Standards in the global value chains of the European Single Market

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\textbf{ABSTRACT}
We examine the impact of formal standards on trade in global value chains (GVCs) in Europe. Using a gravity model approach for panel data, we estimate the influence of national, European and international standards on trade in value-added and gross trade flows within Europe. We find that national standards on their own hamper trade in European value chains while European and international standards foster trade. European standards have greater influence on trade in inner-European value chains whereas international standards have positive effects on imports into Europe from third countries. European standards therefore reduce information asymmetries between market actors in the value chains of the European Single Market. International standards serve as a means of global communication between international trade partners. In addition, we find a positive effect of an interaction term between national and European standards in European value chains confirming the necessity of national standardization. Furthermore, we consider our findings not only within international political economy’s theoretical literature regarding the governance of GVCs but also, the subsequent policy implications of our findings in terms of economic growth and development.

\textbf{KEYWORDS} Single Market; trade; global value chains; standards; standardization union; gravity model

\textbf{Introduction}
Research on global value chains (GVCs) is evolving in international trade and innovation economics literature (Baldwin, 2013; Kaplinsky, 2010; World Trade Organisation, 2014). GVCs describe the fragmentation of production in cross-border company networks and the trade of goods and services along the chains. Production in multiple countries requires a sufficient amount of coordination and communication between the collaborating market actors. They need to ensure compatibility and the meeting of quality levels of their goods and services. Formal standards are one means to help fulfill these requirements and are therefore essential for production in today’s GVCs (Gereffi, Humphrey, & Sturgeon, 2005; Nadvi, 2008).

We focus our research in this study on the role of voluntary standards as key component of the ‘tripartite standards regime’ consisting of standards-setting, accreditation and certification defined by Loconto and Busch (2010) for the development of GVCs in the European Single Market, but exclude obligatory technical regulations released by the European Commission or national governments. Instead, we differentiate between
national, European and international standards published by national, European or international standardization bodies. The separation of the different types of standards makes it possible to identify the effects of standards-related GVC governance in Europe in addition to that of national and international GVC governance. Previous research shows that standards are trade-enhancing since they facilitate the exchange of information (Blind, 2004). When the costs to adapt to a standard are too high, however, they can act as barriers to trade (Mangelsdorf, 2011; Mönius, 2004; Swann, 2010).

The theoretical contribution of the paper is to complement the economic-based arguments of standardization by international political economy (IPE)-related theories. Within a GVC governance analytical framework, we do not attempt to provide a novel unified theoretical framework but rather, to gain further insights that might also prove to be useful for the IPE theory and debates regarding GVC governance. We attempt to analyze in whose best interests certain standards are (for the European market) within the context of GVC and what the policy implications may be for developing nations.

The empirical contribution of this study is that we now take a step away from the examination of the effects of standards on gross trade flows and move toward the assessment of actual GVCs. The trade in value-added database by the Organisation of Economic Cooperation and Development (OECD) and World Trade Organisation (WTO) enables us to examine the detailed structure of global production patterns (Organisation of Economic Cooperation and Development, World Trade Organisation, & United Nations Conference on Trade and Development, 2013). The value-added that is traded from one country to another resembles the contribution of the exporting country to the value of the good or service without counting any prior activities, i.e. by exporting a car, not all the imported components, from the steel to the engine, but only the value-added in the last stage of the value chain is taken into account and not the whole value of the car (see for example a value chain across four countries in Figure 1).

Figure 1. Value added trade: how it works.
Source: UNCTAD (2013)
Baldwin and Lopez-Gonzalez (2014) develop a global overview of these patterns. According to the authors, GVCs constitute geographical clusters which they call Factory North America, Factory Asia and Factory Europe. Value-added trade mainly takes place within these regional clusters and there is little trade between the clusters and third countries (Baldwin & Lopez-Gonzalez, 2014). In other words, GVCs are less global than their name suggests.

In this contribution, we focus on the European cluster, Factory Europe. We apply a panel gravity model for the years 1995–2008 covering 17 European countries and 18 industry sector aggregates. To compare our results for GVC trade, we perform the same exercise using traditional gross export data. Our results show a positive correlation between trade in value-added and European standards for Factory Europe. We interpret these findings as an indication that European standards reduce information asymmetries between different market actors in Europe, which increases integration in GVCs.

Next to reporting the technical effects of standards, the study allows to draw policy implications. Regarding European integration, our approach makes it possible to display the effects of policy measures in the European Union and its partner countries that aim at the harmonization of technical standards and the standardization system (Pelkmans, 1987). In the following, we review the literature on GVCs and on the standards and trade nexus. Consequently, we develop a number of hypotheses regarding the impact of standards on value-added trade. Eventually, we describe our empirical model and data and present the results of our regression analysis before we conclude.

The role of standards within GVCs

Global fragmentation is mainly enabled by a large reduction of tariffs in developed and developing countries as well as reduced cost of information and communication technology and services. In this section, we present theoretical and empirical findings from literature concerning the characteristics and implications of these developments.

De Backer and Miroudot (2013) show that the number of stages in a GVC has increased between 1995 and 2008. They find that fragmentation has not increased in the domestic portions of a GVC, but in the part that is produced internationally. This provides evidence for a shift toward global production patterns. Miroudot and Nordström (2015) find the same development. Their study shows that GVCs are indeed becoming longer with regard to their geographical length as well as to the number of foreign production stages within a GVC. These more fragmented patterns create more interfaces and possible sources of information asymmetries and therefore have a greater need for standards (Blind, Gauch, & Hawkins, 2010).

Baldwin and Robert-Nicoud (2014) present the first comprehensive theoretical framework that integrates goods-trade and task-trade. It combines the trade of final goods with the trade of intermediates and services along GVCs for production purposes. The authors explicitly mention coordination costs as ‘task-specific parameters’ (Baldwin & Robert-Nicoud, 2014, p. 54). Task-trade can hence be facilitated by a reduction of coordination costs. Standards fulfill this purpose by providing information on the quality and specifications of goods and services (Blind, 2004).

To measure the contribution that a single country attributes to the global production process, we regard the value-added. This allows us to avoid the double-counting bias (see Figure 1 in the introduction) that would come up by using the whole export value. Gross export numbers keep adding up at each border-crossing. This way, the
contribution of a specific country to the product or service cannot be identified any-
more in the GVC. Moreover, it would not be possible to identify how much of the value
is an actual economic contribution and how much is due to tariffs and other fees. The
use of value-added data allows this distinction and is thus a means to examine the
actual GVCs.

We focus our research on formal standards, i.e. standards that are published by offi-
cial standardization bodies. The scope of a standard is an important criterion for their
influence on GVCs. In general, standards can have national, regional (e.g. European)
or international scope. We use this geographical differentiation to be able to draw pol-
cy policy recommendations with regard to the standardization regimes and their role for
GVC governance.

National standards are developed by the national standardization body located in one
country. Everyone can use these standards but they are more prominent for market
actors in the country in which the standard was developed, especially when they are only
published in the local language. Moreover, even though a national standard is publicly
available, foreign market actors have more difficulties to apply the standard than domes-
tic market actors (Blind, 2004): In some cases, the adaptation costs for foreign market
actors are prohibitive (Blind & Jungmittag, 2005). Furthermore, the heterogeneity of
national standards that cover the same subject but are developed by different countries
leads to additional costs. Market actors have to react by duplicating processes to be able
to comply with differing standards requirements (OECD & WTO, 2012).

Domestic market actors may be put in a favorable position when national standardi-
ization bodies specify a domestic standard requirement that is different from the best
practice or from an international standard used in the GVC it affects. These domestic
market actors might already adhere to this standard and have adapted their facilities
and processes. In contrast, for a foreign market actor, it is costly to switch to a foreign
national standard (Fischer & Serra, 2000). This is a possible protectionist strategy which
bears the risk of damaging both the foreign and domestic market actors. Whereas for-
eign market actors have to deal with the increased cost, domestic market actors might
be excluded from GVCs because they will not find enough suppliers that can deliver
intermediates that are in accordance with the domestic standard (OECD & WTO,
2012). These difficulties can be circumvented through harmonization of national stand-
ards into international or regional ones (OECD et al., 2013).

Regional standards are published in multiple countries of one geographical or politi-
cal region. European standards, for example, are developed in technical committees of
the official European standardization organizations (European Committee for Stan-
dardization CEN, European Committee for Electrotechnical Standardization CENE-
LEC, European Telecommunications Standards Institute ETSI). Once the national
members of the European standardization organization have agreed on the content of
standards, they have to be published in all member states of the European Union and
in the associated countries – Iceland, Liechtenstein, Norway and Switzerland with equal
status to a national standard (CEN, 2015). Therefore, all information that are codified
in standards are immediately available for purchase at the national standardization
bodies to all interested parties. This mechanism of creation of European standards is
one part of the European Single Market. The creation of the Single Market aims at
European Union-wide economic integration through the reduction of barriers and the
simplification of rules.1
Compared to national and regional standards, international standards have the broadest scope and are developed by all member states of an international standardization body (International Organization for Standardization ISO, International Electrotechnical Commission IEC, International Telecommunication Union ITU). International standards reduce information asymmetries between market actors globally because they are the compromise of the largest number of possible stakeholders in a standard (ISO & IEC, 2015). For exporting firms that simultaneously adhere to multiple standards, e.g. national and international ones, however, the duplication can create adaptation costs (WTO, 2005).

For the remainder of the paper, we use the following classification of standards. A standard is regarded as national if it has not been published by a European or international standardization body. It is counted as European in case a European standardization body but no international body has published it. If it was published by an international standardization body, it counts as international standard.

The effects of standards on trade flows hence differ with regard to their scope. The trade effects of national and international standards have been the subject of research in the past with the most comprehensive study executed by Blind (2004). National and international standards can generate competitive advantage by improving the quality of products and services or by reducing their prices. The demand on the world market for a product or service that was improved in such manner will then increase so that exports increase. The need for imports of other, now inferior, products and services decreases so that the effect is negative for imports. In addition, both national and international standards have an effect on intra-industry trade. By conveying information about products and services, standards decrease information asymmetries and increase the openness of markets. In this case, the trade effects are positive for both exports and imports. A third trade effect is only caused by national standards: Possible adaptation costs reduce the openness of national markets and hamper the marketing possibilities on foreign markets. In this case, they constitute barriers to trade and decrease both exports and imports (Blind, 2004). Theory thus predicts no clear direction of the trade effects of national and international standards but makes it dependent on the type and use of the particular standard.

Regional standards are a niche topic in literature so that to our knowledge, no comprehensive models of their trade effects exist. Gandal and Shy (2001) examine the incentives to form standardization unions. According to the authors, national economies have such incentives when adaptation costs to national members’ standards are high. In addition to these considerations, they show that standardization unions are welfare-increasing for members but exclude trade from non-members. Similarly, Young (2004) points out that common standards within the EU have a positive effect for the internal market but possibly lead to the exclusion of third countries. Notaro (2011) shows that the European Single Market Program, and the harmonization of standards as a part of it, increases the productivity in the EU. Thus, we conclude that regional standards have trade effects among the members of the standardization union that are similar to the effect of international standards as described above with regard to competitive advantage and intra-industry trade. Toward countries that are not members of the standardization union, however, the regional standards have effects similar to those of national standards that can be explicit trade barriers.
International political economy, GVCs and standards

Throughout recent history, the global economy has experienced various changes. The most drastic being after the Second World War as multilateral institutions were set up. The role of the nation state changed within this new global economic order where Trans National Corporations (TNCs) or multinational enterprises emerged as powerful players establishing a global division of labor through value chains. These value chains have over time become larger, more complex and in order to function efficiently, require certain standards. Furthermore, recently, as this form of globalization has matured, so has the ownership structures within GVCs changed. Whereas previously GVCs were often fully integrated within a TNC which set up subsidiaries, nowadays, in many developing nations, the production is either owned by citizens of the home countries or by other developing nations (Gibbon, Bair, & Ponte, 2008). Such developments are naturally, from a policy perspective, extremely relevant for countries of the global South. Indeed, GVCs provide an opportunity for development, which to a certain extent are less-dependent on foreign nation states’ policies and aid. Consequently, as GVCs dynamics are not deemed to spontaneously occur, particular attention has been paid to how GVCs are managed as well the actors, forces and strategies behind certain actions. This leads to the notion of GVC governance and its theoretical underpinnings in the IPE literature.

Attempts to formally interpret and theorize GVC governance can be separated into ‘governance as driving’, ‘governance as coordination’ and ‘governance as normalization’ (Gibbon et al., 2008). Governance as driving was an early attempt to theorize global commodity chains by Gereffi (1994) where the governance structure was categorized as either ‘producer-driven’ or ‘buyer-driven’. The former represented more ‘capital-intensive’ areas with higher technological requirements whereas the latter, more ‘labour-intensive’ areas (Gibbon et al., 2008). Central to this dual categorization was the role played and nature of the lead firm where the former was dominated by manufacturers and the latter by marketers/retailers. Criticisms though arose regarding this theory. These included the criticisms that this producer-driven versus buyer-driven categorization was too idealized and limited, not accounting for a larger array of governance forms and other external actors. Furthermore, the division was less relevant as buyer-driven GVCs permeated all sectors, where not only were the lead-firm-types more varied but also the way they influenced the GVCs was more diverse. The accommodation of these criticisms and the importance of a more dynamic theory incorporating the more complex interactions observed in GVC leads us to the next theory namely, GVCs as coordination (Gibbon et al., 2008).

GVC as coordination was outlined by Gereffi et al. (2005) and was built around the dynamic linkages that had been lacking in the governance as driving theory. Five forms with different governance structures were outlined: market (price), modular (standards), relational (trust and reputation), captive (buyer power) and hierarchal (management hierarchy) (see Ponte & Sturgeon, 2014). Furthermore, ‘the particular form of governance that prevails in a given value chain at a given point in time is determined by the complexity of transaction, the codifiability of information and the capability of suppliers’ (Nadvi, 2008, p. 331).

Of particular interest are the modular value chains. Developed by Sturgeon (2001, 2002), the notion of modular value chains was a vital component that led to the development of the theory of governance as coordination. He disagreed with the original
Gerrefi theory stating that production that was deemed less profitable, was outsourced by lead firms to their suppliers within ‘buyer driven chains’ (see Gibbon et al., 2008). Rather by analysing the electronics industry, he found that Personal Computer (PC) companies would outsource the manufacturing work to companies that was actually rather profitable and who were not fully dependant on the direction from the lead company. This relationship between the lead company and the other connected companies was termed ‘modular’. Here, complex information can be codified and where, as a result of common standards, there is independence between lead firms and suppliers where the latter can make specialized products for the costumers (Gibbon et al., 2008). Consequently, Gereffi et al. (2005) developed the more dynamic coordination theory. Moreover, central to modular value chains is governance by standards. Standards play a fundamental role within these networks and as the presence of modular value chains increases so does the importance of standards. Indeed, the last theory in regards to governance of GVCs is governance as normalization, focused around norms and standards. Governance as coordination has also encountered criticisms of its own. Gibbon and Ponte (2005) question whether the demarcation between various coordination networks is as clear as it is suggested within the coordination theory (see Gibbon et al., 2008). Furthermore, they also point out that external structural boundaries and limitations have not been tackled including corporate strategy or regulation (ibid).

Governance as normalization is based on convention theory linked to Boltanski and Thévenot’s (2006) work (see in ibid.). This is rooted within a normative framework. Actions and behavior in the GVC are based on certain judgment ideals and ideologies. Whether it be the division of labor in a value chain or the strategies employed by firms, all economic behavior is based on a framework of ‘justification’ (Gibbon et al., 2008). Indeed, conventions could mould the quality of a product and characterize the geographical layout of GVC and firms’ business models.

These three theories provide useful insights and a basis for the analysis of GVC and their governance. However, Gibbon et al. (2008) outline how it is difficult to find one theoretical framework or paradigm of GVC governance that can fully explain how different lead firms and suppliers interact with one another. Solving these theoretical and structural issues is though not the purpose of this paper. Rather it is to accommodate information provided by these analyses and conversely, provide further information regarding the role of standards in trade and GVC bearing in mind the policy implications this study could have. Furthermore, understanding the extent to which standards influence trade specifically, what level of standards (national, regional and international) benefits whom, is vital. Indeed, insights might be gained as to how GVCs are managed and governed and which standard-setting forum is preferred depending on varying interests and power positions. The hypotheses of this paper work within this framework in demarcating the varying effects different levels of standards have for different interest groups.

**Review of empirical studies**

Empirical research on standards and trade started with Swann, Temple, and Shurmer (1996). The authors show that national standards have a significant impact on trade flows. British national standards exert positive effects on British exports and imports. German national standards used as benchmark, on the contrary, influence British exports and imports negatively. National standards can therefore both facilitate trade but also serve as barriers to trade.
Mönitus (2004) examines the influence of standards on trade using a sample of 12 European countries. The study deals with the effects of both purely national standards and standards that are shared between the trading partners. The results show that the shared standards have a positive influence on trade. In contrast to the expectations, national standards, too, have an overall positive influence. The author explains this result by differences between sectors. Trade is positively influenced by national standards only in manufacturing sectors, but negatively influenced in non-manufacturing sectors. The author assumes that non-manufactured products are unaltered and more homogenous than products that are already further processed. Therefore, standards requirements put an unnecessary burden on producers in a sector in which the characteristics of products are already defined because of their simplicity.

Blind and Jungmittag (2005) compare the trade effects of standards regarding trade between Germany, the UK and the rest of the world. They measure trade as export and import values. The results show that the effects of national and international standards on imports, exports or trade balances vary. On the one hand, standards reduce adaptation costs. On the other hand, they increase domestic competitiveness and hence block trade. The authors come to the conclusion that it is important to take a country’s characteristics like innovativeness into account when one examines standards.

Mangelsdorff, Portugal-Perez, and Wilson (2012) focus on food exports from China to examine the effects of standards on trade. The results show that standards have a positive influence on Chinese exports. The trade-enhancing effect of internationally harmonized standards proves to be stronger than the effect of national standards.

Chen and Mattoo (2008) examine the influence of regional standards agreements on trade. They find that standards that are harmonized in a regional agreement increase trade flows between the partners. The regional standards influence trade flows from countries that are not part of the agreement negatively. The external countries’ production costs rise because of the regional standards and make it less profitable to trade with the partners of the regional agreement. These results are in line with the deductions we draw from the theoretical considerations regarding regional standards.

A comprehensive overview of the research on standards and trade is given by Swann (2010). The majority of the reported studies find a significantly positive influence of both national and international standards on exports. The effects on imports do not point to one direction as clearly. National standards can have negative as well as positive influence on imports whereas international standards rarely have negative, but predominantly negligible or positive effects.

In the following section, we relate the trade effects of standards to their influence on GVCs.

Policy decisions can influence company participation in GVCs more so than general global trade policy because GVC policy can target niches. That is, GVC policy can be configured to aim at integrating specialized domestic sectors, e.g. high-tech industries, into already existing value chains. The goal is to generate access to GVCs for those companies that are in these specialized sectors to eventually increase the market size for domestic market actors. In doing so, countries can choose between all globally available GVCs and pick those that fit a country’s endowment and relative advantage best. When pursuing this kind of policy, a country only specializes in certain fields that promise the highest possible degree of integration in GVCs (Gereffi & Sturgeon, 2013).

Standards facilitate this process of integration because of the information they provide about the properties of goods and services. The implementation of certain
standards hence enables companies to become part of the desired GVC and assures long-term involvement. Consequently, standards facilitate fragmentation within GVCs and influence the regional composition of actors in the GVC (Kaplinsky & Morris, 2001). Standards enable collaboration between unrelated firms and allow for the diffusion of information. Additionally, not only known specifications but also new technologies are often codified in standards and are thus made publicly available (OECD, WTO, & World Bank, 2014). By supplying proper flow of information, standards make it possible for GVCs to exist (WTO, 2005). Consequently, we develop several hypotheses toward the effects of standards in GVCs.

National standards can foster the restriction of competition, when only domestic firms are able to produce a certain product (Swann et al., 1996). In accordance with the trade effects, national standards then decrease the openness of the national markets and hamper trade (Blind, 2004). In the case that all market actors in a GVC adopt these national standards as best practice, domestic companies that used them previously are put in a favorable position as they avoid switching or adaptation costs. Foreign market actors consider complying with the national standard when the adaptation costs are lower than the expected benefits. Without standards, if the gap between foreign and domestic knowledge and technological endowment is too wide, no adaptation will take place due to high costs. The information contained in a national standard can help to overcome this gap by providing information (Mönious, 2004).

Hypotheses

For the stated reasons, empirical studies find both positive and negative trade effects of national standards, depending on the model specification in the study (Swann, 2010). Within Europe, there is a special situation: National standards contain specific national specializations that are only used in the respective countries. Standards that are of interest for other countries are turned into European or international standards as a consequence of the different collaboration agreements between the national governments and the higher-level standardization bodies (European Parliament & Council of the European Union, 1998; IEC & CENELEC, 1996; ISO & CEN, 2001). Therefore, we assume that national standards hamper trade in Europe because they express purely national specializations and hence impose high adaptation costs. This equally concerns trade in value-added and gross trade.

Hypothesis 1: National standards have a negative effect on trade volumes in Europe.

One means to reduce barriers and to decrease the coordination costs for actors in value chains in different European states is European standards (European Commission, 2015). European standards are thus tailor-made to European needs and possibilities. They are drafted by representatives of European companies or companies that have offices in the EU and by other interested stakeholders (Frenkel, 1990). For this reason, we assume that European standards facilitate production within Factory Europe. Since countries in the rest of the world are different from European countries as to their economic characteristics, European standards may impose high adaptation costs unto them (WTO, 2005).

European standards remove not only technical barriers within Europe. As the EU is a customs and economic union, there are externalities in any case. These arise because goods and services admitted in one national market will likely be traded in the other
countries as well. In this case, common standards further exploit these externalities. Moreover, there is a learning curve when the companies’ representatives meet to draft standards. These national experts can bring their technical expertise into the European standardization committees and learn from the ideas of other countries’ representatives at the same time (Pelkmans, 2005). This is also true for international standards. However, since European countries are endowed similarly, no large trade-offs have to be made to achieve agreement between differently endowed committee members.

For these reasons, following trade theory, we assume that European standards foster trade within Europe. Moreover, because European production patterns geographically concentrate in Factory Europe, these European GVCs are governed and managed principally by European standards. We therefore expect a positive influence of European standards on trade in value-added. For the portion of European value-added that is contained in the gross trade figures, European standards also have positive influence. Because of the non-European value-added contained in gross trade, the influence of European standards will be smaller in the latter case.²

**Hypothesis 2:** European standards increase trade volumes within Europe. The increase in trade volumes with third countries is positive, but smaller.

Even though all national standardization projects in European countries have to be reported to the European level, not all projects are taken over by CEN, CENELEC or ETSI. If no stakeholders from other European member states are interested in drafting the standard on the European level, the project is continued as a national standardization project. Whenever there is no European interest, this means that other member states and market actors expect no benefits from the standard. The standard hence only fits one nation’s properties and expresses the technological specialization of this one country. Therefore, there exist national standards in Europe that benefit single national economies. We presume that these national standards can play out their strength only when they are combined with European standards in the final good or service as follows: In practice, a specific country contributes to a good or service using its national specialization. The national specialization is a key competency that is only available in the concerned country and that is codified in a national standard. An example could be a domestic car manufacturer that builds a specific part of a transmission. The production of the part complies with a national standard and there is no European standard because no other European country specializes in producing these kinds of parts.

The part is then exported to a different European country and built into the transmission; the transmission is eventually built into a car. This further processing and the consequent marketing throughout the European value chains use European standards. At the end, the good has been created by combining national and European standards. The finalization and marketing take place in the Single Market with the help of European standards. Through the combination of national and European standards, value chains in Europe grow.

**Hypothesis 3:** Combining national and European standards in production increases trade volumes.

International standards are specifications agreed upon with the consensus of global stakeholders. If there is, however, a national or regional standard that satisfies the preferences of local market actors better, the international standard will be overruled and the national or regional standard is used (Blind, 2004). International standards present
the lowest common denominator that all negotiating parties can agree to. Hence, highly
developed economies will not necessarily find their best technological possibilities by
implementing international standards and might opt to produce differently.

This is why we expect international standards to play a less important role in Euro-
pean value chains. The market actors in Factory Europe rely on European standards
that are tailor-made for them and that make intra-European exchange easy. Still, inter-
national standards have positive influence on trade in value-added because European
market actors use them whenever they fit their needs or when there is no European
alternative. When goods and services are imported from outside of Europe, interna-
tional standards play a more important role because they contain specifications that
countries from outside of Europe comply with. Consequently, we assume international
standards to have greater positive influence on gross trade figures, which contain
value-added from third countries, than on trade in value-added.

**Hypothesis 4:** International standards foster trade within Europe. Yet they generate
the greatest trade volumes with third countries.

In the following sections, we develop and employ a gravity model in order to test our
hypotheses.

### Empirical model and data

In order to estimate the influence of standards on trade in value-added as well as on
gross exports, we use a gravity model as introduced by Tinbergen (1962). The basic
model has since been refined, e.g. by Anderson (1979), Deardorff (1998), Anderson
and Van Wincoop (2003) and Baier and Bergstrand (2007). Gravity models suggest
that trade is influenced by factors outside the traditional comparative advantage such
as geographical proximity, economic development and network effects. As such, the
theoretical underpinnings of gravity models are elements of the new trade theory
(NTT) which suggests that network effects are critical factors in determining interna-
tional trade patterns. Since standards (through ensuring compatibility and reducing
transaction costs) are essential in ensuring network effects, we use an NTT-based grav-
ity model to study the interactions of producers in global production patterns, and the
effects of standards on all of these actors.

Since Head and Mayer (2014) have recently presented the current state-of-art of the
possible applications of the gravity model for analyzing international trade flows even
within the European Union, we apply it also for addressing our research question.

As a result of these refinements, we include multilateral resistance terms into our
estimation as proposed by Anderson and Van Wincoop (2003). A computationally
easy way to do so is to use country-specific fixed effects. Following Baier and Berg-
strand (2007) and Baldwin and Taglioni (2006), we also include time and sector fixed
effects. In order to avoid all endogeneity biases, fixed effects should also control for the
time-varying country dimension and for the country pair dimension. As our variables
of main interest, i.e. standards, have a time-varying country dimension themselves, we
cannot include the respective fixed effects. Instead of country pair fixed effects, we
include other dummies like the geographical distance that covers this dimension. This
allows us to gain more detail in the interpretation of the variables as compared to the
interpretation of the plain fixed effects. We will, however, be very cautious in the inter-
pretation of the results with regard to possible endogeneity.
Some authors argue that the traditional gravity specification should be used with caution when it is applied to trade in value-added because gravity equations are designed to show the effect of trade costs on the final demand of a country’s goods. Value-added trade, however, allows for trade flows of factors of production such as labor that add value to an intermediate product via third countries to their final destination. Consequently, trade costs between the third country and the final destination have an influence in the equation (Noguera, 2012). We work around this issue by using a dependent variable that gives us the demand in the final country for the value-added of the first country as a bilateral relationship. This way, the original supply–demand structure without intermediaries is in place.

Our baseline estimation model is defined as follows. The dependent variable $X$ takes on the values of trade in value-added (TiVA) or gross exports (EXGR). We estimate the trade flows from country $i$ to country $j$ in sector $k$ at time $t$.

$$
\ln(X)_{ijkt} = \alpha + \beta_1 \ln(GDP)_{it} + \beta_2 \ln(GDP)_{jt} + \beta_3 \ln(\text{dis})_{ij} + \beta_4 \text{contig}_{ij} + \beta_5 \text{comlang}_{ij} \\
+ \beta_6 \text{eu} + \beta_7 \text{eu} + \beta_7 \ln(\text{nStd})_{ikt-1} + \beta_8 \ln(\text{nStd})_{jkt-1} + \beta_9 \ln(\text{eStd})_{ikt-1} \\
+ \beta_{10} \ln(\text{eStd})_{jkt-1} + \beta_{11} \ln(\text{iStd})_{ikt-1} + \beta_{12} \ln(\text{iStd})_{jkt-1} + fe + \epsilon_{ijkt}
$$

The dependent and all non-binary independent variables are in logarithmic form. As independent variables, we use the nominal gross domestic product, GDP; the geographical distance between the trading partners, dis; and dummies for contiguity and common language, contig and comlang, respectively. The variables eu and euro control for the membership of the countries in the EU and in the Eurozone, respectively. They take a value of one if both countries $i$ and $j$ are members of the respective group and a value of zero otherwise.

We split the standards into three groups: national standards, nStd; European standards, eStd; and international standards, iStd. Because standards will need some time after their publication until they have an actual effect on the economy, we use the standards data with a lag of one period. At the same time, this procedure reduces the possible endogeneity of the standards variables caused by a simultaneity bias with regard to the trade variable. It is unlikely that there is a causal relationship between trade and standards in a way that the trade volumes in $t$ have a reverse effect on standards in $t-1$. We replace standards stocks of zero with standards stocks of one to avoid the country pairs to drop from the sample when taking the log. The vector $fe$ contains the fixed effects. The last term is the standard error term $\epsilon$.

Table 1 provides an overview of all used variables as well as some descriptive statistics. We retrieve our TiVA and EXGR trade data from the trade in value-added database that was released by OECD and WTO in 2013. The data are calculated from input–output tables for each country. This means that the actual production inputs and outputs are considered. TiVA measures the domestic valued-added embodied in foreign final domestic demand, i.e. it can be regarded as ‘exports of value-added.’ EXGR is the actual gross exports as measured by the national statistical offices at each border-crossing of goods or services. All trade data are available as country aggregates and also for 18 selected industries. In order to avoid biases generated by the financial crises in 2009, we use only data covering the years 1995, 2000, 2005 and 2008. This also reduces problems with serial correlation that would occur in yearly panel trade data.
Due to the restricted availability of standards data, we are left with 17 countries all of which we choose to include in our final model. Note that there are only 394 zero trade flows in the EXGR variable and one zero trade flow in the TiVA variable. Given the number of observations, these zero trade flows can be neglected in the analysis.

The variable dis and the dummies contig and comlang are taken from the GeoDist database by the Centre d’Etudes Prospectives et d’Informations Internationales (Mayer & Zignago, 2011). The distance variable is a weighted measure. It describes the geographic distance between two countries using the locations of urban agglomerations and their share of the total population as weights.

Standards stocks are retrieved from the Perinorm database. The database allows us to differentiate between national, European and international standards. The standard stock in year t is defined as all standards published until the end of year t minus all withdrawn standards in this period. Perinorm provides information if a given standard is purely national or if it has been harmonized on European or international level. A standard is categorized as European if the database indicates that it was published by CEN, CENELEC or ETSI. If there is an international reference for a standard in the database, i.e. if it was published by ISO, IEC or ITU, it is classified as an international standard. If there is no European or international reference, a standard is national. Moreover, we classify the standards stocks in concordance to the 18 industries. Standards are classified by the International Classification for Standards (ICS). There exist no official concordance tables between industry classifications and the ICS. Therefore, we can only manually align standards and sectors. The sectoral data are available as aggregates of multiple sectors. Consequently, an in-depth analysis on sector level is not yet feasible. Therefore, we constructed a concordance table.
In a trade context, another important variable to control for is tariffs. Due to a large number of missing values in the available tariff data, it is, however, not feasible to include a direct measure of tariffs in this sample. Instead, we rely on the different fixed effects to capture the effects of tariffs at least partly (Chen & Mattoo, 2008; Disdier & Marette, 2010).

**Estimation and results**

The first two columns of Table 2 show the estimation results for a reduced model specification with two different independent variables. The reduced model only contains the basic gravity and control variables in order to check for the validity of the model and data. The variables indicating the economic mass of a country GDP\(_i\) and GDP\(_j\) yield the expected results in both model specifications and show a strong and positive effect

| GDP\(_i\)   | 0.503*** | 0.364*** | 0.973*** | 0.581*  | 1.185*** | 0.873*** |
|-------------|----------|----------|----------|---------|----------|----------|
| (0.08)      | (0.12)   | (0.23)   | (0.30)   | (0.23)  | (0.31)   |          |
| GDP\(_j\)   | 0.824*** | 0.666*** | 0.784*** | 0.825***| 0.788*** | 0.862*** |
| (0.07)      | (0.11)   | (0.17)   | (0.26)   | (0.15)  | (0.24)   |          |
| dis         | -1005*** | -1327*** | -1025*** | -1.349***| -1.031***| -1.358***|
| (0.09)      | (0.12)   | (0.09)   | (0.12)   | (0.09)  | (0.12)   |          |
| contig      | 0.262*** | 0.357*** | 0.208**  | 0.288** | 0.202**  | 0.276**  |
| (0.09)      | (0.12)   | (0.09)   | (0.12)   | (0.09)  | (0.12)   |          |
| comlang     | 0.060    | 0.100    | 0.091    | 0.134   | 0.092    | 0.136    |
| (0.11)      | (0.15)   | (0.11)   | (0.15)   | (0.11)  | (0.15)   |          |
| eu          | 0.034    | -0.058   | -0.014   | -0.103  | -0.004   | -0.087   |
| (0.09)      | (0.14)   | (0.10)   | (0.15)   | (0.09)  | (0.14)   |          |
| euro        | 0.121**  | 0.118    | 0.172    | 0.186   | 0.178**  | 0.197*   |
| (0.05)      | (0.08)   | (0.11)   | (0.08)   | (0.11)  | (0.11)   |          |
| nStd\(_i\)  | -0.079***| -0.087***| -0.201***| -0.248***|          |          |
|             | (0.02)   | (0.03)   | (0.03)   | (0.03)  |          |          |
| nStd\(_j\)  | 0.022    | 0.019    | 0.028    | 0.007   |          |          |
|             | (0.02)   | (0.02)   | (0.02)   | (0.03)  |          |          |
| eStd\(_i\)  | 0.076*** | 0.061**  | -0.138***| -0.214***|          |          |
|             | (0.02)   | (0.03)   | (0.03)   | (0.04)  |          |          |
| eStd\(_j\)  | -0.012   | -0.070***| 0.012    | -0.073**|          |          |
|             | (0.02)   | (0.02)   | (0.02)   | (0.03)  |          |          |
| iStd\(_i\)  | 0.122*** | 0.204*** | 0.124*** | 0.204***|          |          |
|             | (0.02)   | (0.04)   | (0.02)   | (0.04)  |          |          |
| iStd\(_j\)  | -0.008   | -0.004   | -0.014   | -0.012  |          |          |
|             | (0.02)   | (0.03)   | (0.02)   | (0.03)  |          |          |
| nStd\(_i\) \times eStd\(_i\) | 0.040*** |          |          |          |          |          |
|             | (0.00)   |          |          |          |          |          |
| nStd\(_j\) \times eStd\(_j\) | -0.002   |          |          |          |          |          |
|             | (0.00)   |          |          |          |          |          |
| Country, year, sector, fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant    | -7386*** | -2.313   | -12.624***| -7.273  | -14.801***| -10.671** |
|             | (1.67)   | (2.39)   | (3.25)   | (5.22)  | (3.04)   | (4.83)   |
| Observations| 13,695   | 13,302   | 9,343    | 9,102   | 9,343    | 9,102    |
| R-squared   | 0.826    | 0.716    | 0.821    | 0.718   | 0.827    | 0.725    |

Note: Standard errors in parentheses. Standard errors are robust and clustered at country pair level.  
*** \( p < 0.01 \), ** \( p < 0.05 \), * \( p < 0.1 \)
on both trade in value-added and on gross exports which is comparable to other studies on trade flows that use gravity models (e.g. Baier & Bergstrand, 2007; Baldwin & Taglioni, 2006; Disdier & Marette, 2010). As expected, dis as a proxy for trade costs shows a negative effect. Contiguity has a significantly positive effect on trade in value-added and gross trade because it reduces trade costs. The common language dummy is not statistically significant, i.e. it plays no role for the trade relationships of these European countries if a common language is spoken. Likewise, the dummy for EU membership is insignificant. This is not surprising as all countries in the panel are either EU members or maintain extraordinarily strong economic agreements with the EU, making them equal to EU members in most economic questions. The dummy for the Eurozone has a positive effect but is only significant for trade in value-added.

Columns (3) and (4) report the results for the baseline model as presented above. The lower number of observations compared to the reduced model results from the one-period lag in the standards variables, which are now introduced. First, the basic control variables remain robust. As our panel is built of bilateral trade relationships, it is possible to report the effects of standards for both the exporting and the importing countries. National standards show a significant negative effect on trade flows for the exporting country, no matter if we measure trade in value-added or gross exports. This shows that within Europe, national standards act as barriers to trade as assumed in Hypothesis 1 for the exporter. Goods and services that are produced according to national standards are therefore too specific to be easily exported. The effect for the importing countries is not significant. Hence, certain specific requirements for imports do not influence trade in either case.

Following our assumptions, European standards have a significant and positive impact on exports of value-added and gross exports. Countries that comply with European standards therefore find partners to export to more easily because of the common use of standards within the standardization union. From the positive trade effect in the case of trade in value-added, we infer that European standards foster trade along value chains in Europe. Moreover, the size of the coefficients is slightly larger for trade in value-added than for gross exports. This shows that European standards foster the portion of gross trade that contains the same value-added that is measured by the trade in value-added figures. The coefficient for gross exports is smaller because the gross trade numbers are larger and European standards only influence a part of this gross trade. These results confirm Hypothesis 2. For imports, the effect of European standards is insignificant for trade in value-added. They have no signaling or openness function in Factory Europe. The coefficient is negative for gross imports which shows that the use of European standards hampers import flows when the imports contain value from outside Europe (Chen & Mattoo, 2008). European standards therefore pose requirements that these imports find difficult meeting.

International standards have a significant and positive effect for exporters in both cases. In contrast to European standards, the effect is larger when gross exports are measured, which means that the use of international standards especially fosters trade when value from third countries is included in the good or service. These findings confirm Hypothesis 4. For importers, there is no significant effect of international standards in both model specifications. The use of international standards does therefore not attract imports in Europe. This result is in line with the ambiguous results regarding the effects of international standards on imports collected by Swann (2010).
Finally, we turn to the test of Hypothesis 3 in columns (5) and (6). To examine the interaction effects between national and European standards in European value chains, we include a multiplicative interaction term between the nStd and eStd variables in the gravity equation. The coefficient of the interaction term is positive and significant for the exporter and insignificant for the importer. This confirms our assumption of Hypothesis 3 that the combination of national and European standards in Factory Europe has a positive influence on the European value chains. When we regard the base variables, the picture becomes even clearer. Because the interaction effect is controlled for, the base variables show their isolated effect. The coefficients for the national standards become strongly negative for the exporter and remain insignificant for the importer. This is a signal that national standards have to be combined with other standards to generate gains and are at the same time an essential part of the European division of labor. Isolated national standards hamper exports. The coefficient for European standards of the exporting country turns from positive to negative. European standards are therefore an equally important part in the division of labor. The inclusion of the interaction term reveals that like national standards, European standards only work in combination. They always have to be combined with national specializations. Otherwise, their effect on trade is negative. The size and signs of the coefficients for the effects of international standards stay comparable to the baseline model.

Policy implications

GVCs have emerged as the driving force in our modern globalized economy. Their governance, geographical layout and ownership structure have become increasingly diverse and complex. In order for these GVCs to work, standards are essential. Their uses have increased significantly and are vital to ensure the efficiency and smooth running of international trade. Our findings suggest that a general theory in explaining GVC management, governance, strategy and standardization might be difficult as it is highly dependent on what one is producing, who the consumers are and the competitive environment. Nonetheless, it becomes, for example, clear from our analysis of the EU that it is in the best interests of a developing country that owns a specialized production in the GVC (which is then exported), to advocate for international standards. Indeed, GVC and standards do not only have an economic affect but also a political one. Neilson, Pritchard, and Yeung (2014) point to how the use of standards could be seen as a protectionist measure. From our findings, for example, national standards were found to be barriers to trade. However, international standards were found to have a positive effect on trade with regards to developing nations’ exports to the EU. Regardless, this frame of analysis may be limited as the governance of GVCs and the increase of standards have led to a less state-centric analysis of the global economy. Indeed, regional and international actors have emerged such as non-governmental organizations and TNCs, whose influence on the standardization process and outcomes, challenge the traditional regulatory entities of nation states. Most significantly, as the GVC ownership structures have changed as well as certain economies of the global South have become more developed, so have power-relations and opportunity arisen for new development policies.

Gereffi (2014) argues that the development model shifted from import-substituting industrialization in the 1950s to export-orientated industrialization in the 1960s. This was the result of the East Asian miracle with south East Asian economies’ increased growth. This model was part of what was known as the ‘Washington Consensus’. 
Gereffi (2014) argues that after the 2008 financial crisis, the increase in industrial capacity of large developing economies (e.g. China and India) has created a ‘...profound shift in global demand for both finished goods and intermediates from North to South, with both positive and negative implications for developing countries exporters...’ (p. 11 Gereffi, 2014). He goes on to argue that within the changing environment of the global economy, the Washington consensus has diminished in legitimacy in terms of a development framework. In this ‘post Washington-consensus world’, a new model for development is required. Indeed, at the root of changes in global production and some shift in power to large emerging economies of the global South, is the role-played by GVC. Hence, a development policy can be organized around not only being well positioned within a GVC, but also owning said production processes. Standards are essential within this framework and working with the international standardization system could bring a variety of benefits to developing nations, as too high standards leading to protectionism can be mitigated (e.g. by exploiting the one country one vote principle within international standardization). Our findings complement such a notion, as it was found that international standards have a positive impact on the exports from developing nations to the EU. However, many developing nations are not well represented within the international standardization system due to financial limitations or lack of experts (Nadvi, 2008). Consequently, a further policy recommendation would be for developing nations to invest and understand the value of being part of Technical Committees at the international standardization level potentially supported by foreign aid. Furthermore, state entities could monitor that certifications, standards and codes are being respected and followed (Gereffi, 2014).

**Conclusion**

We examine the effects of standards on trade in value-added and gross trade flows in Factory Europe. We find differing trade effects of standards with regard to their different scopes. Whereas international standards facilitate global trade, European standards impact European GVC trade. In closely connected economic clusters such as Factory Europe, regional standards like European standards are tailor-made for the local market actors. European standards therefore play an important role as a means of communication in European value chains. They have negative influence, however, when the trade figures contain value from outside of Europe because these imports are either produced in compliance with foreign national standards or with international standards. National standards prove to be hampering exports within Europe because they express national specializations that other European market actors cannot use. Furthermore, we find evidence that combining national and European standards in production leads to a fruitful division of labor in Europe that generates gains from trade.

Our findings therefore present an incentive for policy-makers to foster regional harmonization of standards to steer production patterns. Especially, as the need for communication between market actors grows because the number of production stages in GVCs increases, standards prove to be an important means in reducing information asymmetries. The results also show the success of economic integration in Europe through the Single Market and they prove the necessity of European standards. This fact has been recognized by European policy-makers who aim to further stimulate and develop the European standardization system (European Commission, 2015). Nevertheless, even in a standardization union, national and international standards are
beneficial to the economies and serve their specific purposes. National standards codify the technical specialization of a single country. International standards facilitate trade with third countries and are additionally useful within Factory Europe when there is no European standard that is more specific than the international standard. Furthermore, international standards are found to be beneficial for the exports of developing nations with the policy recommendation for these countries being to understand the value of international standards and to participate in the standardization process as well as control key areas in a GVC.

Several limitations apply to this study. Since the sectoral data are only available as aggregates of multiple sectors, an in-depth analysis on sector level is hence not yet feasible. In future research, the examination of panels covering a longer time span will be a promising path to follow. A further interesting question for future research might be to differentiate standards differently, e.g. into product and process standards.

Notes

1. Although they are not EU members, Iceland, Liechtenstein and Norway participate in the Single Market through the EEA (European Economic Area) Agreement. Switzerland participates in the Single Market through bilateral agreements.

2. Trade in value-added figures only contain the value-added from the previous production stage (see Figure 1). Since we only regard European countries, all value-added in our sample is from a previous production stage within Europe. Gross trade figures, on the other hand, contain the entire value that was added to the product or service in all prior production stages. Therefore, these figures can contain value that was added before the product or service was imported into Europe.

3. List of countries: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Italy, Lithuania, Netherlands, Norway, Poland, Slovakia, Spain, Sweden, Switzerland, United Kingdom. The countries that entered the EU in 2004 (Czech Republic, Lithuania, Poland, Slovakia) are included in the panel starting from 2005.

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We do not have any financial interest and expect no financial benefit arising from the direct application of our research for this article.

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