between firms and how this affects their strategic decision-making. Distancing themselves from the sociologists' capitalist-critical position, the GPN stream counters that it is in fact capitalist dynamics which drive economic production in a spatially-integrated network. Accordingly, the main actor in a GPN is not the policymaker in the state, but the firm, which *"can ... be thought of as a managerial device to optimize the accumulation and deployment of its available resources, defined as its core capability, at the lowest possible cost"* (Yeung & Coe 2014 p. 38). By restoring agency to the firm, GPN literature predicts the fact that there will be differences between firm performances and outcomes within every industry-location dyad. This is a fact that the GVC governance typology illustrates, but does not explain.

Firms are subject to economic and political forces at work in the network and react accordingly. An understanding of individual actor strategies bridges the conditions at both firm and industry level. GPN 2.0 thus proposes four constructs or *"explanatory tools"* (Yeung & Coe 2014 p.5) to help think about how firms respond to competitive challenges. They are motivated by any number of the following objectives: 1) Optimizing cost-capability ratios 2) Market development 3) Financial discipline and 4) Risk management. The dynamic recombination of these four motivating objectives produces one of three *"types of firm-level strategy that explain the particular configurations of global production networks in specific historic and geographic contexts"* (Yeung & Coe 2014, p.15):

1. Intrafirm Coordination is selected by firms competing in promising, but risky markets, who choose to internalize their network through FDI and acquisitions.
2. Interfirm control is displayed by firms with high cost-capability ratios and subject to financial discipline who choose to outsource non-core activities and integrate dependent suppliers into their global network.
3. Interfirm partnership must be developed by firms when all three objectives of high cost-capability ratio, high market potential, and high risk, converge. Success will depend on cooperative behavior responding to immature or uncertain market conditions, and fuzzy technologies. *"The prospect of an expanding and unsaturated market assures a lead firm and its partners and suppliers that they can collectively benefit from their cooperative value creation process"* (Yeung & Coe 2014 p.50)

With this logic, GPN 2.0 not only reframed the unit of analysis from industry to *“individual lead-firm based configurations”* (Coe & Yeung 2019, p.778), it provides causal explanations for structure and behaviour, to arrive at a differentiated understanding of upgrading pathways, and their link to uneven developmental outcomes. This foresees a more active and entrepreneurial role for the state than as a *“background institutional context”* (Coe & Yeung 2019, p.782), or as a combative regulator. Consistent to its *“actor-centric conception of Global Production Networks”* (Coe & Yeung 2019, p. 782), the state can take on several influential roles, that of regulator, producer, buyer, and investor. It recommends a dynamic approach to regional policy implementation which would *“incorporate both endogenous regional assets and strategic imperatives in global industries”* (Yeung 2015, p.1). Analysing the cases of successful development (Singapore, South Korea, Taiwan, China’s Pearl River Delta), as well as those of developing nations, GPN scholars recommend a structured and *“strategic coupling”* between regions and production networks, which *“is therefore a mutually dependent and constitutive process involving shared interests and co-operation between two or more groups of actors who otherwise might not act in tandem for a common strategic objective.”* (Yeung 2014, p.5).

### **Smile Curve Economics**

Because of its importance, Smile Curve Economics will receive dedicated attention in this literature review. The GPN 2.0 stream is complemented by a seminal article *“Location, control and innovation in knowledge-intensive industries»* (Mudambi 2008), on the spatial distribution of value creation and capture, published in the Journal of Economic Geography. Its declared objective is to create an interface between the two independent research streams of International Business, which examines the organization of firms across national borders, and Economic Geography, which examines the location of economic activity. It effectively describes a major shift in *“the dynamics of rents in GVCs, which are increasingly determined by intangible assets (such as copyrights, brand names and design)”* (Gereffi 2014, p. 11).

The fundamental question that Mudambi addresses is that of a managerial decision-maker: “How should the firm control the various parts of the value chain and where should it locate them? More specifically ... to what extent should the firm implement vertical integration and geographical dispersion with respect to its value chain activities?” (Mudambi 2008, p.3). To answer this question, the research takes the type of work as its unit of analysis. Within the



GVC network, the tasks being traded are categorized as either tangible or intangible and this distinction will ultimately determine how value is added and appropriated by individual participants. Because they constitute the essence of highly- creative and innovative work, intangible assets will be the source of future wealth and *ceteris paribus* will deliver higher returns. Not to be restricted to patents, brands, and other forms of intellectual property, intangible assets *“can also appear in the form of superior returns generated by inimitable organizational structures and inter-organizational relationships”* (Mudambi 2008, p.2), in other words, the network configuration is an intangible asset and system design a valuable capability.

As a result of globalization, which presents new market choices and pressures, firms are distributing their assets across geographies. To get this right, i.e. in order to achieve superior rents, it will be necessary to analyse the value chain along two dimensions: location and control. Firms can thereby implement one of two possible strategies, the traditional default mode of vertical integration, which would retain control over the *“linkage economies”*. According to Hirschmann (1977), linkages create surplus value when knowledge flows from one activity to another within the firm, improving efficiency and effectiveness. The second possible option is a *“specialization strategy”* which *“focuses on identifying and controlling the creative heart of the value chain, while outsourcing all other activities.”* The choice of strategy is not predetermined and will vary from firm to firm. In cases with poor or no linkage economies, the vertical integration detracts focus on core competencies, or maintains economic activities which are less productive when executed internally by the firm, than is externally available in a market. The rapid spread of GVC trade, and the dis-integration of production, suggests that linkage economies are on the decline.

The resulting geographic distribution of activities reflects both comparative advantage, trade in tasks, and firm strategy. The more creative, higher value-adding activities are usually located in developed countries, while the lower-value adding repetitive activities tend to be shifted to developing countries. When the amount of value-added is graphed against position in the value chain and geographic location, the resulting pattern is a “smile curve of value-chain disaggregation” (figure 5).

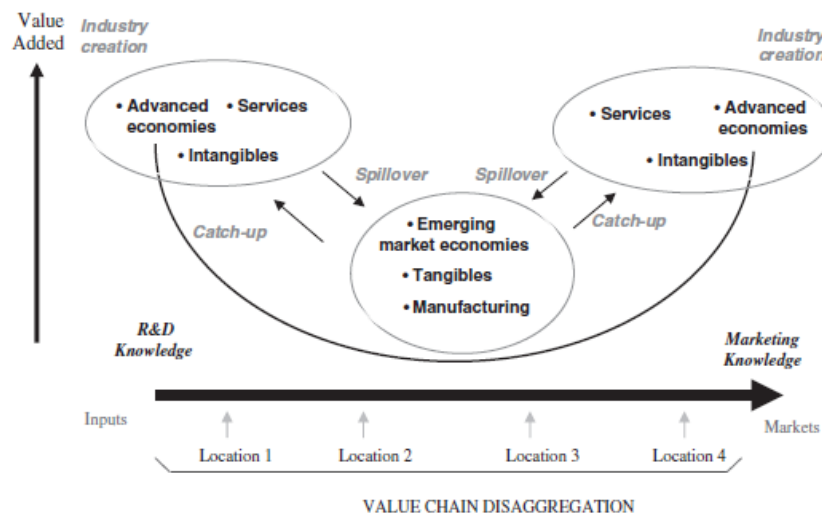


Figure 5: The smile curve of Value Chain Disaggregation  
Source: Mudambi 2008, p.11.

At first glance, emerging economies are identical to low-cost locations which tend to work on low knowledge-intensity, repetitive and tangible tasks like mass assembly. This is confirmed by individual industry studies like Kraemer et al (2011). They occupy the bottom of the value curve. The configuration of value creation and trade is also not static. The division of labour reveals opportunities as well as inequalities. The tensions which arise between the differences in value and position provoke both firms and locations to respond. As a result, the positions on the curve are in a state of flux. According to Mudambi's illustration, there are three dynamics of the activities within the chain each of which have broader economic impact on their geographic location. The first is "*industry creation*" which occurs at its extremes, as product development and marketing result in innovations and the launch of new industries, usually in developed countries. As firms move even lower value activities to developing countries, "*spillovers*" occur in the form of knowledge transfer, which are intensified when R&D functions are offshored. The third dynamic is the "*catch-up*" which developing countries strive to achieve by developing capabilities in the more creative, high-value activities, thereby moving up the smile curve.

This is an alternative view of economic and functional upgrading based on inherent, essential capabilities, static comparative advantages, and market location. It conceptualizes the firm as a territorial player, with both manual and service-based value propositions, both of which can develop and shift along the curve, as a direct result of participation and learning from the larger system. It suggests that for developing nations the simple, low-paid tasks of repetitive

assembly are entry-level jobs which can lead to better work and more wealth through learning and development.

As previously mentioned, smile curve economics have gained currency beyond geographic studies. From their position as economists advising governments on where to invest for growth, Baldwin & Evenett discuss smile curve economics in depth (2012 p. 90) noting that in the golden age of European growth (1950-1973) when manufacturing jobs were onshore and paid well, and lower cost offshore options were not accessible, the smile curve was flat in vertically-integrated firms. With the onset of the second wave of globalization, and especially the opening of China, the value added by manufacturing dropped, as they were offshored to emerging economies. This coincided with the commoditization of both standard products and the tasks (repetitive assembly), which produced them.

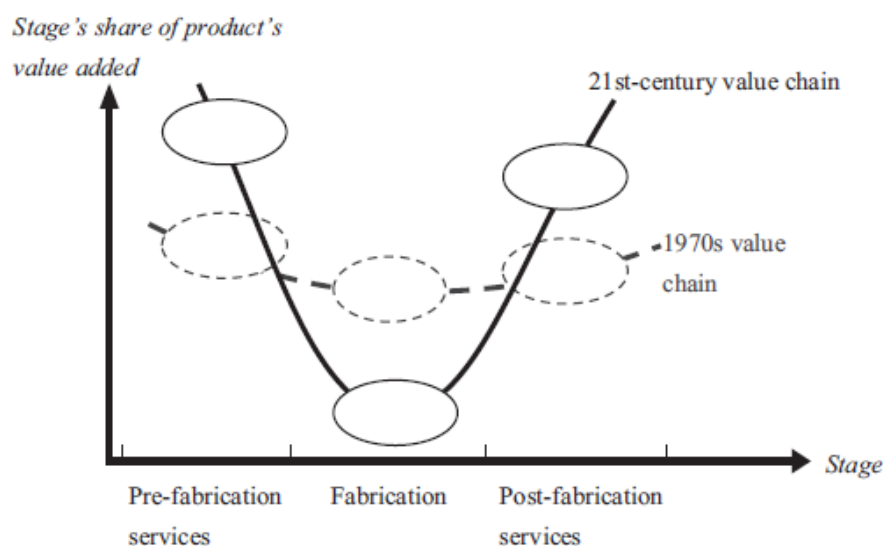


Figure 6: The smile curve, good and bad stages in the value chain  
Source: Baldwin 2014, p.217.

In "Mis-thinking Globalization", Baldwin describes the evolution of the smile curve from a flat distribution of value across production stage in the 1970s, to the deep smile of today in which "bad" stages are the low-paid fabrication which has been shifted to developing factory nations and "good" pre- and post-fabrication stages which are retained in G7 nations (Baldwin 2014 p.217, figure 6). This is a reminder that the curve has not been fixed in the past, that structure is not destiny, and that participants have both incentives and opportunities to improve their position through specialization on more lucrative tasks. It also opens questions

to GVC researchers from all disciplines: will all manufacturing converge upon low-cost locations and constantly migrate to the next low-wage nation which opens up to trade? If not, can the smile curve be re-flattened to counter-act what seems to be the inevitable de-industrialization of developed nations?

Based on this review of the economic geography literature on GVCs, the stream's answers to the 6 conceptual questions of this dissertation are listed below:

Q1: What is the global division of labour in the GVC and what determines location choice?	The division of labour between firms and locations is determined by the strategic intent of the firm and the potential for strategic coupling in that location.
Q2: What role does the institutional and territorial context play in GVC activity?	The state regulates and negotiates and bargains on tax and local content. It bids for firms to locate their operations in particular jurisdictions to create jobs and drive tax revenue. The state takes on the role of regulator, producer, buyer, and investor. Facilitative public governance can influence the progress of strategic coupling.
Q3: What effects do GVCs have on social and developmental outcomes?	Surplus is created through a division of labour (orthodox economic rationality). There are uneven developmental outcomes at the regional level, resulting in evolving <i>"territorial patchworks"</i> (Coe & Yeung 2019, p.777).
Q4: What are the incentives for participating in a GVC rather than be a stand-alone firm?	Highly- differentiated outcomes depend on the strategy of individual firms and the entrepreneurial intent of hosting states.
Q5: What are the mechanisms of value creation and capture in GVCs?	Optimizing cost-capability ratios. Market development, Financial discipline, and Risk management in the network.
Q6: What is the role of managerial agency, and business strategy in GVCs?	<i>"The firm is a managerial device to optimize the accumulation and deployment of its available resources, defined as its core capability, at the lowest possible cost"</i> (Yeung & Coe 2014, p.38)

## 1.4 The literature on International Business (IB)

IB literature is in the early stages of GVC conceptualization and in a dialogue with the sociological stream and Gereffi in particular, who enjoins its community of scholars to have more impact on policy formulation (not business strategy formulation, as its eponymous domain might suggest). In spite of its name, International Business is essentially the economics of the MNE and makes no reference to Business or Management studies, which are concerned with how firms achieve superior performance.

A review of 50 years of IB research traces three units of analysis which represent two distinct phases of inquiry (Figure 7) and roughly correspond to the gradual refinement of macro-economic phenomena into micro-economic and firm-level activity. The first phase of IB studies took the *Country* as a unit of analysis and used national statistics on trade and FDI to examine the international exchange, which was assumed to be driven by Country-specific advantages. In its second phase, IB scholars turned their attention to the organizational challenges of operating outside their home market and studied the Multinational Enterprise (MNE) in the form of a *parent company* and its *foreign subsidiary* as the unit of analysis (Rugman et al. 2011). The interest in the MNE as a unit of analysis remains central to IB research.

IB has traditionally been dominated by economists who apply orthodox principles to characterize efficient systems of international exchange, including Rational Action modeling (and profit maximization in particular), as well as transaction cost economics. IB applies the Coase theory of the existence of firms to examine the structure and development of the Multinational Enterprise (MNE), defined as “*a firm that owns and controls activities in two or more different countries based on the principle that the boundaries of a firm are set at the margin where the benefit of further internalization of markets are just offset by the costs.*” (Buckley & Casson 2009, p. 1564). In 1977, Dunning formulated the Eclectic Paradigm to define three determinants of FDI: **O**wnership, **L**ocation, and **I**nternalization (OLI). Combined, they provide a “*tripod*” framework for analyzing and explaining the rationale with which MNEs and their production are internationalized. In summary, the OLI paradigm first states that a firm seek advantages through the ownership of assets or resources outside its home country. Second, a firm will expand its footprint to gain access to the value of particular sites. And finally,

incorporating transaction cost economics, the internationalization process will proceed only if the advantages of internalization exceed the costs and benefits of market-based transactions or contracts (Dunning, 1977, Dunning 2000)<sup>9</sup>.

Internationalization can progress gradually, in stages, or firms can be “born global” (Paul & Rosado-Serrano 2019). Building on this legacy, IB research expanded its focus to study the role of MNEs within GVCs, which in turn generated two points of view.

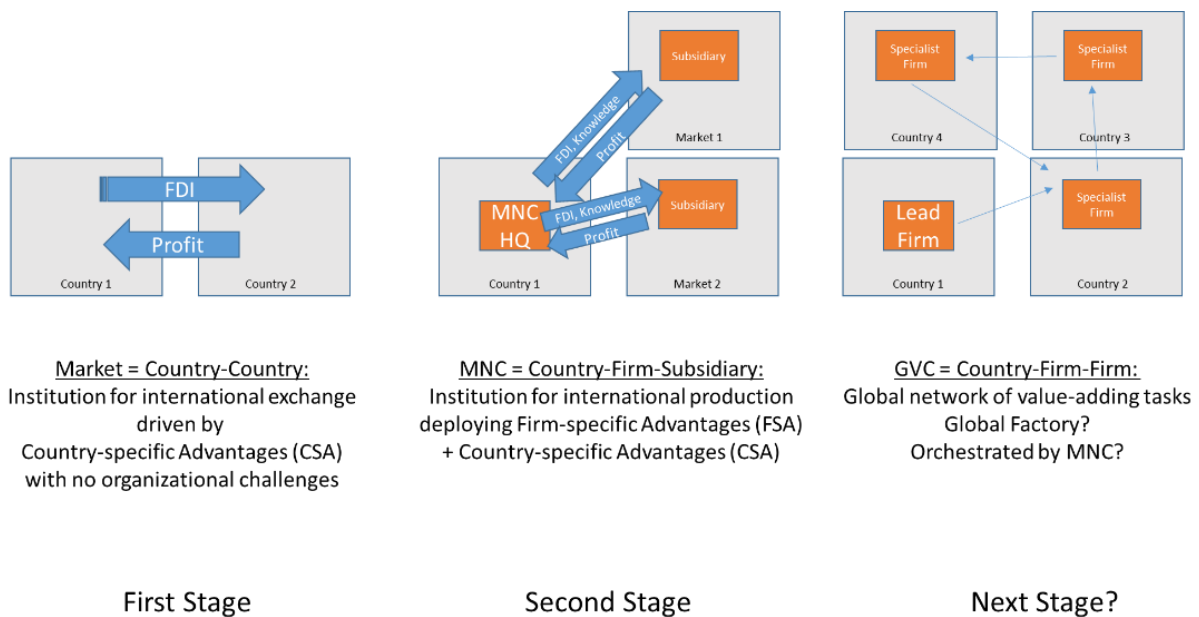


Figure 7: Principle stages of International Business Research in which the units of analysis shift from Country to MNC structures of Headquarter – Subsidiaries in foreign countries. The next stage of research must address the decomposition of the corporate core, which has progressed as world markets were liberalized, and technology enabled the cheaper flow of knowledge, goods, capital, and people. The depiction of the new organizational challenges of GVCs in the Next Stage is speculative. Source: authors’ own summary, based on Rugman et al. 2011.

The first examines how MNEs manage their production function in the form of a Global Factory (Buckley & Ghauri 2004), discussing the strategies for internalization and externalization (Buckley & Casson 2009). The Global Factory acknowledges the “*fine-slicing of activities*” (Buckley & Ghauri 2004, p. 94), and the “*dramatic increase in intermediate product trade*” (p.84) in what they observe as “*virtual networks*”. A MNE determines the “least cost

<sup>9</sup> In an oblique acknowledgement of emerging GVC trade, which would shift the practice from internalization to externalization (outsourcing), Dunning observes the impact of a newly-opened China and increase in market-seeking and efficiency-seeking FDI: “*The extent and pattern of foreign-owned production will depend on the challenges and opportunities offered by different kinds of value-added activity...The reduction of both transport costs and artificial barriers to most forms of trade has led to more ...fdi between developed and developing countries. \*The former mainly in the form of the growth of horizontal i.e. product specialization, and the latter in the growth of vertical, i.e. process specialization.*”(Dunning 2000, p.165)

location of activities” by balancing the “*costs and benefits of using the markets*” (Buckley 2009a, p.224). The result is the “*Global Factory*” (Buckley 2009a), comprised of three functional structures: 1) a brand-owning OEM, which engages 2) external CMs to produce their goods and 3) locally-adapted warehousing and distribution services. The concept assumes the central control of information flows directed via the Headquarters of the orchestrating OEM. The positive effects of the Global Factory structure are efficiency, flexibility, and resilience in the face of uncertainty, and ultimately, higher rents which accrue to the MNE, usually located in a developed nation (Buckley & Strange 2015, figure 8). Even when individual functions have been spun off or contracted out to external firms, the end-to-end network is conceptualized as a new form of the MNE itself, which is the brand owner, with core functions like product design and development are retained in-house and the various contributions to the production function are distributed globally. The output of the MNE’s global factory flows into local markets. Indeed, one of the justifications for the structure is its responsiveness to local requirements.

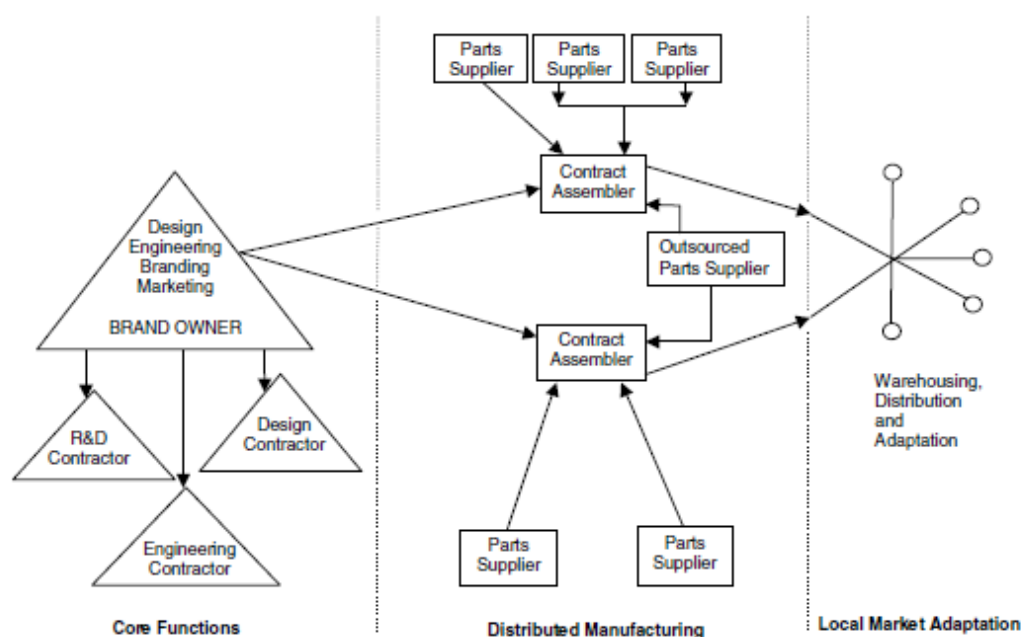


Figure 8: The Global Factory.  
Source: Buckley & Ghauri 2004, p. 89.

The second point of view taken by IB literature is that of Regional Economic Geography, or REG, which builds upon the work of scholars who investigate the “new geography of competition” (Raines 2003, Fujita & Krugman 2004, Krugman 2011) which began to consider

the implications of locations upon economic equilibria theory and models. The REG theory examines the relationships between the locations of business and economic outcomes, characteristics of markets, how they are organized into regional and trade blocs, as well as the spillovers from local MNE activity. The IB stream is admittedly at an early stage of addressing the consequences of de-verticalization. Beugelsdijk et al (2009) provide empirical evidence for an increase in intra-firm trade across borders, especially between developing and developed nations, confirming the trend towards GVC specialization and offshoring within US MNEs, and calling for more research on the changing structure of the MNE. Recent IB publications consider a dialogue with the sociological GVC literature because internalization theory inadequately explains the trends to network specialization. GVC theory can explain the conditions under which control mechanisms are selected, like power asymmetries and codifiability (Strange & Humphrey 2019), or how “*connective efficiencies*” can be increased by investments in relational goods and trust (Benito et al 2019, p.1420).

It is perhaps an irony that IB’s theoretical construct of MNE corresponds more to that of the all-controlling sociological concept than its own GVC governance archetypes do. Since in the IB stream globalization is *per se* defined as an effect of MNE activity, both the Global Factory and the REG points of view continued to assume that network power is concentrated in the hands of these MNEs, and that suppliers are relegated to positions of dependency i.e. they take orders, and are “*leveraged*” to sell at cost i.e. at no profit (Buckley & Strange 2015, p.245). In developing countries, where these suppliers have less access to assets and institutional support, they are essentialized as disadvantaged entities in the virtual network (Choksy et al. 2017). On the other hand, the empirical evidence is clear: not all suppliers work for nothing. Not all MNCs maintain control over their global networks through information monopolies or coercive price negotiations<sup>10</sup>. The historical evolution of GVCs and SCM practice present strong motivations to revise the MNE concept to reflect the progressive vertical disintegration of firms and their behavior in network structures.

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<sup>10</sup> See, for example, the detailed case study in chapter 2.3. for an illustration of a business model, in which scores of large and powerful MNCs pay a small supplier to take control of selected information flows and the replenishment of business-critical parts.



Based on this review of the IB literature on GVCs, the stream's answers to the 6 conceptual questions of this dissertation are listed below:

Q1: What is the global division of labour in the GVC and what determines location choice?	MNE structure and externalization choices. There is a trade-off between the marginal returns of internationalization and its costs. MNEs also move into new territories to gain access and adapt to local markets.
Q2: What role does the institutional and territorial context play in GVC activity?	New markets (buyers), new suppliers, no specific role for the state
Q3: What effects do GVCs have on social and developmental outcomes?	Not addressed. Inequality is not definitively proven, but it can be assumed to exist if all suppliers are at a disadvantage and "leveraged" or coerced to work for <i>no</i> margin.
Q4: What are the incentives for participating in a GVC rather than be a stand-alone firm?	MNEs are a standalone structure. The incentive for suppliers to work for no margin is not clearly explained.
Q5: What are the mechanisms of value creation and capture in GVCs?	Cost arbitrage leverages suppliers to forego margin. MNEs who control the Global Factory have an information monopoly.
Q6: What is the role of managerial agency, and business strategy in GVCs?	The focus on Internationalization and externalization imply that policy and macro-scale forces override microeconomic strategies to determine firm-level outcomes.

## 1.5 The Literature on Operations and Supply Chain Management:

### The History of Global Supply Chains and how they re-configured the world

Rooted in economic and organizational theories of the firm, Business studies consider how firms achieve superior economic rents, with the strategy literature working “...to explain firm performance and the determinants of strategic choice.” (Grant 1990, p.110). The domain has generated a number of theoretical streams which study and generalize how micro-economic performance can be improved, assuming the firm to be a nationally-based producer of finished goods in a vertically-integrated structure, like the original Ford motor company or the early IBM. Domestic mass production was the standard form of operations, which exploited economies of scale, while delivering goods to a growing middle class in the postwar developed economies. The most influential theories of firm strategy include the industry structure view, which defines firm performance to be the outcome of five forces within its industry: industry rivalry, the threat of new entrants into the market, the threat of substitution of its products, the bargaining power of customers, and the bargaining power of suppliers (Porter 1979). Porter’s definition of a necessarily antagonistic relationship between the firm, its suppliers and customers, all of which are in a state of constant tension to gain the upper hand, remains widely-accepted today, exerting a strong influence on Anglo-American business culture. A summary of business theory is beyond the scope of this chapter, which will instead focus on the most relevant aspects to the Operations Management literature.

With the progress of recent globalization, the question of how best to operate across national borders and in foreign markets was addressed by business theory, which drew upon economic orthodoxy. A seminal article by Kogut 1985, which appeared prior to the fall of the Berlin wall and the integration of Eastern European markets, presented a theory of how Global Strategies are designed based on a combination of comparative (location-based factor advantages), and competitive (firm-specific) advantages, which should be analyzed step by step along the value chain. This is an early theoretical prediction of the GVCs that would emerge after globalization opened up China, India, and Eastern Europe, and whose effects combined with the revolution in information and telecommunications technology. Resources which were

previously physically and logically inaccessible were, in many ways, now as close as domestic ones.

New theories in industrial engineering focused on efficiency gains to create competitive advantage and paved the way for supply chain management practice and theory. Over a period of decades, from the 80s to the present, the vertical dis-integration or decomposition of the corporate core was executed by supply chain engineers inside firms of all sizes (Billington and Kuper 2003). One can argue that GVCs are the outcome of countless individual supply chain design decisions based on rational economic principles: minimizing cost, or maximizing availability, or minimizing lead times, or optimizing asset loads. Any number of possible recombinations of this objective function were made. The political changes which introduced new consumer and supplier markets, forced the question of “make or buy” every function which had previously been housed within the firm (Welch & Nayak 1992). The progressive outsourcing, and de-verticalization enabled the emergence of functionally specialized firms (for example, logistics became 3<sup>rd</sup> party logistics), and industries (proprietary factories were replaced by contract manufacturers). Supply Chain Management has since become a specialized business profession comparable to Finance and Marketing with strategic impact on the firm’s performance, and by extension, a previously unsuspected force in regional and global development. In a statement that sounds prophetic today, Forrester’s pioneering work on industrial dynamics predicted that:

“industrial success depends on the interactions between the flows of information, materials, money, manpower, and capital equipment. The way these five flow systems interlock to amplify one another and cause change and fluctuation will form the basis for anticipating the effects of decisions, policies, organizational forms and investment choices.” (Forrester 1958, p. 37)

“...there will come a general recognition of the advantage enjoyed by the pioneering management who have been the first to improve their understanding of the interrelationships between separate company functions and between the company and its markets, its industry, and the national economy.” (Forrester 1958, p.52)

To date, one can argue that the theory of industrial engineering has not responded to Forrester’s call to action and continues to maintain an apolitical operational scope, although an awareness of the broader geopolitical consequences of its practice is growing (Ferdows 2018, p.396, Thakur-Weigold & Hnát 2017).

Similar to international trade itself, the practice of logistics, with its roots in military supply, has been around for centuries. The second wave of globalization put pressure on productive industries to improve their performance across multiple dimensions. As the developed world became richer, the demands of consumers to have more choice, and more availability of products, at no extra cost, was forcing firms to innovate operations which had become global and more complex. Stated simply, the task of Supply Chain Managers is to match supply to demand under conditions of uncertainty, i.e. without knowing in advance how much would sell, or if the price and availability of input materials changed. They have to make sure that enough finished goods are available at the customer point of sale in order to maximize revenue for the firm. When they realized that the success of the task involved synchronized inputs from suppliers, they grasped that uncertainty – what Forrester called “*fluctuations*” of demand, of supply, and of production - makes it exceedingly difficult for firms to simultaneously achieve high service at low cost (Davis 1993). A trade-off, or balancing of customer demand and operational cost would be necessary, and the optimal frontier of cost vs. customer service under various degrees of uncertainty could be computed precisely and cheaply (Chopra & Meindl 2004, p.35-36). Implementing the necessary process improvements across the global chain, to approach the optimal point would require joint efforts among the connected firms. The insights gained from decades of optimizing network performance in this way were eventually generalized in the new supply chain literature.

### **Unpacking the heterogeneous Supply Chain Literature**

In contrast to the social and natural sciences, economics, geography, and even international business, the discoveries of operations and supply chain management originate in practice. Theoretical models did not predict innovations like the Assembly Line (invented by Ford Motor Company), Lean Management (invented by Toyota), and Product Postponement (invented by Hewlett-Packard), which together demonstrate that “*It is...the practitioner – not the academic scientist – who engages in basic research in OM*” (Holmström et al 2009 p. 65). The term Supply Chain Management was coined in the early 1980s by consultants who began to report on the new method of improving customer service while reducing cost (Oliver & Webber 1982, Stevens 1989). The practitioners recognized early on that the supply chain was more than its oversimplified reputation as a technical or clerical execution i.e. making and

moving goods<sup>11</sup>. It is strategic for several reasons: Logistics cost defined as inventory-carrying costs, transportation and other shipping-related expenses comprised 8% of U.S. GDP (Smith 2019), a sizeable enough spend to justify professional management. Best practices revealed that a firm's supply chain strategy must be aligned to its value proposition, and to the uncertainty profiles of its products (Fisher 1997, Lee 2002). This requires expertise in both process design and execution and implies that operations are not always about pursuing lowest cost in all functions, but a unique performance profile tailored to each firm. Empirical evidence indicates that firms which manage their supply chains well, like Walmart, Zara, Toyota, Apple, and Dell, tend to have superior returns and market share. Conversely, those firms which report supply chain issues can lose up to 10% market capitalization measured by stock price (Hendricks & Singhal 2003). Furthermore, companies whose supply chains are designed to fit their product uncertainties deliver superior returns (Grosse-Ruyken & Wagner 2010). Over time, scholars began to recognize the fact of network competition, in which the success of an individual firm depends upon the overall performance of its supply chain. *"Indeed, there is a growing recognition that modern competition is being fought 'supply chain versus supply chain' rather than 'firm versus firm' (Christopher 1992, Harland 1996, Dyer & Singh 1998, Croom et al 2000, Mentzer et al 2001, Ketchen and Guinipero, 2004).*

Among its practitioners, a widely-accepted definition of Supply Chain Management is:

"...a Supply Chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply Chain not only includes the manufacturer and suppliers, but the transporters, warehouses, retailers, and customers themselves... it includes all functions involved in receiving and filling a customer request...(which) include but are not limited to new product development, marketing, operations, distribution, finance, and customer service. A supply chain is dynamic and involves the constant flow of information, product, and funds between different stages. (Chopra and Meindl, 2004 p. 4)

There are multiple functions and processes and firms involved here. The combinatorial possibilities for what to study in this chain, using which unit of analysis, are correspondingly vast. Practitioners address the complexity by convening cross-functional teams to devise and

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<sup>11</sup> Duke University's excellent repository of Global Value Chain resources [www.globalvaluechains.org](http://www.globalvaluechains.org) posts the following statement in its "Concepts and Tools" section: *"Is there a difference between a supply chain and a value chain? Yes. A supply chain emphasizes the manufacturing and distribution-related steps, whereas a value chain also includes the importance of other activities such as design and branding that add value to a product, but do not necessarily reflect a physical transformation."* This misunderstanding of the scope and strategic impact of the supply chain is typical to many disciplines. Accessed September 10, 2017.

execute plans<sup>12</sup>. There is far less consensus among scholars, whose formal academic definitions can vary widely (Ellram & Cooper 2014 p.9, Tan 2001 pp.39-40, Mentzer et al 2001, p.5, Bechtel & Jayaram 1997 p.16). This lack of alignment makes a systematic literature review (SLR), problematic<sup>13</sup> and of little impact in the top-ranked journals (Durach et al 2017, p.2). Ellram & Cooper's retrospective on 30 years of scholarship notes that Supply Chain Management is simultaneously "*a process, a discipline, a philosophy, a governance structure, and a function*" (2014, p.10). Although the extant literature does not meet the strict criteria of a scientific discipline as proposed by Croom et al (2000 p.67), practice shows that it adds value in all the other areas. This highly-cited review drafts a framework to classify the content of supply chains studies along two methodological dimensions: 1) the level of analysis (dyad or chain or network), and 2) what is being exchanged between parties (assets, information, knowledge, relationships). This reveals a heterogeneity of research questions, constructs, units of analysis, and methods, which range from modeling to case and other empirical studies (Croom et al 2007). Because individual sources of uncertainty, like supplier reliability and forecast accuracy, can be modelled statistically, a substantial body of research exists in the form of abstract mathematical models. These demonstrate that the optimal performance of a supply chain can be computed precisely, as an efficient frontier, to which the actual performance can be compared and fine-tuned (Johnson & Davis 1995, Silver et al 1998, Chopra & Meindl 2004 pp.35-36). The coexistence of an equally significant volume of quantitative models and qualitative case studies has led to the empirical-modeling gap, or dichotomy, in the supply chain literature.

The domain of Supply Chain Management can therefore be seen as vacillating between objective, scientific truth-seeking, and grounded, qualitative study. The proliferation of terminologies, methodological approaches, and units of analysis is a logical consequence of this duality. Practice shows that technology or models alone do not change systems involving multinational, intra- and interfirm linkages. The implementation of any mathematical model requires context-dependent adaptation in real complex organizations, and, usually involves

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<sup>12</sup> Practitioners instinctively note that SCM is the opposite of cutting costs in silos and speak of replacing inventory with information

<sup>13</sup> The original purpose of an SLR is to establish a base of evidence, in the tradition of medical sciences, which generate a significant number of SLRs to validate the most effective therapies (Tranfield 2003). The business and SCM literature does not, however, generate a critical mass of studies which test constructs using statistical methods, hence the applicability of meta-analyses is limited.

a cultural shift. For this reason, the most cited reviews distinguish between SCM as an *orientation* (or mindset) and its *best practices* (Lummus & Vorkurka 1999, Mentzer et al 2000, Bechtel and Jayaram 1997). As such, a synthesis of the literature is neither desirable nor feasible. Instead, a summary of the findings which explain how supply chain management impacts firm and network performance is proposed as the best path forward.

### **Summarizing the axioms of Supply Chain Management**

Like international trade, the individual business functions of logistics, materials management, procurement, and production are not new. To establish logical continuity with the topic of Global Value Chains, this section treats a supply chain as a network of firms which trade intermediates and tasks with one another across national borders and in global markets. It will summarize the new paradigm of SCM, explain how it differs from the transactional execution of individual functions and emphasize the mechanisms of achieving superior business results (higher rents).

Although it is often reduced to logistics, i.e. the movement and distribution of goods, the scope of supply chain management encompasses the entire chain, or network. Its nature is not merely clerical, or exclusively in pursuit of the lowest cost of supply or production, as classical economic theory assumes. In fact, the pursuit of single objectives - like lowest production cost - within the complex system is generally considered counterproductive. Minimizing production costs as the single determinant in facility location, for example, has resulted in the moving of production facilities to low-cost labor regions (Ferdows 2010). However, for many of these firms, the process of outsourcing production has resulted in the loss of valuable skills and tacit knowledge, and diminished the capabilities of these facilities. The result has been a suboptimal decision that has thrown many manufacturers into a vicious cycle requiring continued offshoring, inability to regain competitive skills, and loss of strategic position (Ferdows 2010). Utilizing a single perspective and assuming cost efficiency to be the only indicator of viability provided a myopic and suboptimal analysis. (Sanders & Wagner 2011, p.5)

Supply chains are strategic in their nature: the supply chain must align with the unique value proposition of its firm (Fisher 1997), while balancing the costs of executing this promise to its consumers. When properly designed and executed, the SC will have a direct impact on the micro-economic performance of the firms involved (Hendricks & Singhal 2000, Grosse-

Ruyken & Wagner 2010), and developmental outcomes at a higher, Meso (country and region) level (Forrester 1958, Baldwin 2011, p. 7, Thakur-Weigold & Hnat 2017). The developmental outcomes or territorial embeddedness are not a declared concern of the extant literature. The engineering problem-solving mindset is the legacy of SCM literature, which may explain why it does not address macro-level embeddedness, nor the effects of global institutions like the WTO, World Bank, or other conditions which enable free trade. Under the pressure of contemporary anti-globalization, in which developed economies like the US and the UK threaten to revoke free trade agreements, this inattention is changing (Thakur-Weigold & Hnat 2017).

A supply chain exists, whether it is managed or not. Supply chain costs are estimated to comprise up to 20% of net sales value and most hold between 3-5 months of inventory which does not necessarily increase the ability to fulfil orders (Stevens 1989, p.5). Unmanaged supply chains can accumulate up to 50% waste (Davis 1992). Left to their own devices, functions, and by extension, functionally-specialized firms operate in so-called silos, operating in *“complete ...independence where each business function such as production or purchasing does its own thing in complete isolation from the other business functions”* (Christopher 2011, p.15). The economically rational objectives of functional departments (like marketing, manufacturing, distribution, and finance) are typically in conflict with one another, causing them to work at cross-purposes if they are not mediated by a supply chain process or organization which reconciles the conflicting objectives at a systems level (Stevens 1989 p.4). Most firms participate in multiple supply chains simultaneously, and so focus constrained managerial resources on their most important connections (Mentzer et al 2000, p.4). Subject to the most recent wave of Globalization, the topology of most supply chains include multiple territories and flows which cross national borders (Mentzer et al 2000 p.20), which makes them longer, less transparent, more uncertain, more complex, and arguably more costly:

All the lessons of the past fifty years tell us that inventory must be minimized and manufacturing must be responsive. Yet the trends in manufacturing over the past thirty years have driven it precisely the opposite directions: toward bulk and toward distant locales. (Berger 2005, p.164)

The spatial dispersion of a GVC necessarily increases the length of transport trajectories, which generate two cost factors typically ignored by economists and many managers: pipeline inventory is the stockpile required to serve customers while goods are en route. By



manufacturing in “*distant locales*”, every GVC builds in cost to their pipeline, calculated by the number of months of inventory corresponding to the travel time. If the cheapest form of transport is rationally chosen (usually ocean shipping), which can take months from the port of Shanghai to Long Beach, then a firm in the US will need to stockpile several months of finished goods inventory (usually the most costly form of inventory), in their pipeline to fulfill demand during that waiting period. The trade-offs between local cost (transport), and system costs (pipeline inventory or expedited shipping), are determinants of network performance but are rarely mentioned in economic analyses, resulting in a reductive perception of cost as an arithmetic sum of materials + asset utilization + wage. If these inbuilt complexities are unmanaged, leaving the system costs hidden, the performance of a GVC will be suboptimal, compromising competitiveness (see figure 9), under inflationary pressure from consumers and commoditized products.

The new paradigm of managing the end-to-end supply chain emphasizes the management of flows across the network, a departure from the old logic of point-to-point transactions between firm dyads, and makes the hidden system costs easier to identify (figure 9). Vertical dis-integration makes almost every participant in the GVC simultaneously a buyer and a supplier, and indirectly dependent upon the performance of inbound and outbound flows across multiple tiers of the network. While creating this dependency, it disrupts the natural feed-forward and feedback loops that exist in the integrated system. These must be adequately replaced by new supply chain flows. In particular, three flows are of strategic importance (i.e. are relevant to superior performance of the firm), and the focus of managerial decision-making:

1. Information flows from customer to supplier (usually in the form of orders, forecasts, and product specifications)
2. Materials flow from supplier to customer, increasing in value as they circulate through the system.
3. Financial flows from customer to supplier upstream as well.

A disruption, interruption, distortion or delay of these flows trigger inefficiencies in the entire network, which increase cost without adding value or benefiting any single player.

Because logistics is widely perceived as the movement of goods while minimizing transportation costs, it is worth emphasizing the importance of unbroken information flow. The degree to which information is shared among supply chain participants is what distinguishes it

from a transactional exchange between anonymous, market-mediated firms, and will ultimately determine its level of performance. A dysfunctional flow of information leads to both over- and under-ordering between nodes, as well as the precautionary buildup of stock 'just in case'. The wrong information (forecast, order, product specification), can cause the wrong material to arrive at the wrong place at the wrong time. This has negative impacts upon customer service and in turn, revenues. Correcting a disrupted flow involves costly interventions like returns, expedited shipments or accumulation of stocks to protect against uncertainties. The waste is usually measured in excess inventories (which bind working capital), lost sales, or expedited shipments, tends to accumulate in the links between nodes (Christopher 2011 p. 15, Magretta 1998 p.48, Bechtel & Jayaram 1997 p.17, also Porter, see figure 11). What is wastefully accumulated in the network linkages is a proverbial "soft \$3" cost, accruing to no single participant as rent, while adding to the burden borne by all (figures 9 and 11). In the words of Victor Fung, "if you take 50 cents out [out of the linkages] nobody will even know you are doing it" (Magretta 1998, p.42).

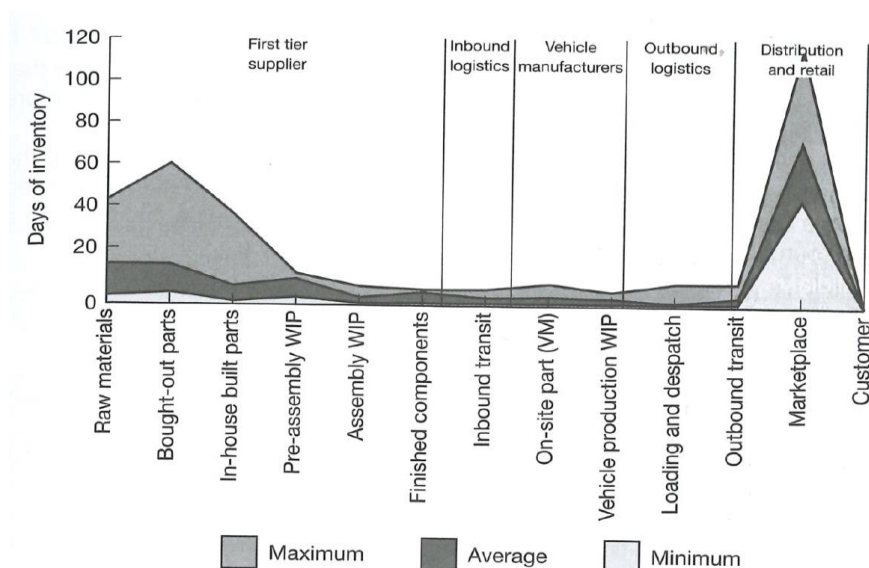


Figure 9: The inventory profile of the Automobile supply chain

Measured across the boundaries of multiple tiers and hence firms starting from raw material supplier to car dealer which sell the finished good to the customer. In this particular case, inventory buildup occurs at the extremes of the chain, while vehicle manufacturers maintain low stocks of materials, presumably because their suppliers hold more to ensure availability. If firms only view and manage local performance and cost, which is the traditional mindset of arms-length trade, they may not recognize the overall inefficiency of the system. The excess inventory can be replaced with information, but the nodes must integrate to make this possible. Those chains which successfully integrate to eliminate the precautionary stockpiles will improve their performance and margins for all firms. Source: Christopher 2011, p. 21, and Holweg & Pil 2004.

The literature distinguishes between the philosophy and the best practices themselves. In order to manage these flows in the smoothest and most productive way, firms must first adopt the right mindset or “orientation” (Mentzer et al p.11, Tan 2001, p.6, Ellram & Cooper 2014, p.13). This philosophy consists of three components: 1) A systems approach to viewing the end-to-end supply chain, 2) strategic and cooperative efforts to converge intrafirm and interfirm capabilities into a unified whole or integration, and 3) a customer focus to create unique sources of value (Mentzer et al 2001 p7). The systems approach (Bechtel & Jayaram 1997, Mentzer et al 2001, Tan 2001, Lummus & Vorkurka 1999 p. 12) looks at all nodes and contributions as part of a whole, and makes the waste visible (figure 9). The system as a unit of analysis and decision-making is particularly important in the aftermath of vertical dis-integration, which created stand-alone firms in pursuit of their own economic objectives. This rational behaviour has several negative economic consequences in the interlinked GVC structure. A false sense of local control in a dependent system leads to “*functional department suboptimization*” (Bechtel & Jayaram 1997, p.21). In the dis-integrated network, information flows poorly, and even powerful buyers do not have a monopoly on information. Every actor is exposed to fluctuations in demand and supply and unexpected events, some caused by economic and business cycles, and others by combative behaviour (like gaming), or environmental changes. Suppliers may be forced to hold stock (see figure 9), because of non-existent or inaccurate forecasts, retailers lose sales because of unreliable manufacturing output, and so on (Oliver & Webber 1982, Davis 1992). Uncertainty like this propagates through a chain, causing alternating bouts of stockout and overstock, called the Bullwhip Effect (Lee et al 1997, figure 10). As Baldwin discovered elsewhere, the network amplifies not only response but the signals which provoked these in the first place. Empirical studies suggest that half to two-thirds of all firms experience the bullwhip effect (Bray & Mendelsohn 2012), and the opportunity to reduce waste in the grocery industry alone was estimated at USD30Billion (Lee et al 1997, p.2)<sup>14</sup>.

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<sup>14</sup> Due to the widespread consumer hoarding behavior in the current Covid-19 crisis, this waste will be presumably more.



Figure 10: Information distortion and its Bullwhip effect on supply chain (and by extension GVC) performance.

Source: Author's MBA students playing the beer game in 2012. The topmost graphs are inventory levels and those beneath represent orders to immediate suppliers. From left to right, each set illustrates, respectively, the retailer, the wholesaler, the distribution centre, and the factory.

Because each node in the vertically dis-integrated chain waits for inputs from its suppliers upstream, the literature acknowledges an inherent mutual dependency (Ellram 1990 p.13, Mentzer et al 2001 p.13, Tan 2001, p.46, Billington & Sandor 2016, p.26), which is not the equivalent of vulnerability and exposure to exploitation. Instead, *"dependence is a prime force in the development of supply chain solidarity"* (Mentzer et al 2001, p.13) which translates into coordinated decision-making, especially planning, which effectively replaces excess, precautionary inventory with information. Working together or *"Systems thinking involves moving away from functional department suboptimization of the supply chain to a holistic optimization of the entire supply chain."* (Bechtel & Jayaram 1997, p.21). Firms in a supply chain therefore strive to integrate with their trading partners (buyers with suppliers), in the network (Stevens 1989) because it increases returns and reduces the cost of inputs necessary to achieve customer service. This alternative to cutting costs in silos, or squeezing weaker suppliers offers potential for improving competitiveness.

The following list summarizes the activities most commonly associated with successful supply chain management (Mentzer et al p.8).. All of them are associated with degrees of integration:

1. Integrated Behavior,
2. Mutually Sharing Information,
3. Mutually Sharing Risks and Rewards,
4. Cooperation,
5. the Same Goal and the Same Focus on Serving Customers,
6. Integration of Processes,
7. Partners to Build and Maintain Long-Term Relationships.

The inter-firm integration targeted here does not presuppose a power asymmetry between a dominant buying firm linked to a less powerful supplier, which it controls (governs). It is also noteworthy that integration (cooperation, collaboration, sharing information and assets) is not pursued on grounds of corporate social responsibility or ethical solidarity. The steps taken to integrate are an economically rational response to the cost of independent decision-making. Integration enables superior returns in a dependent system, because it reduces the total volume of assets in the system which accumulate as a response to uncertainty (figure 11).

The literature provides evidence confirming that integration delivers superior firm-level rents (Frohlich & Westbrook 2001, Power 2005, Gulati & Sytch ). Empirical studies of the automobile industry indicate that, contrary to expectations, *“relational embeddedness and the concomitant social governance mechanisms stemming from joint dependence can be equally effective in resolving uncertainty and enhancing firms’ performance”* (Gulati & Sytch 2007, p.63). By recognizing that the system can only perform well as an integrated whole, *“Companies will not seek to achieve cost reductions or profit improvement at the expense of their supply chain partners, but rather seek to make the supply chain as a whole more competitive.”* (Croom et al 2000, p.68). The consensus among practitioners is that *“Managers in companies across the supply chain take an interest in the success of other companies.”* (Lummus & Vorkurka 1999, p.12). Investments in relationships and self-reinforcing governance structures reduce transaction costs and create a *“snowball”* effect throughout the network (Dyer & Singh 1998, p. 671).

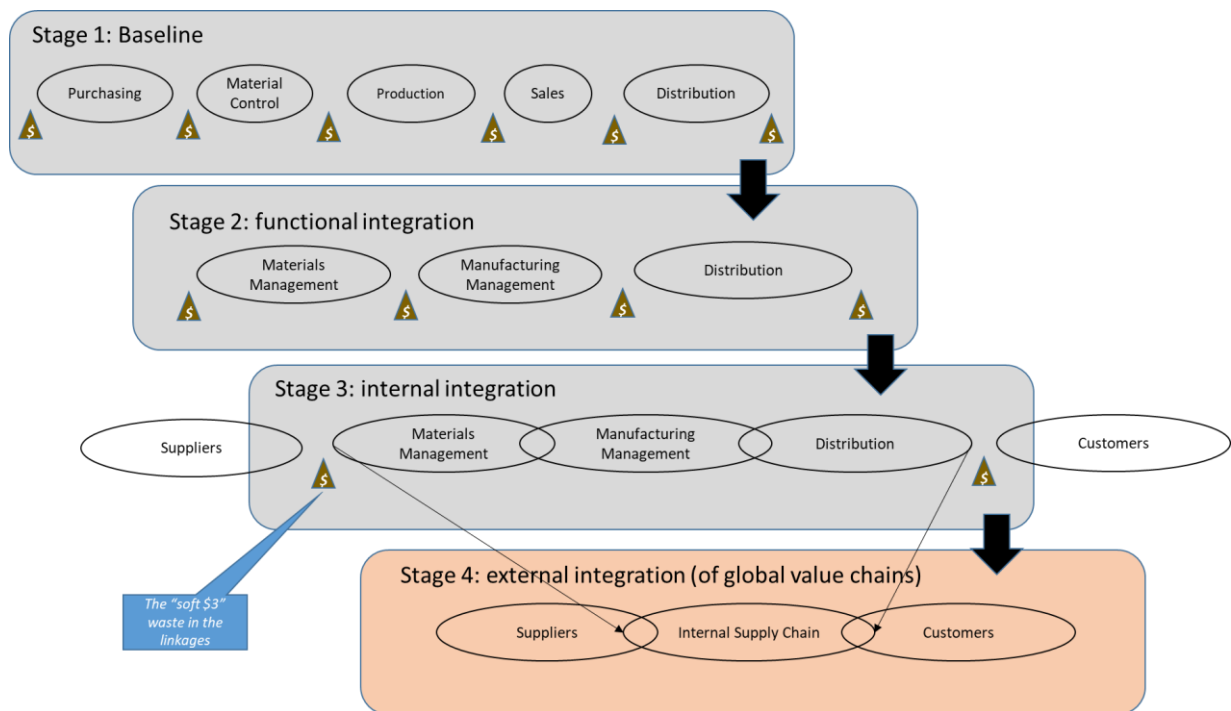


Figure 11: Integration in a dependent system

Without integration in the multiple forms (physical, virtual, and relational), described in the supply chain literature, inventory stockpiles accumulate automatically as a defensive response to uncertainty. By removing the interfaces and information handoffs between specialized functions, and later, specialized firms, the need for protection diminishes and these unproductive and usually depreciating assets dwindle. This is one explanation of the economic justification for integration and alignment of interests in a network.

Source: author, based on Christopher 2011, p. 14, and Stevens 1989, p.7.

The outcome is a redefinition of roles and behavior within the network which can effectively flatten hierarchical governance “suppliers gradually receive and share more information and schedules with OEMs and become co-maker of the product, not just a supplier.” (Bechtel & Jayaram p.21). In some cases, the business cycle or integration can cause the power distribution to switch “since the cost of changing a partner can be huge, the purchasing firm can become a captive of its supplier” (Tan 2001, p.46, Holstein 2002) especially if that supplier becomes a source of key innovations (Wagner 2012). The traditionally combative role of the all-powerful, price-squeezing buyer may not lead to the superior firm-level performance that a ruthless pursuit of savings is expected to deliver. If the bankruptcy of GM, for whom supplier squeeze was policy, is any indication, a selfish buyer strategy may be unsustainable over time (Holstein 2009, Bennett 2016, Supply Chain Digest 2016).

Contrary to Porter’s industry structure theory, which implies that a loss of assertiveness will erode the firm’s financial performance, or the sociological theory that dependency is detrimental to economic development (Gereffi 2018, p.14), supply chain literature claims that business results can also be achieved by the “*Dependent-buyer*”, who is mindful of the cost of combative behavior, and committed to the long-term health of the supplier (figure 12).

Power-buyer vs. Dependent-buyer		
Outcome Area	Power-buyer	Dependent-buyer
Information sharing	As little as possible and biased/finagled toward “proving how meager my margins are.	Open and transparent – won’t be used as a negotiating club but rather a tool to advance continuous improvement.
Focus	Price, bidding, auctions, unilateral demands, risk avoidance, legal agreements and compliance, and replicability	TCO, cost models, joint problem solving, shared risks, process enhancement, and innovation
Waste	Move	Reduce or eliminate
Tenure	Potentially very short	Expected to be very long
Queuing Priority	No incentive but make-believe	High Incentive
Intellectual Property	Shopped	Protected
Technical Support	As little as absolutely needed	Routinely use “A” team
Risks	Passed	Shared
Benefits	Taken	Shared

Figure 12: The role and attitude of the buyer changes in an integrated supply chain. In the long run, the superior power of asymmetric relationship does not guarantee superior rents, because price takedown conceals waste in the system, and ignores the cost of shifting risk elsewhere. Source: Billington & Sandor 2016, p.26.

Some scholars have acknowledged that the success of an integrative strategy will be contingent upon the cultural environment in which the relational rents are created. A “*traditional culture that emphasizes seeking good, short-term company-focused performance appears to be in conflict with the goals of supply chain management*” (Tan, 2001, p.6). Two former CPOs of American TNCs, who are now SCM professors, recently published a critical response to Porter’s industry structure model, which casts buyers and suppliers as price negotiators whose task is to secure a larger piece of the rent than their opponent. The systems-based culture of a SCM paradigm implies, however, that “*using static industry profitability models for individual firms can create inferior performance by framing attitudes, policies, and*

*practices that favor zero sum versus non-zero sum outcomes.*" (Billington & Sandor 2016, p.27). If most business cultures create *"winners and losers"* (Davis 1993, p.36), successful supply chain management needs *"a country-specific institutional environment that fosters good will, trust and cooperation"* (Dyer & Singh 1998, p. 673). The comparison of the Japanese Toyota, which takes a collaborative approach to supplier development, vs. American GM, whose decades of supplier squeeze led to its eventual bankruptcy are cases in point (Bennett 2016, Holstein 2010).

Based on this review of the supply literature on GVCs, the stream's answers to the 6 conceptual questions of this dissertation are listed below:

Q1: What is the global division of labour in the GVC and what determines location choice?	Specialization and network optimization modes determine the division of labour in any particular location in the GVC (SC).
Q2: What role does the institutional and territorial context play in GVC activity?	Not considered at all beyond tax optimization and local content regulations.
Q3: What effects do GVCs have on social and developmental outcomes?	Not considered at all although supply chain managers made the countless make-or-buy decisions which resulted in the GVCs of today.
Q4: What are the incentives for participating in a GVC rather than be a stand-alone firm?	When properly executed and managed, specialization and trade increase quality, efficiency, access to markets and capabilities in a way that vertical integrated firms cannot achieve on their own.
Q5: What are the mechanisms of value creation and capture in GVCs?	Optimized supply chain processes that are integrated across the network. System optimization increases the total sum of rents (and ROA), available to all participants.
Q6: What is the role of managerial agency, and business strategy in GVCs?	Supply chain managers must reconcile conflicting interests, measure and manage the performance across the chain and identify the necessary adjustments required to maintain a systems optimum. The supply chain strategy must support the value proposition of the firm to ensure maximum returns.



Domain	Principle Construct	Unit of Analysis	Intellectual Tradition	Paradigm Shift	Definition of Developmental Effects	Policy Implications
1 Macroeconomics	Global Supply Chains, "The Great Convergence"	Nation - GDP, MACRO level	Macroeconomic Trade Theory	New measurement of value-added instead of export value of finished goods. Nations must import in order to export. Old policy instruments like tariffs may backfire because they effectively "build a wall through the factory". Investments may not target local growth.	De-industrialization of the North Industrialization of the South, join rather than labouriously build an industrial base, opportunities for small suppliers	Support GVC trade and facilitate the movement of intermediaries through local value-adding firms. Measure TIVA instead of traditional export values. Encourage trade in high-value intermediaries, knowledge and learning economies in agglomerations
2 Sociology	Global Value Chains (GVCs)	Nation-Industry dyad, Governance types, MNE-supplier dyad, MACRO-MESO-MICRO	Anti-capitalist World Systems Theory, Dependency Theory, Development Theory	Understand the "impoverishing effects of globalization", how the deep economic integration of poor and rich nations results in structural or architectural determinism of the input-output chain.	Globalization reproduces the core-periphery structures of the world economy with its unequal distributions of developmental opportunities, driven by huge MNEs which rival the power of the state	Support labour power, curtail MNE power, State intervention in redistribution
3 Economic Geography	Global Production Networks (GPNs)	Location-Economic activity	Geography, Microeconomics	Smile Curve, Fleetfootedness of Business relocation	Global shift, Community structure, Deepening inequality within nations and regions, complex interrelationships and causalities	Create better conditions for the location of work
4 International Business (IB)	Global Factory	MNE	Microeconomics	No paradigm change. Coasian theory of firm with focus on Internationalization and Externalization. Fragmentation of production is acknowledged.	No direct impact	No overt policy intent.
5 Supply Chain Management	Supply Chain	Various and heterogeneous	Logistics, Business Strategy, System Dynamics	Network competition, Dependency is mutual, Structure determines network performance, Configuration is as important as negotiation.	Collaborative end-to-end strategies deliver superior rents for all participants. Small suppliers can exert power over MNEs. Power shifts are ongoing and cyclical, or driven by structure.	No overt policy intent. Improve business outcomes at firm level. Corporate social responsibility, Advisory role and feasibility studies

Table 3: Overview and summary of the five in-scope domains which study GVCs.

Source: author.

## 2. Global Value Chains and Competitiveness: “The question is empirical”

The previous chapter presented an overview of the extant literature on GVCs, leading to the research questions addressed in this chapter. The first of these questions is how both firms and nations can compete in the world which trades in tasks within global value chains and the second asks with what specific strategies? The fate of economies that are either Headquarter or Factory (Baldwin and Lopez-Gonzales, 2014) have been well studied, with a selective focus on a subset of global industries subject to strong competitive pressures: automaking, textile, electronics, and agricultural products (Cattaneo et al., 2010), usually in developing countries. The 3 empirical studies summarized in this chapter pay attention to two relatively unstudied categories in GVC research: 1) a sunrise industry, 2) in developed countries outside North America. Aggregate economic structures of a single industry in different locations are considered together with the business and supply chain innovations at the firm level, in order to interpret total competitive strategies.

As the literature review made clear, the extant streams of GVC research in macroeconomics, economic sociology and economic geography strive to explain the role of GVC trade on developmental outcomes which are unequal between and within regions. When distributional conflicts are the point of departure, factors like governance (synonymous with degrees of power and control exerted by a MNE), are presented as drivers of developmental inequality, again with a predominant focus on the automotive, electronics and textile value chains in developing nations (Kraemer et al., 2011; Sturgeon et al., 2008). A late entry into the GVC research cohort, International Business theorists simply extended their traditional focus upon the internalization mechanisms of Multinational Enterprises (MNEs) to examine their effects upon suppliers in developing nations (Choksy et al., 2017; Rugman and Verbeke, 2004).

Michael Porter claimed that *“A good test of a new theory is that it makes sense to managers as well as to policy makers and economists”* (1990, p.21). This chapter seeks to shift the discourse away from the prevailing assumption that coercive inter-firm power determines GVC structure, which in turn determines the appropriation of rents. It takes a more agent-based

view of competitiveness, drawing upon the Supply Chain Management literature to consider how performance can be improved within the dependencies imposed by embeddedness in a global network configuration (Davis 1993 p.36, Berger 2005, Christopher 2011). Let us consider the possibility that structure is an outcome of managerial and institutional agency which is continuously recombining available resources to respond to market opportunities and pressures (Berger 2005 p.265). It will be vital to study economic performance at the firm level within any selected industry, and identify where possible, differences between economic outcomes within that industry. Empirical cases demonstrate that not all MNEs are successful, that not only nations must contend with distributional inequality, but firms within a single location and sector achieve different levels of success or failure, depending on their ability to compete and deploy their resources for better or worse.

The chapter is organized as follows: building upon Vlckova & Thakur-Weigold (2018), the first section will present a comparison of the two European locations, each of similar size but with divergent developmental trajectories. It will examine their respective economic performance within the GVCs of an emerging knowledge-driven industry, Medical Technology (MedTech). The second section (Thakur-Weigold 2020<sup>15</sup>) traces the trajectory of a Contract Electronics Manufacturer (CEM), with a global network of factories, as it developed a growth strategy in the MedTech industry, by integrating a high-cost Swiss factory, into a global order fulfilment process. This case study is the outcome of a two-year Design Science research project with an industrial partner of the ETH Zurich, which allowed access to firm-level data, as well as the company's managerial logic and decision-making processes. Further details of the Design Science research method and the solution search are summarized in Table 9 and Figure 19. The third and final section is an essay (Thakur-Weigold 2018a) on how orthodox theoretical assumptions, especially in IB and sociological economics, should be revised to reflect both the risks and opportunities that small firms face when operating within GVCs. This is illustrated by the case of a c-part supplier, again located in high-cost Switzerland, forced by globalization to compete with cheaper rivals in China using supply chain process innovation.

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<sup>15</sup> Currently under review by the Journal of Manufacturing Technology Management, Special Issue on "Rethinking international manufacturing in times of global turbulence: convergent perspectives of international business and international operations management".

## 2.1 Global Value Chains in Switzerland and the Czech Republic in the Medical Technology Industry

To explore the macro-economic context of GVC trade, it is necessary to address the following questions:

1. How do two small, open economies in Europe position themselves within the GVCs of a growing Medical Technology industry?
2. How do the economic outcomes compare, and what are possible reasons for divergence?
3. Are there any particular local competitive strategies, structures, or contexts which explain differences in macro-economic performance or outcomes?

The GVC framework proposed by economic sociology (Kaplinsky & Morris 2001, Gereffi & Fernandez-Stark 2011) takes the combination of location and sector as a unit of analysis to uncover drivers of inequality and developmental outcomes along the value chain. This first study will take the same unit of Analysis in the GVC methodology – place + industry – but begins by creating a macro-economic context for the deep dive to the firm level. It will proceed to emphasize the real existing differences within that Unit of Analysis, to demonstrate that managerial choice is both possible and necessary. Within the local GVC structure, generalizable variations emerge from the empirical data. The study conducts a comparison of how two different developed locations fare in a growth industry in which both countries have a tradition, or what Porter calls a home base advantage (Porter 1990, p.68). **The choice of Switzerland and the Czech Republic** is a deliberate response to the gaps in the GVC literature, which displays a selective emphasis on the US (which is not strongly integrated into GVCs), Asia, and developing nations that are seen as ‘left behind’ by globalization. This paper contrasts two countries, of comparable size, in the European space, a region relatively unstudied by GVC scholars. It compares one of the strongest economies in the world to a once emerging economy, which only fully opened to capitalism and global trade after 1989 but, in a remarkably short macro-economic catch-up trajectory, was reclassified by the World Bank as a developed nation in 2006. Both countries have small and fragmented domestic consumer markets which makes them dependent upon exports to maintain their current levels of GDP. As

a consequence, it is not surprising that both Switzerland and the Czech Republic are highly integrated into GVCs.

Central European countries are among the new emerging markets that have integrated into the global economy, attracted FDI and substantial production activities from the EU15 countries. The majority of FDI activity was directed towards export-oriented production, taking advantage of the relatively skilled and cheap labor force, investment incentives and later integration into the EU (Vlčková, 2017). A number of GVC studies have looked at the Czech Republic, although most of the focus has gone to the automotive industry, which is the leading manufacturing industry in the country (Pavlínek and Ženka, 2011; Jürgens and Krzywdzinski, 2009). The findings indicate that local suppliers were integrated into the production network, and upgrading occurred through knowledge spillovers in both domestic and foreign-owned firms. The upgrading process was, however, highly selective and uneven (Pavlínek and Ženka, 2011) as higher-tier, foreign-owned companies in the automotive industry created and captured more value than the lower-tier domestic firms (Pavlínek and Ženka, 2015).

Despite, or possibly due to, the unique position of Switzerland in the global economy, research on GVCs is much more limited. Nathani et al. (2014) demonstrates how deeply its industry is embedded in Global Value Chains, which improves competitiveness. Existing studies of Swiss value chains focus on well-known and highly-specialized industries like financial services, or watchmaking (e.g. Thierstein et al., 2008; Glasmeier, 1991). The contribution of this paper is partly a response to Egger (2014), who confirmed a gap in GVC literature on Switzerland, in spite of the country's material dependence on both imported intermediates and exports, and called for more investigations of this form of industrial activity and trade.

The comparison brings several interesting competitive factors (both advantages and disadvantages), to the foreground: Switzerland is one of the highest-cost countries in the world, with an overvalued currency (Economist, 2015). Any decisions to locate manufacturing or any business activity will have to justify the extraordinary cost burden with other competitive advantages. The Czech Republic has an unusually low-wage labour force for a developed European country, and has established itself as a low-cost manufacturing location, particularly for the automotive industry headquartered in Germany. For their recent economic success, both nations worry about sustainable growth and macroeconomic stability. The question which will therefore be addressed here, with the example of the MedTech industry, is what each location is doing to compete, and what sources of value-capture are emerging? The potential

for the successful aspects Switzerland to serve as a benchmark for policy development in the Czech Republic is logically higher than the US, whose cultural and economic differences make a comparison and transfer of learnings problematic.

For lack of comprehensive GVC-appropriate macro-economic data in each case, the paper applied a novel mixed methodology, which draws from economics and industrial engineering and the supply chain literature. The GVC methodology of the Gereffi school (Kaplinsky & Morris 2001, Gereffi & Fernandez-Stark 2011) also takes location and industry as a unit of analysis, then makes the input-output structure explicit, analyse the geographic context, governance structure, and institutional context to demonstrate how rents are appropriated by participants in the chain. We argue that this four-dimensional framework obscures the logic with which the business decisions were made, in the context of the respective national and institutional environments. The theory states that Governance is an outcome of supply chain strategy and market vicissitudes. Individual variants of the five archetypes will be operating in every interfirm dyad in the entire network (these can be in the thousands), and because product portfolios and technology and industry rivals change over time, continues to evolve over the course of trade relations between firms and nations. An exclusively power-based snapshot of an MNE, presumably orchestrating scores of dependent suppliers, neither accounts for the fluctuations of business cycles over time, nor the firm-specific competitive logic which responds to both endogenous (like learning or relational rents), effects and the exogenous forces of the environment (subsidies, regulation, stockouts, and the like).

This study therefore begins with the application of macroeconomic data to reveal the extent to which each country is embedded in GVCs. It then proceeds to review the economic importance and performance of each location in the Medical Technology industry. It then drills down to the national firm level, to analyze a sample of MedTech enterprises, and discuss representative cases of each location. The differences between Switzerland and the Czech Republic will be described and possible root causes identified, to arrive at recommendations for both policy and further research.

**The focus on Medical Technology**, a knowledge-based industry characterized by user-level innovation is deliberate for a number of reasons discussed here, the most important being that it arguably lowers the barriers to entry to value creation. The reasoning for this is as follows. Compared to automaking, in which developing nations are dependent on knowledge

transfers or spillovers from MNCs in developed nations, one could argue that every country in the world, and especially the poorer ones, has some level of medical know-how institutionalized within both practice and research. Consequently, according to smile curve economics, the potential combinations of value capture from low-paid tangible and high-paid intangible tasks in the MedTech industry should be accessible with more equal opportunities to firms around the globe. In the simplest of terms, any health care professional – and sometimes the patients - can theoretically invent a new MedTech product (The Economist 2018).

Compared to autos and consumer products, in which the manufacturing systems have been continuously improving for decades, there is virtually limitless potential for process and supply chain innovation in Medical Technology. MedTech displays three characteristics which create specific conditions along its value chain. First of all, it is a highly-regulated sector that must comply to safety standards designed to protect patients. This makes its production processes highly specific, while regulatory complexity and compliance drive up supply chain costs. Secondly, the MedTech Industry remains one of the most innovative, filing the highest number of patents in Europe with EPO in 2015, more than double the number of patents filed by pharmaceuticals in the same year. The industry is thus characterized by a proportion of products manufactured and designed in-house. Commoditization does not occur to the same degree that it does in consumer goods like electronics, and product life cycles can vary<sup>16</sup>. Thirdly, the customers are national and private healthcare providers with public procurement and distribution processes, as well as individual hospitals and patients. This industry is siloed (Dümmler et al., 2014) with collaboration limited to customers, like individual hospitals joining Group Purchasing Organisations<sup>17</sup> (GPOs) and public tender systems to exploit savings potential through economies of scale, and concentrated power of negotiation (Burns and Yovovich, 2014). Overall, service levels are high, because neither patients nor regulators tolerate stockouts of medical products. The three conditions all exert pressure on supply chain

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<sup>16</sup> Certain prosthetics, for example, can be stored for years and be used decades after their production without significant decay or obsolescence.

<sup>17</sup> According to Burns and Yovovich (2014), in the US „The vast majority of hospitals (90%) utilize national GPOs... Hospitals have remained loyal to their national GPOs, with an average tenure of eleven years as members...Hospitals route the vast majority of commodity, pharmaceutical, and dietary purchases through their national GPO, as well as a near majority of capital purchases.”

operations: regulatory requirements, customer demands, new product introductions, and the higher inventories required to assure near perfect availability tend to drive up costs.

There is no unified definition of MedTech in academic or industrial literature. In general, however, it involves technologies „from diagnosis to cure“, which apply both to diagnostic and treatment of disease, as well as preventive or follow-up therapy and infrastructure in healthcare. According to MedTech Europe (2016) „*Medical technology is any technology used to save lives in individuals...diagnosing, monitoring and treating virtually every disease or condition that affects us.*“ We count over 500,000 registered medical devices, which are coded by the Global Medical Device Nomenclature (GMDN) agency to 16 classifications, covering a wide range of products from instruments to lab equipment, diagnostic, and therapeutic devices, hospital supplies and implants. There is an observable trend to an overlap in these traditional classifications, with wearable devices or implants performing diagnostic and therapeutic tasks, and infrastructure like smart hospital beds transmitting the vital signs of patients. MedTech products differ in complexity and value - from large capital investments like MRI machines to low-cost consumables like disposable syringes. Our research excludes data from individual specialized artisans or technicians (like orthopedic shoemakers), as well as caregiving services to the patient directly (like physiotherapists, or private nursing). Pharmaceutical and drug products are also out of scope because their production systems more resemble those for chemicals more than medical devices. The specific complexity of R&D processes and lifecycles also make pharmaceuticals difficult to compare with that of devices and materials coded by GMDN (MedTech Europe, 2016).

Growth in the MedTech industry is driven by rising incomes, and ageing populations, both of which increase demand and rates of innovation. The US spends almost double on MedTech for its patient population than Europe, whose weighted average of expenditure is approximately €195, compared with €380 in the US. Accordingly, when measured by manufacturer prices, the largest market for MedTech in the world is the US (39%), which is followed by Europe (31%), Japan (9%) and China (6%) (MedTech Europe, 2016). Although, developed countries still account for the majority of global demand at 70%, expanding middle classes in emerging countries represent an important growth opportunity for the industry.

Bamber and Gereffi (2013) draw up a generalized map of the MedTech GVC (Figure 12) with the highest benefit going to the firms which work at the respective ends of the chain, confirming the smile curve (Mudambi 2008, Shi 1996). The value-added by prototyping, and



regulatory approval, all of which are time-consuming, legally complex, and dependent on highly-qualified specialists is not only well-paid, but establishes control over downstream activities early on in the product lifecycle. At the other end of the smile, sales of specialized equipment, together with services like training and consulting also require highly-trained specialists who are highly-paid. On the other hand, the value creation is the lowest in the middle section of the smile curve associated with the repetitive manufacturing and assembly of parts designed, sold, and maintained by these specialists. The governance mode in the global sector is hierarchical (particularly among big MNEs), where most decisions regarding vendors are made in corporate headquarters and at a scale to support manufacturing plants around the world (Bamber and Gereffi, 2013).

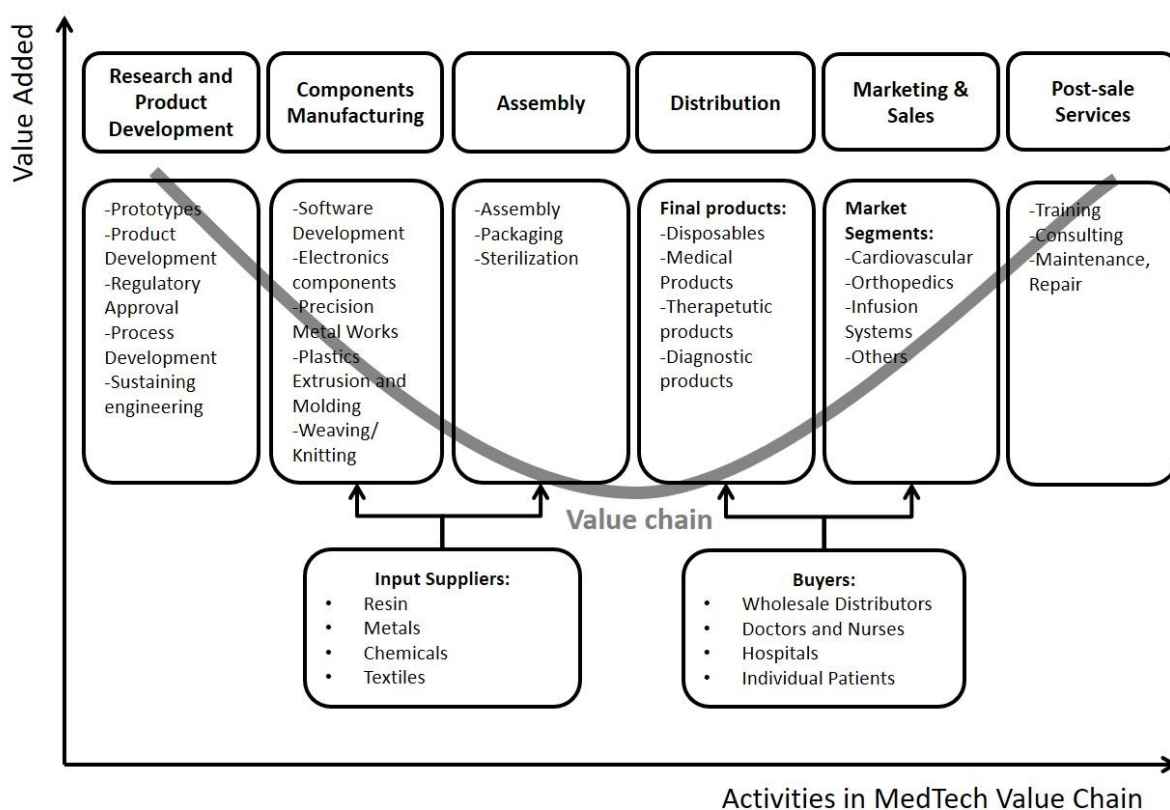


Figure 13: Value creation along the MedTech Value Chain.  
Source: the authors based on Shi (1996), Mudambi (2008), Bamber and Gereffi (2013).

The MedTech industry is still predominantly located in developed countries and the top ten MedTech companies are either headquartered in the US or EU (MedTech Europe, 2016). The biggest exporters are, with the exception of China and Mexico, all high-income countries (see Figure 13). As in other industries, the MedTech industry has offshored production activity

extensively, especially to lower cost countries like Ireland initially (Forfás, 2009), and later to Mexico or Costa Rica. These countries focus on making labor-intensive goods of low value, such as disposables, although there are signs of upgrading into more complex products, associated with FDI inflow. Offshoring can also be driven by initiatives in emerging markets (Bamber and Gereffi, 2013). The question which we shall address next is how two small, open European economies position themselves to compete in the GVCs of the MedTech industry.

### **Data and methodology**

In the absence of reliable and dedicated datasets on MedTech GVCs, this combination provides a foundation for the more detailed mapping of value chains (Kaplinsky & Morris, 2001) and interpretation of competitive supply chain strategies in the Czech Republic and Switzerland.

The standard datasets which measure international trade present several challenges when they are applied to GVCs. To begin with, the data do not detect the multiple border crossings of intermediate products moving within the chain between nodes. This can lead to double-counting of the flows of components and semi-finished materials as they are transformed into the final product, and draws a misleading picture of the origins and destinations of value-added, as well as of total export value (Koopman et al., 2010). The double counting based on conventional trade data inflated world trade volume by 32% in 2011 (OECD-WTO, 2016). To rectify this, two major groups of studies emerged. The first is based on case studies of individual industries, usually at the firm level (e.g. Nathani et al., 2014). The second group of studies uses country-level data derived from international trade statistics; particularly input-output tables (e.g. Baldwin and Lopez-Gonzales, 2014). Several new, multi-country datasets, including the OECD-WTO Trade in Value Added (TiVA), or the World Input-Output Database (WIOD), have emerged recently, stimulating both research and interest among policy makers. In spite of this progress, all of the data has only been compiled for highly-aggregated industries, and do not provide a detailed picture of the MedTech industry.

MedTech GVCs will be described by combining macro-level (country) indicators with micro-level data from firms, the latter drawing upon our own compilations. We extract the OECD-WTO TiVA data to demonstrate how the Czech Republic and Switzerland are positioned within GVCs in general, based on the forward and backward participation index devised by

Koopman et al. (2010)<sup>18</sup>. In general, small open economies have a relatively high participation in GVCs and a correspondingly high share of foreign value-added (FVA) in their exports (OECD-WTO, 2016).

Furthermore, detailed export statistics from UN COMTRADE (classification HS96) is used to assess how exports of MedTech products evolved in the Czech Republic, Switzerland, and also other countries. Since data on trade in services are highly aggregated, they are not available for the MedTech industry. For identification of MedTech products, we follow the distinction made by Bamber and Gereffi (2013), who split MedTech products into four categories based on their value and technological sophistication. These are: disposables (needles, syringes), medical and surgical instruments (dialysis devices, dental drills), therapeutic devices (artificial joints, pacemakers) and diagnostic and imaging equipment (MRI, ultrasound). Drawing on trade statistics, we proceed to identify which countries have revealed comparative advantage (RCA) in MedTech products based on the index proposed by Balassa (1965). Although we are aware that RCA computed on gross exports is slightly distorted by the fact that these exports can include inputs produced in other countries and industries, there is no other data available. We note, however, that there is usually only a slight difference between RCA based on gross exports and that which is derived from value added exports.

For the identification of MedTech firms, we rely on NACE classification, specifically NACE 325 (Manufacture of medical and dental instruments and supplies), and NACE266 (Manufacture of irradiation, electromedical and electrotherapeutic equipment). We also include firms which focus on services in the MedTech industry, although both activities are often performed by the same firms. The Czech Republic compiles detailed and relatively high-quality statistics in relevant categories (e.g. the number of enterprises, employment, value added, etc.). In contrast, the Swiss federal statistical office does not compile comparably detailed data. Although Eurostat includes statistics for Switzerland, official estimates of the number of enterprises in MedTech industry in Switzerland are two times lower than the figures estimated by industrial clusters and consortia (Hofrichter and Dümmler 2016). Due to the inconsistent quality of official Swiss data, we draw upon those collected regularly by MedTech clusters, which employ dedicated specialists who conduct frequent surveys of local member

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<sup>18</sup> The backward index measures the foreign value added (FVA) embodied in exports of countries (located upstream). The forward index measures the exports of countries which are further processed and exported by a third country (located downstream). Simply put, these are exports where the country of final demand differs from the country, to which these exports are headed.

firms. Our own study compiled a dataset of over 250 Swiss firms and over 70 of Czech firms drawing from webpages, news articles and databases such as Albertina or Magnusweb. This was complemented by interviews with managers and clusters/consortia in both countries.

The Czech Republic is a transition country which focuses on the export of manufacturing products. Its comparative advantage is derived mostly from labor-cost effectiveness (Pavlínek et al., 2009). Despite having the smaller population, export volumes of goods and services in Switzerland are twice as high as in the Czech Republic, especially due to bigger exports of services (Nathani et al., 2014). However, the share of exports of goods and services to GDP reaches 63% in Switzerland and 83% in the Czech Republic. Also in terms of participation in GVCs, Switzerland is relatively less embedded in GVCs than the Czech Republic, whose GVC participation index belongs to the highest in the world (58.6 in CZ and 41.8 in CH in 2015). This is attributable to the bigger role played by manufacturing, since manufacturing industries are in general more fragmented than services (de Backer and Miroudot, 2013).

The backward and forward participation index helps reveal where each country is located in its respective GVCs: the highest value added (like product design and service), is generated at the beginning and end of the chain, whereas activities in the middle of the chain, like processing or assembly, are generally associated with low added value, and higher backward linkages (see the smile curve in figure 13). Switzerland's forward linkages are higher than its backward linkages, indicating an upstream position in its GVCs. Although, the structure of GVCs vary across and between sectors, the financial sector, which is Switzerland's most dominant, is present in all of them. Traditional trade data indicate that services account for only 20% of trade value, but input-output tables enable an estimation of the services which are embedded in manufactured products. These accounted for 62% of value added of Swiss exports in 2011, and the majority of the services originated from Switzerland itself (OECD-WTO 2016, Nathani et al. 2014). In contrast, the Czech Republic, has significantly lower forward linkages, and their exports include a large share of foreign value added (backward linkages), in the form of both intermediate products and services originating in other countries. Services accounted only for 38% of gross exports, and less than half of these originated in the Czech Republic.

Both trade data and research thus indicate that positions of the Czech Republic and Switzerland within GVCs differ in significant ways (Pavlínek and Ženka, 2011; Nathani et al., 2014). This is related to the differences between these two economies, affected particularly by their geographic characteristics (location, natural resources...) and history. Whereas the Czech

Republic belonged to the most industrialized countries in the first half of the twentieth century, forty years of communism with focus on heavy industry and exports mainly to other socialist countries made its products uncompetitive on global markets. Its transformation process following the Velvet Revolution was characterized by FDI inflows to service sector serving the home market (e.g. banking) and manufacturing mainly for exports. Its industrial tradition, favorable geographic location, cheap and relatively qualified labor force, as well as political stability and investment incentives were the main drivers of FDI inflows and the Czech Republic has started to serve as an export platform (Myant and Drahokoupil 2011). Due to the large role of FDI and foreign ownership in Visegrad countries, managerial decisions are often made in other countries. The economies of Eastern Europe have thus been identified as a new variety of capitalism called “*dependent market economies*” (Nölke and Vliegenthart 2009).

Exporter	Rank	Disposables		Medical		Therapeutic		Diagnostic		Total	
		Value	Share	Value	Share	Value	Share	Value	Share	Value	Share
USA	1	7713	18,7%	14275	23,9%	9540	18,8%	18953	22,3%	50480	21,3%
Germany	2	3502	8,5%	9014	15,1%	5263	10,4%	16356	19,2%	34135	14,4%
Netherlands	3	4425	10,7%	2956	4,9%	6285	12,4%	7246	8,5%	20913	8,8%
China	4	3533	8,5%	2411	4,0%	1183	2,3%	6049	7,1%	13177	5,6%
Belgium	5	3611	8,7%	3750	6,3%	4331	8,5%	1080	1,3%	12772	5,4%
Switzerland	6	613	1,5%	2576	4,3%	6412	12,6%	1089	1,3%	10689	4,5%
Japan	7	1019	2,5%	1745	2,9%	99	0,2%	7376	8,7%	10240	4,3%
France	8	1071	2,6%	2079	3,5%	3111	6,1%	3749	4,4%	10011	4,2%
Ireland	9	3013	7,3%	1404	2,3%	4865	9,6%	256	0,3%	9539	4,0%
Mexico	10	2732	6,6%	2950	4,9%	795	1,6%	1310	1,5%	7787	3,3%
Czech Rep.	27	419	1,0%	386	0,6%	80	0,2%	122	0,1%	1007	0,4%

Table 4: The comparative position of the Czech Republic and Switzerland in the MedTech Industry.

The position becomes apparent in the list of top 10 Exporters of MedTech products in 2014. Source: UN COMTRADE, 2016.

The situation in Switzerland is very different. Due to limited natural resources Switzerland has specialized in precision industries and its service sector. Small fragmented domestic markets forced it to expand to foreign markets, where products had to be competitive, creating relentless pressure to innovate. Political neutrality helped Switzerland during the world wars because, unlike its neighbors, the production base was preserved from destruction. Its infrastructure, institutions, and vocational education system are crucial for

Swiss ability to innovate. This system of factors helps account for why Switzerland is consistently ranked the most competitive country in the world by the World Economic Forum.

Because sectors can differ broadly, we will focus on each country’s positioning in the MedTech industry. The MedTech production is highly concentrated in developed countries (table 4), although there are some emerging production locations also among the middle-income countries such as Mexico and China and even small countries like Costa Rica or Dominican Republic. In general, these emerging countries focus on the production of lower-value added products, like disposables, and are more dependent on labor than they are on capital and knowledge.

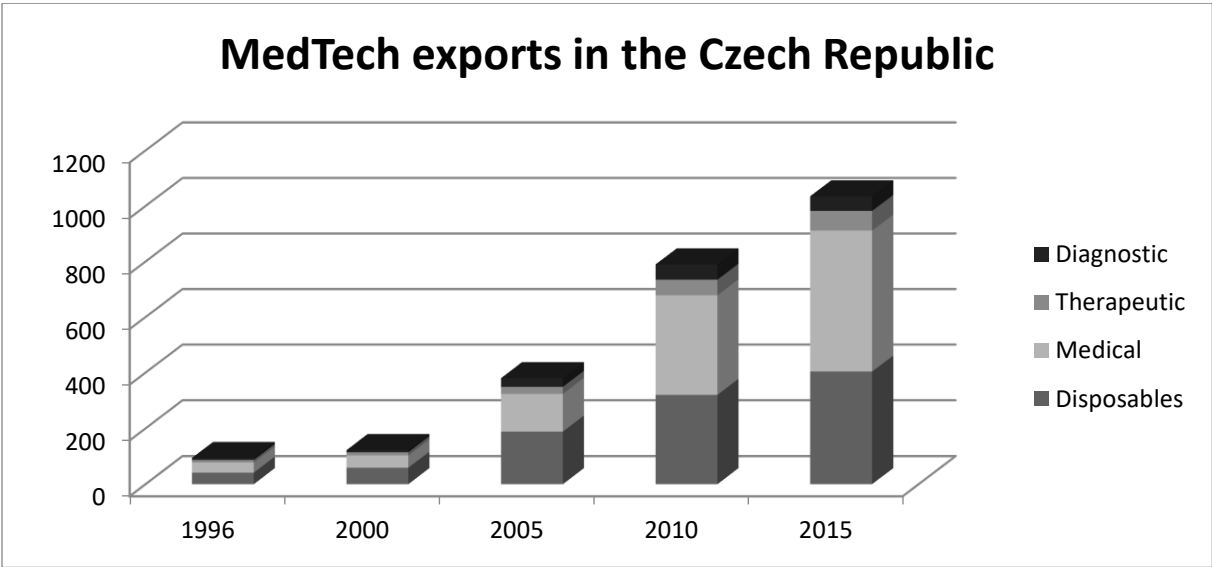


Figure 14: Czech exports of MedTech products between 1996 and 2015.  
Source: UN Comtrade, 2016.

Since the absolute value of exports does not reflect the relative importance of the MedTech exports for individual countries, we also calculate Revealed Comparative Advantage or RCA<sup>19</sup>, which, despite its limitations, proves to be a useful reference within a GVC analysis. Overall, fewer than 20 countries have a RCA (RCA>1) in MedTech exports. The top five countries include Ireland, Israel, Netherlands, Finland and Switzerland. Drilling down, we observe large differences between the product categories. The group with RCA in disposables encompasses almost 20 countries, including Ireland, Mexico, Dominican Republic or the Czech Republic. As

<sup>19</sup> See appendix 2 for details on the computation and logic of Revealed Comparative Advantage.

product sophistication rises, however, the number of countries displaying RCA decreases to 13. In the category of diagnostic products, only Western European countries display RCA: Japan, United States, Israel or Singapore. This pattern seems again to confirm the Smile Curve Economics, in which a small group of developed countries specialize in capturing higher value in the MedTech GVCs.

In the Czech Republic, the MedTech industry has experienced significant growth in recent years, and at present, close to two-thirds of production are dedicated to exports. Since 1996, the MedTech exports in the Czech Republic increased almost 10 times in nominal terms, although they are dominated by disposables and medical and surgical products<sup>20</sup>. The share of therapeutic and diagnostic products, which add more complex and higher value, has risen less steeply. Currently, its major export product group is medical products, and the share of disposables are stagnating (Figure 14). The MedTech exports from Switzerland have quadrupled between 1996 and 2015 and are concentrated on high-value therapeutic and medical devices, like joint reconstruction, heart stents, insulin delivery, and a range of minimally invasive surgical tools. Diagnostic products and disposables make up a relatively small percentage of total exports (Figure 15).

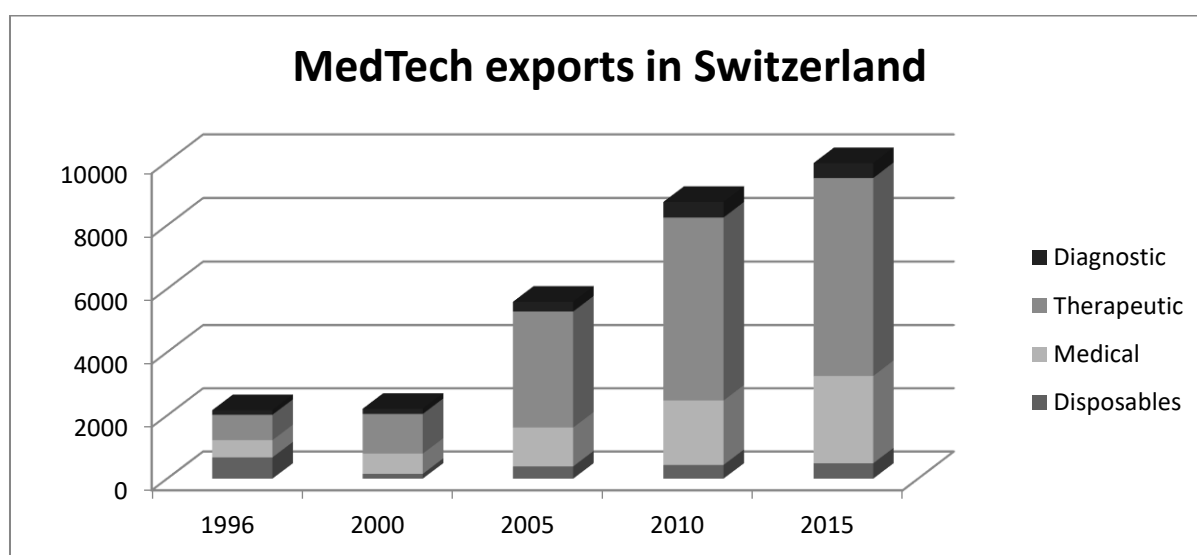


Figure 15: Swiss MedTech exports between 1996 and 2015.  
Source: UN Comtrade, 2016

<sup>20</sup> Medical wadding, gauze, dressings, surgical and medical instruments, hospital furniture, needles, and catheters together accounted for almost 80 % of exports in 2014.

The differences between Switzerland and the Czech Republic are not only related to the type of products that are being exported but also export destinations. The top three destinations of Czech exports are Germany (14%), Belgium (10%) and Italy (7%), whereas in Switzerland it is Netherland (13%), Germany (9%) and United States (8%). The types of products as well as major investors (see table 4 and 5) affect where countries export their MedTech products. In the Czech Republic, Germany is the main investor, whereas in Switzerland, it is United States. The Czech Republic also exports more to former socialist countries such as Slovakia, Russia or Poland. This can be attributed to a number of factors including geographic proximity, historical ties, as well as less demanding market, but should be further explored. In general, both countries export more sophisticated products (such as diagnostic products), to more distant locations like the United States, whereas disposables are exported to neighboring countries. Viewed from a supply chain perspective, the differences in export destinations could be due to a portfolio of supply chains. In the local one, transport costs of low-value goods are optimized, while the simultaneously competing globally with a focus on innovative, high-value goods. The fact that the Czech Republic's former communist neighbors source their low-value disposables from a European location, and not the even cheaper Southeast Asian suppliers, also suggests that responsiveness is more important to compete than absolute low cost. Even disposables are vital supplies for MedTech consumers, who can tolerate no stockouts.

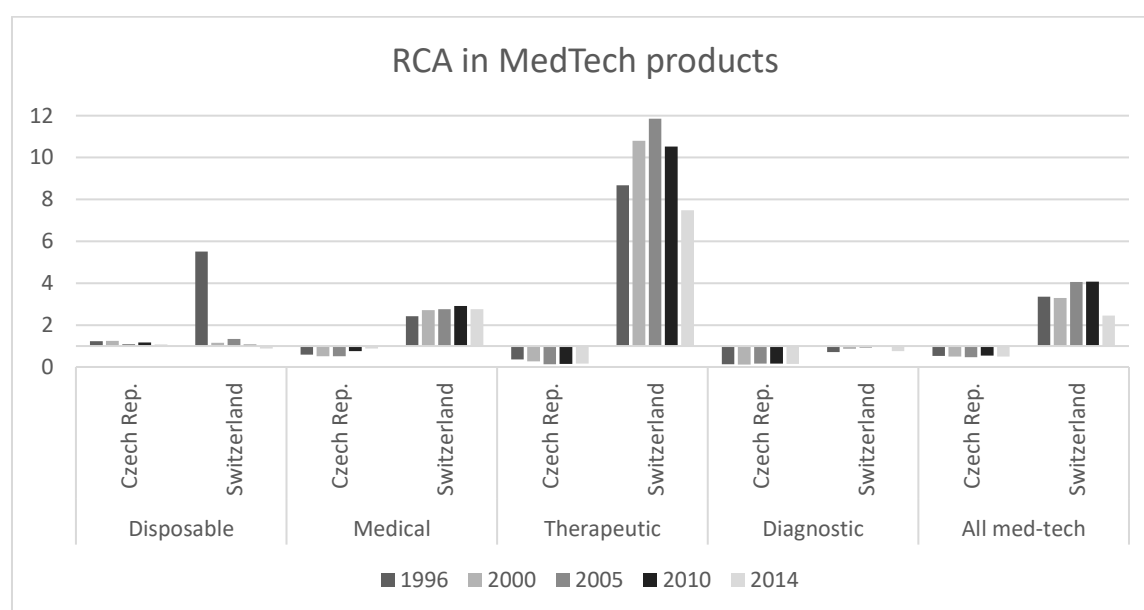


Figure 16: Revealed Comparative Advantage of Czech Republic compared to Switzerland in the four major categories of MedTech Products.

Source: UN Comtrade, 2016.



In terms of Revealed Comparative Advantage, figure 4 indicates that the Czech Republic only has RCA in disposables, although for medical products, its RCA approaches 1 over time. In the case of therapeutic and diagnostic products, the country has a significant comparative disadvantage. Switzerland's most significant RCA is in therapeutic as well as medical products. Over the 18-year period of measurement, its RCA in disposables steadily decreased, and is currently measured below 1, confirming the shift of production towards lower-cost locations. Switzerland also has a comparative disadvantage in diagnostic products.

### **How the Czech Republic and Switzerland compete in the MedTech industry**

The MedTech industry has a long tradition in the Czech Republic, including the invention of polarography or hydrogel contact lenses. The production of medical technology started in the 1950s and focused mostly on ECG machines, anaesthetic, and laboratory devices. Exports have risen significantly since the 1990s (Figure 14) and the export structure has also changed. The rising share of medical products at the expense of disposables may be an indication of product upgrading. Although the negative balance is diminishing gradually, overall the Czech Republic remains a net importer of MedTech products in terms of value because it imports sophisticated MedTech products (like electromedical and electrotherapeutic equipment), while its exports are dominated by lower-value products.

Despite the growth of this industry in recent years, the MedTech exports still account only for 0.6% of Czech manufacturing exports (UN COMTRADE, 2016). Between 1995 and 2008, the value added in the MedTech industry increased by 40% and employment by 13% (ČSÚ, 2015), a situation that has not changed much after the financial crises. Between 2008 and 2014 the value added increased by 20%, although employment stayed relatively stable. In sum, not only assets but also labor productivity and wages are rising steadily.

In 2014 MedTech industry accounted only for about 0.9% of value added in the manufacturing sector, the employment was higher, reaching 1.2% (ČSÚ, 2015). This can be interpreted as more labor-intensive production associated with low-value added products. On the other hand, employment in R&D reached 1.8% of the manufacturing R&D employment, whereas the expenditures were at 1.6% of the manufacturing sector. These apparently contradictory findings are probably due to the heterogeneous character of MedTech companies in the Czech Republic, whose level of value-added can diverge broadly. We identified four distinct groups (Table 5): the first being highly- innovative, often Czech-owned

firms (such as LINET spol. s.r.o., UJP Praha s.r.o., or Beznoska, a.s.), who conduct their own R&D. The second are foreign subsidiaries focusing on R&D and other advanced services, and/or high-value added manufacturing. In contrast to Switzerland, these firms are almost absent in the Czech Republic (the exception is Olympus Czech Group). The third group includes domestic firms which specialize in low-value-added manufacturing, particularly disposables, applying a cost-saving supply chain strategy (e.g. DINA – HITEK, spol. s.r.o. or Panep s.r.o.). The fourth is a group of foreign subsidiaries (such as HARTMANN – RICO a.s. or Lohmann and Rauscher, s.r.o.- see Table 6), which focuses on labor-intensive production of basic disposables, applying technologies developed elsewhere, controlled by parent companies.

	<b>Characteristics of firms</b>	<b>Czech Republic</b>	<b>Switzerland</b>
1	Innovative, locally-owned (often SMEs), with in-house R&D	A few	Numerous
2	Innovative or high-value production, foreign subsidiary	Very few	Numerous
3	Low-cost production, locally-owned	Numerous	A few
4	Low-cost production, foreign subsidiary	Numerous	Virtually absent

Table 5: Four different types of firms.  
Source: authors' analysis

From around 2200, MedTech companies in the Czech Republic, only 85 are foreign-owned, though they are much bigger in size (55% of employment and 57% of value added). Five out of the ten biggest MedTech companies belong to this group (Table 6). Nevertheless, this indicates that Czech Republic is in another position than MedTech exporters in middle-income countries such as Costa Rica or Mexico, where 95 % of medical production was under a preferential tax regime (Bamber and Gereffi, 2013). Foreign-owned companies chose the Czech Republic for its industrial tradition, low operating costs, and convenient geographic location (iTrade 2016). These companies also benefit from investment incentives.

A case in point is Smith Medical (in CZ since 2013, 300 employees) which received two investment incentives of ca 5.5 million EUR each, in the form of corporate income tax relief (Czechinvest, 2016). Fresenius HemoCare CZ s.r.o. and Mölnlycke Health Care AB also received a total of 22 mil. EUR in investment incentives, all in the form of income tax relief (Czechinvest, 2016). The production of these companies is usually destined for exports while most of their inputs come from abroad. They do not have any R&D centers in the Czech Republic because

the technology is provided by its foreign owner, and most of the local labor force is low-skilled. For them, the major locational benefits are a cheap labor force and possibly, the tax system. The situation in MedTech is very similar to the whole manufacturing sector. The big role of MNEs and foreign capital is related to the nature of the post-communist market transformation process, when foreign capital was welcomed to provide jobs, and new technology and investment incentives served as a way to attract this capital.

Company	Owner-ship	Mainly MedTech products?	Turnover (x1000 EUR)	Employees	Main products
HARTMANN – RICO a.s.	DE	yes	157 939	1362	disposable surgical drapes, plaster bandages and gauze products
Linet s.r.o.	CZ-DE	yes	105 649	900	hospital beds, other hospital furniture
Mölnlycke Health Care Klinipro s.r.o.	SE	yes	88 439	600	surgical sets, bandages
Gerresheimer Horšovský Týn spol. S r.o.	DE	yes	88 681	613	inhalers, insulin pens, lancing devices, dialyzer components
Olympus Czech Group, s.r.o.	DE	no	82 842	318	Endoscopes
Lohmann and Rauscher, s.r.o.	AT	yes	66 212	826	dressing material, bands, braces
Fresenius HemoCare CZ s.r.o., koncern	DE	no	42 661	550	medical products for infusions and transfusions
BMT Medical Technology s.r.o.	DE	yes	32 134	385	steam, hot air and low-temperature sterilizers, laboratory drying ovens
BioVendor – Laboratorní medicína, a.s.	CZ	no	25 755	200	Imaging and diagnostic equipment, laboratory technology and equipment
BORCAD cz s.r.o	CZ	no	21 123	243	birthing beds and chairs, gynecological workplace equipment

Table 6: The ten biggest MedTech companies in the Czech Republic.  
Based on turnover in 2014. Source: authors' analysis.

Innovative Czech MedTech companies tend to operate R&D units in addition to manufacturing operations. The skill-level of their workers is mixed and companies with bigger manufacturing production usually have a higher share of low and semi-skilled workers. Some of them also provide services such as the clean room projects. This group includes firms like LINET s.r.o., the world's third biggest producer of smart hospital beds which are digitally integrated to provide caregivers with patient vital signs and analytics. Originally a Czech

company, it is now a part of the LINET Group headquartered in the Netherlands, although the Czech owners continue to retain 50% of the company. LINET has its own R&D team and many patented solutions. Other companies in the top ten list (table 6) include BioVendor – Laboratorní medicína, a.s. focusing on laboratory technology, or BORCAD, which was taken over by LINET in 2016. Domestic innovative companies also benefit from the low-cost of labor, although some of them struggle to find workers with the right skills in the current period of low unemployment. They source inputs from the Czech Republic as well as internationally. However, if more specialized high-quality intermediates are needed, these tend to be sourced from abroad. Many of them cooperate with local research institutions and make use of governmental programs, such as EU structural funds or program Gamma. The government can simultaneously become a major constraint through regulations, and the weaknesses of a legal system which is considered slow, inefficient, unpredictable, and corrupt. This critique is also directed to Czech laws of public procurement, which puts price over quality and is, according to one CEO *“the worst in the world”*.

In terms of domestic firms which focus on low-value-added manufacturing, these companies are usually small in size and specialize in disposable production, although some of them are extending their operations to neighboring countries, particularly Poland and Slovakia. Their inputs are often from the Czech Republic and they deliver to local clients (mostly hospitals), although the role of exports differ widely among individual firms. If such firms do export, it is mostly to nearby, usually former socialist countries. Compared to the even lower cost of Chinese factories, this may actually represent a high cost manufacturing strategy which enables local responsiveness for critical items.

Both in terms of product and process innovation, MedTech is a knowledge-based industry. Because of this, cluster structures, infrastructure, and educational institutions play a role in efficient idea generation and transfer. The Czech Republic has an extensive network of research institutes and universities. Several innovative MedTech companies cooperate with universities or academy of sciences, though the general patterns of collaboration between companies and universities/research institutions in the Czech Republic has been limited. Both sides identified a mismatch of needs with resources, resulting in inefficient misunderstandings (TAČR, 2015). Certain companies have admitted that they cooperate on less complicated challenges with local universities, resorting to high-prestige foreign institutions for their more complex R&D questions. This would be the equivalent of outsourcing high-value work abroad,

clearly a reversal of the usual arbitrage or low-wage locations in global markets. Overall, Czech companies feel limited by a lack of qualified labor. Despite rising R&D expenditures by firms, venture capital investment in the Czech Republic lags far behind the EU average (European Commission, 2015). These aspects limit further upgrading among foreign subsidiaries as well as local firms.

Additional success factors, such as institutional context, or overall business friendliness need to be taken into consideration. In terms of inefficient government bureaucracy, the Czech Republic lags behind considerably. Another problem is labor market efficiency (WEF, 2016). Beneficial is, however, the existence of two associations of producers of medical products: the Association of Manufacturers and Suppliers of Medical Devices (AVDZP) focuses on industrial development and exports and has over 90 members. The Czech Association of Medical Devices Suppliers (CzechMed) concentrates on improving the regulatory framework, ethics and reimbursement in the industry.

With a total production value of CHF14.9Bn CHF (€15.6 Bn),<sup>21</sup> growing 1.8% yoy in 2015, the MedTech Industry in Switzerland plays a significant part in a powerful, export-oriented economy. MedTech comprised 2.3% of its GDP, compared to 0.7% in the EU and 0.8% in the US. It employed 1% of the country's workforce, relatively the highest share in the world (Hofrichter and Dümmler 2016). In 2014, at €11Bn Switzerland was the fourth largest European exporter of MedTech equipment, behind Germany (€28Bn), Netherlands (€18Bn), and Belgium (€11Bn) (MedTech Europe, 2016) and the sixth largest in the world. The high value of exports is achieved in spite of an overvalued currency, whose exchange rate saw a step change in February 2014, when the SNB abandoned its peg with the Euro (The Economist 2015). According to Hofrichter and Dümmler(2016), the exchange rate of the Swiss Franc remains one of the main challenges to competitiveness in world markets. At the same time, the country's strong embeddedness in GVCs provides a natural hedge through the reduction in the cost of components and raw materials sourced abroad (Nathani et al. 2014).

The four distinct groups of firms we have identified appear with different weights in Switzerland (table 5). We observe two main groups of industrial firms in the Swiss MedTech

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<sup>21</sup> Computed at the exchange rate of 1.05 CHF per €. The hardening of the Swiss franc in January 2015 distorts the historical data, whose value will retroactively increase in proportion (the current output will thus appear smaller than in the past).

industry which specializes in high value, usually high-tech products. The first are usually small and medium-sized, often family-owned enterprises (SMEs) headquartered in the country who conduct their own R&D (like Biotronik or Geistlich). The second are foreign subsidiaries focusing on R&D and other advanced services, and/or high-value added manufacturing, (like Johnson and Johnson Medical, or Medtronic). Foreign subsidiaries which focus on labor-intensive production of basic disposables, applying technologies developed elsewhere, controlled by parent companies and domestic firms which specialize in low-value-added manufacturing, applying cost-saving supply chain strategy are almost absent in Switzerland.

The industrial base is populated by both startups (55 firms in our sample of over 250 had been founded after 2000), and long-standing firms which were operating before the current wave of globalization (29 firms were founded before 1950). The number of young firms operating in Switzerland is consistent with the highly innovative character of MedTech, although the new product development is not restricted to small startups. The R&D activities of Swiss MedTech firms benefit from a strong cooperation with well-funded Swiss research institutes (Smith et al., 2016), both highly-ranked Federal Institutes of Technology and also colleges of applied sciences like Rapperswil and Lucern, to drive product innovation (Hofrichter et al., 2016). In their comparison of Switzerland with Ireland's innovation drivers, Roper et al. (2012) acknowledge that Switzerland is dependent on innovation for its productivity, and its firms are strong in product innovation. Foreign ownership does not change the knowledge-sourcing patterns of its local firms from a combination of internal R&D, horizontal networks, and external research groups.

Swiss MedTech firms are mostly Small and Medium-sized Enterprises. Our data sample shows that only 20 firms employed more than a 1000 workers, while a full 87 had less than 100 and 54 of these had less than 20 employees. The high productivity of Swiss MedTech employees is in line with that of the industry in general: its share of GDP is roughly double its share of employment. When we look only at the large multinational corporations operating in Switzerland, the productivity increases dramatically. In 2014, the Swiss-based but US-owned multinationals generated up to CHF25M per Full-time Equivalent employee (FTE), with an average of CHF17.75M among the top 5 American companies. In stark contrast, the top 10 Swiss-owned MedTech companies achieve an average of only CHF 1.37M , a figure which drops to CHF0.78M if the multinational Roche Diagnostics is excluded from the computation (Table 7).

Most Swiss MedTech companies continue to manufacture in high-cost Switzerland, as do the majority of their local suppliers, which suggests that factors other than production costs motivate location decisions. The exact cost differentials between Switzerland and lower-wage regions will differ according to supply chain requirements and firm strategies, but the consensus is that the cost basis in Switzerland is much higher. One manufacturer we interviewed in the Zurich region calculates the fully-loaded unit cost of producing in the Swiss factory as over 400% that in China. At the same time, the share of intermediate goods being sourced from abroad is increasing, presumably driven by strength of the currency which reduces the cost of foreign-made inputs (Hofrichter et al. 2016, Nathani et al. 2014, authors' own data).

Company	Ownership	Mainly MedTech products?	Turnover M CHF/€*	Employees	Main products
J&J Medical	US	Yes	27381/22725	6000	Orthopedics, Neurosurgery, Cardiology, Surgery
Medtronic	US	Yes	16918/14042	1000	Cardiovascular, Orthopedics, Neuroscience
Baxter	US	Yes	16599/13777	900	Medical delivery, Renal Therapy, Bio Science
Roche diagnostics	CH	Yes	10766/8936	2200	In-vitro diagnostics
Abbott	US	Yes	10070/8358	400	Diagnostics
Stryker	US	Yes	9625/7989	565	Orthopaedics, neurotechnology and spine
B. Braun	DE	Yes	6528/5418	934	Consumables for hospitals
Zimmer Biomet	US	Yes	4649/3859	1000	Orthopedics
Smith and Nephew	US	Yes	4577/3799	410	Orthopedics and wound management
Dentsply	US	Yes	2904/2410	900	Dental products

Table 7: The ten biggest MedTech companies in the Switzerland, based on turnover in 2014. On the 15th of January 2015 the exchange rate jumped from € 0.83 to a CHF to 1.01, or roughly parity, when the SNB removed the € peg. To better reflect the value in 2014, this table converts using the historical January 14, 2014 rate.

To illustrate a typical Swiss firm (type 1 in table 5), we describe a hearing aid producer which operates two manufacturing facilities in Switzerland, and makes 80% of its turnover with products which are less than 2.5 years old. The firm customizes models to deliver tenders from international purchasing organizations like the veterans' administration in the US or the NHS in

the UK. They have over 50 new product introductions per annum (including accessories), all designed in-house by a staff of over 250 in the R&D department. A supply chain executive commented that *“We do not sell a hearing aid. We sell a hearing solution for a certain period of time”*, emphasizing the responsiveness of the supply chain to the needs of patients. Because of short product life cycles and the demands of these customers, combined with the injection moulding which they consider a core competence, the firm sees no alternative to manufacturing their devices in Switzerland. The proximity of the R&D engineers to the production line enables new ideas to be tested and implemented immediately. Following an attempt to move their service department to the UK, which failed due to issues in quality and speed, this high-value activity was also retained in Switzerland. Because the critical GVC activities of design, custom manufacturing, and service turned out to be more expensive in low-wage locations, the highest value generated by the company is created in Switzerland, where its know-how is generated and protected.

An example of foreign subsidiary (type 2 in table 5), is a German-owned firm which manufactures coronary vascular intervention devices in a small town near Zürich, with a workforce of 1000 and growing. It develops all products in-house and maintains partnerships with local universities. A top-selling product (by volume) is a drug-eluting heart stent, which it invented in 2011. The company typically registers 10 patents a year. This rate of innovation would not be possible without a qualified technical workforce, as a result of Switzerland’s highly-regarded 3-tiered vocational system. In this long-standing traditional system, industry cooperates with public educational institutions to train skilled workers on the shop floor when they are not in the classroom. Graduates are productive as they study and specialize to meet the requirements of each industry. The supply chain manager of the company cites the availability of highly-skilled workers as one of the reasons for locating operations in Switzerland.

## **Conclusions and Discussion**

The MedTech industry demonstrates high growth around the world with an expanding portfolio of both standardized, and innovative products. MedTech Global Value Chains present growth opportunities for small, open export-dependent economies, who can specialize without investing in the entire industrial base. By comparing macro-economic and firm-level data of two countries of similar size, Switzerland and the Czech Republic, both located in the heart of



Europe, we explore several generalizable differences, and make recommendations for policy-makers and further research.

Both Switzerland and the Czech Republic look back on a long tradition in Medical Technology, which should be a good foundation for development. Although it is growing in both locations, the MedTech industry is much more important for Switzerland than Czechia. In Switzerland the industry accounts for over 2% of GDP and around 1% of workforce, whereas in the Czech Republic it is less than 0.4 per cent of employment and even less on GDP. Furthermore, Swiss MedTech exports are almost ten times higher. Viewing wage differential in isolation, Switzerland should be too expensive to locate competitive production facilities, while Czech Republic is a more suitable source of affordable labor. Nevertheless, production occurs in Switzerland, just as product design and innovation takes place in the Czech Republic, though to a much smaller extent. The fact that very long GVCs often cannot support the responsiveness required by innovative products (Berger 2005), as is the case with MedTech devices, is a possible explanation for this division of labor. It is important to drill down to the firm level logic.

MedTech companies in both countries are embedded in GVCs, as is typical for small open economies. Swiss companies operate mostly in the extreme upstream and downstream, in high value-adding activities. They export more sophisticated (such as therapeutic) products, while companies in the Czech Republic engage predominantly in lower value-adding activities with exports dominated by simple disposables and medical products, although small number of elite firms engage in product development and higher value-added activities.

The MedTech industry in both the Czech Republic and Switzerland is polarized into a small number of large, foreign-owned MNCs and a large number of SMEs. Among them, we identify four different types of firm with specific supply chain strategies: 1) Innovative, locally-owned firms which are usually SMEs, 2) Foreign subsidiaries with innovative or high-value production, 3) Locally-owned firms with low-cost production, and 4) Foreign subsidiaries with low-cost production. Whereas the first two types of firms (both innovative), are widespread in Switzerland, the Czech Republic is dominated by the latter two types (with low-cost production). Innovative activity in MedTech is mostly carried out by a few elite Czech-owned companies, although MNEs in other sectors have begun to establish local research centers (TAČR, 2015). In Switzerland, low-value production by domestic firms is rare, and in foreign-owned subsidiaries, it is virtually absent. This pattern repeats itself in exports. Whereas

Switzerland has RCA in more complex medical and therapeutic products, the Czech Republic only demonstrates RCA in disposables.

In Switzerland, the biggest challenge faced by domestic MedTech firms is an overvalued currency that puts local operations under pressure, and permits only the highest value-adding activities to compete profitably. Switzerland predominantly engages in knowledge-based activities, especially product development and specialized manufacturing of high-tech instruments and devices, as well as solution-selling, after-sales service, and repair. The close cooperation of industry with regional educational and research institutions maintains the skill base necessary for this, together with high levels of homegrown innovation. At the same time, efforts to reduce cost by sourcing intermediaries abroad with the purchasing power of a hard Swiss Franc are evident. The fact that production segments are retained at high cost suggests a flattening of the smile curve in certain competitive scenarios.

In the Czech Republic, by contrast, GVC activity is more cost-driven, taking advantage of the lower wages of low- or semi-qualified labor. EU membership and existing investment incentives are factors which favor the location of production and assembly in the Czech Republic. Its future will depend on the country's ability to produce more technically-skilled workers, as well as the improvement of the business environment, particularly its legislative body and the functioning of the courts. Building public and private partnerships to provide high-quality vocational training, strengthening links between university and industry, and promoting technology transfer would go a long way to support progress. This will require both investment and commitment over the long term.

The geographic situation of both countries within Europe and in proximity to the larger German-centred headquarter economy ensures physical proximity to suppliers and customers, which in turn enables the responsive supply chains usually required by innovative MedTech products. Any increase in logistics friction is known to impact GDP (Hausman et al., 2005). Both countries should therefore actively protect the competitive advantage of location, as well the cultural compatibility which Europe and the EU treaties afford them. This embeddedness is more fragile in Switzerland, which is not a full EU member, identifies strongly as an independent state, and chooses to ratify its agreements regularly.

Building upon this initial description, further research should undertake a more detailed mapping, based on firm level data, to generalize the Supply Chain strategies and governance structures which are currently in place and how these differentiate, if at all, between the four

types of firm. Porter's seminal study not only coined the term Value Chain, but identified that firms either compete on cost or on focus on particular market segments or special products (Porter, 1985). At first glance, our study seems to confirm that the emerging economy of the Czech Republic competes on cost, while the mature Swiss MedTech firms compete with focus. Since we are not examining firms in isolation, but within GVCs, this initial finding should be cross-validated by the supply chain strategies: do the low-cost products actually fit within efficient supply chains and the focus products into responsive ones (Chopra and Meindl, 2004; Wagner et al., 2012). The range of export destinations for certain product groups, could be the outcome of segmented supply chain strategies which support responsiveness and focus, over mere cost-driven efficiencies. To address this question would require a more detailed set of firm-level, operative data. The effects of linkages and their trade-offs in end-to-end networks also deserve further scrutiny. Complex, highly-regulated technical industries may produce heterogeneous supply chain strategies in which the trade-offs induced by the linkages justify a reconfiguration of the smile curve: high cost manufacturing lowers the cost of innovation and quality, or high-cost manufacturing lowers the cost of responsiveness, even in low-tech MedTech categories like disposables. Size also matters. The behavior of globally-active SMEs should also be studied to clarify how their strategies operated within GVCs, and compared with those of the well-researched MNEs. More differentiated answers to these questions will help identify additional competitive factors for lucrative participation in GVCs.

## 2.2 Advanced Manufacturing in Switzerland: the case of a CEM competing in MedTech

As firms have de-verticalized, focused on their core competencies by outsourcing labour-intensive work to low-cost countries, manufacturing is a core task which is globally traded today. The resulting Global Value Chains are also known as Global *Production* Networks for good reason. What classical economics describes as a monolithic production function, composed of tangible tasks, is still widely perceived as a source of value creation, and perhaps more important, of entry-level jobs for a broad swathe of the local population. By extension, the decision of where to operate a factory, a key element in network design, has become divisive enough to trigger political interventions, which increase uncertainty and cost in global

operations (Thakur-Weigold & Hnát 2017, Mickle & Nicholas 2017). The operations managers who worked to transform local, integrated firms into global value chains have not engaged in the broader discourse to the degree that their experience would suggest (Ferdows 2018 p.393, Roth et al. 2018 p.1477, Thakur-Weigold & Wagner 2014). In fact, economic, sociological, and IB theory is formulated as if operations managers and industrial engineers made few decisions of strategic import. It was economic and industrial policy and “*impersonal forces*” (Buckley 2009a, p. 234), which set up Global Value Chains (GVCs) to develop or de-industrialize nations. Although there is potential for manufacturing to become a “*Tool of Economic Development and Source of National Competitiveness*” (Roth et al. 2016 p. 1477), OM remains at the “*receiving end*” (Ferdows 2018 p. 396), of policy and strategy decisions. This research responds to the call for OM scholars and practitioners to develop factories as “*Centers of Expertise*” (Ferdows 1997, p.73), or “*think tanks*” (Veerecke et al 2006, p. 1747), where intangible value is created with a material impact on firm, network, and regional performance.

The previous section in this chapter concluded that firm-level supply chain strategies deserve closer scrutiny to explain the choice of manufacturing in a high-cost country like Switzerland. When firms deliberately reject the option of lower-cost suppliers within easy reach (like the Czech Republic, to say nothing of Asian contract manufacturers), there must be value-adding factors at work which justify the cost burden. In real cases of MedTech GVCs, the smile curve is effectively flattening, without a return to the “*golden age of manufacturing*” (Baldwin 2012 p. 90), in which vertically-integrated firms used to tolerate excess capacity and higher costs within their organizations. This empirical study<sup>22</sup> examines those value-adding strategies, and is the outcome of two years of action research at a Swiss Contract Manufacturer (CM), a longtime partner of the ETH Zurich, a federally-funded university which was founded to support industry. The research partner is a holding which operates 10 proprietary factories in 7 international locations, including Switzerland. At first glance, the firm does not resemble the MNE embodied by Apple (a potential customer), or Foxconn (a competitor), yet it operates globally to benefit from markets, capacity, knowledge, and cost structures. Since it expanded its manufacturing network into lower-cost locations, the high wages, currency, and other costs of doing business in Switzerland have brought the competitiveness of the Headquarter location

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<sup>22</sup> At the time of writing, it was under review by the Journal of Manufacturing Technology Management, Special Issue on “Rethinking international manufacturing in times of global turbulence: convergent perspectives of international business and international operations management”

under scrutiny. At the same time, when offered the choice among alternative production sites in the firm's network, a segment of customers requests its orders be built at a premium in Switzerland. The Swiss General Manager emphasizes "*We do not force our customers to work with us*". But they do. The Swiss factory also has an engineering department capable of high-quality development, which they consider a competitive differentiator, with untapped potential for commercialization. Under these complex conditions, the research team was asked to formulate a growth strategy in which the Swiss manufacturing site maintains an active and profitable role.

### **Choice and application of the Design Science Methodology**

The team chose a design science methodology, not only to generate a firm-level solution, but because the close partnership between researcher and managers represents an invaluable opportunity to test theory *in situ*, and learn from the implementation. Design Science has been applied to problems of engineering, medicine, and information technology, and is becoming more common in Supply Chain Management research (Van Aken et al. 2016, Johansen & Rolstadås 2017, Wagner & Thakur-Weigold 2018, Reinerth et al 2017). It is a goal-seeking approach which, compared to natural science, is exploratory, rather than explanatory. It strives for synthesis, not analysis, of an artificial phenomenon (Simon 1996), by applying multiple disciplines to create context-dependent, mid-range theory, or Mode 2 Knowledge Production (Van Aken 2005). Table 8 provides an overview of the methodological differences.

The research selected the Design Science Methodology for several other formal reasons. To begin with, the management challenge is an ill-structured, or wicked problem, which resists solution (Buchanan 1992, Hopp 2004), and for which theory offers no unequivocal answer. The problem does not lend itself to conventional modeling with clear and simple objective functions, within a narrow and unchanging scope. The fact that "*OM scholars are highly-skilled in reducing real-world complexity by modeling*" (Ferdows 2018, p.7), may explain their absence in the larger GVC discourse dominated by social scientists and policymakers. To make a broader impact, OM scholars need to address the detail, dynamic complexity, imprecision, and hysteresis of manufacturing networks with more case-based, and grounded research (Ferdows 2018, Cheng and Johansen 2014).

	Natural Sciences	Design Science
<b>Intent</b>	Discovery	Goal-seeking, problem-solving
<b>Focus</b>	Problem	Solution
<b>Object of study</b>	Natural pre-existing phenomena with inherent characteristics	Synthetic Artifacts, to be created in the course of the research process
<b>Approach</b>	Prescriptive, Explanatory, Objective and detached	Descriptive, Exploratory, Subjective and interactive
	Prioritizes rigour	Prioritizes relevance
<b>Technique</b>	Analysis within narrow scope	Synthesis within wicked problem space
	Data-collection and reconstruction ex post (if empirical)	Reflecting on multiple iterations of solution refinement. Co-opting of unintended outcomes,
<b>Outcome</b>	Falsifiable & Generalizable theory. Right and Wrong answers.	Context-dependent “satisficing” outcomes for a group of problems. Mid-range theory or “Mode 2” knowledge which targets complex and relevant field problems.

Table 8: A comparison of Natural Science to Design Science.  
Adapted from Aken, Holmström et al., Corbett & Van Wassenhove.

Design science creates not only the rich, differentiated detail of a case grounded in practice, it strives for relevance, an imperative for the research partner. Manufacturing systems are arguably the quintessential form of an Artificial Science (Simon 1996). They require actionable artifacts like a training solution to improve supply chain collaboration (Wagner & Thakur-Weigold 2018), a tool to assess supplier sustainability (Reinerth et al 2018), or the growth strategy for our research partner. Design Science bears more than a passing resemblance to the interactive, learning-by-doing concept of Advanced Manufacturing, in which interventions devised by the R&D lab are tested by the production line, whose feedback is incorporated into subsequent refinements of the prototype.

Although design science is not primarily theory-generating, its artifacts can add value to theory by capturing insights from field-testing, averting what the editor of *Management Science* regretfully described as the accumulation of “*facts,...But no science, or at best a very feeble one. Because we don’t know how to use the facts to lead a sane life*” (Churchman in Hopp 2004, p.4). The research team expected valuable insights because, in contrast to the natural sciences, the discoveries of management originate in practice. Models did not predict innovations like the Assembly Line (invented by Ford Motor Company), Lean Management (invented by Toyota), and Product Postponement (invented by Hewlett-Packard), which demonstrate that “*It is...the practitioner – not the academic scientist – who engages in basic research in OM*” (Holmström et al 2009 p. 65).

To impose rigour, the study implemented the two-phase approach proposed by Holmström et al. 2009) consisting of 1) Solution Incubation, and 2) Solution Refinement (Holmström et al, 2009, Van Aken 2005). Drawing on literature from the multiple disciplines reviewed here (Economics, Sociology, IB, OM, SCM, see chapter 1), the research framed the problem in a new way, adapted existing tools and solutions, incorporated learnings from the iterations, and co-opted unintended consequences to avoid missing out on valuable development options (Corbett & Van Wassenhove). The project completed three rounds of Solution Refinement until a “satisficing” (Simon 1996, p. 27) version was achieved. The synthesis is presented in the section “Practical contributions”, especially figure 19.

### **Theories of how GVCs affect regional development**

The research context illustrates most of the regional developmental effects and tensions described in the literature review of chapter 1. The economic sociologists emphasize their impoverishing effects in selected regions (Gereffi 2018, Kaplinsky & Morris 2001, Humphrey & Schmitz 2002). Macroeconomists remind us, however, that the world share of GDP is being transferred to the very nations which had de-industrialized in the 19<sup>th</sup> century, resulting in a “*great convergence*” (Baldwin 2012, 2016, Buckley & Strange 2015). The controversies around the developmental impact of MNC internationalization has therefore created a “*cluster debate on inter-firm relationships*” (Humphrey & Schmitz 2002, p.11). Depending on the intellectual genealogy, industrial location, and level of aggregation, globalization is seen as either an engine of development, or “*immiserising*” growth (Kaplinsky & Morris p.21). Developed countries like Switzerland and the U.S. face de-industrialization as factories move to lower-cost regions, like Eastern Europe and Asia (Egger 2014). This tension was the point of departure for our work at the research partner, whose acquisition of its Romanian manufacturing site originally intended to create a low-cost option. Since every order must justify its location costs, the network expansion created economic pressure to move production volume from Switzerland to Romania.

In the ongoing cluster debate, there is consensus that Global Factory and Global Value Chain structures also offer opportunities to firms in emerging markets (Buckley 2009b p.134, IMF 2013). Because “*globalization operates on an economy with finer resolution*”, GVCs magnify factor advantages (Baldwin 2014 p. 257). At the task-level specialization, scale and market size no longer matter because firms can effectively dock onto an existing production system

(Baldwin 2011, Gereffi 2014 p.18), turning even small increments of knowledge or skill into tradeable services (Grossman and Rossi-Hansberg 2008). This results in the specialization of emerging economic regions in single components and services: consider Thailand's cluster for hard drive production, Bangalore's business service providers, Manufacturing Assembly in China's Pearl River Delta, or the automaking regions of Czechia. Aggregating this effect, entire nations can rapidly rise to the productivity levels of developed countries, without the protracted and risky investment in a full industrial base. Romania, a location of the research partner is a case in point.

The new world of opportunity does not, however, spare firms (and regions), the imperative to develop strategies for gainful participation. Especially the literature of economic sociology suggests that some fail to do so. The influential stream led by Gereffi includes case work which confirms that buying and governance power are concentrated in developed-country multinationals, while suppliers in emerging regions face inherent structural disadvantages. At a regional and sector-level, the network architecture reproduces the core-periphery hierarchy of the world economy by allocating centralized control to MNCs, and away from firms in developing countries. (Buckley 2009b, Kaplinsky & Morris 2001, Humphrey & Schmitz 2002, Gereffi et al. 2005, Choksy et al. 2017). Concerned with international imbalances of power and distributional conflicts (Helpman 2011), developmental GVC studies declare network governance to be of primary concern to policy-makers and other stakeholders (Gereffi et al 2001, Gereffi et al 2005). It is the challenge of developing country suppliers to upgrade from a position of lower power and value capture to a higher one (Humphrey and Schmitz 2002).

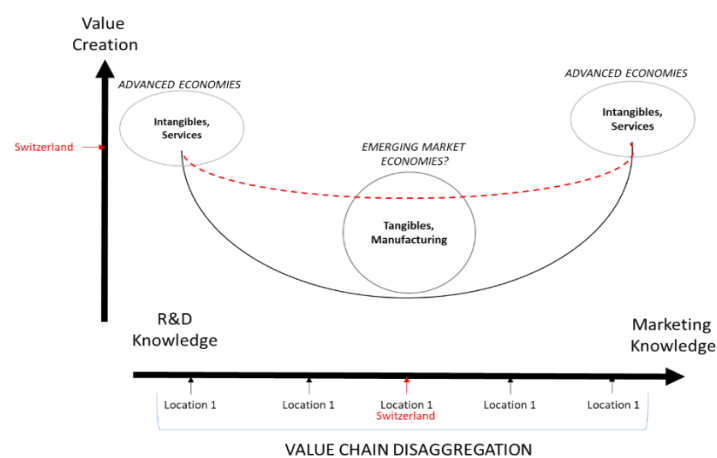


Figure 17: Switzerland's Manufacturers positioned on the Smile Curve of a generic, production-oriented value chain.



The value creation is disaggregated by location and activity yields. This illustration does not anticipate Manufacturing of Tangibles in developed market economies and so presents Switzerland with a challenge to add value in manufacturing, commensurate with its cost structure and knowledge base. Adapted from Mudambi 2007.

Although the empirical data do not deliver conclusive evidence of the growth of inequality at a global level, there are economic models which predict it. An arithmetic calculation of margin accumulation across a network concludes that the customer-facing entity, usually a rich-country MNC, will always extract the most value (Buckley & Strange 2015). Smile Curve economics (Mudambi 2007, Shih 1996) assumes that early and late stages of value creation (product design and development, as well as after-sales service, both usually in the hands of the OEM), are knowledge-intensive, highly-remunerated, and located in developed regions. Manufacturing and assembly occupy the lowest point of the graph, and belong in less developed locations. According to this logic, factories should have no place in Switzerland (Mudambi 2007, 2008, Figure 17)<sup>23</sup>.

It is beyond the scope of this section to engage in the political debate on global manufacturing, especially the question *“To what extent have MNCs supplanted the national autonomy of governments?”* (Gereffi 2018, p.6). It is, however, a part of its motivation. The uncertain future of manufacturing in a developed country has been explored from a North American perspective (Berger 2013, Pisano and Shih 2012, Brennan et al 2015). This research project considers how manufacturing can justify the cost of doing business in Switzerland, balance power with its OEM buyers, and, by extension, maintain a local industrial base. To support the decision-making of our research partner, we turned to OM and SCM literature, to shed light on the black box of operations, and specifically on global manufacturing networks.

Operations management dedicates much attention to optimization models and continuous improvement practices, often in single plant studies. As globalization progressed, and outsourcing resulted in the geographic dispersion of multiple production sites, interest in the mechanisms of International Manufacturing Networks, or IMNs, grew in importance (Brennan et al 2015). Ferdows’ influential paper (1997) argued for a more strategic view of the foreign factory, proposing a taxonomy of characteristics and relative influence. Managers could use the classifications as mobile *“building blocks”* to assess and target capabilities (Vereecke et

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<sup>23</sup> Heeding Porter’s recommendation that a theory should make sense to managers (Porter 1990, p.21) the author reviewed the smile curve to managers on the research team. Their response was *“According to this, we should not exist!”*. The paradox increased the team’s general motivation in their solution search.

al 2006 p. 1747), or plan upgrading paths from less sophisticated to more strategic roles within the firm's network (Ferdows 1997 p. 79). Typology studies like these also observed that changes in one location had effects on others. For example, developing one factory may cause another in the network to become a candidate for divestiture.

The assumption that the IMN was owned by a single, hierarchically-organized MNC became problematic, as de-verticalization showed "*that the manufacturing system now crosses the firm's boundary and into a complex inter-firm relationship*" (Shi & Gregory 2005 p. 627). In Global Virtual Manufacturing Networks (GVMNs), the electronic transmission of information and instructions enable individual, specialized firms to work together virtually. Delegating part of the production process to CMs made fabless manufacturing a reality for MNCs. Case studies illustrate how inter-firm collaboration enables smaller firms to work profitably in an international manufacturing network and grow (Shi & Gregory 2005), as predicted by Baldwin (2011). Cheng et al 2011's review of International Manufacturing Network (IMN), literature, observed that while studies at the plant level considered their location and roles, those at the network level shifted their focus to configuration and coordination. Network capability depended on its design (Shi & Gregory 1998, Colotla et al. 2003), and different network configurations required their own coordination models to manage performance. In an IMN owned by a hierarchically-organized MNC, decision-making was concerned with process and technology transfer, product specifications, volume allocations, optimization of resources, and general strategy. By contrast, in GVMNs, management attention focused on the determinants of network performance, which were design and control (Cheng et al 2011, Fischer 1997, Rudberg & Olhager 2003).

In spite of sociological GVC taxonomies (Gereffi et al 2005, Gereffi et al 2011), network design and governance are not static structures, since "*the very process of outsourcing undermines the power asymmetries that were inherent in the original externalized relationship*" (Buckley & Strange 2015 p. 246). Empirical studies indicate that specialization and the global trade in tasks causes a progressive transfer of knowledge from OEMs to suppliers. As participants shed or develop competencies, traditional categories like hierarchy or market, "*exploitative or symbiotic*" do not adequately describe inter-firm governance. Shifting structures lead to more dynamic, modular, and self-reliant relationships (Sturgeon and Lee 2001 p. 2). Cheng and Johanson (2014)'s comparison of intra-firm to inter-firm networks reveals how a GVMN evolves over time. In three case studies they discover that outsourced

manufacturing created a *“snowball effect”* (Cheng & Johanson 2014, p.1363), which in turn led to the externalization of supporting functions like R&D and procurement. In a more optimistic view, the new suppliers eventually became strategic partners, in what was no longer a chain of companies expediting the flows of goods-money-information, but a *“value network”* (Cheng & Johanson 2014, p. 1363). Not only would a structurally *“... dynamic model ...help managers develop a more evolutionary vision and avoid competence traps”* (Cheng & Johanson 2014, p. 629), suppliers can become sources of innovation (Wagner 2012) or competition (Arruñada & Vázquez 2006). New procurement and co-creation processes are emerging to capitalize on more advanced supplier contributions (Cheng & Johansen 2014, Billington & Jager 2008, Wagner 2012, Wagner 2019).

The *“snowball effect”* of progressive externalization has drawn attention to the synergies between manufacturing and R&D (Cheng et al 2015b). The fact that *“Manufacturing has become increasingly separate from research and development”* (Baily and Bosworth 2014, p.19), disrupts the feedback and learning loops between a knowledge-intensive R&D function and the realities of the production line. Outsourcing production will eventually erode innovative capacity in the home nation of a MNC (Hockfield 2011, Pisano & Shih 2012). In a variation of populist calls to bring factories back, Political scientists and economic policy advisors recommend that the *“industrial commons”* be restored (Pisano and Shih 2009), reconfiguring the geography of value capture so that countries *“make what they invent”* (Hockfield 2011), and enable Advanced Manufacturing (Berger et al 1989, p.14, Berger 2013, Hockfield 2011, Tasseey 2014).

We will not apply the original concept of Advanced Manufacturing (Kota 2010, P-CAST 2011, Pisano & Shih 2009) which emphasized the manufacture of new products using cutting edge or Advanced Manufacturing Technologies (AMT), like CAD, CAM, additive manufacturing, nano-engineering, next-generation electronics, materials science, the internet of things, and robotics (Boyer et al 1997). Instead, we refer to the Production in the Innovative Economy (PIE) definition of *“advanced manufacturing technology as an interface between the innovation system and industrial production. This might be depicted as a system of feed-forward and feedback mechanisms”* (Berger 2013, p.158), and observe that less research has been dedicated to the information flows in cross-functional ecosystems, in which manufacturing is co-located with research and product design. This kind of Advanced Manufacturing is expected to stimulate entirely new industries, with production centered in their country of invention

(Kato 2010, Hockfield 2011, Berger 2013). Although originally directed to policymakers who fund research programs, incentives, and institutional conditions, Advanced Manufacturing reveals competitive potential at the Swiss factory of the research partner, whose manufacturing has direct access to a world-class development team under one roof.

The research partner is a 50-year old, publicly-listed multinational holding with a total of approximately 2000 employees worldwide. Comprised of 11 companies, it produces printed circuit boards, hybrid circuits, and electronic manufacturing services. The holding orchestrates a proprietary network of 10 production facilities, of which 3 are in Switzerland, 2 in Germany, 1 in Romania, and 4 in Asia. Each production location is managed as a company. The holding management and headquarters are co-located with the Swiss company, close to the German and Austrian borders in Switzerland, a historically liberal, export economy with a number of industrial clusters including precision manufacturing, medical devices, pharmaceutical products, and watchmaking.

The geographic footprint of the production network is a legacy of acquisitions, not of optimized design, and is evolving, as the history of the Romanian company demonstrates. From its founding in 1996 as a workbench, the Romanian factory is a story of learning and development. 15 years after the fall of communism, the firm acquired a site in Romania as a low-cost assembly option. It initially worked on the simplest assembly and soldering tasks but graduated to functional testing after two years of operation. Initially, customer orders were entered by other organizations in the network, materials were managed centrally by consignment, and all financial flows regulated elsewhere. By 2005, a common ERP system implemented the platform for information exchange at the transactional level, and at which time, the Romanian site began producing for customers it acquired and managed itself. One year later, it began managing its own materials (table 9).

The study focused on the 2 European companies within the holding which are Contract Electronic Manufacturers (CEM) only, a type of firm whose production output flows into the supply chains of its customers, largely OEMs. As such, they are simultaneously part of a GVMN and CEMs. Considered the quintessential GVC participant, CEMs are the subject of focused study (Shi & Gregory 2003, Sturgeon and Lee 2001, Kraemer et al 2011), which examines global competition, uncertainty and its network effects, as well as opportunities to gain from linkages, global cost arbitrage, and the amplification of local factor advantages. The wicked question is how to best commercialize these opportunities for long-term competitiveness in Switzerland.

Year	Event or milestone
1972	Swiss production site founded as an affiliate of a big multinational, manufacturing with mostly manual labour.
1990	Automated Assembly processes are installed in Swiss factory
1996	Romanian site founded by a Swiss company as a workbench
1997	Manufacturing started in Romania, activities are mostly manual assembly and soldering using consignment stock of materials
1998	Start of testing activities (electrical and functional tests) in Romanian factory
2000	Relocation of Romanian factory to a new building.
2001	Installation of first machines in Romania to reduce manual labor
2003	Holding acquired by a Swiss Private Equity fund
	Expansion of purchasing and sales activities in Swiss company
	Romanian factory begins to collaborate with Swiss company after the formation of an EMS group within the holding.
2004	Automated Assembly processes installed in Romania
2005	Implementation of ERP System in Romania
2006	Romania begins its own sourcing (compared to the past when they were consigned stocks procured by other subsidiaries)
2007	Swiss factory adds Engineering services to its portfolio
2007	Swiss factory acquires certifications to produce MedTech
2008	Romania starts to acquire its own customers

Table 9: History of development of two EMS sites, Switzerland and Romania

*The Design Trajectory beginning with Solution Incubation: Controlling Cost*

The CEO of the holding, with a view of the financial performance across all subsidiaries, noticed that Networking Capital (in the form of inventory) was higher than expected. In spite of the material buildup, some customers were waiting for their orders. Issues of demand-supply matching and ad-hoc firefighting to ship orders are typical symptoms of supply chain dysfunction (Davis 1992). To remedy the situation, the research project was initially launched to reduce Networking Capital at two European sites, Switzerland and Romania, with the goal to release cash for both operations and investment and improve customer satisfaction.

At the time, the team considered their inventory levels to be an inescapable consequence of their business model. A CEM does not produce to replenish channel inventory, but delivers components into the value chains of its customers for further processing. To meet the volatile and unpredictable demand in a made-to-order business, stockpiling of inputs is common. Data analysis, however, unearthed self-inflicted, therefore addressable, sources of uncertainty. Breakdowns of information flow between functional departments working in silos were creating bullwhip triggers. To solve this, the companies convened account teams from

their sales, procurement, production departments to coordinate the order fulfilment across functions and without handoffs.

A cost-to-serve analysis (Braithwaite and Samakh 1998) revealed accounts which consumed more organizational resources than their margins warranted, diverting attention from more profitable and strategic orders. The solution was not to close these accounts, but to devise business rules to replace the one-size-fits all operations model with a portfolio of supply chain responses (Billington et al 2002, Christopher and Towill 2002, Lee 2002, Jonsson et al 2011). Improvements in efficiency, networking capital and the stress of firefighting were measured.

#### *Solution Refinement, Iteration 1: Shifting focus from Cost to Value*

Operational excellence had reduced the cost of each location, improving bottom line performance. The top line, determined by revenue was unaffected by the reductions in capital and other resources employed. It is not unreasonable for top management to begin expecting the best cost performance of each site to be a given. The ongoing comparison between sites showed a cost differential between highly-developed Switzerland and emerging Romania, in line with Smile Curve economics. With the integration into the GVMN's IT platform, product and process technology transfer was developing Romanian capabilities by the day. This returned to the question of why more production was not being shifted to where the cost of goods sold could be lower.

To maximize the financial performance of the firm's global network, top management weighed two conventional initiatives: 1) roll out a lean production program, and 2) sell high-margin engineering services out of Switzerland. The project team questioned the effectiveness of both proposals. Lean management programs usually require years of investment and change management and, if they do not stall, eventually reach limits (Netland & Ferdows 2016) and did not target long-term growth. The engineering department had specialized technical expertise, but was not yet scaleable for significant sales volume. Even if they hired more staff members, they were wary of entering into competition with both domestic and Asian engineering service providers. Furthermore engineering projects like contract prototyping, were often one-off jobs which did not generate revenue streams.

Drawing on the general strategy literature, the decision was not to invest in cost leadership but to focus (Porter 1985). This required an understanding of the customer base and

its order-winning criteria. From the cost-to-serve analysis, the team had already learned that not all accounts yielded the same margins, and that certain categories consumed more resources than others. The search for high growth customers set twin goals of increasing profitable volume, while binding them over the long term. The first step towards top line – or revenue – growth involved market segmentation and targeting those with high-potential which were Medical and Specialized Industrial accounts. Interviews with Sales and Business Development helped identify why customers chose this particular CEM and prefer to pay the higher costs of production in Switzerland.

The analyses yielded two key insights. The first was that value co-creation requires physical and cultural proximity, confirming the arguments for Advanced Manufacturing (Tassey 2014). The second insight was the concentration of the Swiss company's high margin accounts in a sunrise industry, Medical Technology (MedTech), where Switzerland has a growing startup scene, cantonal clusters with ties to research universities, and spillover effects from the pharmaceutical industry (Vlckova & Thakur-Weigold 2018, Dümmler et al. 2014, Thierstein et al 2008). MedTech firms in the regional cluster were developing new smart devices which required close, ongoing collaboration with suppliers certified for highly-regulated medical applications. In this industry, the expense and delays caused by re-certification deterred OEMs from switching suppliers during the development and production phase. A lock-in factor like this could give the company an advantage over remote foreign competitors, even if they offered engineering services at a lower cost.

#### *Solution Refinement, Iteration 2: Configuring and Coordinating Network Performance*

Buckley & Strange (2015) assert that those who understand the activities which generate value to the final consumer will increase their share of economic rent in the network. This led the team to conduct a GVC analysis which looked at the customers of their customers. To expand their own overview, the research team broke down the activities of new product introduction, from higher to lower value-adding: engineering, scaling, commercialization, and culminating in the handoff to mass production, at which point the margins and knowledge-intensity declined, and international competition increased. For the top 15 accounts, each block was allocated to the GVC participant which completed the activity, and secured the rent. This created a new visualization of how the network participants (composed of the Swiss production site, its suppliers, and customer/OEM), divided up value-adding steps among themselves,

naming it *capability map* (Table 10). The capability maps graphically depicted how different categories of production value (Regulatory, Design, Ramp-up, Serial production and product sustaining) were added by four tiers of the supply chain to generate varying levels of revenue.

The capability maps enabled new analyses and action plans. By mapping differentials of contribution to revenue projections, the project team could assess and fine-tune the network configuration to target growth. The teams could identify blank spaces in the map, evaluating the potential of upgrading to a more influential position, or withdrawing from less promising engagements. The maps revealed how regulatory complexity could work in their favour, by occupying the activities which required special certification.

	Activity	Supplier	Swiss CEM	Customer/OEM	Integrator	Final User
<b>Regulatory</b>	Legal Manufacturer			R		
<b>Regulatory</b>	Contract Manufacturer		C	R		
<b>Regulatory</b>	Product/Customer specific Norms and Standards		C	R		
<b>Design</b>	Product Specification		C	R		
<b>Design</b>	HW Design		C	R, Certification required		
<b>Design</b>	SW Design		C	R, Certification required		
<b>Design</b>	PCB Layout		R	Certification required		
<b>Design</b>	Mechanical Design		C	R		
<b>Design</b>	Mold Design		R			
<b>Ramp Up</b>	Supplier Evaluation (critical parts)	C	C	R		
<b>Ramp Up</b>	Supplier Qualification	C	R			
<b>Ramp Up</b>	Mechanical Tools		R	C		
<b>Ramp Up</b>	Test Equipment PCBA		R	C		
<b>Ramp Up</b>	Test Equipment Module		R	C		
<b>Ramp Up</b>	Production Equipment		R			
<b>Ramp Up</b>	Prototypes		R			
<b>Serial Prod.</b>	Supplier management		R			
<b>Serial Prod.</b>	PCBA		R			
<b>Serial Prod.</b>	PCBA Test		R			
<b>Serial Prod.</b>	Injection Molding		R			
<b>Serial Prod.</b>	Assembly (Module)		R			
<b>Serial Prod.</b>	Module Test and calibration		R			
<b>Serial Prod.</b>	Assembly (Device)		C	R		
<b>Serial Prod.</b>	Final Test and calibration		R			
<b>Product Sustaining</b>	Product Specification		C	R		
<b>Product Sustaining</b>	HW Design		R	C		
<b>Product Sustaining</b>	SW Design		C	R		
<b>Product Sustaining</b>	PCB Layout		R			
<b>Product Sustaining</b>	Mechanical Design		C	R		

Table 10: A capability map at a single production site.

Emphasizing embeddedness by making the division of labour between the CEM, its suppliers, and customers visible. The user and other downstream participants are shown as a blank space to stimulate what-if analyses. Blocks of activity are listed vertically by decreasing value, and mapped horizontally against the GVC (from OEM



upstream across two supply tiers). C = contributing, R= responsible. This is a map for a single account, a Swiss OEM of specialized electronic surgical equipment and is being used to track revenue growth.

Strategic focus was made possible by the holistic and integrated visualization of the global value chain in which the Swiss company works. Because they were a design tool to improve GVMN financial performance through configuration (Rudberg & Olhager 2003, Cheng et al 2011), the project's Capability maps were a departure from detailed process and value-stream maps to optimize flows, identify inefficiencies, or illustrate geographical presence (Gardner & Cooper 2003, Singh Srai & Gregory 2008, De Backer & Miroudot 2013).

#### *Solution Refinement, Iteration 3: Capability mapping to exploit GVMN effects*

The team first applied its capability map to the top accounts of the Swiss company only. It soon became clear, however, that each of the activity blocks involved multiple functions, which could be located anywhere in their GVMN and that further specialization was possible. A second version of the Capability maps was generated, in which value-adding categories were expanded to include the international account management and factory location. This map visualized not only the functional value chain, but how orders could be managed and fulfilled by the entire GVMN (table 11).

The visualization of how value was added at a global scale confirmed production to be the core competence of the firm. It also recognized that, if markets were to be profitably developed, linkages to sales, engineering, and product sustaining functions in all locations were vital. The capability maps at GVMN level effectively depicted the manufacturing sites as an integral part of a global Order Fulfilment system, as foreseen by the SCM literature. This logical reframing of value creation is *"more than [literally] fulfilling orders. It is about designing a network and a process which permits a firm to meet customer requests, while minimizing the total delivered cost."* (Croxtton 2003, p.19, Croxtton et al 2001, p.20). Lambert and Cooper note that *"the objective of SCM is to create the most value, not just for the company, but for the whole supply chain network, including the customer"*, (Lambert & Cooper 2000, p.81). Advanced manufacturing, in which engineering is co-located with production, embedded in a global order fulfilment system can help the GVMN to expand its financial and strategic impact. It could not only create superior performance of the holding, but improve the competitiveness of the larger customer-linked networks into which its output flows, leading to more sustained

growth for all participants. This is in line with the observation of SCM literature that it is no longer firm competing against firm for profit and market share, but supply chain vs. supply chain, network vs. network (Harland 1996, Lambert & Cooper 2000, Christopher 2011, Srai & Gregory 2008). The design trajectory can be summarized as three broad shifts: from the trade in tasks to solution selling, from minimizing cost to maximizing value, from competing in deflationary price wars to competing through differentiation (table 12).

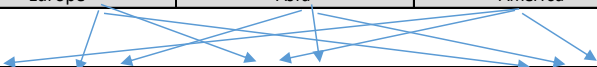
		<div>Sales Regions</div>					
		Europe		Asia		America	
		<div></div>					
		<div>Production Sites</div>					
		Switzerland	Romania	Singapore	Singapore	Vietnam	Indonesia
Design	Product Specification	x					
Design	HW Design	x					
Design	SW Design	x					
Design	PCB Layout	x					
Design	Mechanical Design	(x)					
Design	Mold Design				x		
Ramp Up	Supplier Evaluation (critical parts)	x	x	x			
Ramp Up	Supplier Qualification	x	x	x			
Ramp Up	Build Mold Tools				x		
Ramp Up	Build Test Equipment PCBA	x	x				
Ramp Up	Build Test Equipment Device	x	x				
Ramp Up	Build Production Equipment PCBA	x	x			x	
Ramp Up	Build Production Equipment Assembly	x	x			x	x
Ramp Up	Produce Prototypes	x	x		x	x	x
Serial Prod.	Supplier management	x	x	x	x	x	x
Serial Prod.	Plastic Injection Molding				x	x	x
Serial Prod.	PCBA	x	x			x	
Serial Prod.	PCBA Test	x	x			x	
Serial Prod.	Assembly (Module)	x	x			x	x
Serial Prod.	Module Test and calibration	x	x			x	x
Serial Prod.	Assembly (Device)	x	x			x	x
Serial Prod.	Final Test and calibration	x	x			x	x
Product Sustaining	Product Specification	x					
Product Sustaining	HW Design	x					
Product Sustaining	SW Design	x					
Product Sustaining	PCB Layout	x					
Product Sustaining	Mechanical Design	(x)					

Table 11: Capability map as an Order Fulfilment System.  
Across the GVMN of the holding, which would be configured per customer account for revenue targets, together with sales and engineering teams. This depiction illustrates the potential of subsidiaries not only to specialize and trade production tasks among themselves, but to operate as a global Order Fulfilment system.

Date	Activity	Reframing strategy: Incremental change	Refinement of Outcome
June 2017	Project launched by CEO and executive committee.	Aggregate networking capital increased above industry benchmarks without improvements in responsiveness.	Project launch to analyze and address system inefficiencies, beyond the inherent uncertainties created by a build-to-order business model.
October 2017	Romania: kickoff of design project to address Networking Capital in 2 European EMS sites	Cost reduction in local plants (Switzerland and Romania)	Began research of problem set and data collection
February 2018	Workshop in Romania with cross-functional teams from CH and RO companies.	Elimination of waste which arose from a one-size-fits-all Order Fulfilment process.	Definition of a differentiated order fulfilment strategy using a portfolio of supply chains. Introduction of order fulfilment teams.
June 2018	Switzerland: Workshop to review Cost performance and Strategy which focused on operational excellence.	Customer focus leads to differentiation of response. Cost-to-serve segments accounts by profitability rather than volume.	Shifted attention to growth potential per manufacturing location and MedTech in general. Looked at revenue per customer.
Aug 18	ETH Zurich	Focus on high-growth and high-margin industry.	Researchers clean up existing database of MedTech customers.
December 2018	Switzerland Workshop	Sales motion is included in the scope of the production value.	Interviews with Sales Executives on growth potential in MedTech in immediate vicinity of the Swiss production site. Summary reported to management.
May 2019	Switzerland	Customer requirements are identified.	Sales teams brainstorm success factors for closing MedTech deals
July 2019	Switzerland	Re-examined current division of labour by cost. Revised strategy to divide labour by capability and customer intimacy.	Capability maps of key accounts depict division of labour between Suppliers – Swiss Company – OEM, triangulated with actual and projected revenues.
Aug 19	Switzerland, ETH Zurich	Differentiated GVMN strategy organized by industry, Order fulfilment capability, and ultimately, network competitiveness.	Business case questions based on the portfolio of SCs based on its internal GMVN. Clarification of Location factors: Order fulfilment capabilities of each Supply Chain. Discussed applicability of known academic categories to plants. Mapped actual customer requirements and preferences. Identified opportunities and niches that present themselves to

			the network. Conducted what-if analyses.
Next steps, ongoing	Global network	Ongoing implementation of strategy based on capability maps.	Measurement of impact and triangulation with external factors, like changes in macroeconomic conditions and trade policies.

Table 12: Timeline of solution iterations.  
Listing increments of logical reframing and refinements in outcome.

## Discussion of Results and Contributions

### *Theoretical contributions*

The research adds to extant theory in several ways. First of all, it adds to the body of design science studies in operations management, which in this case, is inseparable from developmental economics. The artifact it produced is a competitive strategy which addresses globalization challenges faced by firms in developed countries, specifically Switzerland. Sociological development studies foresee no obstacles for rich country firms, since in the long run, the GVC accrues value to MNCs in the core countries, to which Switzerland belongs. This aggregated static view disregards real differences in individual firm performance. Our design iterations confirmed what is known from practice: that rich country firms do not passively wait for the comparative advantages of their location to take effect. They are constantly reworking and implementing strategies to contend with the changing face of global competition, which in this case emanates from within the firm.

Our design project created a strategy in which a GVMN operates as an integrated Order Fulfilment system, a new competitive approach which bypasses the cost arbitrage of externalization. The goal of the artifact is growth, unlike standard optimizations of the production function, or continuous improvement approaches, which would have continued to treat the factory as a cost center. Cost-based assessments like these would have overlooked the growth potential enabled by the network's order fulfilment capability. Furthermore, it reveals alternatives to the de-industrialization predicted by Smile Curve economics, which suggest that Swiss plants are economically infeasible *per se*. By extension, our study suggests that the smile curve is not a universal phenomenon, but flattens out in certain configurations and business cases (figure 17).

The GVMN-based order fulfilment strategy also expands the notion of Advanced Manufacturing based on the deployment of new technologies to make new products. Customer value is created through the linkages between functions, and decentralized knowledge flows, rather than exploiting localized knowledge or centers of competence, as conceptualized by Ferdows 1997 and Veerecke et al 2006 . Advanced manufacturing's link to R&D is confirmed, but competitiveness is further enhanced by the link to sales and account management. The solution can be considered a case of supply chain integration (Christopher 2005, figure 17), in which the barriers between individual functions are progressively removed to create more integrated teams (purchasing plus material control become materials management, production plus sales become manufacturing management).

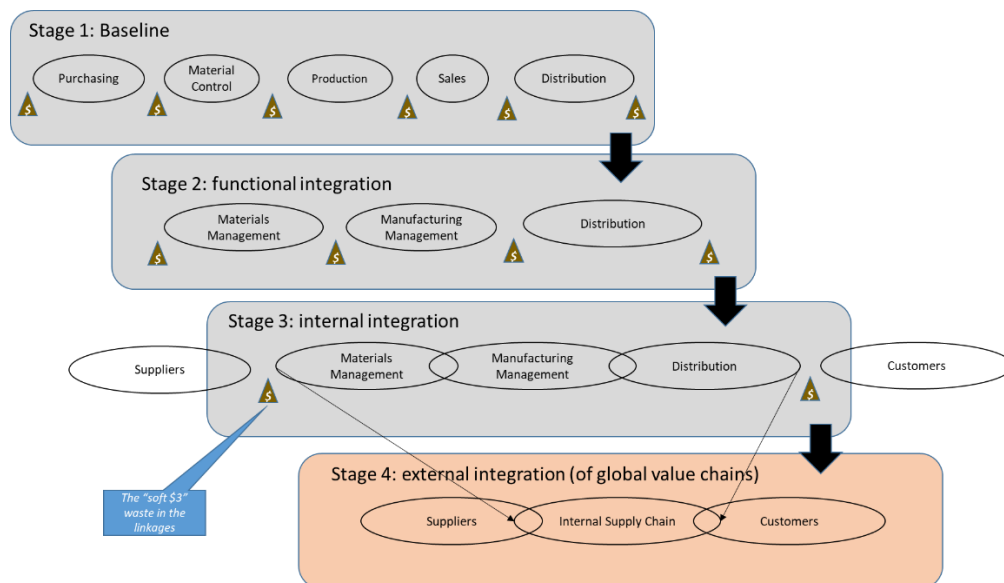


Figure 18: Progressive integration of internal and external supply chains. In which Stage two – functional integration - already approximates an order fulfilment process. The waste that accumulates between silos through handoffs and uncertainty are represented by the inventory symbols, but can also be the cost of expedited delivery and quality issues. The potential to improve networking capital is indicated by the “soft \$3” which is wasted in the linkages between value chain entities. Adapted from Christopher 2005.

The value created by integrating product design, sales and account management with engineering and manufacturing within an order fulfilment system in a single location, preserves feed-forward and feedback loops between these functions, and is hard to imitate, even in lower-cost locations. In contrast to a conventional IMN, the virtual integration of customer-facing and product-development results in an agile system of value creation, which binds it to OEMs in a way which would not be possible by selling one-off services. In effect *“their business is shifting from product manufacturing to providing solutions.”* (Shi & Gregory 2005 p.629).

### Practical contributions

The research did not only ask what the company can do better *with* its factories. It asked what the company can do better if it *is* the factory in the GVCs of its customers. It also showed how a single factory can contribute to a GVMN's value proposition. The capability maps gave heterogeneous stakeholders (site management, sales, production, and engineering), a holistic view on value creation using a simple excel-based tool. This supports both the strategic logic of the network configuration, while serving as a communication tool to support implementation with more systems thinking.

The growth strategy based on a global order fulfilment system offers the firm several advantages. It builds on unique local capabilities like cultural and geographic proximity to the type of account which requires ongoing engineering support with high feedback and feed-forward intensity. Because focus and integration are a logical change, they do not require extensive capital investments. The strategy exploits existing capabilities and differences in the GVMN to increase network competitiveness. Integrating engineering and sales into the global order fulfilment process creates the potential for modular and more self-reliant governance structures.

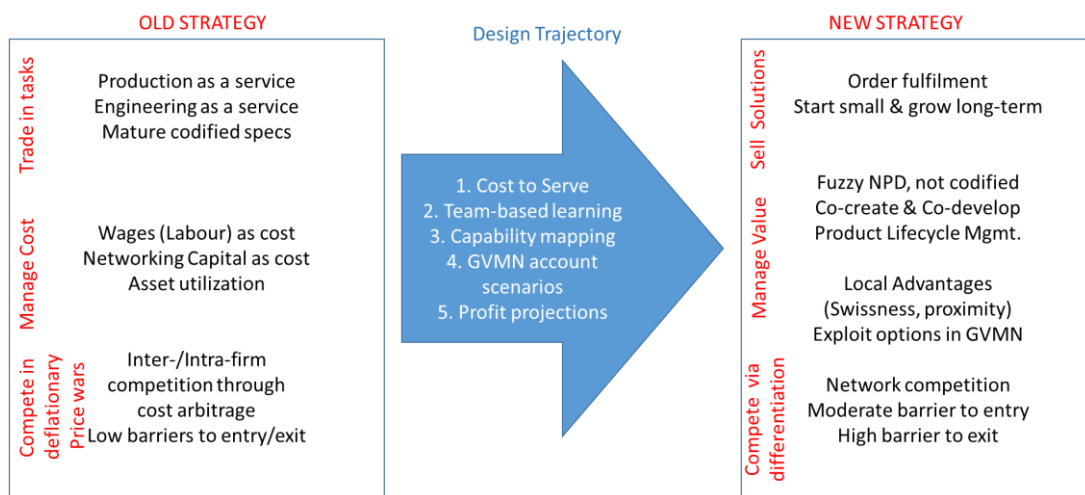


Figure 19: The solution design trajectory.  
Connecting the old strategy to the new one (design artifact)  
Source: author

At the most general level, the outcome shows how manufacturing could be deployed as a development tool in a high-wage location under pressure from globalization, as predicted by Brennan et al:

“Companies with their home base in high-wage countries ... are also increasingly focusing on utilizing the strengths and potentials of their factories in their home base. We might see the beginning of a stronger imperative for local manufacturing in strategic markets, characterized by either high volumes, dynamic growth potentials or concentration and specialization of the necessary engineering and manufacturing competencies.” (Brennan et al 2015, p. 1262)

The innovation of a GVMN-driven growth was originated by the practitioners who are committed to implementing it. Successful execution will require the definition of business rules at transactional level, IT support, and the training of stakeholders across functional departments and regions under committed leadership. In particular, sales will need to shift from a product and technology focus, to solutions. A business development executive describes the opportunities why these change would be worthwhile:

“Here in Switzerland we have a lot of medical companies, from startups to big players in the market. ... a lot of Swiss companies are coming to us. ... looking for partners ... in a close location, to speak German. We help them to industrialize their products. We have the advantage that we are there from the beginning and help them to get started and once we have done that we are in. We have this chance to be a part of this supply chain.”

#### *Limitations and Further Research*

The cross-disciplinary breadth of the discourse on GVCs, development, and manufacturing networks necessarily means that a single design science project cannot answer all questions that arise. We acknowledge the most important limitations of our research. Firstly, the insights generated during the solution incubation and refinement phases proved useful to create a growth plan, but do not deliver evidence of business results. The GVMN order fulfilment strategy has yet to be implemented with target accounts, which will be a non-trivial, time-consuming change process. Sustainable revenue growth will only be measured by field-testing, which will extend the research project by years.

A second notable limitation of the exploratory study is its presentation of a single GVMN case, which does not permit statistical generalizability. The specific characteristics of the electronics manufacturing industry are not directly comparable to production systems like agriculture, or the cut-and-sew operations in the garment industry.

Third of all, location development in any country depends upon a number of economic factors like trade openness (which in Switzerland is heavily dependent upon its relationship

with the EU), and especially macroeconomic stability. Switzerland is exposed to spillovers from monetary policy and capital flight into its tiny economic zone, driving up its currency value, to the detriment of local exporters. Typical of SCM and OM studies, the scope of our research does not address any of these factors.

There is hence both strong potential for further research on the performance of advanced manufacturing systems in global markets. There is a consensus that GVC research must examine more firm-level data, and the insights from two years of exploratory study are a start. Explanatory research and theory-building should consider variations of the capability maps of a GVMN and compare alternate configurations with revenue over time. OM theory-building should compare order fulfilment strategies to the upgrading mechanisms described by the Humphrey & Schmitz 2002, which has been applied to industry-location dyads in developing countries. Their partial view should be complemented by studies of developed, and de-industrializing locations. Our research suggests that a GVMN Order Fulfilment strategy could achieve the four categories of upgrading strategy in an accelerated way. The GVMN supports moving into the co-development of more sophisticated product lines (e.g. NPI of medical devices), hence upgrading *product*. It reorganizes the production system by managing the plant as part of an integrated process linking the GVMN into its customers' value creation process with higher barriers to exit, hence upgrading *process*. The order fulfilment integrates new functions into traditional production: sales, engineering, R&D, finance (cost-to-serve, capital investment), which upgrades *function*. Finally, the firm will move into sunrise industries like Medical Technology through co-creation of un-commodified, non-standardized, products, which upgrades *chain*. These upgrading options were originally conceived as sequential stations in a process of industrial maturity, usually in a developing region. An interesting research question would be to test whether a GVMN with a global order fulfilment process enabled multiple types of upgrading simultaneously.

Particular focus should be directed to examining functional integration between IMN/GVMNs and their suppliers and partners, to evaluate total system costs instead of single factor efficiencies only. Returning to Porter's original observation, optimizing linkages in the system offers an alternative to the zero-sum logic of value-capture and upgrading. The cost savings potential in individual functions, most of which, like manufacturing, have been continuously improved over long periods, will reach a point of diminishing returns. However, what is wasted in the network linkages is a proverbial "soft \$3" cost, accruing to no single



participant, while adding to the burden borne by all (figure 18). In the words of Victor Fung, “*if you take 50 cents out [out of the linkages] nobody will even know you are doing it*” (Magretta 1998, p.42). This alternative to cutting costs in silos, or squeezing weaker suppliers offers potential for improving competitiveness.

Another promising area of the study of Advanced manufacturing systems would explore the interaction between R&D, manufacturing, and macroeconomic development in terms of learning dynamics. This could apply the economic theory of a Learning Society, which explicitly contradicted the aggregated production function to predict differences in performance at the microeconomic level based on learning by doing (Arrow 1962). According to Stiglitz and Greenwald, “*Development entails learning how to learn*” (2014 p.15).

The expertise of OM as an active, instead of “*receiving*” (Ferdows 2018, p.396), participant in the multi-disciplinary and increasingly political debate on growth and network strategy is urgently needed. Manufacturing systems have caused social upheaval in the past, and the illiberal trends evident today are no exception. At the time of writing, populist hostility to global trade, in the name of national and economic security, is rising. Amid such turbulence, the enlightened role of OM research to influence policy can make a difference. Research on GVCs and GVMNs must address the policymaker who decides what infrastructure, regulations, and institutions will support performance at both the firm and regional level, to fulfil the vision of “*Manufacturing as a Tool of Economic Development and Source of National Competitiveness.*” (Roth et al 2016, p.1477).

## 2.3 Perspectives on GVC and IB Research from Switzerland

In this section, a synthesis of three publications (Thakur-Weigold et al. 2016, Thakur-Weigold 2018a, Thakur-Weigold 2018b), argues for a revision of key assumptions made by GVC theory. In particular, IB research on GVCs continues to focus on Multinational Enterprises or MNEs, assuming that they exert control over the network through buying power and superior knowledge. This configuration implies a rigid hierarchy under the authority of a powerful buying firm with the supplier in a position of dependency and economic disadvantage. The essay draws upon the supply chain literature and empirical cases, to present evidence that GVC network structure and interfirm governance are not always destiny. Each firm participating in the GVC will have a competitive strategy to contend with its own niche market in traded value or task,

deploying factors which include, but are not restricted to, lowest unit cost of labour (only 10% of the costs of high-tech companies are direct labour, according to Christopher 2011, p.175). Porter's original definition of the Value Chain noted that successful competitive strategies will manage not just local isolated costs, but the effects of Linkages between dependent nodes. This third and final section of chapter 2 presents a case study of a Swiss firm to illustrate how a small supplier of a low-cost commodity achieves above-average rents (measured against its industry competitors), by managing such network effects without squeezing its own suppliers or through cost-cutting measures. Arguing that the dedicated management of supply chain processes is becoming a new industry with real economic value, it concludes with a discussion of the role of new business models and strategies on IB research and practice.

### **Opportunities for IB scholarship**

GVCs have created entirely new business models like Li and Fung's asset-free supply chain control tower (Magretta 1998), strategies, and breeds of firm (like contract manufacturers, original design manufacturers, location service providers, and more, see Figure 1), the relevance of this new paradigm of trade for International Business research is therefore hard to overstate. To date, however, the principle focus of IB scholars has been an orthodox understanding of the Multinational Enterprise, or MNE. Within this focus, a review of 50 years of IB theory-building acknowledges the evolution through three distinct analytical stations. The first stream of macroeconomic studies began at the *Country level*, using national statistics on trade and FDI. The second stream proceeded to study the firm-specific behaviors of the Multinational Enterprise (MNE)'s *parent company*. The third stream takes the *foreign subsidiary* as the unit of analysis to examine its role in the international network of the MNE (Rugman et al. 2011). When GVCs came to their attention, IB research built on this legacy by incorporating the production function into its scope. The MNE thus became a *Global Factory*, implementing strategies of internalization and externalization (Buckley & Casson 2009).

What happened next followed the lead of sociological GVC scholarship: the Global Factory concept continued to assume that power is concentrated in the hands of the MNE, and that suppliers are relegated to positions of dependency. In developing countries, where these suppliers have less access to assets and institutional support, they are defined *per se* as disadvantaged (Buckley & Strange 2015, p. 245, Choksy et al. 2017, see also Gereffi & Kaplinsky 2001). MNE Governance of the Global Factory is characterized as centralized control through

non-market coordination of economic activity (Buckley & Casson 2009, see also Gereffi & Kaplinsky 2001), and becomes the primary concept in the IB stream of GVC analysis, with the logical consequence that Upgrading, in whatever form, within the given configuration is the only way to grow. The significance of other business strategies and scenarios remain unexamined.

Like any new paradigm, GVCs will require the revision of some of these unquestioned assumptions. By building on the GVC work of sociological economists, IB theory perpetuates the understanding of the MNE as similar to colonialism, with roots in mercantilist organizations like the East India Company. It is important to recall that both the Gereffi School began by studying “Global *Commodity* Chains”, in which raw materials and bulk agricultural products were extracted from developing countries for shipment to rich country markets. This neo-colonial mental model was eventually updated to reflect the reality of complex manufactured products like aeroplanes and computers. The sociologists renamed Global Commodity Chains as *Global Value Chains*, but made little or no reference to Porter’s seminal work on value chains and competitiveness (Porter 1985). The structural inevitability of an imbalance of power between developing and developed locations remains a given. The fact that MNEs are considered to operate outside the control and boundaries of the nation-state, justifies the sociological prioritization of governance in its theory-building. This stream of research renders the entire question of managerial agency irrelevant (Yeung & Coe 2014).

IB scholars should however take into account that, unlike the East India Company which had the Royal Navy guarding its material flows, today’s GVCs were not born of violence and conquest. Managerial agency played a role at both the political and firm level. Postwar history reveals that developing countries signed a raft of Preferential Trade Agreements (PTAs), in which they deliberately gave up a degree of sovereignty in exchange for participation in global markets. These market openings occurred with a swiftness and unanimity never seen before (Allen 2011). GVCs offered developing regions the extraordinary opportunity to simply *join*, and contribute to a single segment of the production process, rather than build an entire industrial base (Baldwin 2011). In effect, the technologies of GVCs enabled economies of scale, without the scale. The preliminary outcome was a windfall, as the new entrants typically moved from very low levels of agricultural productivity to generating basic industrial outputs. Moving from farm work into the factory, even at the lowest point of the global smile curve, meant a step change in local productivity and growth. This explains the remarkable performance of countries

like China, which lifted hundreds of millions out of poverty since its opening, and plans to eradicate it altogether in the foreseeable future (Johns et al. 2015, Economist 2019).

The benefits that GVCs have brought to developing countries are not as emphatically stated by the Gereffi School as the disadvantages which can arise over time. GVCs are associated with the EOI policies of a neoliberal agenda and the controversial Washington Consensus, which perpetuated crises in Latin American countries, which Gereffi and others consider a failure (in spite of the Asian growth patterns). Pursuing a Keynesian agenda, Gereffi has recently encouraged IB scholars to exert more influence on policy-making (2019). The proposed support of interventionism would be consistent with a *“pre-dominant IB view that suppliers are not able to reap sufficient benefits from participating in GVCs...due to a lack of (or lack of control of) firm-specific assets”* (Choksy et al 2017 p.27). All relevant assets are assumed to be in the hands of the MNE, the powerful buyer.

Supply Chain research and practice suggest that there are, however, other explanations of value creation and capture in an interconnected GVC system. The accelerated industrialization enabled by simply joining a GVC rather than building one, permits participants to skip not only the risky, long-term investment, but also the learning curve and institution-building which comes with it. This lag in business acumen may partly explain the power asymmetry between buyers in developed regions, and their suppliers in emerging markets. For any manager, experienced or not, upgrading presents a daunting challenge. Again, the empirical evidence suggests that practice is simultaneously a learning experience, releasing forces which, over time, reconfigure the GVC. In other words, *“The very process of outsourcing undermines power asymmetries that were inherent in the original externalized relationship”* (Buckley & Strange 2015, p.246).

The biggest opportunities for IB research arguably lie in the business strategies that are being formulated within GVCs, at all tiers, in all locations of the countless networks in operation today. Simplifying discourse to the structural issues of strong-buyer vs. weak-suppliers does not do justice to the dynamics of the ever-evolving Global Factories. Depending on business cycles and world market conditions, even the most powerful buyers occasionally compete for the allocations made by their suppliers (recall the recurring shortages of DRAM since the 1990s). Neither are GVCs exclusively composed of colossal Multinational Enterprises expanding into unsuspecting foreign markets. They are increasingly networks of independent firms, each of which can vary in size. The size of an individual firm (node) does not necessarily determine its

power, since both suppliers and smaller firms can wield considerable influence over the system. In certain cases, strategic buyers seek deeper relationships with suppliers to assure availability, as well as use them as a source of innovation (Wagner 2012). In developed countries, they can be brand owners like Intel, Bosch, Recaro, Zegna fabrics, and 'Swiss-made' design. Supply chain research has long recognized the strategic nature of individual functions like procurement, which should be the management of supply within a production network (Krajlic 1983). The fact that Krajlic defines categories of suppliers as delivering "*bottleneck*" parts with "*strategic*" importance, indicates that a supplier is not inevitably at the mercy of the buyer. The power dynamic can reverse if the supplier controls a material which the buyer needs to achieve its own rent. The latter may have to wait for its allocation of supply, upon which it is dependent to make its own margin. Logistics and foreign factories can also become sources of competitive advantage, if positioned strategically within the network. (Ferdows 1997, Cooper et al. 1997, Thakur-Weigold 2020 in review).

This section therefore take a strategic approach to what Porter calls "*linkages*" within the chain. There is, in fact, enormous potential in the study of the network itself, rather than the role of any single node, point of control, or function. Porter articulates an overlooked fact about the behavior of systems, in which each node is dependent upon inputs and conditions created by other nodes. It is worth recalling that a Value Chain is:

...more than the sum of its activities...[it is] is an interdependent system or network of activities, connected by linkages. Linkages occur when the way in which one activity is performed affects the cost or effectiveness of other activities. *Linkages often create trade-offs* in performing different activities that must be optimized. For example, a more costly product design, more expensive components, and more thorough inspection can reduce after-sales cost.

(Porter 1990, p.41, emphasis added).

As demonstrated by the previous section, Advanced Manufacturing can reduce the cost of development. The effect of linkages creating trade-offs can be extended to today's GVCs, in which materials, information, and money flow between different firms all over the world. Measured in isolation, the cost of a certain function (like manufacturing assembly) may appear low. When the costs of linked tasks are compounded, and the effects of waiting or dependency on inputs (usually precautionary overstocking), are counted, the total may unexpectedly skyrocket, especially when multiplied by the total volume of trade. The aggregate view of IB

research posits that the structure of GVCs creates an inbuilt advantage for MNEs, which see and control all flows. Supply chain literature and Porter however remind us, that this very structure conceals unsuspected costs which metastase if they remain unmanaged (as they would be by traditional, single factor economic measurements). It is not centralized control or governance which extracts the most rent from the network but strategies which reduce the cost of linkages and optimize their trade-offs. Perhaps because of its counter-intuitive nature, the study of linkages and their trade-offs has still to be addressed by all disciplines of GVC research. Its impact on both policy and practice will, however, be high, and yield more sustainable insights than single factor competition models, or (worse) protectionist ones.

There is a growing awareness across disciplines that, contrary to popular perception, low wages and material costs are not always the best criteria for location within a network (Christopher 2011, p. 185). Explaining the trade-off of relocating parts of the value chain to remote low-cost countries, a recent supply chain study on reshoring noted:

*“Because labor comprises only a small portion of the total cost of doing business, other costs of doing business must also be competitive or less expensive to make a manufacturing location attractive...Additionally working capital is increasingly tied up in inventory trapped on slow-steaming ocean transit and in safety stock held at distribution centers. Innovation also suffers from the physical and sometimes cultural distance between manufacturing and design operations.”* (Tate et al. 2014, pp. 382-383)

To cite a manager at Schaffner, a small Swiss producer of specialty electronic equipment, “Lean does not mean Cheap” (Thakur-Weigold & Lorenzon 2015). In other words, local cost-cutting in an interdependent system does not necessarily result in a low-cost GVC. To use one of Gereffi’s terms, the Territoriality that affords a GVC access to low-cost functions can, in some cases, actually reduce its ability to capture value when costs and capabilities are measured from end-to-end. According to Little’s Law, long (geographically dispersed) supply chains are susceptible to hidden costs like inventory buildup (Berger 2005, Tate et al. 2014). As the previous section and the trend for reshoring makes plain, if manufacturing is carried out in high-cost locations, the Smile Curve may occasionally be flattened. It is not only access to assets and factors, which determines successful participation, but human ingenuity in the face of trade-offs and more efficient linkages. Because of its modularity, the GVC presents firms with a virtually infinite combinatorial set of strategic and competitive levers. There is indeed much to explore beyond structural determinism.

## Perspectives from the Highest Cost Country on Earth

According to the Economist's Big Mac Index and OECD wage tables, Switzerland is the most expensive place on earth. According to the simplest economic arithmetic, no rational firm should select the tiny alpine nation to manufacture anything. So why do so many firms, both local and MNEs, defy this fundamental logic and profitably maintain operations there? Contrary to popular perception, Switzerland's wealth consists of more than watches, banks, and pharmaceuticals, although its considerably less visible manufacturing sector maintains strong links to each of these powerful industries. With less than 8.4 Million inhabitants, it is slightly less populous than Manhattan, and so incapable of growing at its current rate by serving its domestic market. Switzerland is a champion in export and is well-integrated into GVCs. Economic data like the backward and forward participation index help determine where countries are located on the curve. In Switzerland, its forward linkages are higher than its backward linkages, which suggests a strong upstream position. Although GVC structure varies across sectors, and there might be differences between them, the financial sector, Switzerland's most dominant, is present in all of them. Traditional trade data indicate that services account for only 20% of trade value. The input-output tables, however, enable an estimation of these services embedded in manufactured products, which accounted for 62% of value-added of Swiss exports in 2011 and the majority of the services originated from Switzerland itself (OECD-WTO 2016; Nathani et al., 2014). Let us consider the business model of a Swiss firm which is not a MNE, yet maintains global market leadership through innovative engagement in GVCs. The intent is to demonstrate the potential for new research questions and models in IB research.

### *The position of an industrial c-part supplier*

Bossard AG, located in the small alpine town of Zug, is a family-owned company which was founded in 1831 as a small hardware store. A so-called hidden champion, highly specialized on niche products and markets, it employs over 2000 people in 71 locations the world over, designing and selling nuts, bolts, and screw fasteners to manufacturers and infrastructure projects. The fact that individual fasteners (nuts, bolts, screws), cost very little, renders Bossard a so-called c-part supplier to automakers and other large MNEs. In theory, this is a structurally weak position. In fact, during the wave of globalization in the 1990s the company found itself losing the battle against commoditization. Their products were easily interchangeable, and could only compete by lowering prices to match those of emerging competitors in Asia. At that

point, it seemed inevitable that all European manufacturing would move to low-cost countries, and firms paying Swiss wages stood little chance of survival.

At the same time, even a lowly c-part like a screw plays a mission-critical role in the assembly of a car, plane or even a bridge. The Bossard engineers realized that the true value of their product was not *material* but in its uninterrupted availability. A car without screws was nothing more than a heap of scrap, and should the supply of these screws run out, the production line will come to a costly halt and profit is at risk. Nuts and bolts on an assembly line were comparable to basic utilities like water or electricity: they were cheap, banal and vital, and nobody should have to think about them being there when they were needed. With this insight, Bossard shifted its competitive focus from product cost, to assurance of supply, a form of risk management. By understanding the replenishment processes of their customers, they eventually developed a vendor-managed-inventory system called the 'SmartBin', which took on the transactional work – inventory control and re-ordering - that their customers normally executed themselves. This supplier-owned proprietary system not only automated the delivery of the fasteners to the factories of their customers, the materials were placed in bins attached to electronic scales which transmitted the inventory levels and consumption rates from the shop floor back to Bossard's IT department. Rather than wait for the customer to erratically re-order the necessary parts, precise real-time information from the SmartBins enables the supplier to automatically trigger replenishment orders based upon optimally computed quantities. By handing over their replenishment process to their supplier, the manufacturing firms not only save the cost of re-ordering but the frequency of stockouts declined, improving the overall availability of the fasteners in the customer's factory, and ultimately improving the performance of the GVC network in which both firms are embedded.

Today, there are more than 200,000 scales installed and operating at more than 800 customer locations worldwide, including the new Tesla factory in the United States, prompts the question of what this low-level supplier is actually selling to its powerful MNE buyers in more than 800 GVCs. Is Bossard a supplier of products or of services or of network intelligence? Depending on the unit of analysis, it proves to be a bundle of all three forms of value. The business model continues to evolve as the network operates, and learns from itself. Through SmartBin technology, Bossard effectively became a trader of industrial scale equipment, but did not compete in that market for weight measurement directly. It developed software, but did not compete in that market directly either. Its manufacturing customers continued to



purchase their nuts and bolts, but increasingly realized that both they and Bossard would be better off if the management of materials were outsourced to the supplier of these cheap but critical parts.

This re-configuration of tasks and shift of control had a profound impact on information flow within the firms. Compared to the days when contact was maintained through intermittent orders, the distance from the shop floors of their customers was effectively shrinking. After installing the SmartBins the suppliers knew much more precisely what was happening at the factories of its manufacturing customers, most of whom were MNEs like ABB and John Deere. In the locations of the latter, non-value-adding activity had been eliminated in the factory, while at Bossard, new job categories were created at the Swiss headquarters. One example is the customer logistics specialist who masters software, process flow, replenishment logic, customer facing and service. This proved to be a role that more closely resembled consulting than technical support.

At the level of interfirm governance, the large MNEs which are Bossard's customers not only trust this small supplier to provide the right fastener to the right location at the right time, ensuring business continuity, and ultimately protecting profit. They also request analyses of their running operations from their c-part supplier. It is the highly-specialized Bossard IT system which best recognizes consumption patterns and manufacturing performance, providing more insight than proprietary ERP systems of its MNE customers. Once the relationships have been established and processes redesigned, driven by improvements in technology, the supplier's knowledge of the GVC network accumulates by feeding on itself. Aware that their customers will continue to demand more insight and better service, the Bossard team is working on the next generation of shop floor logistics.

The Smart Factory Logistics system team members are prototyping this year builds on the intelligence and supply chain integration expertise the company has accumulated from thousands of SmartBin installations. Because mass customization and reconfiguring of the shop floor is becoming more common in industry, Bossard today offers a shop floor management system that can add or change items in real time using interactive graphic tools. One of the company's large pharmaceutical clients used to have 8,500 work location bins that were annually collected to check their contents because manual Excel records had become out of date and impossible to handle. In systems of such scale and complexity, it is easy to forget to delete an item once it is moved on the line. Should a worker forget to enter a single digit in an

item or send the wrong list, the resulting errors will impair manufacturing flexibility and changeovers. The new generation of Bossard logistics systems includes last mile management mobile apps to replace the old-fashioned water spider workflow management, which manually picks items from the shelves, walks around the shop floor and drops them off at refill containers. Instead of having to walk back to the shelf to scan the part number, the worker needs only be in the vicinity of the bin with a Bossard SMARTLABEL. The near-field communication (NFC) technology enables real-time updating of the system status without any deliberate (or error-prone) action on her part. She then is guided through the entire transactional flow with intelligent graphics. This shop-floor worker essentially holds a detailed inventory map in the palm of her hand, increasing her agility, precision and, not least, productivity.

In retrospect, the expansion of Bossard's core competency into integrated supply chain management has proven to be a strategy that successfully moved the corporation's position up the value chain. No margins were squeezed or suppliers "*leveraged*" to work for nothing. By creating continuous flows of demand information, waste was removed from the system and converted into bigger rents for both supplier and buyer. This has had material impact on talent development and, not least, on the financial results of the company. The case shows that a Global Factory as defined by IB (Buckley & Ghauri 2004)) does not necessarily concentrate power and an information monopoly in the hands of an MNE. The division of labour within the GVC effectively shifts the information advantage from large buyer to small supplier, adding value to the former and capturing value from the latter without either conceding a portion of their profit margin. Visionary MNEs like Tesla, however, are eager to work with suppliers and pay them for providing transparency, analytics, business continuity and, not least, the nuts and bolts of their products. Collaborative systems like these point to a different scenario for the future of the manufacturing industry around the world.

### 3. Conclusion and Policy Recommendation

If we uphold Sturgeon's modular approach to constructing GVC theory, selecting "*one of a few important causal mechanisms that can be used to partially explain and predict outcomes*" (Sturgeon 2008, p.2), each with a clearly defined explanatory scope, let us recap the key insights from five relevant disciplines which have established perspectives on de-verticalized production and global integration in the first chapter of this dissertation thesis.

The Macro-economic school led by Baldwin describes the GVC paradigm as a second unbundling comparable to the first one triggered by the industrial revolution. They deliver empirical evidence of a rebalancing of developmental outcomes at a global level. It attributes the measured convergence of world GDP to the accelerating effects of global supply chains (which we call GVCs), which have allowed previously underdeveloped countries to simply join, rather than labouriously build, their own industrial base. Since it is no longer finished goods which are being traded, but intermediates and smaller increments of added-value, GVC trade facilitates the emergence of entire firms or industries on the basis of niche specializations. This also creates unprecedented opportunities for smaller firms to compete globally. The combined accelerating and exponential effects of the global network, in which information and knowledge flow move almost instantly, also means that competition takes place at a finer level of resolution, that of task or module, and jobs will become more uncertain as firms are able to rapidly reconfigure the location and nature of work in response to changing world markets and conditions.

The Sociological literature led by Gereffi, which coined the term GVC, established heuristic tools which contributed to a new perspective on contemporary global trade, away from flows of FDI between nations towards a holistic view of the network structure, its end-to-end map of activity drafted by combinations of sector-locations. Originally motivated by a concern for social downgrading, its researchers attribute malicious intent to the apparently unconstrained market power of MNCs, which they frame as a form of neo-colonial exploitation and a threat to the state. By this logic, the deep integration of globalization was effectively a contemporary case of rich, core nations invading poorer ones, extracting material at low cost,

while imposing dependency and impoverishment. These hypotheses led to a heightened attention to private governance: by determining the power structure of inter-firm relationships, the analysis expects to unearth the mechanisms of developmental inequality. It is interesting that the stream formulated a typology of governance which is not inevitably skewed in favour of a large lead firm, but varies under circumstances. The identification of variables like power asymmetry, component modularity, and supplier capabilities highlighted that upgrading was possible, through impersonal structural levers that can be influenced by firms to better compete and increase their share of rents. From an inherently anti-capitalist motivation, many of cases studied by the grounded sociological research revealed success stories and positive developmental outcomes, in addition to those which are left behind.

The Manchester School of economic Geography, led by Dicken builds explicitly on the basic constructs and generalizations of the GVC as defined by economic sociology, to draft a theory of Global Production Networks or GPNs. It takes, however, a revisionist stance which insists upon more balanced explanations (rather than descriptive frameworks only), and debunking what Dicken considers oversimplified myths like the world is flat, MNCs rule the world, or that globalization is always good or always bad. The GPN stream insists upon recognizing the complex interaction of networks within networks, and especially their territorial embeddedness. These scholars also distance themselves from the sociological Keynesianism, with its striving for autarky and liberation from world systems of trade as a path to growth, in favour of a more orthodox economic rationality. In a capitalist system, firms must compete as managerial devices to optimize available resources, defined as core competencies, at the lowest possible cost. The school emphasizes that the state is not powerless in the face of large corporations, with institutions and territoriality playing an active role at the micro-level, engaged in the ongoing negotiation and re-balancing of interests with MNCs, their suppliers, and other stakeholders in the GVC. At a high level, the GPN theory of Economic Geography revises the notion that it is a combination of public policy and macro-level forces which cause entire nations to develop or de-industrialize (Buckley 2009a, p.234). Firms do not generally wait passively for the state or comparative advantages to take effect. They formulate, execute, and renegotiate competitive strategies, location by location, on an ongoing basis and an entrepreneurial, agile state can promote the interests of its region to benefit from GVC participation through strategic coupling.

The stream of IB literature, which is an economic sub-discipline theorizing the development of the MNC, is only beginning to consider the implications of GVCs on its theory-building of internationalization and internalization. The first publications acknowledging the existence of vertical specialization appeared in the last decade, and show an emerging interest in modularization. Nevertheless, the centralized governance structures described by the IB research on the Global Factory confirms what one would expect from the sociological stream of research, which equates globalization with the dominance of rich world MNCs. The IB model also predicts that large MNCs are in a position to “leverage” their suppliers to work without margin, which always accrues through the network structure to the lead firm. This theoretical position essentializes small firms to be at a structural disadvantage, always struggling to capture a larger share of the value they add. The publication of the very results that the sociological stream originally sought to confirm (but were not able, to due to their empirical findings), may have motivated Gary Gereffi’s recent recommendation for IB scholars to target public policymakers as a stakeholding audience.

Conspicuously absent from the GVC debate have been the supply chain engineers and scholars themselves. This expansive and heterogeneous stream of literature resists systematic review, yet reveals important and little-known firm-level mechanisms for value creation in an inter-firm network. That network structure amplifies the effects of interdependence and uncertainty. Dealing with these effects requires inter-firm integration based on collaboration, which implies new roles for decision-makers. A non-combative relationship between buyer and suppliers tends to yield higher returns for all participants. As the summaries of economic disciplines illustrate, a dependent mindset and culture stand in contrast to received wisdom about market and assertive competitive behavior. Like the sociological GVC framework, supply chain researchers study the end-to-end system, but unlike all other GVC theories, they work to compile fully-loaded cost models across the system. This redefinition of cost is a radical departure from the intuitive notion of single factor optimization, which assumes that GVCs exist because of the arbitrage of wage or material cost at a global scale<sup>24</sup>. The systemic mindset of

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<sup>24</sup> This is not only widely accepted among economic scholars, but in the press. In “*The world economy’s strange new rules: How economies work has changed radically*” (October 10, 2019), *The Economist* recently stated that “*Inflation no longer rises reliably when unemployment is low, partly because the public has come to expect modest price rises, and also because global supply chains mean prices do not always reflect local labour-market conditions.*” This implies that globalization has a deflationary effect because the price of goods do not reflect local wages, as if the unit labour cost of developing countries were the single factor which determined selling

supply chain theory makes the hidden costs of low wages (the false sense of centralized control, and long lead times, to name but two) explicit: both of these can dangerously increase uncertainty in the system, which in turn drives up inventory and capital employed. Firms must work to integrate their processes and information streams to restore feed-forward and feedback loops in order to increase their network competitiveness.

A central claim of this dissertation is that GVCs were created by practice and that theory lags behind to explain how they work. Another argument is that no explanation of the observed GVC structure will be complete without an understanding of the supply chain strategy pursued by both the lead and supplying firms in their respective territorial contexts. The empirical evidence presented in chapter two supports these claims with three different studies.

The first study emphasizes that the GVC framework which applies a combination of sector-location as unit of analysis effectively obscures the real differences between individual firms and how they perform. Whereas the sociological literature defines *the* MedTech GVC in Puerto Rico and compares its economic success and social upgrading to that of *the* MedTech GVC in Ireland, the research in this dissertation found 4 discrete groups of firm which engaged in the MedTech sector in the two countries being compared. Each type of firm coupled strategically with its location to profit from comparative advantages (like wage level, labour skill base, or knowledge spillovers from related industrial clusters like pharmaceutical production), but configured its own supply chain depending on its competitive strategy. There is no doubt that Czech Republic has low wages and Switzerland has high wages, but these single cost factors must be evaluated as part of the end-to-end system when studying the GVC. Applying a supply chain analysis, geographic location is more than a wage level, but represents a position within supply chains which creates specific lead and throughput times, can serve multiple markets, and enable different strategic service levels across a range of total costs. This is best illustrated by example. Certain MedTech products, like a disposable bandage, if produced in the Czech Republic for consumption in China may be integrated into a high-cost and responsive supply chain. The same disposable bandage produced in the Czech Republic for the German market may however be a node in low-cost, efficient supply chain. Even if the aggregated macroeconomic data suggest that a formerly developing country like the Czech Republic has

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price levels. Supply Chain Management proves that it is but one of many hidden factors that compound to arrive at the consumer, including managerial ingenuity.

a RCA in low-cost disposables and competes on low-wages, it is critical that analysis drills down to the firm level to qualify what is happening in the GVC. There appears to be no single way to compete but a virtually infinite combinatorial set of strategic and competitive levers which can be reconfigured to target value capture in any one location. This presents firms and locations with business and growth opportunities, and indicates potential for more research.

The second and third studies turn to the possibility of flattening the smile curve for the advantage of high cost locations, again using the extreme case of Switzerland. It is perhaps unusual to regard one of the richest and most stable countries in the world as struggling to deal with Globalization, but the literature from the Baldwin stream has made the fact of de-industrialization plain. Furthermore, smile curve economics would suggest that manufacturing has no future in a high-wage location, dooming factories and the communities which depend on them in the small country to closure and decline. The choice of the highest cost country also shifted the solution search away from upgrading in a GVC, because according to IB and sociological theory, its firms are already competing from the pinnacle of factor advantages i.e. endowed with the most capital, most assets, most knowledge, and most technology compared to other firms. The question that a Swiss firm must therefore ask is: if you cannot upgrade from low to high value capture in production processes, then how do you compete? The solutions will surely be interesting to nations struggling with competency and middle income traps.

The design science study of a CEM, conducted over a period of two years, in close collaboration with its management team, tested the predictive capabilities of extant GVC theory in situ. The answers which the mixed team of managers and academics produced is that, when you cannot upgrade because you are already working at the top of the curve, the only way to create growth is to innovate your processes. The smile curve disaggregates value as it is added to the product, with a logic centred around single cost factors, especially wage levels. The GVC structure reveals sources of value in the linkages, information flows, and the capabilities which optimize these. This CM competing against powerful MNEs from developing nations like FoxConn, decided against competing on cost and deploying its manufacturing network as a global order fulfilment system. This was made possible by re-establishing information flows between nodes that were severed by specialization and offshoring, by creating capability maps that extended from the customer to the supplier. Furthermore the integration between product development and manufacturing enabled a form of Advanced Manufacturing (co-development), which binds the CEM-supplier to its OEMs in a way which

would have been impossible by selling one-off services like product design. The growth strategies produced by the Design Science demonstrate how a factory under pressure from globalization can be deployed in a high wage location to fulfill the vision of *“Manufacturing as a Tool of Economic Development and Source of National Competitiveness.”* (Roth et al 2016, p.1477). Since process innovations like this require no additional assets, the research claims that similar breakthroughs are possible in lower-wage locations if the same logic is applied, i.e. the systemic search for sources of value beyond competing on cost.

Assuming that a snapshot of the network structure determined its future, or single factor cost analyses would have driven Bossard, the small GVC supplier explored by the third study, to bankruptcy decades ago. This is another case of supply chain innovation which uncovered sources of value in the linkages and information flows of the inter-company system. The fact that the world’s largest MNCs, including Tesla, ABB, and John Deere are willing to pay this small provider of cheap nuts and bolts for managing their replenishment process is evidence of the value of network intelligence and risk management. The continuous expansion of the vendor-managed SmartBin and SmartFactory Logistics system points to the virtuous cycle of learning that can be triggered by sharing information collaboratively across nodes. Over time, the supplier comes to learn more about the manufacturing process of its buyer than the OEM itself, demonstrating that *the very process of outsourcing undermines the power asymmetries that were inherent in the original externalized relationship*” (Buckley & Strange 2015 p. 246). Information monopoly is correlated to power in a GVC, as IB research claims but contrary to their conclusions, it is not always predetermined where that monopoly will reside. Within the hundreds of GVCs in which Bossard engages, governance power is not inevitably retained by the MNCs at the expense of this supplier, but is distributed between the two firms and constantly shifting. For the decision-makers in the firm, the supply chain innovation that they eventually implemented required a shift in economic logic and system perspective. In the words of Urs Güttinger, today the CTO of Bossard, *“I was here as a hardware guy, but I soon learned it was only a small part, and it was all about the process”* (Thakur-Weigold et al. 2016 p. 46). Both research and practice will benefit from the rigorous study of these enablers of success.

Dis-integration and specialization require new policies to cope with the New Globalization. The walls of the factory today traverse national borders and one might argue that there are no continuous brick and mortar walls in a virtually-operating GVC. The “dis-



integration of production” essentially redefines each participant in the decentralized value chain as a specialized *service-provider*, even if their contribution is material production (Billington 2003). In a GVC, even manufacturing services (sewing, assembly, soldering, etc.), are bought and sold in discrete packets, according to the specifications of the supply chain control tower, which may or may not always be the lead firm. Concerned with how “the offshoring of work ...reduced labor’s leverage”, Robert Solow recently commented that “we do not fully appreciate how many people now work in service industries...[and] it’s probably harder to organize service workers than factory workers’. Six employees scattered in a CVS<sup>25</sup> do not have the same type of experience as 600 on a factory floor....Workplaces over time in the economy as a whole have become more isolated...In fact, the image of anybody working today is one person, staring at a computer screen.” (Dizikes 2019, p.13). This dissertation has shown that new industrial organization is emerging, displacing traditional forms of community with new forms of physical and logical interaction, all of which demands new forms of private and public governance. In this final section, we turn to the challenges of public governance, with recommendations for the policy maker (not only) in the Czech Republic.

### **Recommendations for Policy**

The most widely-cited GVC theory, the Gereffi school, has spilled much ink to address policymakers and encourage statist interventions. They urge that the predatory behavior of MNCs be curbed, that weak locations are supported to upgrade, and that labour be empowered to get a better share of the limited pie. This section will not repeat the recommendations of these publications, although they serve as a point of departure for a less interventionist, more collaborative approach to public GVC governance. The simplified assumptions which underlie this section are as follows:

1. Firms create growth in their host locations by paying corporate tax
2. Firms create growth in their host locations by employing and developing local talent, who in turn pay tax and generate further economic growth
3. Regions should try to attract firms assuming that most of them operate within GVCs at some level

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<sup>25</sup> CVS is an American chain of drugstore-pharmacies. See [www.cvs.com](http://www.cvs.com).

The recommendations are grouped into the following six subtopics:

1. alignment of interests
2. information base (gauges)
3. system mapping
4. reducing logistics friction
5. systems benchmarking
6. ongoing business education for public servants.

We begin with the question of the culture of engagement between policymaker and firm leadership. The supply chain literature reviewed in this dissertation emphasizes the mutual dependency of actors in a GVC. Following Yeung (2015), this research argues that a regional coupling strategy, with an *alignment of interests*, is a pragmatic way to deal with that interdependency. The speed at which firms are able today to adapt to new regulations and local conditions will generally exceed that of local legislators to develop new boundary conditions for business. Therefore, a combative attitude to firm interests may be counterproductive because of the options that GVCs have to relocate to more welcoming and supportive territories.

In order for this to be successful, decision-makers on both sides must create an *adequate information base* that delivers more than the traditional (i.e. old Globalization) economic indicators. Borrowing from the metaphor of the dashboard of a moving vehicle, this would be the equivalent of the driver reading the most relevant gauges of activity before deciding upon which buttons and pedals to press. For example, when researching the current state of trade and value capture, Baldwin urges that the decision-maker be wary of applying old economic thinking to the new GVC paradigm (2014, 2017). A measure of export volume will be much less useful than the TiVA, or national Input-Output tables. Both data sources will provide a more realistic picture of the value increments moving across borders and im/balances of trade. Returning to the metaphor of buttons and pedals (i.e. interventions), the old regulatory instruments of export trade will no longer fit in a system in which nations must import in order to export. Tariffs are likely to be counterproductive. When embedded within GVCs, firms often create jobs elsewhere, hence subsidies which target “national” industries may well create jobs abroad, as firms select the most competitive suppliers.

The ongoing research and *mapping of the system* will therefore be vital inputs to policy and decision-making. The Gereffi GVC framework is a useful starting point for this purpose, visualizing the input-output structure of a sector, across territories, and with a breakdown of key value-adding segments. This will provide a much better understanding than FDI data alone. However, I recommend that this method be complemented by analysis of the types of firms which operate in these sectors and group them by size, supply chain strategy (efficient and low-cost, agile and high-cost, treasure hunting, and so on), and where possible, ownership. This will deliver a deeper understanding of how and where value is added in the network structure, beyond the production function alone.

Infrastructure like roads and ports tend to be top of mind when policymakers think of facilitating trade. This priority is still valid but locations should pay equal attention to **reducing logistics friction** in their processes. It is helpful to recall Hausmann et al (2005)'s measurement of just how substantially different forms of logistics friction can compromise growth. Nations open to trade, like those in the EU, and who strive to improve their competitiveness in the decentralized ecosystems of GVCs should not overlook the practical conditions under which materials flow through supply chains, and which amount to non-tariff trade barriers. These constraints tend to disappear in high-level economic models. Their data arrives at a robust index to measure logistics performance of a country, but it is their narrative description which makes the point clear:

The quality and performance of logistics services differ markedly across countries. In Kazakhstan it takes 93 days to export a 20-foot full container load (FCL) container of cotton apparel, and in Mali 67 days, while in Sweden it takes only 6 days. In Namibia the costs of all trade-related transactions for a 20-foot FCL container, including inland transport from the ocean vessel to the factory gate, amount to slightly more than \$3,000, and in Georgia to slightly less than \$3,000. In Germany these costs amount to only \$813, and in Sweden to a little more than \$500. These variations in time and cost across countries stem from differences in the quality and cost of infrastructure services as well as differences in policies, procedures, and institutions. They have a significant effect on trade competitiveness. (Hausman et al 2005)

It is worth emphasizing that friction is not always the result of inefficient customs or bureaucracy. It can arise from geopolitical forces that, at first glance, appear unrelated to export market regulation, or supply chain shipments. The European migration crisis, together with the fight against terrorism in the wake of bombings in Paris and Brussels, are increasing pressure on Europe to close borders, or at least re-introduce personal checks. Not only does

this threaten the Schengen agreement and the union's fundamental commitment to a free movement of people within its borders, the economic repercussions are immediate and material. Press reports offer varying estimates of the damage, but the costs are significant whatever the imprecision. For instance, Alderman & Kanter (2016) describe the losses faced by small businesses waiting for the delivery of fresh produce, and of just-in-time German factories idling because trucks with inbound components have been held up at the borders. Tallying the cost of supply chain disruption, with that of reduced tourist spending, the cost of border controls is estimated to be €18 Billion per year. This is based on traffic of 57 million vehicles and 1.7 million workers crossing inner-European borders per annum. A separate study (Chasany 2016), considers the damage to the economy of the entire bloc to be 0.8% of GDP and costing France in specific €100BN annually. A German think tank set the cost at €460 BN over a ten-year period (Barber 2016). To varying degrees, the same factors have always reduced the efficiency of developed markets: inspections, tariffs, taxes, paperwork, and so on. With the proliferation of GVCs, however, the cost of obstruction will have a heightened effect on competitive pricing. Any export and import tariff, for example, will be levied in the multiples of which the intermediates cross borders to reach their next value-adding station. Their damaging effects are easily underestimated:

Trade intermediate inputs incur tariffs and transport costs every time they are shipped to another country for further processing. The cumulative effect of tariffs can significantly raise prices by the time the finished good reaches final consumers, thereby reducing demand and affecting production and investment at all stages of the value chain. Furthermore, the magnification effect is intensified because tariffs are levied on the gross value of imported goods, rather than on value-added. If foreign content accounts for a large fraction of the value of a good even small tariffs have a sizeable impact on costs. (OECD 2015 p. 89)

Reviewing globalization in general, Samuelson already recognized that “In 1900 free traders proclaimed, ‘Tariffs are the Mother of trusts.’ In this millennium a more pregnant truth may be: ‘Tariffs are the breeder of economic arteriosclerosis.’” Especially since economists tend to think arithmetically about markets, policymakers must take the non-linear and magnifying economic effects on GVCs into consideration when devising apparently unrelated strategies to deal with political issues like the inflow of migrants or national security.

Although a cut-and-paste of best practices may be counterproductive in a new context, *benchmarking successful industrial systems* like those of Singapore (whose entrepreneurial

administration serves as a role model for the policymakers of China), and Switzerland, as has been attempted here, may reveal forms of innovation worth piloting in other locations. It stands to reason that predominant focus on the US, which is not strongly embedded in GVCs, and the struggling economies that apparently fail in their attempts to compete in GVCs will not deliver the volume and quality of learnings that professional and business-friendly public administrations, with a history of success, might do. There are also a number of interesting policy experiments which could be useful as a knowledge brokering exercise (Hargadon & Sutton 2000). Canada has, for example, reduced tariffs and non-tariff trade barriers on intermediate goods, with the goal of making it more attractive for factories to settle in the region (OECD 2013). This is not an endorsement of uncritical, copycat decisions. Benchmarking of trade systems and their individual policies are most useful when they are conducted between roughly comparable cases, with compatible cultures of capitalism and business.

The challenge of understanding the new complexity of GVC trade may be daunting to civil servants commonly trained in fields like the law, international relations, political science, sociology, economics, but rarely in business administration and almost never as an industrial engineer. As I mentioned in the introduction to this dissertation, the speed at which the New Globalization is reconfiguring the organization of work and its geographic distribution outpaces the speed at which regulators and policymakers can analyse, reach a consensus, and enact legislation. Furthermore, the institutions of democracy are less agile in their response than centralized authorities like China and Singapore. A slow-moving democratic institution will surely benefit from *ongoing education of its civil servants* in system dynamics and the new conditions of global trade, to encourage more entrepreneurial and innovative responses to GVCs than old-fashioned (and counterproductive) showdowns between labour interests and MNCs. Again, Switzerland delivers interesting examples of consulting firms which provide advisory services to local authorities on how to attract GVC firms to locate their operations in often remote cantons, and support their local development.

In conclusion, it is fitting to return to Forrester, who recognized the correlation between industrial dynamics and economic growth, if managed as a system:

“industrial success depends on the interactions between the flows of information, materials, money, manpower, and capital equipment. The way these five flow systems interlock to amplify one another and cause change and fluctuation will form the basis for anticipating the effects of decisions,

policies, organizational forms and investment choices.”  
(Forrester 1958, p. 37)

“...there will come a general recognition of the advantage enjoyed by the pioneering management who have been the first to improve their understanding of the interrelationships between separate company functions and between the company and its markets, its industry, and the national economy.” (Forrester 1958, p.52)

The managers of place and firm will benefit from grasping the new world system as a whole, and managing it as such. May this dissertation play a small role in stimulating fresh thinking on the topic, revealing unsuspected opportunities in Global Value Chains, to drive growth in communities over the long run.

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# Appendix

## Appendix 1: Structured literature review methodology

As a basis for the structured literature review, the research conducted searches on two platforms: SCOPUS and Google Scholar. The selection of these two search engines was made with the following reasoning. SCOPUS is considered the most comprehensive source for scholarly references, while Google Scholar provides a broader indication of worldwide usage of publications that include, but are not restricted to, peer-reviewed academic publications. I refer to the statement „*Results with Google Scholar are displayed in relation to times of visits from users, not in relation to another index of quality of the publication*“ (Falagas et al 2008 p. 341).

The SCOPUS search makes the list of journals transparent and the selection criteria accessible to its paying subscribers (like my home institution the ETH Zurich). The research platform is self-referential, closed to all save its own community of users, and not available free of charge to the general public. It is commonly used to generate a ranking of published scholarship, which has in turn generated further research impact, measured by scholarly citations.

The Google platform and search algorithm is neither transparent nor reliably stable. Its logic and criteria can be modified at any time without obligation to inform users (researchers and the lay public alike). The private business interests of Google choose to withhold disclosure of its search and selection logic. If this intransparency is acknowledged, and not construed as a rigorous or comprehensive selection, the Google results can be both useful indicators of how intellectual property is currently of interest to both researchers and practitioners. In contrast to SCOPUS, Google's inclusive policy allows both accessibility to and inclusion of material available to the general public, which is reflected in higher citation frequency. A case in point is Gereffi et al 2005, the top-ranking GVC reference which is cited 7549 times counted by Google, but only 2748 times when counted by SCOPUS, a divergence of a factor of almost three. Google Scholar results are therefore considered compatible with the research scope of the present dissertation which addresses not only other researchers, but three stakeholder groups in GVC: scholars, decision-makers in firms, and policy-makers.



The following lists were generated to create an initial overview of the most relevant and scholarly influential publications on Global Value Chains and Supply Chain Management. (Note that the original searches were refreshed in \*April 2020). The long lists generated by the initial searches were refined by eliminating highly technical papers focused on a single factor in the supply chain (like the Internet of Things or current topics like Sustainability), which are important but not within the explanatory scope of this dissertation. The references were grouped according to the five research streams reviewed in chapter 1, which revealed that the social sciences, like sociology, indeed dominate both the general understanding of the GVC topic as well as the specialized scholarship. The participation of Economic Geography was also visible in the initial rankings, which revealed the stream on GPNs and the Smile Curve Economics. Conspicuously absent were macroeconomists from the Baldwin school, whose contribution to the topic is undisputed. This led to a separate keyword search by author, revealing a substantial and high-quality research stream.

The references were subjected to a detailed review, then coded according to the six conceptual questions designed to facilitate comparison (see chapter 1). If the most impactful scholarly references were the point of departure for the literature review, in the framework defined for comparison, combined with the empirical studies, they inevitably branched out to the bibliography which now supports this dissertation manuscript. The publications from the first search which were eventually included in the final list of references are marked in grey fill.

The keyword searches are explained individually per search. Because SCOPUS permits its users to limit the searched journals to relevant fields, the feature was used to narrow total yield.

The following academic fields were explicitly searched:

- Business, Management and Accounting
- Engineering
- Decision Sciences
- Computer Science
- Social Sciences
- Economics, Econometrics and Finance

The following academic fields were accordingly *excluded* from the long-list of most-cited literature:

- Environmental Science
- Mathematics
- Energy
- Agricultural and Biological Sciences
- Materials Science
- Multidisciplinary
- Chemical Engineering
- Earth and Planetary Sciences
- Arts and Humanities
- Chemistry
- Physics and Astronomy
- Psychology
- Medicine
- Biochemistry, Genetics and Molecular Biology
- Health Professions
- Nursing Immunology and Microbiology
- Pharmacology, Toxicology and Pharmaceutics
- Neuroscience
- Veterinary

Top 20 publications search string = „*Global Value Chains*“ in Google Scholar, sorted according to relevance as defined by the Google Scholar Search Bot and not explicitly disclosed by the provider.

Rank by Relevance*	Full Reference	Citations*
1	Gereffi, G., Humphrey, J. and Sturgeon, T., 2005. The governance of global value chains. <i>Review of international political economy</i> , 12(1), pp.78-104.	7549
2	Humphrey, J. and Schmitz, H., 2002. How does insertion in global value chains affect upgrading in industrial clusters?. <i>Regional studies</i> , 36(9), pp.1017-1027.	3058

3	Humphrey, J. and Schmitz, H., 2001. Governance in global value chains. <i>IDS bulletin</i> , 32(3), pp.19-29.	1284
4	Ponte, S. and Gibbon, P., 2005. Quality standards, conventions and the governance of global value chains. <i>Economy and society</i> , 34(1), pp.1-31.	913
5	Gibbon, P., Bair, J. and Ponte, S., 2008. Governing global value chains: an introduction. <i>Economy and society</i> , 37(3), pp.315-338.	623
6	Timmer, M.P., Erumban, A.A., Los, B., Stehrer, R. and De Vries, G.J., 2014. Slicing up global value chains. <i>Journal of economic perspectives</i> , 28(2), pp.99-118.	734
7	Giuliani, E., Pietrobelli, C. and Rabellotti, R., 2005. Upgrading in global value chains: lessons from Latin American clusters. <i>World development</i> , 33(4), pp.549-573.	1322
8	Gereffi, G., 2014. Global value chains in a post-Washington Consensus world. <i>Review of international political economy</i> , 21(1), pp.9-37.	677
9	De Backer, K. and Miroudot, S., 2014. Mapping global value chains.	507
10	Nadvi, K., 2008. Global standards, global governance and the organization of global value chains. <i>Journal of economic geography</i> , 8(3), pp.323-343.	480
11	Cattaneo, O., Gereffi, G. and Staritz, C. eds., 2010. <i>Global value chains in a postcrisis world: a development perspective</i> . The World Bank.	396
12	Humphrey, J. and Memedovic, O., 2006. Global value chains in the agrifood sector.	268
13	Milberg, W. and Winkler, D., 2013. <i>Outsourcing economics: global value chains in capitalist development</i> . Cambridge University Press.	489
14	Taglioni, D. and Winkler, D., 2016. <i>Making global value chains work for development</i> . The World Bank.	333
15	Gibbon, P. and Ponte, S., 2005. <i>Trading down: Africa, value chains, and the global economy</i> . Temple University Press.	997
16	Humphrey, J. and Schmitz, H., 2002. Developing country firms in the world economy: Governance and upgrading in global value chains.	375
17	Pietrobelli, C. and Rabellotti, R., 2011. Global value chains meet innovation systems: are there learning opportunities for developing countries?. <i>World development</i> , 39(7), pp.1261-1269.	537
18	Gereffi, G., 2001. Beyond the producer-driven/buyer-driven dichotomy the evolution of global value chains in the internet era. <i>IDS bulletin</i> , 32(3), pp.30-40.	412
19	Milberg, W., 2008. Shifting sources and uses of profits: sustaining US financialization with global value chains. <i>Economy and society</i> , 37(3), pp.420-451.	350
20	Dedrick, J., Kraemer, K.L. and Linden, G., 2010. Who profits from innovation in global value chains?: a study of the iPod and notebook PCs. <i>Industrial and corporate change</i> , 19(1), pp.81-116.	686

SCOPUS Search results according to following key criteria:

TITLE-ABS-KEY(Global Value Chains) AND ( LIMIT-TO ( SUBJAREA,"BUSI" ) OR LIMIT-TO ( SUBJAREA,"SOCI" ) OR LIMIT-TO ( SUBJAREA,"ENGI" ) OR LIMIT-TO ( SUBJAREA,"ECON" ) OR LIMIT-TO ( SUBJAREA,"COMP" ) OR LIMIT-TO ( SUBJAREA,"DECI" ) )

Rank by Impact	Full Reference	SCOPUS Citations
1	Gereffi, G., Humphrey, J. and Sturgeon, T., 2005. The governance of global value chains. <i>Review of international political economy</i> , 12(1), pp.78-104.	2748
2	Frohlich, M.T. and Westbrook, R., 2001. Arcs of integration: an international study of supply chain strategies. <i>Journal of operations management</i> , 19(2), pp.185-200.	1382
3	Humphrey, J. and Schmitz, H., 2002. How does insertion in global value chains affect upgrading in industrial clusters?. <i>Regional studies</i> , 36(9), pp.1017-1027.	1027
4	Rugman, A.M. and Verbeke, A., 2004. A perspective on regional and global strategies of multinational enterprises. <i>Journal of international business studies</i> , 35(1), pp.3-18.	896
5	Coe, N.M., Hess, M., Yeung, H.W.C., Dicken, P. and Henderson, J., 2004. 'Globalizing' regional development: a global production networks perspective. <i>Transactions of the Institute of British geographers</i> , 29(4), pp.468-484.	807
6	Ostrom, A.L., Bitner, M.J., Brown, S.W., Burkhard, K.A., Goul, M., Smith-Daniels, V., Demirkan, H. and Rabinovich, E., 2010. Moving forward and making a difference: research priorities for the science of service. <i>Journal of service research</i> , 13(1), pp.4-36.	774
7	Lee, I. and Lee, K., 2015. The Internet of Things (IoT): Applications, investments, and challenges for enterprises. <i>Business Horizons</i> , 58(4), pp.431-440.	599
8	Eisenmann, T., Parker, G. and Van Alstyne, M.W., 2006. Strategies for two-sided markets. <i>Harvard business review</i> , 84(10), p.92.	582
9	Brohee, S. and Van Helden, J., 2006. Evaluation of clustering algorithms for protein-protein interaction networks. <i>BMC bioinformatics</i> , 7(1), p.488.	562
10	DuPuis, E.M. and Goodman, D., 2005. Should we go "home" to eat?: toward a reflexive politics of localism. <i>Journal of rural studies</i> , 21(3), pp.359-371.	562
11	Ernst, D. and Kim, L., 2002. Global production networks, knowledge diffusion, and local capability formation. <i>Research policy</i> , 31(8-9), pp.1417-1429.	557
12	Cherubini, F., Bird, N.D., Cowie, A., Jungmeier, G., Schlamadinger, B. and Woess-Gallasch, S., 2009. Energy-and greenhouse gas-based LCA of biofuel and bioenergy systems: Key issues, ranges and recommendations. <i>Resources, conservation and recycling</i> , 53(8), pp.434-447.	548

13	Mudambi, R., 2008. Location, control and innovation in knowledge-intensive industries. <i>Journal of economic Geography</i> , 8(5), pp.699-725.	485
14	Manuj, I. and Mentzer, J.T., 2008. Global supply chain risk management strategies. <i>International Journal of Physical Distribution &amp; Logistics Management</i> .	454
15	Giuliani, E., Pietrobelli, C. and Rabellotti, R., 2005. Upgrading in global value chains: lessons from Latin American clusters. <i>World development</i> , 33(4), pp.549-573.	421
16	Ponte, S. and Gibbon, P., 2005. Quality standards, conventions and the governance of global value chains. <i>Economy and society</i> , 34(1), pp.1-31.	420
17	Gibbon, P. and Ponte, S., 2005. <i>Trading down: Africa, value chains, and the global economy</i> . Temple University Press.	409
18	Kaplinsky, R., 2000. Globalisation and unequalisation: what can be learned from value chain analysis?. <i>Journal of development studies</i> , 37(2), pp.117-146.	401
19	Chan, F.T., Kumar, N., Tiwari, M.K., Lau, H.C. and Choy, K., 2008. Global supplier selection: a fuzzy-AHP approach. <i>International Journal of production research</i> , 46(14), pp.3825-3857.	379
20	Sturgeon, T., Van Biesebroeck, J. and Gereffi, G., 2008. Value chains, networks and clusters: reframing the global automotive industry. <i>Journal of economic geography</i> , 8(3), pp.297-321.	373

Top 20 publications search string = „Supply Chain Management“ in Google Scholar, sorted according to relevance as defined by the Google Scholar Search Bot and not explicitly disclosed by the provider.

Rank by Relevance*	Full Reference	Citations*
1	Lambert, D.M. and Cooper, M.C., 2000. Issues in supply chain management. <i>Industrial marketing management</i> , 29(1), pp.65-83.	4018
2	Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. and Zacharia, Z.G., 2001. Defining supply chain management. <i>Journal of Business logistics</i> , 22(2), pp.1-25.	6434
3	Buurman, J., 2002. <i>Supply chain logistics management</i> . McGraw-Hill.	2850
4	Davis, T., 1993. Effective supply chain management. <i>Sloan management review</i> , 34, pp.35-35.	1591
5	Ballou, R.H., 2007. <i>Business logistics/supply chain management: planning, organizing, and controlling the supply chain</i> . Pearson Education India.	4613

6	Lambert, D.M., Cooper, M.C. and Pagh, J.D., 1998. Supply chain management: implementation issues and research opportunities. <i>The international journal of logistics management</i> , 9(2), pp.1-20.	4141
7	Tan, K.C., 2001. A framework of supply chain management literature. <i>European Journal of Purchasing &amp; Supply Management</i> , 7(1), pp.39-48.	1434
8	Lambert, D.M., 2008. <i>Supply chain management: processes, partnerships, performance</i> . Supply Chain Management Inst.	1036
9	Thomas, D.J. and Griffin, P.M., 1996. Coordinated supply chain management. <i>European journal of operational research</i> , 94(1), pp.1-15.	1995
10	Ellram, L.M., 1991. Supply-Chain Management: The Industrial Organisation Perspective. <i>International Journal of Physical Distribution &amp; Logistics Management</i> .	813
11	Cox, A., 1999. Power, value and supply chain management. <i>Supply chain management: An international journal</i> .	910
12	Harland, C.M., 1996. Supply chain management: relationships, chains and networks. <i>British Journal of management</i> , 7, pp.S63-S80.	1548
13	Chopra, S., Meindl, P. and Kalra, D.V., 2013. <i>Supply chain management: strategy, planning, and operation</i> (Vol. 232). Boston, MA: Pearson.	737
14	Croxton, K.L., Garcia-Dastugue, S.J., Lambert, D.M. and Rogers, D.S., 2001. The supply chain management processes. <i>The International Journal of Logistics Management</i> , 12(2), pp.13-36.	986
15	Cooper, M.C., Lambert, D.M. and Pagh, J.D., 1997. Supply chain management: more than a new name for logistics. <i>The international journal of logistics management</i> , 8(1), pp.1-14.	4051
16	Cooper, M.C. and Ellram, L.M., 1993. Characteristics of supply chain management and the implications for purchasing and logistics strategy. <i>The international journal of logistics management</i> .	1643
17	Christopher, M., 2016. <i>Logistics &amp; supply chain management</i> . Pearson UK.	736
18	Stadtler, H. and Kilger, C., 2002. <i>Supply chain management and advanced planning</i> (Vol. 4). Springer-Verlag.	1608
19	Christopher, M., 2005. <i>Logistics and supply chain management: creating value-adding networks</i> . Pearson education.	3925
20	Monczka, R.M., Handfield, R.B., Giunipero, L.C. and Patterson, J.L., 2015. <i>Purchasing and supply chain management</i> . Cengage Learning.	1335

SCOPUS SEARCH BY CRITERIA TITLE-ABS-KEY(Supply Chain Management) AND DOCTYPE(ar OR re) AND ( LIMIT-TO (SUBJAREA,"BUSI" ) OR LIMIT-TO ( SUBJAREA,"ENGI" ) OR LIMIT-TO ( SUBJAREA,"DECI" ) OR LIMIT-TO ( SUBJAREA,"SOI" ) OR LIMIT-TO ( SUBJAREA,"ECON" ) OR LIMIT-TO (SUBJAREA,"MULT" ) )

Rank by Impact	Full Reference	SCOPUS Citations
1	Reichheld, F., 81. and Sasser WE, Jr.(1990). Zero defections: Quality comes to services. <i>Harvard Business Review</i> , 68(5), p.105.	2765
2	Lee, H.L., Padmanabhan, V. and Whang, S., 1997. Information distortion in a supply chain: The bullwhip effect. <i>Management science</i> , 43(4), pp.546-558.	2592
3	Seuring, S. and Müller, M., 2008. From a literature review to a conceptual framework for sustainable supply chain management. <i>Journal of cleaner production</i> , 16(15), pp.1699-1710.	2427
4	Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. and Zacharia, Z.G., 2001. Defining supply chain management. <i>Journal of Business logistics</i> , 22(2), pp.1-25.	1891
5	Srivastava, S.K., 2007. Green supply-chain management: a state-of-the-art literature review. <i>International journal of management reviews</i> , 9(1), pp.53-80.	1872
6	Naylor, R.L., Goldburg, R.J., Primavera, J.H., Kautsky, N., Beveridge, M.C., Clay, J., Folke, C., Lubchenco, J., Mooney, H. and Troell, M., 2000. Effect of aquaculture on world fish supplies. <i>Nature</i> , 405(6790), pp.1017-1024.	1748
7	Carter, C.R. and Rogers, D.S., 2008. A framework of sustainable supply chain management: moving toward new theory. <i>International journal of physical distribution &amp; logistics management</i> .	1451
8	Lambert, D.M. and Cooper, M.C., 2000. Issues in supply chain management. <i>Industrial marketing management</i> , 29(1), pp.65-83.	1446
9	Frohlich, M.T. and Westbrook, R., 2001. Arcs of integration: an international study of supply chain strategies. <i>Journal of operations management</i> , 19(2), pp.185-200.	1382
10	Lee, H.L., So, K.C. and Tang, C.S., 2000. The value of information sharing in a two-level supply chain. <i>Management science</i> , 46(5), pp.626-643.	1320
11	Zhu, Q. and Sarkis, J., 2004. Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. <i>Journal of operations management</i> , 22(3), pp.265-289.	1285

12	Cooper, M.C., Lambert, D.M. and Pagh, J.D., 1997. Supply chain management: more than a new name for logistics. <i>The international journal of logistics management</i> , 8(1), pp.1-14.	1265
13	Flynn, B.B., Huo, B. and Zhao, X., 2010. The impact of supply chain integration on performance: A contingency and configuration approach. <i>Journal of operations management</i> , 28(1), pp.58-71.	1228
14	Chen, I.J. and Paulraj, A., 2004. Towards a theory of supply chain management: the constructs and measurements. <i>Journal of operations management</i> , 22(2), pp.119-150.	1186
15	Chen, F., Drezner, Z., Ryan, J.K. and Simchi-Levi, D., 2000. Quantifying the bullwhip effect in a simple supply chain: The impact of forecasting, lead times, and information. <i>Management science</i> , 46(3), pp.436-443.	1176
16	Ho, W., Xu, X. and Dey, P.K., 2010. Multi-criteria decision making approaches for supplier evaluation and selection: A literature review. <i>European Journal of operational research</i> , 202(1), pp.16-24.	1175
17	Savaskan, R.C., Bhattacharya, S. and Van Wassenhove, L.N., 2004. Closed-loop supply chain models with product remanufacturing. <i>Management science</i> , 50(2), pp.239-252.	1172
18	Rao, P. and Holt, D., 2005. Do green supply chains lead to competitiveness and economic performance?. <i>International journal of operations &amp; production management</i> .	1143
19	Tang, C.S., 2006. Perspectives in supply chain risk management. <i>International journal of production economics</i> , 103(2), pp.451-488.	1134
20	Gunasekaran, A., Patel, C. and Tirtiroglu, E., 2001. Performance measures and metrics in a supply chain environment. <i>International journal of operations &amp; production Management</i> .	1124

It was striking that neither of the search engines yielded references to Richard Baldwin and macroeconomic researchers in his school. This motivated the research to conduct a separate search based on the keyword author. The following are the Top most-cited publications (a limit of 100 yielded a total of 17 found by the combination of criteria), based on SCOPUS author search= Richard E. Baldwin plus keyword search = *Global Value Chains* and *Supply Chain Trade* (accessed November 9, 2019).

1. Baldwin, R. 2016, "The world trade organization and the future of multilateralism", *Journal of Economic Perspectives*, vol. 30, no. 1, pp. 95-116.



2. Baldwin, R. 2014, "Misthinking Globalisation: Twentieth-Century Paradigms and Twenty First-Century Challenges", *Australian Economic History Review*, vol. 54, no. 3, pp. 212-219.
3. Baldwin, R. 2014, "WTO 2.0: Governance of 21st century trade", *Review of International Organizations*, vol. 9, no. 2, pp. 261-283.
4. Baldwin, R. & Lopez-Gonzalez, J. 2015, "Supply-chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses", *World Economy*, vol. 38, no. 11, pp. 1682-1721.
5. Baldwin, R. & Okubo, T. 2019, "GVC journeys: Industrialisation and deindustrialisation in the age of the second unbundling", *Journal of the Japanese and International Economies*, vol. 52, pp. 53-67.
6. Baldwin, R. & Robert-Nicoud, F. 2014, "Trade-in-goods and trade-in-tasks: An integrating framework", *Journal of International Economics*, vol. 92, no. 1, pp. 51-62.
7. Baldwin, R. & Venables, A.J. 2015, "Trade policy and industrialisation when backward and forward linkages matter", *Research in Economics*, vol. 69, no. 2, pp. 123-131.
8. Baldwin, R. & Venables, A.J. 2013, "Spiders and snakes: Offshoring and agglomeration in the global economy", *Journal of International Economics*, vol. 90, no. 2, pp. 245-254.
9. Baldwin, R.E. & Evenett, S.J. 2015, "Value creation and trade in 21st century manufacturing", *Journal of Regional Science*, vol. 55, no. 1, pp. 31-50.
10. Baldwin, R. 2014, "Misthinking Globalisation: Twentieth-Century Paradigms and Twenty First-Century Challenges", *Australian Economic History Review*, vol. 54, no. 3, pp. 212-219.
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13. Baldwin, R. & Okubo, T. 2019, "GVC journeys: Industrialisation and deindustrialisation in the age of the second unbundling", *Journal of the Japanese and International Economies*, vol. 52, pp. 53-67.
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15. Baldwin, R. & Venables, A.J. 2015, "Trade policy and industrialisation when backward and forward linkages matter", *Research in Economics*, vol. 69, no. 2, pp. 123-131.
16. Baldwin, R. & Venables, A.J. 2013, "Spiders and snakes: Offshoring and agglomeration in the global economy", *Journal of International Economics*, vol. 90, no. 2, pp. 245-254.
17. Baldwin, R.E. & Evenett, S.J. 2015, "Value creation and trade in 21st century manufacturing", *Journal of Regional Science*, vol. 55, no. 1, pp. 31-50.

## Appendix 2: Revealed Comparative Advantage

Revealed Comparative Advantage was first proposed by Balassa (1965), and was applied in the comparison of the relative productivity of the Czech Republic and Switzerland in Medical Technology using the following logic:

$$RCA_{cp} = \frac{E_{cp} / \sum_{p' \in P} E_{cp'}}{\sum_{c' \in C} E_{c'p} / \sum_{c' \in C, p' \in P} E_{c'p'}}$$

Where:

E = Exports

c, c' = country index

p, p' = commodity index

P = Set of Commodities

This computes the ratio of the total exports of a commodity class in a country as a percentage of its total export volume over all commodity classes, compared to the percentage of world exports of that commodity class compared to total world export volumes.

When interpreting this index, a country is considered to have a comparative advantage in a commodity class if the value > 1. Should that value be < 1, the country is considered to have a comparative disadvantage when exporting the good.

The following summary by French is useful: “The concept [of RCA] is simple but powerful: if, according to Ricardian trade theory, differences in relative productivity determine the pattern of trade, then the (observable) pattern of trade can be used to infer (unobservable) differences in relative productivity.” (French 2017, p.83).

The RCA has been widely used in spite of known drawbacks. The index does not account for trade friction and other market distortions, and the data should ideally be drawn from bilateral trade flows rather than aggregations across importers. For a more in-depth discussion which includes revised measures for more accurate RCA computations, see French 2017.