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No Transfer, No Production

– a Report on Cross-border Data Transfers, Global Value Chains, and the Production of Goods

Kommerskollegium
National Board of Trade

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Foreword

A constant and seamless flow of goods, services, capital, people, and data is necessary for competitive production. Ensuring competitiveness is very much about facilitating these flows. This is not the least true for the flow of data, since the movement of data already is an indispensable part of today's production process. If cross-border data transfers are important today, they will be even more central to production in the future. Embracing these changes is about staying competitive.

With this report, we hope to broaden the understanding of the importance of data transfers for production and trade, underlining the fact that they are central for all companies and not only so called high-tech companies. This is essential to understand when discussing how to regulate data, including in trade agreements.

The report is written by Magnus Rentzhog. We wish to give our special thanks to company representatives for their time and willingness to discuss data issues with us.

Stockholm, March 2015

Anna Stellinger
Director General
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Summary

Production is today mainly done in fragmented and geographically dispersed global value chains (GVC). This ability to split up production is driven by the fast spread of information and communication technology (ICT) and the Internet. For a GVC to function, large quantities of digitized information (i.e., data) must be moved, usually cross-border, since both Internet and many GVCs are transnational in nature. This report maps the transfer of data in global value chains, focusing on tasks that relate to actual production of goods.

There are five main reasons why manufacturers need to move data for their production process to work: i) for overarching control and coordination of the geographically spread-out production, ii) to conduct R&D and testing in the pre-production phase, iii) for efficient supply chain management and the smooth flow of goods, services, and capital necessary for production, iv) to manage actual production and final assembly, including controlling robotics, and v) in the post-sales phase, run and monitor products sold, including moving data to be used as input in earlier stages of the production process.

Many different types of data must be moved, from employment data and customer data, to technical product data and data produced during the usage of a product. The amount of data moved is immense and will grow as manufacturers move into more advanced production involving sensors and intelligent robotics, as well as, introducing 3D printing into their processes. A significant part of the data being moved is personal data.

Legislation restricting the movement of data too much can become a burden for manufacturing companies. Too restrictive legislation can bring forth two types of effects on production processes, namely changes in GVC set-up, and less optimal functioning of the value chain. GVC set-up involves issues like how companies set up their production processes, where different functions are located and who carries out a certain task. Less optimal functioning is about increased costs, delays and inability to use different functions.

Companies interviewed for this report highlighted forced localization and restrictions on cross-border data transfers (including export restrictions) as two central types of measures affecting cross-border data movement. Additionally, governmental intrusion and censorship is seen as a central obstacle. All these measures impact on GVC set-up and efficiency.

Another central aspect for manufacturers is the existence of robust digital infrastructure. The transfer of large amounts of data and the installation of security measures (to counter public and private intrusions) mean that sufficiently developed digital infrastructure is a parameter of growing concern for companies and can affect GVC set-up.

The movement of data is vital to the operation of a global value chain and for production to be effective. With increasing digitization of production, the need to move data will increase. Embracing and facilitating this transformation is about supporting companies' competitiveness. Allowing data transfers are not about circumventing data protection regulation, but rather about efficiency and the ability to produce goods. Regulators must take every day practices and needs of goods-producing firms into account when formulating data regulation.

From a trade perspective, forced localization is the most intrusive form of data barrier and, as a general rule, forced localization regulation should not be allowed. This may be addressed in trade agreements. Trade agreements may also play a role when it comes to the building of adequate digital infrastructure and trade in cyber security solutions, including training.

Sammanfattning på svenska

Produktionen sker idag främst i fragmenterade och geografiskt spridda globala värdekedjor (GVK). Denna förmåga att dela upp produktionen drivs av den snabba spridningen av informations- och kommunikationsteknik (IKT) och Internet. För att en GVK ska fungera krävs att stora mängder digitaliserad information (= data) överförs, vanligtvis över riksgränserna eftersom både Internet och många GVK:er är gränsöverskridande till sin karaktär. Denna studie kartlägger överföringen av data i globala värdekedjor, med fokus på uppgifter som har att göra med faktisk produktion av varor.

Det finns fem huvudskäl till att tillverkarna behöver överföra data för att deras produktionsprocess ska fungera: i) för övergripande kontroll och samordning av den geografiskt utspridda produktionen, ii) för att bedriva FoU och tester i förproduktionsfasen, iii) för effektiv styrning av leveranskedjan och ett jämnt flöde av varor, tjänster och kapital som behövs i produktionen, iv) för att hantera faktisk produktion och slutmontering, inklusive styrning av robotsystem, och v) i efterförsäljningsfasen, för att köra och övervaka sålda produkter, inklusive överföra data avsedda att användas som indata i produktionsprocessens tidigare skeden.

Många olika typer av data måste överföras, från anställningsdata och kunddata till tekniska produktdata och data framtagna under användningen av en produkt. Den mängd data som överförs är enorm och kommer att växa i takt med att tillverkarna övergår till mer avancerad produktion med sensorer och intelligent robotteknik samt inför 3D-printning i sina processer. En icke-försumbar del av den data som överförs är personuppgifter.

Lagstiftning som begränsar dataöverföring alltför mycket kan bli en börda för tillverkningsföretagen. Alltför begränsande lagstiftning kan ha två typer av effekter på produktionsprocesserna, nämligen förändringar av GVK-konfigurationen och en mindre optimal funktion hos värdekedjan. GVK-konfigurationen rör frågor som hur företagen organiserar sina produktionsprocesser, var olika funktioner sköts och vem som utför en viss uppgift. Mindre optimal funktion handlar om ökade kostnader, fördröjningar och oförmåga att använda olika funktioner.

De företag som intervjuades för denna studie framhöll påtvingad lokalisering (*"forced localization"*) och begränsningar av gränsöverskridande dataöverföringar (däribland exportrestriktioner) som två centrala typer av åtgärder som påverkar den gränsöverskridande dataöverföringen. Dessutom ses statlig inblandning och censur som ett centralt hinder. Alla dessa åtgärder påverkar GVK:ernas konfiguration och effektivitet.

En annan central aspekt för tillverkarna är förekomsten av en robust digital infrastruktur. Överföringen av stora datamängder och införandet av säkerhetsåtgärder (för att motverka offentliga och privata intrång) innebär att en tillräckligt utvecklad digital infrastruktur är något som företagen blir alltmer angelägna om och som kan påverka GVK-konfigurationen.

Överföringen av data är avgörande för att verksamheten i den globala värdekedjan och produktionen ska bli effektiva. Behovet av dataöverföring kommer att öka i takt med en allt högre grad av digitalisering av produktionen. Att anta och underlätta denna omvandling handlar om att stödja företagens konkurrenskraft. Att tillåta dataöverföring handlar inte om att kringgå dataskyddsreglerna, utan om effektivitet och förmågan att producera varor. Lagstiftarna måste ta hänsyn till de varuproducerande företagens dagliga rutiner och behov när de tar fram bestämmelser avseende dataöverföring.

Ur ett handelsperspektiv är påtvingad lokalisering den mest inkräktande formen av datahinder och generellt sett bör reglering genom påtvingad lokalisering inte tillåtas. Detta skulle kunna fastställas i handelsavtal. Andra områden där handelsavtal skulle kunna spela en roll rör konstruktion av en tillfredsställande digital infrastruktur och handel med lösningar för cybersäkerhet, inklusive utbildning.

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1. Introduction

Trade in the 21st century can, in many ways, be summarized into two concepts:

- the fragmentation of production into geographically dispersed global value chains (GVC), and
- the digitization of production and trade, including the subsequent need to move digital information (data).

Production in global value chains is commonly portrayed as the flow of intermediary goods and services being brought together, sold and used. The fast spread of information and communication technology (ICT) and the Internet are the main drivers behind the proliferation of GVCs. ICT and the Internet are used by manufacturers to manage complex industrial processes – with tasks performed by various partners in different geographical locations.[1] ICT and the Internet are about moving digital information. Hence, production is about moving data.[2]

For a GVC to function, large quantities of data must be moved, usually cross-border since both the Internet and many GVCs are transnational in nature. This report maps the transfer of data in global value chains – with a focus on tasks that relate to actual production of goods (hence, leaving marketing and sales outside of this discussion – two tasks that are often in focus when discussing data transfers).[3] The reason for this is to explain how not only the so called "big tech"-companies like Google and Facebook rely on the movement of data, but how smaller ones do as well. Cross-border data movement is equally crucial for companies producing goods, and the amount of data that needs to be moved to ensure effective production processes is already immense.

Production is now entering a new digital age, sometimes referred to as the 4th Industrial Revolution.[4] Future production is evolving among two interlinked paths: i) further digitization of production, including using new business techniques like cloud solutions, the Internet of Things, and big data, in addition to ii) the growth of 3D printing. Both trends will greatly increase the amount of data that needs to move to ensure optimal production and GVC set-up. This transformation of production to the digital future is a question of competitiveness and survival in an increasingly competitive trading environment.

> *"Data wanders in all directions, all the time, all over the world"*
>
> *Information officer, at a white goods manufacturer, describing the importance of data for a company with numerous production and R&D-centres supplying sales organizations in over 150 markets.*

Consequently, as data transfers become increasingly central to the production process, regulations that hinder data from moving cross-border will become more disruptive.

In addition, as about 80 percent of world trade takes place within the framework of global value chains[5], increased knowledge on how and why data is moved within these production networks is important. Restrictions on data movement can affect the majority of trade. Subsequently, the report will also discuss how data protection regulation can affect production and GVC set-up.

This report is based on existing literature and discussions with (or written input from) goods-producing companies and business associations located predominantly in Sweden but also in Germany, Belgium, and the U.S.A.[6]

The report starts with discussing geographically dispersed production and the data that has to be moved to ensure that production processes function. The second part analyses barriers to the movement of data and what effects these barriers can have on production/GVC set-up. The report ends with a concluding discussion.

2. Data transfers in GVC-based production

This chapter describes why data transfers are already essential for production to take place. The first part illustrates how the production of goods takes place, focusing on showing how digitized production process is in many cases. Building on this description, the report then explains why data must be moved, especially when production is spread out internationally. Finally, this chapter shows what kind of data that is moved to ensure production in a GVC.

2.1 Production and digitization

Figure 1 shows a simplified GVC. The picture illustrates how production takes place and who participates. Below, we describe how dependent this GVC-based production is on digital solutions. That is, how much production *uses* data.[7]

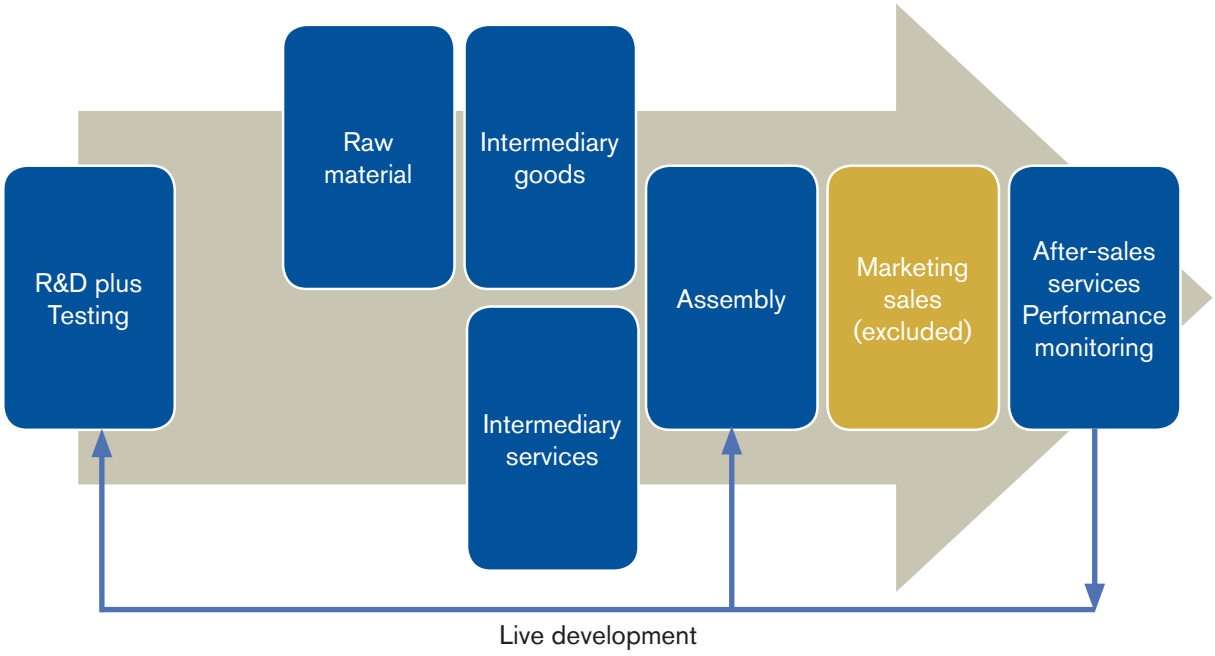
> *"We witness a new industrial revolution driven by digital data, computation, and automation".*
> *EU Commission (2014)*

R&D plus testing – this first step many times involves researchers, scientists, design and IT specialists working in different places and sharing ideas, information, prototypes, test data, and so forth. Prototypes and new material are tested virtually through simulations and modelling. Many times cloud solutions are used to coordinate the work. Sometimes external partners are involved, as with customers, for example, as well as other companies, and universities; and entails the need for data transfer outside the company doing the R&D.

Raw material – today, production of raw material is often automated and remotely operated (especially oil and gas production, with mining catching up). Numerous sensors monitor operations and equipment to prevent failures and accidents. The digitization has also redrawn the industry ecosystem by opening niches for small software and digitally-enabled service companies to participate in the production process.[8] Raw material is often bought on digital commodities markets.

Intermediary goods – production usually relies on input of intermediary goods. Generally,

Figure 1: Simplified GVC model



Note: A model of a global value chain, starting with R&D and testing. The assembly of the product relies on input in the form of intermediary goods and services. After being sold, most products include after-sales services (from repairs to upgrades) and often remote monitoring of the product's performance. Information collected in this last part is analysed and sent back into the chain ("live development") to be used in the development of new products or deciding output levels (i.e., number of units in the assembly phase). The marketing/sales phase is excluded in this report, hence a different colour.




final goods manufacturers source more and more of required input parts and materials.[9] A large part of the companies supplying the input are small- and medium-sized companies (SME). Production is increasingly automated (see more under Assembly). The intermediary goods must be moved to final assembly. This is done by supply chain management, which includes everything from package tracking and customs procedures, to coordination of flows by the company governing the GVC. Finally, information like know-how and market knowledge are transferred to subcontractors in order for them to be able to produce the right goods, with the right specifications and quality, at the right time.

Intermediary services – services are becoming an increasingly important input into production (a development known as servicification[10]). Production and movement of intermediary services is often done digitally. As in the case of goods, many SMEs supply intermediary services (in fact, joining GVCs is the easiest way for services SMEs to start exporting)[11] and, since this input often is digital, a large amount of information must be moved to ensure the production of the right services.

Assembly – this stage includes final production and assembly. Today, this process is often based on digital solutions, including both the actual production/assembly, the packaging process, as well as process control. Machinery (robotics) is data driven, linked together (communicating) to improve production. Here there is a trend from large contained robots to smaller robots working alongside humans on the factory floor (so called "cobots"). Beyond robotics, sensors produce data, used to improve product quality, increase throughput, avoid accidents, measure energy and material consumption, predict maintenance, and eliminating downtime.[12] Coordination between different plants is continuously taking place to ensure effective production. Data from the market allows for near real time adjustment of production.

Sales, marketing, shipping to customer – not part of this report.

Facts

Internet of Things

Devices that use embedded software to communicate with other devices are commonly referred to as Internet of Things (IoT) devices. IoT applications and services can be used by governments, companies, and individuals to raise revenues, increase productivity, and reduce costs.

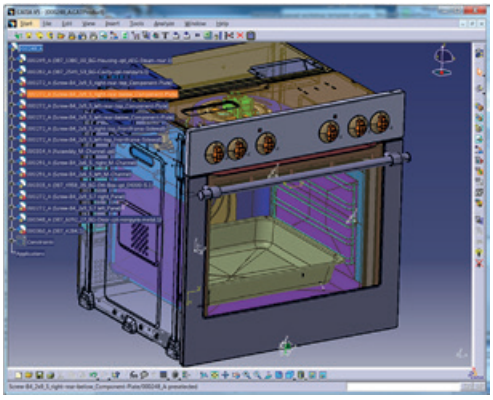
Many IoT solutions consist of industrial devices like machines or engines, which are being utilised by manufacturing companies. IoT applications can be used to monitor the machinery used in the manufacturers' own production (process control) or to monitor the performance of goods that have already been sold.

Live development – refers to how companies use customer feedback, social media, and actual product usage data to improve existing products, develop new products, and adapt the production process. Digital information from homepages and sensors in products is very valuable in order to assess what customers look for and how products are used. Like all processes described above, this feedback is digitally based, and depends on transfer of data in order to function.

Post-sales – while not being a step in the actual production per se, this part is immensely important for production. Post-sales include i) running or monitoring sold products, ii) handling maintenance, repairs, and spare parts, and iii) consumer interaction and usage of the products (i.e., live development; see next step). A large number of companies run their own products (e.g., a telecommunication system) for customers. In other cases, they monitor product performance to ensure performance optimization, detect wear and tear, and to get information on how products are used, which in turn is a part of further product development. Covering wear and tear and faulty products requires handling maintenance and repair as well as spare production and deployment. All of this is based on sensors and communication between products, operators, and customers (Internet of Things, IoT). This could also involve data from 3rd parties, like retailers selling the produced product.

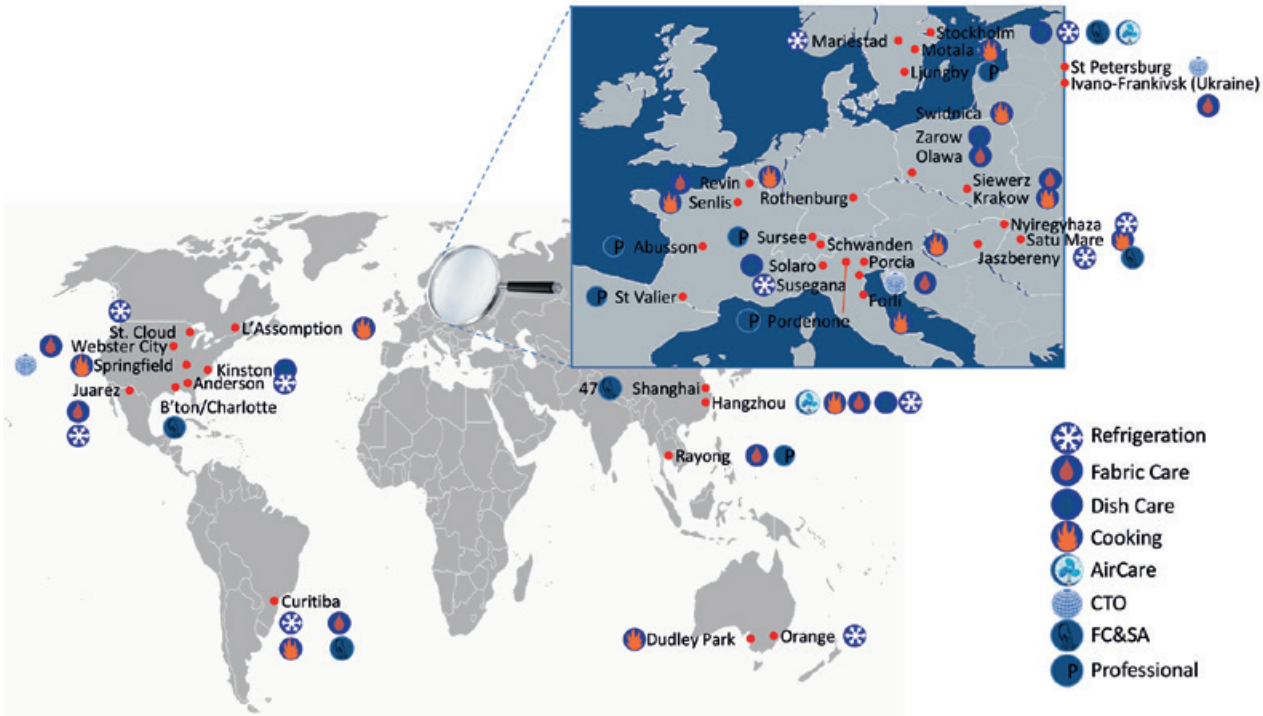
Live development[13] – refers to how companies use customer feedback, social media, and actual product usage data to improve existing products, develop new products, and adapt the production process.[14] Digital information from homepages and sensors in products is very valuable in order to assess what customers look for and how products are used. Like all processes described above, this feedback is digitally based, and depends on transfer of data in order to function.

Picture 1: R&D taking place in a 3D environment



Companies use digital solutions to conduct R&D and develop and test designs. Finalized products are available in 3D in the systems so that engineers, developers, the procurement department, and trusted subcontractors have immediate access to the entire range of products offered, including the product itself as well as sales and performance data.

Picture 2: Example of internationally dispersed R&D and production

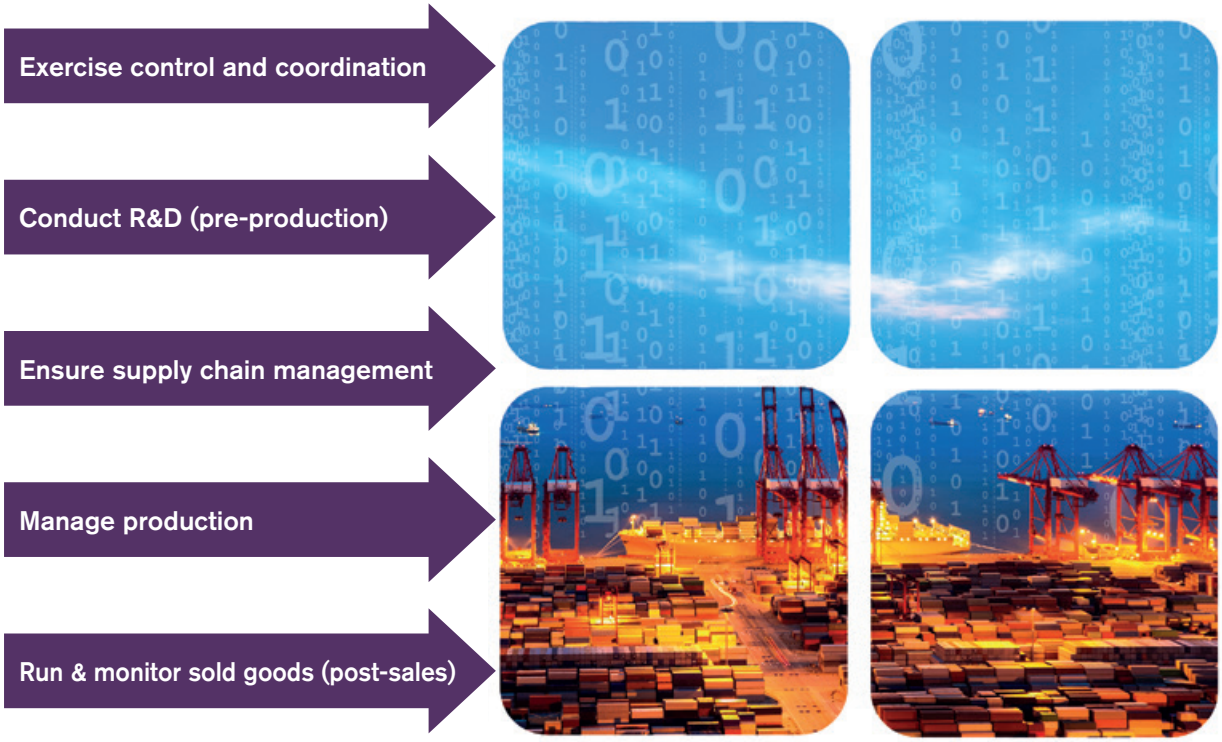


2.2 Five reasons why data must be moved

There are five main reasons why manufacturers *need to move* data:

1. To exercise overarching control and coordination. Governing geographically spread-out production requires close control of the process. Data must be moved to control and coordinate the production in several parallel locations. This involves, among other things, moving data to organize input flows, working with subcontractors and suppliers, and handling internal issues like human relations at production sites in different countries.
2. To conduct R&D in the pre-production phase. As described above, R&D and testing relies on data being moved in-house, which can still involve several different locations, as well as with external partners. Different kinds of data such as test data, technical data, for example, must be sent back and forth in a continuous flow until competitive and qualitative output is reached.
3. To ensure efficient supply chain management. Data must move in order to manage the input flow of goods, services, and capital necessary for the production. This includes sending information about inventories, sales, demand forecasts, order status, production schedules, and so forth. Information must be shared across different entities to ensure smooth functioning.
4. To manage actual production. Data transfers are also necessary to handle the production floor. This covers information flows during the actual production and assembly of the product. Data has to be sent to instruct robotics. Sensors on the work floor send real-time data that is analysed and used to control the production process.
5. To run/monitor sold products and move generated data in the post-sales phase. Information is gathered and shared after goods have been delivered to customers. Data must be moved during the running or monitoring of sold products in order to handle maintenance, repairs, and spare parts, in addition to moving it during consumer interaction and usage of the products. This also involves moving data to be used as input in earlier stages of the production process.

Figure 2: Five reasons why data must be moved



2.3 The type of data that must be moved for production to function

Production driven by digital data, computation, and automation depends on data transfers. As described above, production of goods is fully dependent upon digital solutions to ensure efficient production and to allow for optimal GVC set-up. Table 1 shows a non-exhaustive list of what *kind of data* that needs to move under each of the five categories identified above. It becomes evident that production processes heavily rely on the transfer of many different sorts of data, usually to different locations.

Note that Table 1 only summarizes a number of important types of data. In fact, it can be broken down even further. One business initiative mapped 108 different types of data needed to manage logistics and to enable efficient time-to-market of fashion products, which is comparable to "supply-chain management" in this report.[15]

Obviously different companies in the value chain will need, wish, or be forced to use and transfer different types of data. How companies decide to arrange their contractual relationships will also impact the need to transfer data – setting up a subsidiary to produce needed input will entail different transfer needs compared to buying the input at arm's length.[16]

Table 1: Example list of data that needs to be moved in production

Control/ coordination	Pre-production	Supply chain management	Production	Post-sales
- Employment data	-Market information	-Customs data	-Data from sensors	-Usage data
- Market data	- Usage data	-Customer data (incl. names and addresses)	-Instructions for robots, incl. communication between robots	-Performance data
- Market prices	- Social media data	-Package tracking	-Know-how/training	-Social media input
- Operations, planning, and processing	- Technical data	-Delivering input services	-Testing final product	-Customer reactions
- Production/ output data (from several facilities)	-Virtual design	-Payments (for products)	-Diagnostics, maintenance and repair	-Diagnostics, condition monitoring, maintenance and repair, incl. spare part management
- Production planning (incl. just-in time and adapting production)	-Test results	-Inventory levels	-Market data	-24 h service
- Monitoring performance	-Names of scientists	-Transport route optimization and transport time	-Product data	-Data from third parties (e.g., retailers)
-Demand forecasting	-Location data	-Procurement details	-Quality control	-Content as part of product
- Know-how/training	-Know-how	-Communications (e.g. e-mail)	-Technical data	-Storage management
- Licensing	-Customer data	-Info to logistics partners		-Data on parts availabilities
- Customer data	-Communications (e.g., e-mail)	-Orders, orders data		- "Life of product" (what version a customer has)
- Energy and material consumption	-Project information	-Sales data		-Technical data
-Internal communication (e.g., e-mail)		-Production schedules		-Product offer data
		-Performance metrics (quality data, lead times, queuing delays, service performance)		-Sales guides

All categories

Storage
Back-up
Software installation and updates
Troubleshooting and data repairs
Documentation of work flow

Note: The list is based on literature review and interviews with companies. It is represents a broad sampling of types of data needed in production.

How much data is actually moved in the chain? One study notes that a single manufacturer alone can house 20 petabytes of data.[17] Considering the fact that a GVC includes numerous raw material producers, manufacturers, and services providers, the amount of data in a GVC is thus very hard to measure.

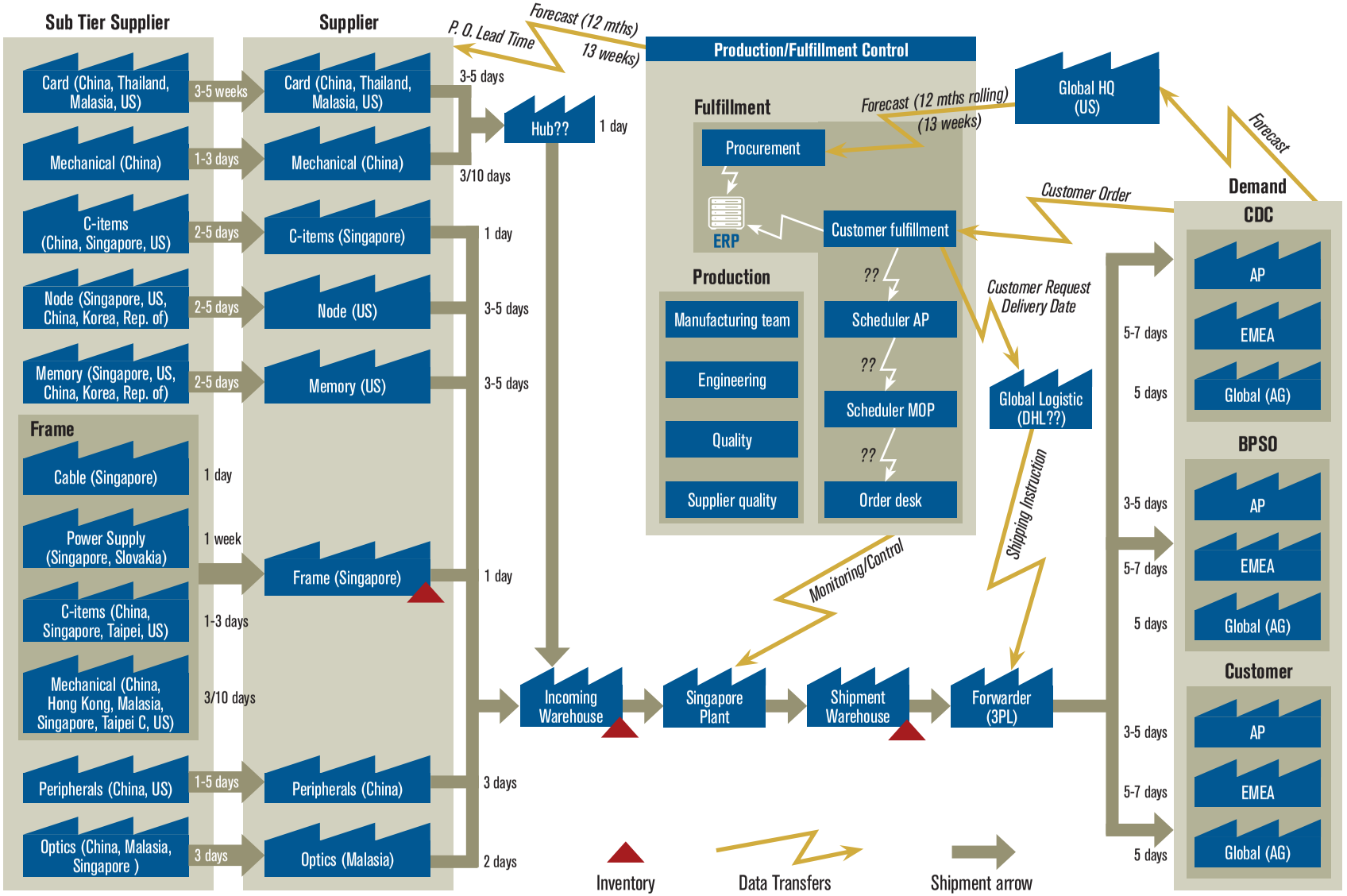
While all data presented above is important for GVC-based production to take place, the question follows whether some kinds of data are more valuable than others. For this report, the answer is relevant as it indicates the magnitude of the effects that different kinds of barriers to data movement bring forth (see Chapter 3).

Based on interviews, data like know-how, especially related to pre-announced products, and production methods are considered very valuable. Other examples of high-value data include market information, technical product data, customer data, and R&D. Information gathered in the post-production stage, especially customer usage data, is of high value. However, although it is recognized – as one interviewee put it, "…that this is the future, the more we can collect and use, the more value is created" (see also Footnote 14) – many companies do not today know how to reap the benefits from this data.[18] Other types of data ought to be of lesser value, such as employment data, internal communications, customs data, and documentation.

Again, this differs depending on the GVCs. The value of data might be different if the company governing the GVC primarily produces input and final goods through its own subsidiaries, or if it relies on subcontracting, contract production, and arm's length trade. For example, data on product design and product methods change in value if using a contract manufacturer for production as compared with a situation where this is done in-house.

Finally, data relating to supply chain management is generally not seen as valuable, *per se*. However, considering the immense importance of frictionless supply chain management, any constraint can have a huge impact. One company, with 100,000 order lines per day in Europe only, said that moving and using this supply-chain related data is the key to their competitiveness; it's "…a matter of being number one or number two".

Figure 3: Manufacturing supply chain map with examples of data transfers



Source: Goh (2013)
The supply chain of an electronics product showing the movement of input components and finalized products. It also shows some of the data that has to move to govern this supply chain.

3. Data protection regulation restricting production

3.1 Barriers to cross-border data transfers

Production and GVC participation is extremely competitive. Avoiding excessive costs are essential in a situation where even small extra costs have huge impacts. Regulation entails costs, and this is not disputed. However, for manufacturers it is a question of what kind of barriers and how they influence their operations. Hence, no company questions the need to regulated data transfers but the quality of the data regulation is worrisome. That is, too restrictive data regulation can impact on companies' ability to stay competitive by having optimal value chains and production set-up.

When it comes to regulating data transfers, interviewees identified a number of current regulatory practices as problematic:[19]

1. Forced localization (requirements to store data and locate data centres within a country's borders),
2. Restrictions on cross-border data transfers (restricts on the ability to move and process data across borders[20] as well as export controls), and
3. Governmental intrusion and censorship.[21]

The following discussion focuses primarily on these three categories of barriers. However, note that numerous others legal demands, beyond these three categories, can make life difficult and require companies to navigate in uncertain legal and technical waters. One company, producing machines mostly used by private individuals, raised rules around opt-out and rights to having data erased, and wondered how they should handle such claims legally and technically.

> *"Restricting data transfers is essentially about restricting business development"*
>
> *Group Information Security Manager at a global engineering company with a B2B focus*

This chapter should also be read in the light of ongoing developments regarding regulating data, and not just the current legal situation. Some concerns raised by companies did not necessarily mean that there is a problem today, but that they see a trend towards an increasingly challenging legal digital environment.[22]

3.2 Personal data and production

It is important to pay attention to personal data as around 100 countries have different kinds of data protection regulation in place, usually in order to, for good reasons, protect personal data (data related to an identified or identifiable person[23]). Also forced localization measures can be based on such concerns. These laws can influence on how this type of data can be used.

Contrary to what might be thought, personal data is central to the production process, even though most of the data that is moved in the production of goods is technical data from the production process, or corporate, and merchant data.[24] One interviewee, representing a company that only trades B2B, concluded that, "…privacy always gets into the process somewhere".

Personal data is generated and used in different parts of the production process. It is important in all five categories of data transfer needs identified in Chapter 2.2. Table 2 exemplifies how personal data is generated and/or used in the five categories.

Table 2: Examples of personal data in production

	Personal data used	Personal data generated
Control/ coordination	Employee data, user data, social media	Employee data
Pre-production	User data, social media data	Names and CV of scientists/researchers, test-persons' user data
Supply chain management	Customer data	Business contacts
Production	User data	Employee data
Post-sales	User data, sensor data	User data, social media data

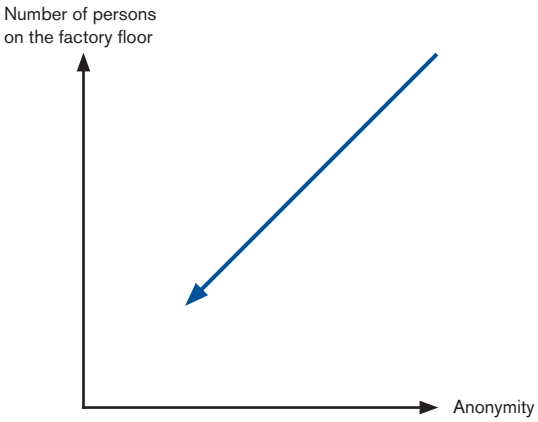
Here customer data refers to data relating to a manufacturer's customers and their employees. User data is about how a product is used. Employee data can range from, for example, names and salaries, to how a person behaves and operates a machine.

The personal data generated and used obviously differs in terms of sensitivity. Nevertheless, personal data plays a decisive role in production and global value chains.[25]

Personal data is even produced on the factory floor. Humans working alongside robots will have their work and actions registered. Also, companies register names and processes for traceability rea-

sons.[26] There is a connection between the numbers of people on the factory floor (e.g., being replaced by robotics) and anonymity.

Figure 4: Anonymity vs. number of employees on the factory floor



It is difficult to estimate how much personal data that is generated and used in the process, or exactly pinpoint where the data is produced and moved. One reason is obviously the fact that all production processes differ. Another more problematic reason is that there is no uniform interpretation of what constitutes personal data, and the definition is constantly moving.[27]

3.3 Effects on GVC set-up and optimization

The effect of a legal barrier depends on how companies decide to respond to said measure. This section will look at how companies have responded to the measures identified in Chapter 3.1, in other words, forced localization, restrictions on cross-border transfers, and governmental intervention and censorship.[28]

In this report, we identify two possible effects, namely 1) changes in GVC set-up and 2) less optimal functioning of the value chain. GVC set-up involves issues like how companies set up their production, where different functions are located, and who carries out a certain task. Less optimal functioning is about increased costs, delays, and an inability to use different functions. Many times, effects on GVC set-up involve less optimal operations leading to increased costs, the need to use multiple systems (ICT, HR, R&D-units etc.), as well as inefficiencies such as data being unable to be used globally, and thereby undermining the ability consolidate operations and reach scale. That is, these effects go hand-in-hand.

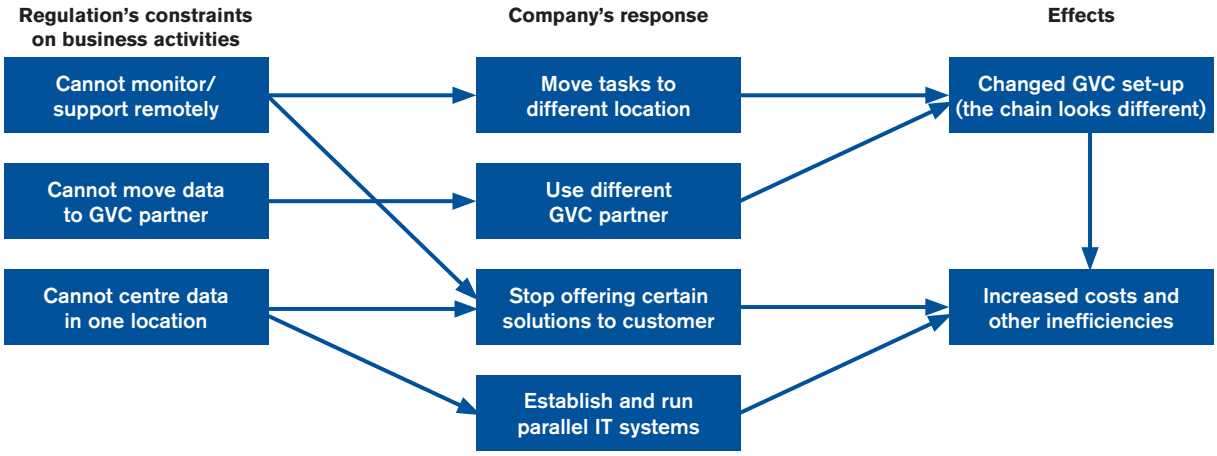
Production, in the form of GVCs, is based on specialisation of tasks, down to the individual level. Hence, too restrictive data regulation does not only affect where data is used, moved, or stored, but also where individuals are positioned. Many times expertise and support personnel are found in certain locations wherefrom they perform their work remotely and add their knowledge to other parts of the production chain. As data is being streamlined, so is competence. Moreover, streamlining is necessary for companies' competitiveness. The way data is regulated can affect this set-up, leading to a need to have both data and expertise and support personnel on every market.

3.3.1 Forced localization

Forced localization involves either that a country a) mandate foreign enterprises to establish a data centre within the country as a condition for being permitted to provide certain services in that country, or b) demand data to be stored locally and restrict the processing and storage of data outside of a country's borders.[29] Demands for local storage can involve storing copies of the data, meaning all data or only certain types of data, or a prohibition on moving the data outside the country.

Forced localization measures can have a direct impact on the GVC set-up. Such measures, especially when forbidding storage outside of a country, can lead to situations where companies need to move part of their operations to that country, or alternatively leave the market. For example, one

Figure 5: Forced localization – company response and subsequent effects

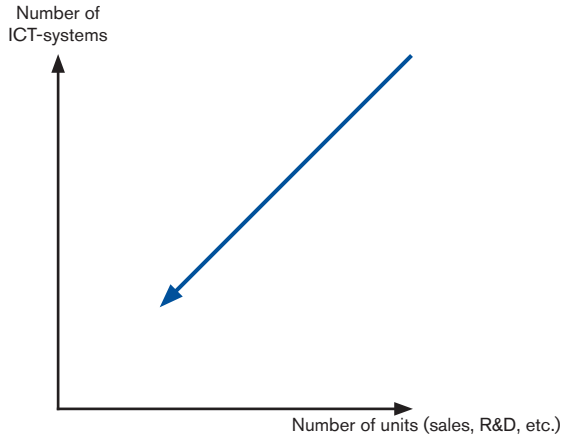


company explained how part of their post-sales operations must be physically moved to a country with strict localization demands. Since data produced by their products and users cannot leave that country, the company is not allowed to rely on online repair solutions, remote monitoring, and expertise input.

Another noted effect is that forced localization can lead to a situation where companies cannot use a certain partner since data, usually personal, is not allowed to be moved to that partner.[30] The higher the cost of these requirements, the higher the risk that GVC-governing companies will shy away from potential collaboration partners in that country, starting with SMEs. A central reason for this is that localization demands will make an SME's business offer less competitive, since they have to rely on local, less efficient cloud providers.[31] Hence, these kinds of regulations can directly affect who participates in the GVC.

Localization measures may mean increased costs and hence a sub optimal GVC set-up.[32] A common concern is the need to create and run multiple parallel ICT systems. Generally, companies try to streamline their oftentimes global ICT infrastructure and processes[33], in order to increase efficiencies and synergies, and thereby become more competitive. The ability to do this is partly dependent upon the ability to move data between different units and concentrate tasks to fewer units that serve larger parts of the company or business group. Streamlining means increased needs to share and move data. Hence, multiple ICT systems have a substantial impact on ICT costs. For example, one interviewed company sought to have ICT costs below two percent of global turnover. However, forced localization demand on financial information in one of its market countries implied a 50 percent increase in costs. ICT costs land at three percent, directly impacting competitiveness.

Figure 6: Streamlining processes

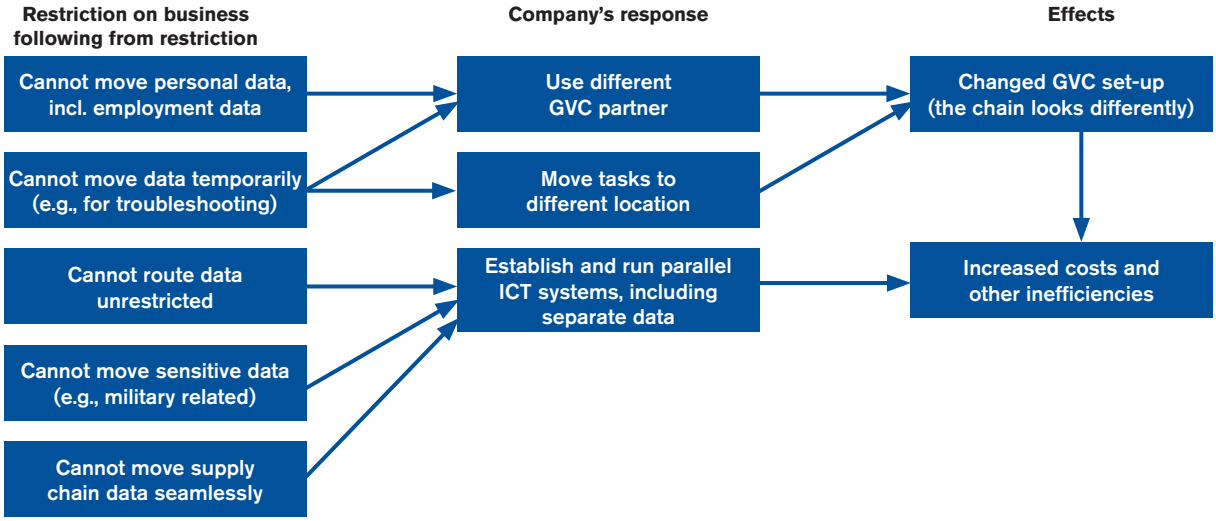


3.3.2 Restrictions on cross-border data transfers

Restrictions on cross-border data transfers include measures that are in place to hinder certain types of data, often personal data, to be transferred out of the country. In this category, export restrictions exist on non-personal sensitive data like military technology and information.

Most of the responses to, and effects of, forced localization are also relevant to restrictions on cross-border data transfers. These kinds of measures can also create situations where a manufacturer

Figure 7: Restrictions on cross-border data transfers – company response and subsequent effects



must change where a certain task is done, who participates in the GVC, and the need to create multiple ICT systems. Beyond the concerns raised when discussing forced localization, companies raised a number of further concerns that more related more to restrictions on cross-border transfer.

Issues with data protection regulation and supply chain management were raised by a number of companies interviewed. They saw that restrictions on cross-border data transfer could add costs to their supply chain management, impacting their ability to instantly and seamlessly move information on inventories, order status, where packages are, and so forth. This in turn impacts just-in-time delivery and lean production. Forced localization could also have this effect.

Supply chain management is an example of where unclear definitions become a central issue (see Chapter 3.2 and Footnote 27). There are divergent views among companies and regulators whether, for example, business contacts[34] constitute personal information. If business contacts are personal information, this data will be harder to move (especially since the sender seldom has a contractual relationship with the business contact) and, in turn, affect the operation of supply chains, which is a crucial competitive tool (see Chapter 2.3).

A number of interviewees also raised the fact that there are calls for restrictions on how data can be routed. In the EU, for example, there are calls for so called "Schengen routing",[35] meaning that certain types of data are not allowed to be routed through networks outside the EU. This kind of regulation would create a need to separate different types of data and to have data move in a sub-optimal way. Companies argued that routing demands would create a balkanized Internet and raise costs (mostly, due to the need to keep data separated).

Restrictions on cross-border data transfers can influence the control and coordination of the GVC, notably tasks that require personal information to be transferred from one facility to another. For example, transfer of knowhow and training can be unnecessarily difficult. One company exemplified this by a situation where employees at different production plants took an online training course to implement a more efficient work method. However, headquarters could not see the names and positions of the ones that had taken the course, only the number of persons. This made it more difficult to ensure that the people with the right training were placed where they were most needed.[36]

A specific concern when it comes to restrictions on cross-border data transfers relates to moving data temporarily for support function, troubleshooting, or routine control. These essential tasks can be hindered by data regulation, sometimes leading to the need to work with non-optimal partners.

As in the case of forced localization, restrictions on cross-border transfers can have a negative impact on SMEs abilities to participate in GVCs.[37] Restrictive rules coupled with sizable sanctions if these are broken (as is the case in the EU, for example), makes even large multinational companies risk-avert. Companies must work with, and share data with, numerous subcontractors, many of them

SMEs. The multinationals are, at least under EU rules, controllers of the data and are, as such, obliged to ensure that all subcontractors comply with data protection regulation. Data controllers already claim that they face problems in ensuring compliance by SMEs participating in their GVC. Further restricting the ability to move data might make the multinationals look for larger partners (that can comply with data regulation more easily) or in-source certain tasks, thereby cutting off the SMEs from the GVC.

Another problem for a large number of developing countries is the fact that many lack data protection regulation. As a consequence, companies in these countries are passed over as potential GVC participants due to increased uncertainty around compliance and adequate handling of entrusted data.

Restrictions on cross-border transfers include export restrictions, and this was raised as a concern by a number of interviewed companies. Some data produced (not necessarily personal information), notably in the monitoring of sold products (but also in other parts of the value chain), can be classified as sensitive and not allowed to be moved outside the country or handled by non-nationals. One company gave an example of problems related to restrictions on moving performance data out of the U.S.A. for troubleshooting in India. The company had to separate the sensitive data from a larger data set. In addition, they had to build a separate server in the U.S.A. with an added cost of roughly 2.75 million euros.

3.3.3 Public intrusion and censorship

Public intrusion and censorship encompass governmental measures like public fire walls and intrusion into companies' operations.[38] These measures can be serious barriers for the interviewed companies' business efforts. The impact from intrusion ranges from theft of business and customer data[39], to national competitors having faster Internet, blocked web-pages[40], or experience a lag in transfer times (which can be problematic when data needs to be moved instantaneously), and transfer interruptions.[41] Additionally, governments can dictate who a company must partner with to be in the market. All in all, companies have to take steps to counter these problems, including not storing data in certain locations, adding security measures, and rethinking cooperation partners in their GVC.

3.4 Secure data and the importance of digital infrastructure

Companies must ensure that their data is secure. Data protection is essential as attacks from both governmental and private parties are common.[42] Moreover, keeping data secured is about protecting know-how and business secrets, ensuring customers' trust, and adhering to data protection regulation (and subsequently being allowed to transfer data across borders). All of this affects production choices, including which partners to work with and where to store and transfer data.

A central aspect when it comes to protecting data is the existence of robust digital infrastructure (including fixed and mobile Internet infrastructure, telecommunications equipment and devices, and cloud infrastructure). This type of infrastructure must be sufficiently developed to allow for transfer of the enormous amount of data involved in production, preferably with minimum lag. And it must allow for installation of security measures.

Digital infrastructure is not a top priority in decisions on GVC set-up today. Interviewed companies are "able to operate ok", as one company put it, with existing infrastructure. However, many firms recognize that infrastructure issues will grow in importance. One company noted that most attempts to break into their systems take place in countries where infrastructure is weak. Companies invest large sums to build secure systems in countries with weak digital infrastructure. At the end of the day, digital infrastructure is a question of performance and security and, as such, of growing concern for manufacturers.

Increased demands for high-quality infrastructure can become a strain for many developing countries. The state of a country's digital infrastructure can become a "tipping point"[43] where the state of the infrastructure decides whether a country can be an attractive GVC partner. As GVC participation will probably rely more and more on the availability of high-quality communication networks and competitive service providers to deliver needed services[44], the non-availability of proper digital infrastructure will restrain the movement of data and keep the GVC set-up less efficient.[45]

4. Discussion

Data has been described as the blood of the modern trading system. In the same vein, data can be described as the blood of global value chains. The cross-border movement of data is vital to the operation of a global value chain and for production to be effective.

Cross-border data transfers will increase in importance as companies will increasingly use intelligent devices, networks, sensors in factories and products (the Internet of Things), intelligent robotics, open source electronics, and big data tools to handle complex processes and value chains. Cross-border data flows will drive better communication, co-ordination, and control in, and around, production. Production can be done in smaller volumes, allow for more customization, and increase reliance on just-in-time production. GVC might become more complex, including by spreading out production into small production units close to customers – small units relying on the same flows of inputs.[46]

"The products run the production themselves"
Johan Ekesiöö, Chairman of Teknikföretagen at "Industridagen 2015", about how machines sense how much material is need in the production, when it is needed etc., and can adapt the assembly accordingly.

3D printing (additive production) is already a part of production, not the least in the automotive, medical, and aerospace sectors. It is expected to grow sharply and is predicted to reshape production, including the after-sales market. However, most impact in the near future is on products that are made in small volumes, require high customization, and are cost tolerant. 3D printing will lower the minimum economic scale of volume production, increase on-demand production, allow for more customization, and bring production closer to customers.[47]

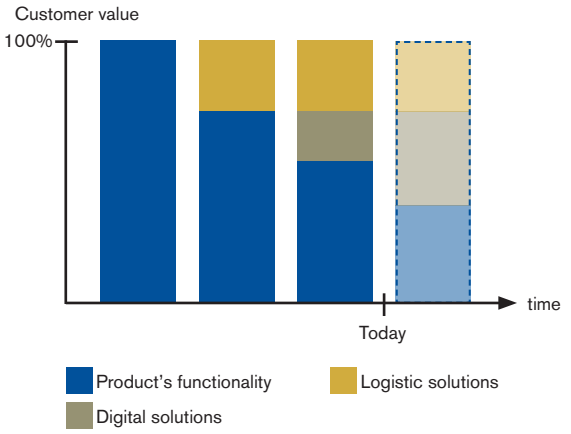
Value chains will be strongly influenced by where data can flow, and not be dictated by physical constraints. Breaking up production into several locations near customers instead of a single plant will shorten supply chains. At the same time, there will be an increased need to coordinate among several short chains in order to meet changes in demand and allocate intermediate input.[48]

The take-away here is that production will evolve and lead to increased cross-border data flows. If cross-border data transfers are important today, they will be even more central to production in the future.

Embracing these changes is about staying competitive. This is not the least true for Europe. The German program "Industry 4.0" (see Footnote 4) and the EU program "Factories of the Future Public-Private Partnership"[49] are both based in a reality where "Europe's position as an industrial power house is eroding"[50]. In many of the discrete production areas, the U.S.A. and Asian countries have been faster and better in embracing digital opportunities[51]. There are clear signs that the EU is even losing ground in today's strong high tech sectors[52]. Hence, for the EU to stay competitive, industry needs to adapt to the new production era.

This is just not a question of competitive production, but also creating value for the consumers of the manufactured goods (consumers being either companies or individuals). Customer value used to be based on the functionality of the product and subsequent productivity increases. However, customer value has now moved towards being a package of solutions that benefit the customer, starting with efficient logistical solutions as being a way to increase value. Today, more and more value is found in digital solutions, not the least design, in Internet of Things solutions and, further on, in intelligent machinery.

Figure 8: Illustrations of changes over time in what creates value for customers



So, data must be able to move, while barriers to cross-border data transfers can mean less value for customers and less competitive production. Regulators must have this in mind when regulating cross-border data.

However, this is not the same as saying that data transfers should not be regulated or that a high level of data protection automatically is a barrier to trade. On the contrary, strong protection of data can entail a comparative advantage (for example, by increasing trust), and it is not uncommon that firms take advantage of restrictive data regulation to better their business offers.[53]

In the end, it is a question for regulators to strike the balance between different interests; they must ensure that companies and customers can reap the benefits that cross-border data movement brings, while ensuring that data is protected. This goes for both internal legislation and trade policy regulation. In both cases, it is vital to recognize that cross-border data transfers are not about circumvention of data protection regulation; transfers are essential features of modern business models.

Clearly, some types of regulations are more burdensome for production and business offers than others. For example, a clear message from interviewees, echoing the conclusion from the National Board of Trade (2014), is that localization barriers are the most intrusive form of data protection regulation. There might be limited reasons for locating data in a specific geographical location (preferably only copies of the data), and there might be differences when it comes to which kind of data that needs to be stored locally. However, as a general principle, localization demands should not be allowed. Trade policy could be a tool in this regard.

Another area where trade policy could help is data security. Data security is an essential issue for all companies handling data. Digital infrastructure and cyber security solutions are key ingredients when ensuring that data is safe. Trade agreements could be helpful by, for example, including provisions about trade with cyber security solutions, including crypto-issues, and working on common standards, and training. In addition, addressing digital infrastructure in negotiations could help countries become more attractive as GVC partners and ensure that the state of that infrastructure does not need to become a central object when companies decide where to locate tasks and with whom to partner with.

> *"Among the conditions that enable a successful shift to networked manufacturing are freedom of trade and freedom of information across borders. Robust communications networks, technical standards, and data security are further prerequisites."*
> *Watts and Freudmann (2014)*

To conclude, the central message is that cross-border data transfers are not just an issue for so called "big tech"-companies and business-to-consumer (B2C) trade, but a question for all companies. Hence, discussions about regulating data must have a broad view and take into account many different interests. Not recognizing the needs of goods-producing firms may, in the end, become a serious obstacle for efficiency and competitiveness. Cutting off the supply of the GVC blood stream can ultimately leave formerly participating firms empty-handed while the GVC lives a long and prosperous life elsewhere.

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Notes

1 In Germany, 90 percent of all industrial production processes are supported by ICT (Industrie 4.0 Working Group (2013)).

2 Data transfer is the non-technical name used in, among other things, trade discussions. In IT-language, one refers to EDI (Electronic Data Interchange), eBusiness or B2B digital data exchange.

3 The report also leaves out production of services in global value chains (see, e.g., National Board of Trade (2013b) for more on this). Here data transfers are many times even more important than for goods production, especially where there is no movement of physical components. Nevertheless, this report will focus on goods in order to not widen to scope too much. The report on the production of the video game Minecraft, which is all done in a digital environment, and where all tasks in the value chain are digital, does, to some extent, cover the same issues as this report (National Board of Trade (2013a)).

4 Mechanisation and electrification were the two initial industrial revolutions, while the third was the use of electronics and ICT (allowing for automation). The term "Industry 4.0" is sometimes used, and refers to a project in the high-tech strategy of the German government, which promotes the computerization of the manufacturing industry. Industrie 4.0 Working Group (2013). Other names for this new production landscape are Smart Manufacturing, the Industrial Internet, or Connected Manufacturing.

5 UNCTAD (2013a), McKinsey Global Institute (2014a)

6 The Board has decided to keep all company and interviewee's names out of this report. In this way, only the National Board of Trade can be held responsible for the content.

7 The text below does not represent all production, but exemplifies how digital solutions can be a part of different stages of the value chain. However, in reality, many companies have not embraced all the aspects presented. For example, sensors (on the factory floor or in the final products) are not used by a majority of producers. In an American survey, only 13 percent of the respondents said that they used so called "smart manufacturing". However, this number is very much an indication of the fact that changing production processes is very costly and complex. Nevertheless, the path towards a more digitally enhanced production process is clear. Kapoor and Swabey (2014)

8 McKinsey Global Institute (2014a) and Martinotti, Nolten and Steinsbo (2014)

9 Only 10 percent of the parts of a Boeing 737 was outsourced compared with 80 percent of the 787 Dreamliner (McKinsey Global Institute (2012)).

10 National Board of Trade (2012)

11 OECD (2014)

12 For example, in a GE battery production plant, 10,000 bits of data are collected, approximately every 250 milliseconds. Weiner and Line (2014)

13 A term borrowed from the video-game industry (see National Board of Trade (2013a)).

14 There is a clear difference among companies about how far they have gone in this aspect. A survey among American companies noted that 96 percent of them used customer feedback to lower cost and improve efficiency. Process historian systems (90 percent) and existing resource planning systems (88 percent) followed. Only 62 percent used sensor-generated data from networked machines, while 42 percent used sensor data from individual machines (Weiner and Line (2014)).

15 The eBIZ initiative (www.ebiz-tcf.eu). CEN (2013)

16 Of the trade happening with production networks, 40 percent is intra-firm trade (e.g., setting up subsidiaries abroad), 40 percent is trade through arm's length trade, and the remaining 20 percent is through non-equity mode (e.g., contract production, licensing, and franchising), (UNCTAD (2013a).

17 20 petabytes is the amount of data in their enterprise resource planning (ERP) system (i.e., system-of-record software). However, only 15 percent of the companies had more than 1 petabyte of data. For reference, a petabyte is 1,024 terabytes and a terabyte is 1,024 gigabytes. 20 petabytes equals 13.3 years of HD-TV video, or the amount of data processed by Google on a daily basis. Cecere (2013)

18 See also McKinsey Global Institute (2014b).

19 These expressed concerns very much echo what is found in the literature, such as the USITC (2013), for example.

20 A number of countries – e.g., all the European Economic Area (EEA) Member States and certain neighboring countries (including Albania, the Channel Islands, Croatia, the Faroe Islands, the Isle of Man, Macedonia, Russia, and Switzerland), as well as countries in North Africa (e.g., Morocco), the Middle East (e.g., Israel), Latin America (e.g., Argentina and Uruguay), and Asia (e.g., South Korea) – restrict the transfer or sharing of personal information beyond their borders.

21 USITC (2014) presents a survey that shows how American companies in different sectors are affected by five different types of barriers presented in the USITC (2013). Roughly 30 percent of the manufacturing companies perceived localization measures and data privacy measures as obstacles, while only about 15 percent saw censorship as an obstacle.

22 The number of countries actually demanding, for example, localization, is limited today. See Chander and Le (2014) for an account of current localization measures.

23 An identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number of to one or more factors specific to that person's physical, physiological, mental, economic, cultural, or social identity. However, this is a broad and ever-moving concept (see National Board of Trade (2014)).

24 See National Board of Trade (2014) for taxonomy of different types of data used by companies.

25 For example, data produced while using products will affect further product development as well as ongoing production levels. This data is central to the future development of the production company and its competitiveness. Many times, this data is personal data. In fact, 90 percent of devices (Internet of Things-solutions) in consumer goods collect at least one piece of personal data (HP (2014)).

26 For example, to be able to trace a malfunctioning product to the person that assembled it and where. This data might sometimes be stored for 30-40 years depending on the lifetime of the product.

27 See National Board of Trade (2014) for a discussion on the definition of personal data. Also, in the EU, for instance, personal data turned anonymous can still be considered personal data – even if the receiver cannot possibly digest personal information from the anonymous data. As long as the sender has a key to open up the data, it is considered personal. Interview with Elisabeth Wallin at the Swedish Data Inspection Board (19th of September 2014) and Schwartz and Solove (2014).

28 This chapter is based on businesses' descriptions of potential barriers and their effects on Production. See also National Board of Trade (2014) for other examples, for example concerning R&D obstacles stemming from European rules on notification.

29 See Chander and Le (2014) and National Board of Trade (2014) for an account of current forced localization measures. See also ECIPE (2014), which in addition includes an estimation of the costs that these measures mean for countries implementing them.

30 Already described in National Board of Trade (2014).

31 UNCTAD (2013b) and Chander and Le (2014)

32 Obviously, the effect will vary depending on what type of data that must be moved by the individual company, what type of data that must be stored (all data or just a certain type of data; for example, financial), and if the requirement is to have a copy of the data, or even a prohibition on it leaving the country.

33 However, today's global companies typically use well over 20 separate applications to manage their supply chain alone (Brady (2015)).

34 For example, the name of the person at a company that shall be the recipient of a parcel or letter/a reference person. See National Board of Trade (2014) for discussion on this.

35 See, for example, Maurer et al. (2014).

36 Other examples are found in the National Board of Trade (2014).

37 In Sweden, 35.7 percent of all GVC-related jobs are found in companies with less than 20 employees. Growth Analysis (2014)

38 This part does not discuss the so called Snowden revelations and governmental monitoring done by, for example, the NSA. The particular concern in this paper is about production abilities and efficiencies, and not the political discussion stemming from NSA-type of activities.

39 This is an increasingly common problem. According to Verizon (2014), almost a third of all data attacks on manufacturing companies involved cyber espionage.

40 In a recent survey conducted by the European Chamber of Commerce in China found 86% of companies had experienced negative business effects as a result of blocked websites or online tools. Chin (2015)

41 See also, National Board of Trade (2014) and USITC (2014).

42 Verizon (2014)

43 In WEF (2013), the authors argue that a country that is removing barriers for supply chains eventually reaches a "tipping point" where the country becomes attractive as a GVC partner. The study focuses a lot on logistics, transportation infrastructure, and border procedures.

44 This would include communications service providers and digital service and content providers.

45 OECD/AfDB/UNDP (2014) notes that telecommunication services and infrastructure are an important element for African GVC participation and upgrading.

46 This part is based on Watts and Freudmann (2014), Evans and Annunziata (2012), McKinsey Global Institute (2012), and Brody and Pureswaran (2013).

47 This part is based on Brody and Pureswaran (2013), McKinsey Global Institute (2014a), and Ford (2014)

48 This, at least, seems to be a general prediction among researchers. See, for example, the references in the two preceding footnotes.

49 http://ec.europa.eu/research/industrial_technologies/factories-of-the-future_en.html

50 EU Commission (2013), Ford (2014), and Industrie 4.0 Working Group (2013)

51 There are many reasons behind this, including lack of investment in ICT, lower levels of research and innovation (R&I) funding, shortage of data experts, and a more complex legal environment. EU Commission (2014)

52 Freyberg, Stenger and Braess (2013)

53 See, for example, Armasu (2014).

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