International Competitiveness in the European Context: Tackling the Inconclusive Evidence

CUMULATIVE DISSERTATION

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Preface of the Author

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Sascha Keil
Chemnitz, May 2024

Slip inside the eye of your mind
Don't you know you might find
A better place to play
You said that you'd never been
But all the things that you've seen
Will slowly fade away
So I start a revolution from my bed
'Cause you said the brains I had went to my head
Step outside, summertime's in bloom
Stand up beside the fireplace
Take that look from off your face
You ain't ever gonna burn my heart out
And so Sally can wait
She knows its too late as we're walking on by
Her soul slides away
"But don't look back in anger" I heard you say

- Oasis

Overview of Research Papers

No.	Research Paper	Points
1	Keil, S. (2023): "The challenging estimation of trade elasticities: Tackling the inconclusive Eurozone evidence". Manuscript published in: *The World Economy (2023), 46(5).* https://doi.org/10.1111/twec.13333	1.00
2	Keil, S. (2024): "Competing for manufacturing value added: How strong is competitive cost pressure on sectoral level?" Manuscript published in: *Structural Change and Economic Dynamics (2024), 69.* https://doi.org/10.1016/j.strueco.2023.12.003	1.00
3	Keil, S. (2024): "Assessing the Role of Non-Price Factors: Shedding New Light on the European Competitiveness Puzzle" Manuscript published in: *International Economics (2024), 178.* https://doi.org/10.1016/j.inteco.2024.100495	1.00
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I. Executive Summary

1.1 Introduction

The introduction of the Euro in 1999 significantly altered the economic dynamics of major European countries. Northern and Central European nations like Germany and Austria witnessed above-average growth in GDP, exports, manufacturing output, and related socio-economic indicators, while Mediterranean countries, such as France and Italy experienced contrasting dynamics. Among the most striking manifestations of this divergence are the significant trade imbalances across countries. Consequently, there is a growing interest in identifying the primary drivers of these economic disparities.

A crucial element in explaining these dynamics is the concept of international competitiveness. On a macroeconomic level, competitiveness can be likened to the tide, raising or lowering the positions of boats (businesses) in comparison to their foreign competitors. It essentially reflects a nation's capacity to effectively market its products on the global stage. However, the conceptualisation of competitiveness and its implications for policy has been long-debated topics in economic research (Krugman, 1994). A critical challenge lies in pinpointing the central factors that influence a country's competitive position in international trade. Researchers typically divide competitiveness into price and non-price factors, but empirical applications have yielded inconclusive evidence regarding the individual significance of these factors, leaving room for interpretation and differing conclusions.

While assessing the relationship between trade flows and competitive factors may appear straightforward at first glance, a closer examination reveals complexities in methodology and logical consistency. International economics currently lacks a direct analysis of these methodological challenges and a comprehensive comparative assessment. The doctoral project outlined in this executive summary seeks to contribute filling this gap in research and to generate answers to some of the most important pending questions related to the topic. While the research mainly focuses on conceptual and methodological aspects, it also generates new empirical evidence concerning the major drivers of Eurozone trade imbalances, contributing to the ongoing debate. Special emphasis is placed on testing the hypothesis that the exports of major European countries are not sensitive to changes in international costs and prices.

This executive summary aims to provide a comprehensive overview of the dissertation, which consists of three research articles centred on the role of international competitiveness in a European context. After this introduction, this summary proceeds as follows. Section 2 will present the theoretical background and explore the controversies surrounding the role of price competitiveness. This will be exemplified by focussing on the empirical contributions analysing the exports of Germany and Italy. Section 3 will then provide a concise summary of the questions posed and hypothesis tested by the three articles and briefly elucidate their shared methodological foundations. Furthermore, it will provide a chronological summary of the individual research articles, followed by Section 4, which will delve into the individual outcomes and their contributions to the ongoing scientific discourse.

1.2 Background and Literature Review

1.2.1 Cumulative causation and export-led growth

The phenomenon of economic divergence across countries represents a complex reality posing challenges to the formulation of appropriate economic theories. While some countries thrive, others lose ground in terms of economic prosperity and become less attractive. In many cases, divergence has been observed to start suddenly at a specific point in time. Such changes seem to be difficult to explain by an abrupt change in the collective microeconomic behaviour of economic subjects. Thus, scholars are searching for structural factors driving such processes. Among the most original thoughts in this regard is the circular cumulative causation theory by Gunnar Myrdal (1957). His idea was to describe differing economic dynamics of trade-related regions, which initially were identical. According to Myrdal, an accidental effect or a disruptive sudden change in macroeconomic conditions can trigger regionally divergent dynamics of interrelated economic quantities, such as aggregate demand, the terms of trade, or labour productivity.

In this framework, a prosperous economy experiences increased demand for its products throughout the entire value chain. This growth attracts specialized supplier firms and workers from other regions, contributing to an improved structural profile at the expense of less advantaged regions. Conversely, disadvantaged regions witness a decline in demand for their products, leading to the displacement of domestic production by imports and the exodus of workers. This downward spiral further deepens the crisis. Once such a competitive difference is established, free market forces tend to increase rather than to decrease it. According to Myrdal, "the movements of labour, capital, goods and services do not by themselves counteract" (ibid., p. 26) to stop the divergent dynamics and the system does not converge. Central to this process is the role of free trade among regions. As long as factor endowments are not seen as limiting and production can be readily expanded, additional export demand can be met. Consequently, economic activity concentrates in regions with favourable macroeconomic conditions, while weaker regions lack industrial production capacity, relying on imports to satisfy their demand for manufactured goods.

Building upon Myrdal's concept of circular cumulative causation in open economies, Nicholas Kaldor (1970) developed a theory of a country's economic growth, which is balance-of-payments constrained and, thus, entirely dependent on the growth of exports. This theory marked the beginning of various trade and growth models collectively labelled as "Kaldorian". In the export-led growth model, exports were identified as the catalyst for a potential cumulative and circular growth process. Therefore, exploring the macroeconomic determinants of exports becomes pivotal for economic policy considerations. According to Kaldor, "the behaviour of exports […] will depend both on an exogenous factor - the rate of growth of world demand for the products of the region; and on an "endogenous" or quasi-endogenous factor - on the movement of the "efficiency wages" in the region relative to other producing regions, which will determine whether the regions share in the total market is increasing or diminishing" (p. 486). In this reasoning, efficiency wages are the key competitive factor and are defined as the

nominal wage bill to labour productivity. This concept aligns with what is now commonly referred to as nominal unit labour cost (ULC). [1]

Efficiency wages are central to understanding economic divergence through trade due to two key features. First, they determine the cost level of domestic production, export prices and, thus, international price competitiveness. Second, labour productivity, a major component of efficiency wages, is considered endogenous to economic growth, which is partially driven by exports. This endogeneity is rooted in the presence of increasing returns to scale, a concept originally described by Young (1928) and empirically verified by Verdoorn (1949). Higher demand for a region's goods leads to increased production scale, which lowers unit costs through improved labour productivity. Given that nominal wages are not affected, efficiency wages will consequently grow slower than elsewhere and the region gains a "cumulative competitive advantage" (Kaldor, 1970; p. 487). Importantly, this slower growth in efficiency wages perpetuates, as lower costs translate into lower prices and higher export sales. This, in turn, accelerates productivity growth through increasing returns to scale, creating a self-reinforcing cycle that further increases the competitive advantage.

1.2.2 The Kaldor paradox and the discovery of non-price competitiveness

The applicability of the circular and cumulative causation theory to explain economic divergence among Eurozone countries hinges on two fundamental assumptions. According to the first assumption, industrial production exhibits increasing returns to scale, and productivity growth is partially endogenous to economic growth. In the related literature, the presence of increasing returns to scale is a widely recognised feature shown by the empirical regularity, according to which labour productivity increases by roughly 0.5% following a 1% increase in the output volume (Magacho & McCombie, 2017). The second assumption states that efficiency wages expressed as unit labour cost are a significant predictor of export dynamics. However, the latter assumption has sparked a lively debate, particularly regarding the sign and significance of export the elasticity with respect to cost.

The debate's origins trace back to Kaldor's (1978) empirical investigation of changes in international export market shares, which led him to question his own export-led growth theory. Kaldor noted that relative prices and market shares of most countries tended to increase or decrease simultaneously. Kaldor concluded that "the changes in exchange rates and in "competitiveness" as conventionally measured were not the cause, but the consequence of differing trends in the market shares of different industrial countries, and the "trends" themselves must then be due to factors not susceptible to measurement" (p. 104). Accordingly, he ruled out a pivotal role of price factors and considered not observable non-price factors as the major drivers of exports. This perspective influenced later Kaldorian trade and growth models such as that of Dixon and Thirlwall (1975), where price competitiveness has at most a

[1] The concept of efficiency wages used in this thesis is different to the original notion by David Ricardo. The Kaldorian definition of efficiency wages in this context is similar to that used by Keynes (1929) to describe the implications of the German transfer problem. In order to export more, German products should be favoured by slower growing efficiency wages compared to its competitor countries.

temporary impact and cumulative causation is a limited feature. The well-known balance of payment constrained growth model of Thirlwall (1979) even neglects any importance of prices or cost in the long run.

The conventional wisdom surrounding the role of cost competitiveness in advanced industrial economies' trade flows was thus challenged. Subsequently, scholars turned their attention to structural non-price factors. In this 'structuralist' literature, an economic system is viewed as more competitive if capable of advancing the production structure by fostering innovative activities and promoting production of high-tech goods. Summing up the debate so far, McCombie and Thirlwall (1994) state that technological factors are more central than prices and cost in determining the exports of manufacturing goods. However, the price channel was deemed more relevant for countries specialising in less advanced, low-tech manufacturing sectors.

The concept of non-price competitiveness is defined as the entirety of factors other than prices affecting the consumer choice. This encompasses features such as quality, reliability, speed of delivery, the extent and efficiency of the distribution network or the availability of export credit. However, McCombie and Thirlwall acknowledged that the concept is nebulous and hardly quantifiable, which renders it difficult to estimate its effects on exports. Indeed, claims that non-price factors matter more than price factors rely mostly on indirect evidence on the matter and on the assumption, that price and non-price factors form a dichotomous concept. However, the still inconclusive empirical evidence shapes the further evolution of trade and growth models explaining differing economic dynamics. A remarkable example of these developments is the model proposed by Missio et al. (2015). The authors state that being price competitive enables the build-up of structural competitiveness. [2] Overall, the reported theoretical developments indicate the need for further clarification of the role and implications of international competitiveness in explaining exports and economic dynamics. The mechanisms of action still must be explored from the theoretical, conceptual and empirical point of view.

[2] A comprehensive survey on recent developments in post-Keynesian trade and growth models and how they implement the concept of competitiveness can be found in Boggio & Barbieri (2017) as well as in Blecker (2022).

1.2.3 The case of Germany and Italy

The onset of the Euro in 1999 fixed the nominal exchange rates of the main European economies. That implied, that the differing levels of unit labour cost across countries couldn't be offset by exchange rate adjustments anymore. Since then, significant divergence in terms of trade flows and per capita GDP has built up and persists. Countries, whose cost competitiveness worsened, saw their export market shares falling. Those who gained an advantage in terms of unit labour cost, experienced stronger export growth. So far, this simple descriptive observation fits the narrative and the projection of the efficiency wage-centred view outlined above. However, the research on the Eurozone trade imbalances revived the Kaldor paradox debate due to several counter-intuitive findings. A lot of controversy is concerned with the export elasticity with respect to cost, since its estimates vary significantly in terms of magnitude, sign and significance.

The different trade dynamics of Germany and Italy serve as an exemplary case, showing how different narratives can be built upon such inconclusive evidence. A central piece of the story is the process of wage devaluation experienced by the German economy after the launch of the euro, the consequently slower growing unit labour cost and their impact on the German trade performance. One of the most central steps was the introduction of the Agenda 2010, which mainly consisted of labour market flexibilisation initiated with "several tripartite negotiations in an attempt to lower wage growth and to restore price competitiveness" (ILO, 2012, p. 46). These measures, however, "essentially led to wage deflation," while "little was done to restore competitiveness through increases in productivity" (ibid.). Accordingly, Germany benefitted from the onset of the common currency of the Euro in 1999, since its European competitors couldn't adjust their own currency anymore to restore price competitiveness.

The narrative of fostered price and cost competitiveness as a central cause of the divergence has been strengthened by many empirical estimates of cost elasticities. For instance, Horn & Watt (2017) estimated a German export price elasticity of -0.5. Baccaro & Benassi (2017) found significant short-run price and cost coefficients for German manufacturing exports which even increased in the period from 1971 to 2014. The average effect size for ULC has been -0.4. The research of Storm and Naastepad (2015), however, represents the often-cited 'against the current' example in this regard. The authors detect an insignificant and even positive cost coefficient. The outcome is interpreted as a consequence of Germany's extraordinary strength in terms of non-price competitiveness fostered by its corporative industrial framework and technological level, which renders export demand for its product range insensitive to changes in unit labour cost. Another empirical application confirming this perspective represents the work by Neumann (2020), who failed to detect robust price effects.

Italy is considered one of the main competitors of the German manufacturing sector and has been characterised by slow productivity dynamics leading to significantly faster unit labour cost growth than in Germany. The Italian export market shares fell in almost every manufacturing sector throughout the period starting with the onset of the Euro. Since 1999, the disadvantage in terms of unit labour cost amounts to roughly 20%, which means that every unit of output generated in Italy incurred a 20% higher nominal labour cost than in Germany. That this disadvantage in terms of ULC has been of high significance for Italian exports was found

by the analysis of Paternesi Meloni (2018) with an estimated cost elasticity of -0.8. Accordingly, the faster growth in terms of ULC translated to the weaker trade performance of Italy compared to Germany.

However, also in the Italian case the cost-centred narrative has been questioned by many scholars. One famous example is the assessment of Simonazzi et al. (2013), who argued that the differences in unit labour cost play only a minor role. Hence, the authors attributed a higher significance to structural factors fostering non-price competitiveness. Accordingly, Italy would be lacking a coordinated economic policy aimed at promoting its exports. The empirical work by Breuer & Klose (2015) supports this perspective, since the authors did not detect a significant cost effect for Italy. Other contributions render the Italian competitiveness puzzle even more complex. According to a European Commission report edited by Monteagudo (2010), Italy is exposed more to price and cost competition than Germany. Commonly, countries specialised in high-tech manufacturing activities are assumed to face lower international price competition (Gräbner et al., 2020). The reason is seen in the nature of commodities produced in these sectors, which can only hardly be substituted by competitor goods. Accordingly, the Italian industry is considered to be specialised in the production of rather medium-tech goods. Defying this view, Baccaro and Tober (2017) detected a higher cost sensitiveness of Germany (-0.8) compared to Italy (-0.3). Giordano and Zollino (2016) reported only small differences in cost sensitiveness with coefficients of -0.3 and -0.4 for Germany and Italy respectively. Surveying the empirical work focussing explicitly on the export of Eurozone countries, a conclusive pattern regarding the significance of price and non-price competitiveness is hard to obtain.

Scholars finding low or insignificant price effects commonly highlight the importance of structural non-price competitiveness. Despite the recognized importance of this concept, only a few works assess this factor and its role explicitly. This may depend on the fact that conceptualizing non-price factors (and traducing them into a single metric) is not straightforward. Commonly, the significance of non-price factors is underscored through indirect evidence such as low or insignificant estimates of the price elasticity. This corresponds to the outcome presented by Neumann (2020) for Germany. An alternative indirect approach consists of interpreting the residual from an export equation as conveying information about non-price contribution to exports growth, as proposed by Monteagudo (2010). The author found that both German and Italian exports were positively affected by their non-price competitiveness. Also Giordano & Zollino (2016), using total factor productivity, documented a positive NPC effect on exports for Germany and Italy. A different message, however, arises from Frenkel & Zimmermann (2020), who didn't find an effect of R&D spending for Germany. As can be seen from this survey on the role of price and non-price elements in stimulating exports, this debate has still not reached a conclusive point.

1.3 Presentation of Research Articles

1.3.1 Idea

The research conducted in this dissertation project centres around the Kaldor paradox and the associated inconclusive evidence within a European context. At its core, this research aims to find answers to the question which role is played by price and non-price competitiveness in achieving success in international markets from a macroeconomic perspective. To investigate this and related questions comprehensively in different dimensions, three primary research directions have been elaborated:

Research topic I: The unreliable price coefficient in empirical applications. The first contribution of this dissertation focuses on uncovering methodological explanations for the diverse and sometimes contradictory outcomes observed in studies concerning the price elasticity of exports. By addressing potential methodological and conceptual challenges, this research aims to generate more reliable evidence. Its significance lies in shedding light on whether international differences in price and cost structures have a meaningful impact on a country's export performance in a European context.

Research topic II: Sectoral differences in cost sensitiveness and technological sophistication. The second article explores variations in price and cost elasticity magnitudes across European manufacturing sectors. It investigates whether these differences are associated with the technological sophistication of the traded goods on a sectoral level. By testing the hypothesis that high-tech sectors face lower cost competition, this research provides new insights into the determinants of price elasticity at the macroeconomic level and explores whether industrial specialisation in high-tech manufacturing can mitigate international price pressure.

Research topic III: The concept and the empirical assessment of non-price competitiveness. The third article delves into the conceptual underpinnings of non-price competitiveness, a concept often considered nebulous and challenging to quantify. It explores how non-price competitiveness relates to price competitiveness from a conceptual standpoint and questions whether their effects on exports can be separated. The generation of comparative evidence by applying established indicators to a common dataset represents another central aim of this article. By doing so, the potential effect of non-price factors on exports will be quantified.

1.3.2 Shared methodological framework

The focus of this thesis centres around the issue of the reliability of the price coefficient. The empirical workhorse model commonly used to address this topic is the empirical export equation. This equation can be derived from both Gravity models of trade and Kaldorian trade and growth models, serving as the shared methodological foundation upon which I build my individual contributions. In recent decades, these empirical equations have become integral to economics (Bayoumi, 1999). The standard export equation (which is primarily an import equation, explaining the foreign importers buying behaviour), can be expressed as follows:

$$\ln X_t^i = C^i + \delta_1^i \ln FI_t^i + \delta_2^i \ln ULC_t^i + \epsilon_t^i. \quad (1)$$

In the most standard specification, X represents the volume of export of goods. FI denotes a measure of foreign income or demand and ULC stands for price and cost competitiveness, commonly proxied by nominal unit labour cost in a common currency. When this relationship is subjected to econometric analysis, the estimated long-run coefficients, represented as δ, are interpreted as trade elasticities. Specifically, the export elasticity concerning foreign income δ_1 is expected to be positive, while the elasticity concerning prices δ_2 is assumed to be negative, reflecting the typical demand curve behaviour in competitive markets.

1.3.3 Summary of Research Article I

Keil, S. (2023): "The challenging estimation of trade elasticities: Tackling the inconclusive Eurozone evidence".

Manuscript published in: *The World Economy (2023), 46(5).*

Price competitiveness and its impact on European trade flows are at the heart of this investigation. The central problem to address lies in the lack of consensus regarding whether relative prices truly influence export dynamics, as evidenced by Nicholas Kaldor's paradoxical findings. Various studies have yielded mixed results, with some confirming price competitiveness as a significant factor and others challenging its significance. These inconsistencies have prompted a closer examination of the underlying methodologies and the need for conclusive evidence to resolve these lingering questions. Consequently, in this paper I address the methodological challenges associated with using the empirical export equation to derive trade elasticities.

In this analysis, I identify three central difficulties regarding the estimation of trade elasticities: (1) the pre-differencing of the export equation, (2) the fractionally integrated time series of the price variable and (3) inappropriate cointegration techniques. Several studies estimating the impact of foreign income and relative prices on export dynamics have not succeeded in detecting cointegration among the variables. Thus, using pre-differenced variables is commonly considered a remedy for the cointegration pitfall. I substantiate why pre-differencing of the export equation is disputable since it results in a loss of information. The resulting need for employing the equation in its levels version generates difficulties for cointegration analysis due to the time series properties of the variables involved. In case purchasing power parity is valid, the relative price time series cannot expose a clear trending

behaviour. Testing the time series of the price variable expressed by the relative unit labour cost of eleven Euro area countries (by ADF and KPSS tests) confirms the theoretical conjecture: Relative prices are fractionally integrated, since they trend over a certain period of time before reverting. This characteristic violates the assumptions of commonly applied long-run estimation techniques leading to problems of autocorrelation.

By utilising three different econometric techniques, which all work differently regarding the data characteristics, additional evidence is provided. The main findings can be summarised as follows: As expected, the Engle Granger two step procedure produces spurious evidence, since a cointegrating relationship cannot be detected. By having employed the Johansen approach (based on a vector error correction model) at least one cointegrating vector was found in six out of eleven cases. The ARDL model produces the most stable outcome and detects an equilibrium relationship for eight countries.

Robust cointegration is found for Austria, Belgium, Germany, Ireland, Italy, Luxembourg, Portugal and Spain. The cost elasticity ranges from -0.3 to -1.8. By contrast, the three cases that are not cointegrated show methodological difficulties leading to spurious evidence. When, however, adjusting the specification according to the needs of the individual case, cointegration can be established also for Finland, France and Italy. Thus, provided that the methodological assumptions are met and that the model is specified with diligence, robust long-run evidence can be generated and pre-differencing of variables is no longer necessary. This finding confirms that the pre-differencing of variables can yield misleading spurious results and that controlling for the long-run relationship is indispensable.

The study highlights the significance of competitive unit labour cost levels for trade success. There is neither theoretical nor empirical evidence to neglect the importance of relative prices and cost structures for exports as has been argued earlier in parts of the related literature. Diverging cost levels represent an important determinant of the observed trade imbalances within the Euro area. A remarkably high and significant cost sensitiveness can be detected, even for the most successful exporters like Germany, Austria and Ireland. This research underscores the complexity of a seemingly simple empirical application and the importance of methodological rigor in empirical international economics. In conclusion, the study provides valuable insights into the challenges of estimating trade elasticities and sheds light on the intricate relationship between prices, costs, and trade performance in the Euro area.

1.3.4 Summary of Research article II

Keil, S. (2024): "Competing for manufacturing value added: How strong is competitive cost pressure on sectoral level?"

Manuscript published in: *Structural Change and Economic Dynamics (2024), 69.*

The problem addressed in this study revolves around understanding the intricate relationship between cost competitiveness and the manufacturing sector performance, particularly in the context of Europe's diverse manufacturing landscape. The significance of thriving manufacturing industries cannot be overstated, as they play a pivotal role in driving productivity and economic prosperity. Traditionally, strategies for achieving international competitiveness in manufacturing sectors have been categorized into enhancing cost competitiveness and improving structural as well as institutional factors, with some perspectives suggesting that these approaches are dichotomous. A prevailing assumption is that advanced manufacturing sectors can compete effectively based on quality and innovativeness rather than cost, making cost competitiveness less relevant. Accordingly, by expanding and upgrading the product range offered by a country's manufacturing sector, their exports become increasingly independent from their cost structures. This assumption aligns with microeconomic theory, where cost elasticity is thought to depend on product characteristics and market conditions. However, empirical studies have yielded contradictory results, challenging the applicability of microeconomic theory at a more aggregated level.

The globalization of manufacturing and the organization of production in global value chains introduce further complexity. Acknowledging the productive organisation in global value chains and the potential for relocating stages of production, this article aims to go beyond the export dimension for assessing industrial competitiveness. To address these complex issues, this study employs an innovative methodological approach. Within different ARDL models, the relationship of two advanced measures is tested: national shares of sectoral manufacturing value added (VAS) and vertically integrated nominal unit labour cost (VULC) based on input-output data. This choice for VAS instead of exports as the left-hand side variable is motivated by the principle of global cost arbitrage acknowledging the vertical dimension of production. A central advantage of the measure of value added is that it does not account for the import content integrated within export flows, providing a more accurate representation of sectoral productive activity. The use of VULC as cost competitiveness variable is particularly significant, as it comprehensively accounts for the cost situation of an entire sectoral value chain, considering input-weighted unit labour cost across all input sectors. This method allows for a nuanced examination of the relationship between cost competitiveness, industrial specialisation, and globalisation trends in manufacturing sectors.

The results confirm the general importance of unit labour cost for manufacturing activity. The cost sensitivity of manufacturing value added ranges from -0.7 to -1.3. When employing the vertically integrated instead of the direct sectoral cost metric, the elasticity magnitude is consistently higher indicating its higher relevance due to the productive organisation in value chains. The results of this study challenge the prevailing assumption that cost competitiveness becomes less relevant in advanced manufacturing sectors. Surprisingly, high-tech industries, such as vehicle manufacturing, pharmaceuticals, electronics, and computers, exhibit a marked sensitivity to changes in relative cost levels. Consequently, industrial policies that seek to specialise in more advanced manufacturing sectors cannot assume that such specialisation inherently diminishes the significance of cost competitiveness. The heightened price sensitivity of high-tech sectors is seemingly attributed to their deep integration with international markets, exposing them to increased competitive pressures. This challenges the view of technological characteristics as the main determinant of the aggregated cost elasticity magnitude.

1.3.5 Summary of Research article III

Keil, S. (2024): "Assessing the Role of Non-Price Factors: Shedding New Light on the European Competitiveness Puzzle"

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The article delves into the intricate world of export performance in industrial economies, with particular emphasis on non-price competitiveness (NPC). NPC is a multifaceted concept encompassing everything aside from prices and costs that influences trade performance. However, conceptualising and measuring NPC presents significant challenges, leading to fragmented and contradictory empirical evidence in the field. With the backdrop of a European context, this study strives to shed light on this issue. The central problem is the lack of consensus on how to effectively measure and understand NPC and its contribution to export growth. On a theoretical level, non-price competitiveness is a broad and elusive concept, which can only be defined in contrast to price and cost factors that shape export dynamics. Empirical assessment should acknowledge this complexity and consider multiple indicators instead of relying solely on single measures. I address this topic by reviewing different direct and indirect NPC indicators. By doing so I show how single NPC approaches contribute to forming a consistent narrative and how valuable these measures are in the overall assessment.

The study generates new evidence on how the export performance of individual countries has been influenced by differences in non-price competitiveness. For this purpose, I reproduce several established macroeconomic measures of non-price competitiveness for a set of 10 Eurozone countries over the period 1995 - 2019. The econometric approach chosen to assess the relationship is based on dynamic fixed effects and pooled mean group models. Two indicators, the estimated income elasticity and the index of economic complexity, can provide a useful descriptive starting point. However, both indicators are conceptually not capable of distinguishing price from non-price effects. If price competitiveness is accounted for appropriately, the non-price side can be reflected indirectly by the unexplained part of an export function. In this regard, the calculated trade frictions (TF) measure, derived from rearranging the equation, has shown conceptual consistency and can serve as a powerful indication.

Conversely, the residual-based estimation approach to NPC did not yield robust evidence across different specifications. Apart from these indirect indicators, the introduction of additional direct NPC arguments to the standard export equation revealed that the index of economic complexity correlates significantly with the export volume. However, its corresponding low semi-elasticity (0.1 – 0.3) does not indicate that the Economic Complexity Index (ECI) can serve as an overarching indicator. Other additional NPC arguments introduced to the standard export equation, such as patent stock, R&D expenditure, capital stock, investment intensity, and multi-factor productivity, did not demonstrate significant effects in this context, or the evidence was ambiguous. Furthermore, the introduction of these additional arguments did not significantly affect the income and price elasticities in terms of effect magnitudes and significance. The analysis indicates that unit labour cost is not solely a robust indicator of the relative price stance but also encapsulates information about the structural factor of productivity, making it a comprehensive indicator of international competitiveness.

Analysing the obtained estimates and the movements of the individual factors provides strong evidence that changes in non-price competitiveness have shaped trade flows of European countries. For instance, Germany, often regarded as having a competitive edge due to improved cost competitiveness from 1995 to 2019, shows a decline in residual-based NPC indicators, as well as in the ECI and other innovation-related measures, indicating a significant decrease in non-price competitiveness. This assessment holds true for the entire period but is particularly pronounced during the period characterized by the build-up of trade imbalances until 2008. A similar steady deterioration of major non-price competitiveness factors can be observed for France and, particularly, Italy. On the other hand, Portugal stands out as a country that has consistently improved its structural non-price stance throughout the period. The evidence for Belgium, Finland, Spain, and the Netherlands, however, is less conclusive. In short, this analysis does not identify a single overarching indicator of non-price competitiveness or a suitable proxy for econometric purposes. However, using these indicators in conjunction allows for a consistent descriptive assessment, providing valuable insights into changes within the macroeconomic structure.

1.4 Conclusion

1.4.1 Main results

Over the past five decades, a lot of effort has been devoted to identifying the major macroeconomic drivers of trade flows. Ultimately, the economic divergence across European countries related to the introduction of the Euro led to a resurgence of the competitiveness debate. The resulting views on how to achieve international competitiveness to foster exports couldn't be more different. Inconclusive empirical evidence, conceptual challenges and methodological complexities still shape the related scientific debate. The probably most controversial issue is whether being competitive in terms of prices really matters in comparison to structural competitiveness factors such as innovativeness or product quality. In this dissertation project, I tackle the topic of competitiveness systematically and generate comparative evidence using the empirical export equation as a common framework.

Various empirical applications assessing the importance of price and cost competitiveness employing the standard export equation produce paradoxical results meaning that they couldn't find a negative and significant effect. Through a systematic analysis of the price elasticity estimation procedure, I identify several pitfalls leading to unreliable results. Firstly, testing the relationship in growth rates instead of levels leads to a significant loss of information and, thus, less robust estimation results. Secondly, export prices used as a price variable are conceptually not appropriate proxying price competitiveness. Unit labour cost represents the preferable measure in this regard. Thirdly, methodological issues such as fractional integration of the price variable and their consequences for the estimation procedure as well as structural breaks have to be taken into account. Tackling these difficulties leads to more robust and reliable estimates. In the European context, I detect an averaged negative export elasticity to prices of unity indicating that price competitiveness is of utmost importance.

A connected topic is the search for structural characteristics causing the price elasticity magnitude to vary across countries and sectors. A widely shared belief is that the export of countries which are specialised in innovative high-tech sectors face a lower sensitivity to relative prices and cost. Since this has not been verified in the connected scientific literature, I test this hypothesis and show that the most advanced European manufacturing sectors are subject to heightened international price competition. The obtained sectoral price elasticity pattern correlates with the sectoral openness to international trade. Accordingly, high-tech manufacturing relies more on export sales than low-tech sectors and, thus, face a more intense international price competition. Consequently, industrial policies that seek to specialise in more advanced manufacturing sectors cannot assume that such specialisation inherently diminishes the significance of cost competitiveness. Being cost competitive is not merely a helpful condition for industrial success; it appears to be an essential prerequisite.

While the role of price competitiveness can be assessed directly, the impact of non-price competitiveness is often neglected due to the absence of an overarching indicator. The explicit assessment of non-price competitiveness in this dissertation falls short of identifying an appropriate indicator capable of representing the entirety of different structural factors. Several proxy measures, established in recent literature, did not prove to yield an economically meaningful and statistically robust contribution in the explanation of export dynamics. Despite this unsatisfactory outcome, the analysed indicators did contribute to forming a consistent narrative while assessing them descriptively in conjunction and contrasting their dynamics with changes in price competitiveness. Interestingly, the latter has not been affected by the consideration of non-price factors within the export equation in terms of effect magnitude or significance.

1.4.2 Contribution to the European debate

The empirical findings presented in this dissertation have significantly enriched the ongoing debate regarding the primary factors contributing to intra-European trade imbalances since the introduction of the Euro. In the individual contributions, I have evaluated multiple dimensions of competitiveness across a shared group of European countries, providing valuable comparative insights. This includes the exemplary case of Germany and Italy, both distinguished by distinctly different trade dynamics. Germany's impressive export performance

during this period underscores the nation's overall high level of competitiveness. Since Germany's exports have been found to be highly price elastic, the improvement in price competitiveness in the early 2000s supported these dynamics. However, examining various indicators of non-price competitiveness reveals that structural factors negatively affected German export performance. Following the 2008/09 crisis, a partial reversal of these trends is observable. A slightly worsened price competitiveness and an improvement in structural factors resulted in a continued robust but somewhat slower export growth. Conversely, Italy shows a lower overall level of competitiveness as evidenced by various indicators. Its comparatively weaker export growth can be attributed to a deterioration in both price and non-price competitiveness. The Italian industry saw a decline in nearly all categories of competitiveness over the entire period. Since 2009, some improvements in the relative stance in terms of prices and cost have taken place, leading to an increase in the still lower export growth rate. According to the research conducted in this dissertation project, cumulating differences in price competitiveness played a pivotal role for the emergence of differing trade trajectories. The evidence regarding the level and the export contribution of non-price competitiveness in the European context is more complex as recent literature suggests.

1.4.3 Closing remarks

In conclusion, the three contributions in conjunction have not merely added another piece of evidence to deepen an existing paradox; rather, they have contributed another vital piece to the puzzle, thereby making an existing paradox less enigmatic and more comprehensible. The central insight gained for economic policy considerations is that price and cost competitiveness expressed by unit labour cost is a crucial determinant for export as well as industrial activity and must not be neglected. The prominence of unit labour cost as a robust and comprehensive indicator of international competitiveness arises not only from its strong econometric performance but also from its ability to account for the non-price factor of productivity. Taken together, the three research articles form a ground from which to depart to further tackling more complex issues in this field. This includes topics that were not addressed explicitly in this thesis. Since I investigated the hypothesised relationships in terms of correlation, a promising further research direction could be that of identifying causal relationships and estimating genuine effect magnitudes. Thereby, the potential endogeneity of the price variable expressed by unit labour cost in relation to exports must be investigated. Moreover, the complex issue of non-price competitiveness deserves further attention from an empirical as well as a theoretical perspective.

II. Research Articles

2.1 Article I:

The Challenging Estimation of Trade Elasticities: Tackling the Inconclusive Eurozone Evidence

2.1.1 Introduction

Differences in international competitiveness are considered an important determinant for trade imbalances. In modern trade economics price competitiveness is distinguished from non-price competitiveness. Both are understood to affect the trade performance of single countries when compared to the rest of the world. In this context, empirical evidence is commonly obtained from the estimation of the standard equation of foreign demand for domestic goods, i.e., export demand.[3] According to this standard income-and-price-elasticity framework, in its most basic version, exports are explained by the dynamics of foreign income proxying foreign demand and of relative prices or, in many cases, of relative costs. Unfortunately, the utilisation of this procedure does not seem to produce consistent results throughout the empiric literature. In particular, the role of prices and costs[4] is discussed extensively. The interpretation of an empirical analysis by Cambridge economist Nicholas Kaldor (1978) is often seen as the starting point of a long-lasting price competitiveness debate. Since Kaldor couldn't detect the expected negative impact of relative prices on export market shares, he concluded that prices are a result, rather than a determinant, of the trade process. Several studies (e.g. Storm & Naastepad (2015) for Germany, Breuer & Klose (2015) for Italy) confirmed this unexpected finding of insignificant or even positive cost coefficients by using a version of the empirical export equation. However, having used a similar research design, comparable studies (e.g. Horn & Watt (2017) for Germany, Paternesi-Meloni (2018) for Italy) were able to detect negative and significant cost coefficients. In general, a common country pattern regarding the trade elasticities is hard to obtain. Thus, various scholars have focused on specification issues of the underlying empirical approaches testing the validity of the so-called Kaldor paradox. Since cointegration analysis appears to be applicable only with certain limitations (Bairam (1993), Bagnai (2010)), a consensus for employing the export equation in its first difference form was established. However, Boggio & Barbieri (2017) highlight the differences in outcomes between employing the level and the first difference of relative prices and costs. According to the authors, the level version is the preferable choice in empirical applications. The relationship

[3] An important strand of literature utilising the export equation exists around the estimation and the existence of a balance-of-payments constraint for national growth. The original concept by Thirlwall (1979) builds on the standard export equation and focuses on the income elasticity, whereas the role of prices is neglected for various reasons.

[4] The expressions of relative prices and costs are used as synonyms and refer to the usually employed real effective exchange rate (REER, the nominal exchange rate corrected by nominal unit labour costs). See section 3 for theoretical substantiation.

employing the cost level, in contrast to the use of the first-difference, is significant, robust and the coefficient shows the expected negative sign. Building on related literature, two central difficulties can be identified, which significantly affect the estimation outcome: the first-difference or levels specification issue and the problematic estimation of long-term coefficients. This paper approaches these issues in a more systematic way and aims at giving conclusive evidence in order to answer pending questions. More precisely, the aim is to clarify whether standard cointegration techniques employing the basic export equation can yield robust long-run evidence and whether the impact of costs on exports is negative and significant. This will be done by a systematic replication of established approaches in empirical international economics.

In section two I explain the export demand equation - the income-and-price elasticity framework - and analyse its standard interpretation from a theoretical point of view. The necessity for employing long-run information (using variables in levels instead of first differences) is substantiated. As a next step, some recent and inconclusive empirical literature on the Euro area trade imbalances as an emblematic case is presented. Section three takes a closer look at technical difficulties coming along with the stationarity of relative prices and it discusses implications for further cointegration analysis. Building on the insights gathered, new empirical evidence is presented in section four. The export equation is tested for eleven member countries of the Euro area in the period from 1996Q2 to 2019Q2. Utilising different cointegration techniques (in particular, the estimation of an ARDL model) helps assessing whether the export equation produces robust and reliable long-run results or spurious evidence.

2.1.2 The empirical export equation

2.1.2.1 The standard export equation and the determinants of exports

Trade flows are commonly treated as being determined by the size of the world market and by domestic prices vis-à-vis the prices of foreign competitors. This causality is assumed to hold true both in a static and a dynamic sense. Respective empirical equations have become an integral part of economics:

> *"Trade equations are one of the older, and more rewarding, parts of empirical economics. Numerous standard trade equations […] have been estimated over the last 20 years or so with notable empirical success, so much that they are now an accepted part of most policy and applied academic work in international economics."* (Bayoumi, 1999, p.3)

Within the empirical standard export equation (which is primarily an import equation, explaining the foreign importers buying behaviour), the dynamics of exports x_t result as a function of foreign income y_t and of relative prices p_t:

$$x_t = \alpha + \beta_1 y_t + \beta_2 p_t + e_t \qquad (1.1)$$

According to the examples of this standard specification[5], some measure of real export flows is used as dependent variable. Either foreign real income or real expenditure is used to proxy foreign demand. The choice of the adequate relative price proxy is a more difficult issue, since the price of domestic production and of substitutes produced abroad should be put in relation to each other. Employing a version of the real effective exchange rate (REER) represents the standard for this purpose. That is the nominal exchange rate adjusted by a weighted scheme of relative export prices, wholesale prices, consumer prices, the implicit GDP deflator or unit labour costs (ULC).

Once this relationship is empirically tested, the estimated coefficients are understood as representations of the trade elasticities. The export's elasticity with respect to foreign income β_1 is expected to be positive. However, that of prices β_2 is assumed to be negative due to a falling demand curve in competitive markets[6]. When interpreting the results, it should be taken into consideration that the estimated elasticities not only reflect an identity, but rather a behavioural relation, with an economic mechanism behind it (McCombie, 1997). Hence, the export equation might explain the behaviour and the determinants of the buying decisions of final consumers as well as of suppliers of an importing foreign country. At first sight, econometric handling and economic interpretation appears to be straightforward, but it becomes more complex when inspected more closely. Indeed, the history of the export equation's application is full of debates regarding its reliability:

> *"The success of the standard trade model does not mean, however, that there are no controversies. Rather, such disagreements have centred more upon the size and importance of specific parameters and variables than on the underlying empirical approach. For example, differing views about the size of the long-run relative price elasticities has generated extensive discussions on the effectiveness of the exchange rate in altering nominal trade balances in the long-run..."* (Bayoumi, 1999, p.3)

An example of such a controversy is the strand of empirical literature trying to explain the different trade dynamics of the Euro area's member countries mentioned above. The interpretation of trade elasticities is often controversial and the results appear to be highly sensitive to the specification (i.e. levels or first-differences) of the export function.

2.1.2.2 Trade elasticities in recent literature

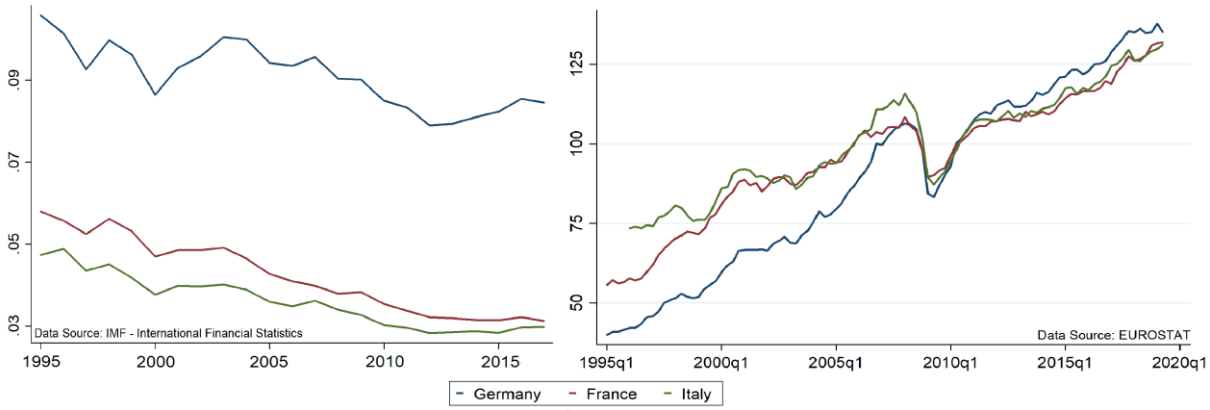
A particular empirical issue derives from the different export dynamics of Germany, France and Italy, as biggest manufacturing countries in the Euro area. The scientific debate on the driving forces of the German export success and the relative weakness of Italy and France are emblematic cases regarding the difficult handling of the export equation. While the huge German trade surplus represents the debate`s starting point, the divergence among Euro member countries in terms of real export of goods and export market shares is the more

[5] See for specification issues chapter 20 of the Handbook of International Economics (Goldstein & Khan, 1985) and for notes and history of the export equation Sawyer & Sprinkle (1997).

[6] This article focusses on the determinants of the trade of manufactured goods which represent the bulk of trade. Since competition in the market of manufactured goods is imperfect, a falling demand curve can be assumed.

interesting fact. Over the last two decades, Germany has experienced a higher export growth path (Figure 1) compared to other European industries, though before, single country dynamics had been similar up to the mid-90s.

Figure 1 Export of goods, world market share (left) and volume 2010Q1=100 (right):



In the last two decades France and Italy have lost 50% and 30% of their export world market share respectively, while Germany's share has fallen by only 15%. Ultimately, there are some signs of stabilisation, although the accumulated divergence persists. The export dynamics, expressed in growth rates (Table 1), confirm this pattern. The German export grew much faster, particularly in the period until 2009. Since then, the performance of France and Italy has been much closer to the German benchmark than previously.

Table 1: Export of goods, average annual growth rates, 1995q1-2021q1 and subperiods

Period	Austria	Belgium	Finland	France	Germany	Ireland
1995-2009	0.058	0.037	0.050	0.039	0.061	0.079
2009-2021	0.038	0.027	0.023	0.019	0.035	0.126
1995-2021	0.049	0.033	0.038	0.031	0.050	0.097
Period	Italy	Luxemb.	The Net.	Portugal	Spain	EZ11
1995-2009	0.022	0.051	0.050	0.048	0.051	0.047
2009-2021	0.028	0.033	0.037	0.047	0.039	0.036
1995-2021	0.024	0.043	0.044	0.048	0.046	0.043

Data source: Own calculation based on Eurostat national accounts database.

In search of the drivers of the dynamics described above, Breuer & Klose (2015) represent an often cited starting point for recently estimated long-run trade elasticities (timespan 1995Q1 to 2012Q4) of the Euro area countries. The estimated elasticity of German exports with respect to foreign demand is 1.75, and -0.82 with respect to the level of the ULC deflated real effective exchange rate. For Italy, the estimation yields an income effect of 0.9 and an insignificant price effect, yet with the expected sign. France is subject to a higher price elasticity of -1.73.

When comparing estimates for the German exports only, Horn & Watt (2017) estimated an income elasticity of 1.1 and a price elasticity (export deflator based REER) of -0.5. Baccaro & Benassi (2017) find significant short-run price coefficients for German manufacturing exports. According to their rolling regression model the price sensitiveness has even increased in the period from 1971 to 2014. The average coefficients from the first differences equation range

from -0.4 for ULC based REER to -0.8 for export prices in relation to import prices. The general outcome of higher income coefficients and exports being less sensitive to prices represents an empirical regularity. The majority of studies on the German case find significant price or cost elasticities with the expected sign.[7] The research of Storm and Naastepad (2015), however, represents an often-mentioned 'against the current' example in the ongoing debate. Using growth rates of income and relative ULC, they detect an insignificant coefficient for relative costs, even with a positive sign. Yet, the estimated effect size of 2.79 for the foreign income is an outstanding result. The outcome is interpreted as a consequence of Germany's extraordinary strength in terms of its corporative industrial framework and technological level, which renders export demand for its product range insensitive to changes in the industrial costs and price structure.

Due to the nature of the commodities produced, Italy's industry is often seen as being exposed to a more intense price competition than Germany (European Commission; 2010a). However, as mentioned above, Breuer & Klose couldn't find a significant price effect for Italy. Defying this result, the analysis of Paternesi Meloni (2018) provides empirical evidence for high price and cost sensitiveness of Italian exports.[8] Using level variables, the author found a remarkable long-run importance of price and cost competitiveness (with a magnitude of around -0.8 for the ULC deflated REER with respect to real exports) for Italian total exports from 1994Q1 to 2014Q1. The estimated price coefficient for various price specifications and geographic samples of trade partners often shows an even greater magnitude than the income coefficient. This holds true in particular for the export of manufacturing goods. However, in the case of the bilateral export performance a higher cost sensitiveness of Germany (-0.8) in relation to Italy (-0.3) was detected by Baccaro and Tober (2017). The sample ranges from 1999 to 2014 and uses the first-difference export equation. Giordano and Zollino (2016) employed a first-difference version in the search for determinants of the trade performance of the most important Euro area countries, too. The reported difference in unit cost sensitiveness among Germany, Italy and France for the period 1993-2012 is very small. The coefficients range from -0.3 to -0.4. Although the relevance of the price effect is confirmed in most applications of the export equation, exceptions still keep the debate on the price paradox alive.

Although the cited research is based on a version of the export equation and focuses on similar periods, it appears difficult to derive conclusive evidence. As described above, the price elasticity of German exports can be found to be higher, as well as similar, in comparison to that of Italy and France, or even to be statistically insignificant. Apparently there is a high sensitiveness of the results to the individual specification and the comparability of the cited work appears to be very low. A general country pattern of the results is hard to reproduce. This raises the need for a more systematic approach, taking the known difficulties of the export

[7] For a literature survey on the German trade elasticities, see Neumann (2020) and on the specific topic of German price elasticities, see Baccaro and Benassi (2017).

[8] European Commission (2010a), through a cross-country analysis found significant and negative price elasticity for Italy, too.

equation's econometric handling and some theoretical issues as a potential source of error more seriously into account.

2.1.2.3 Interpretative remarks

The question whether the trade performance depends more on quality or on prices must be answered by utilising the appropriate statistical methods. First of all, it seems useful to step back from empirics and to pose the question: What do the estimated coefficients tell us on a theoretical level? According to Romero & McCombie (2018), the determinants of the elasticity are not fully understood. In general, trade elasticities reflect supply side as well as demand side characteristics. Income elasticity differences are often explained by different national compositions of traded goods (McGregor & Swales, 1985) and by different productive structures (Thirlwall & Dixon, 1975). High quality commodities are assumed to be only hardly substitutable by competing goods, and their higher apparent income elasticity in combination with a low price elasticity might tell that they, therefore, do not compete on prices (e.g. Krugman, 1989). This might explain differences in income elasticities since countries specialise in the production of different types of commodities. Irrespective of how the coefficient is seen precisely, the interpretations mentioned suggest that the income elasticity catches aspects not connected to the relative price: non-price competitiveness. In the words of the European Commission non-price competitiveness is "*viewed as the sum of all factors other than prices and cost that impact on trade performance*" (European Commission, 2009, p.21). This includes product quality, design, product differentiation, liability, practicality, renovation, efficiency of sales networks and all kinds of services connected to the product.[9] A more macroeconomic interpretation is, for instance, that of firm size, taxation, and access to finance (Altomonte et al., 2013). Commonly used macroeconomic metrics are, i.e., indices of complexity or total factor productivity. Hence, the apparent income elasticity reflects aspects of the preference structure of the importing country, but mainly aspects of the productive structure of the exporting country.

The price elasticity magnitude, however, is assumed to be a result of the products substitutability and, therefore, reflects product properties, too. According to this substitutability interpretation, a country specialised in the production of qualitatively outstanding superior goods should experience a lower price elasticity of demand for its exports. As foreign competitors catch up on the technological level, price elasticity for domestically produced goods will rise. If, however, the price effect is low or even insignificant, the standard interpretation is as follows: the offered products do not compete on prices, because of their particular properties and consequently their low substitutability. On the contrary, a high price elasticity suggests that the product properties and the product range of an economy are highly substitutable by foreign goods and, therefore, the products have to be sold at a competitive price.[10]

[9] According to the European Commission (2017), product quality can be considered the most important feature of non-price competition.

[10] Krugman's (1989, p. 1031) interpretation is emblematic of the substitutability view.

In general, the determinants of the trade elasticities are assumed to be rather exogenous and to be a result of given fundamentals.[11] The effects of price changes reflected in the price elasticity estimates are often treated as being independent from the mentioned determinants of the income effect. Low or insignificant price elasticity coefficients often lead to the view that goods were sold only because of their non-price characteristics.[12]

Apart from this intuitive interpretation, one important logical link regarding the importance of the price level should be kept in mind. Within the standard model of a competitive market, the price level never loses its significance. Unless the demand curve is vertical, the magnitude of both income and price elasticity depends always on the current price level. In this sense caution is required when interpreting the empiric results. Even for the most outstanding superior commodity, the price still counts. A high utility of a good justifies a higher price only up to a certain level. An even higher price would foster the sale of competitor goods, although having much less utility. From a customer's perspective this is not only due to budgetary reasons, but also due to the important price-to-quality ratio. This implies that both effects, resulting from observable past changes of prices or foreign income, can never be disconnected from the price level. Therefore, an appropriate empirical investigation shouldn't neglect information of the prevailing relative price level.

2.1.3 The unreliable price coefficient

2.1.3.1 Historical remarks

Since the famous work of Houthakker and Magee (1969) on trade elasticities, the inconsistency of the estimated price elasticity coefficients has been a central issue. Their estimations yielded insignificant or in some cases even positive coefficients – a result which provoked questions. Morgan (1970) replied to this study, arguing that already controlling for serial correlation renders results more plausible and the price effect turns negative and significant in many cases. He concluded that "*the fact that the price elasticities are, to say the least, unreliable throws doubt on the validity of the whole exercise*" (Ibid, p.304) and that this should be a reason "*for treating the results of almost any econometric analysis of international trade with great caution*" (Ibid, p.305). His criticism was the first to point at the reliability and international comparability of the price measures available at the time. Taking aggregated values and, thus, taking many prices not important for the actual manufacturing trade into account, would bias their estimated coefficient downward, as manufacturing prices show only small changes and low variance through time. Unfortunately, there are more difficulties in this context. Hence, this section will subsequently focus on three important issues connected to the specification of the price variable and its econometric consequences.

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[11] Exceptions are, for instance, the advancements of the balance-of-payments-constrained-growth model with endogenous elasticities. For further insights see Missio et al. (2015).

[12] Kaldor (1978) interprets his findings as prices being endogenous and trade performance depending on non-price "*factors non susceptible to measurement*" (Ibid, p. 104).

2.1.3.2 First differences or levels

Surveying the empirical literature further confirms the guess that the price coefficient is the most problematic and most contended component of the export equation. In Post-Keynesian economics, the problem regarding its sign and significance attained a lot of attention. The income effect, on the contrary, never raised similar doubts. The debate's starting point was an empirical investigation on the determinants of changes in international export market shares, done by Nicholas Kaldor (1978). Relative prices and market shares of most countries under investigation increased simultaneously. The conventional wisdom about the role of prices had been questioned and the discussion about the so-called Kaldor-Paradox was born. Since then, a whole strand of literature has emerged debating the validity of the paradox. Romero & McCombie (2018) sum up the debate, stating that the majority of studies employing the standard export equation is able to find positive and significant income elasticities. In contrast, price elasticities are not significant sometimes. These statements are a response to an earlier debate, in which Razmi (2015) argued that the cost level (in this case the REER level) possesses a notably higher statistical significance explaining trade and growth performance than a periodical REER change, that is usually employed. The insignificance of prices is, therefore, purely a methodological issue. Razmi proposes to use both price level and price change in the equation. Boggio & Barbieri (2017) present further support for the relevance of the cost effect. Regressing the export growth rates on the unit cost level on a cross-country basis yields evidence in favour of the cost competitiveness hypothesis. Although the authors did a market share analysis, results can be compared with some limitation. While the unit cost level is found to be significant in explaining different export performances, its first difference is not.

Besides these purely empirical arguments in favour of the use of the level variables another interpretative reason is intuitive as well. Small but persistent growth rates of relative prices can lead to a significant gap in price or cost levels among countries. Let's assume a country having a cost level 10% above that of its competitor countries producing close substitutes. The accumulated gap may have a stronger weight on the current buying decision of potential importers than a small periodical reversal of this gap. Estimating growth rate coefficients only will not deliver a comprehensive picture. The relative price level accounts for the sum of the past periodical price movements and gives a more comprehensive picture concerning the buying criteria of potential buyers. The "short-term" first difference specification therefore doesn't take this crucial information into consideration as the price level variable is omitted. Using certain lag structures won't make up for this loss of information, since the accumulation of the gap probably does not follow a constant time pattern. Unfortunately, the econometric handling of the export equation in levels form is not as straightforward as required. According to Bairam (1993), it appears difficult to detect a cointegrating relationship among the level variables of the export equation. The "*variables in levels form are not cointegrated*" and the "*elasticity coefficients do not have any desirable properties*". He concluded that "*statistical significance of the estimated elasticities can only be tested from the dynamic* [first differences; note from the author] *specifications*" (Ibid, p.740).

In accordance with the estimation results, the author concludes that the magnitude and the significance of the estimated income effect do not change much when switching from a static to a dynamic specification. Since Bairam is interested in the size of the income effect only,

which, again, seems insensitive to the specification, the abandonment of the level equation shouldn't pose a problem for the relevance of this exercise. Possible consequences regarding the price coefficient weren't taken into consideration any further since the balance-of-payments-constrained growth literature, from where Bairam's work originates, assumes prices to have at most a very limited impact. Bagnai (2010), however, questions the preference to the first differences equation because it may contain a loss of long-run information. Switching simply from the long-term to a sort of short-term equation, without keeping the long-run information, might render the estimates biased and inconsistent. Furthermore, Bagnai argues that the differencing of variables used in a spurious level regression reduces the goodness of the fit and generates spurious significance of the effects, too. According to Bagnai, the commonly undertaken pre-differencing is not justified.

2.1.3.3 Choice of price measure

Another potential source of error is represented by the specification of the variables, since a certain margin for choosing a reasonable proxy exists. Regarding the price variable, the choice should be well-considered. The most common approaches[13] are based on terms of trade, i.e. export prices, or on relative cost structures, i.e. nominal unit labour costs, both measured in a common currency. Terms of trade denote the relation of export prices to import prices. However, it can be questioned, whether this relation, really represents the basis of decision-making for potential importers. Thus, the use of terms-of-trade is subject to criticism:

> *"The role of terms-of-trade in these equations is to capture the effect that export price have on export demand. When choosing to consume a country's exports, foreigners compare between the price of goods from that country compared to the prices of the same goods from competing exporting countries. These prices are not the same as the import prices faced by the domestic country, yet these prices are used in conventional terms-of-trade. Similarly, domestic consumers choose between purchasing imports at those prices and domestic substitutes at domestic prices."* (Duvall-Pelham, 2019, p.5)

It should be added that the export price indices only account for the price of the commodity sold, not for the price of the *relevant* competitor good not being sold, which, again, renders the measure less appropriate. The difficulty of choosing data that matches the corresponding requirements raises the need for a second-best solution. The volumes of nominal unit labour costs appear to be more reliable in this context. Unit costs is a widely used and acknowledged measure, but truly subject to some serious concerns, too. So why use unit costs as a measure to obtain information on the price sensitivity of exports? The cost per unit of output relates labour costs to the real output. An advantage of the cost approach is that, by employing real output, it accounts for productivity. In this sense, to some degree, it controls for industrial efficiency, which represents important supply side information.

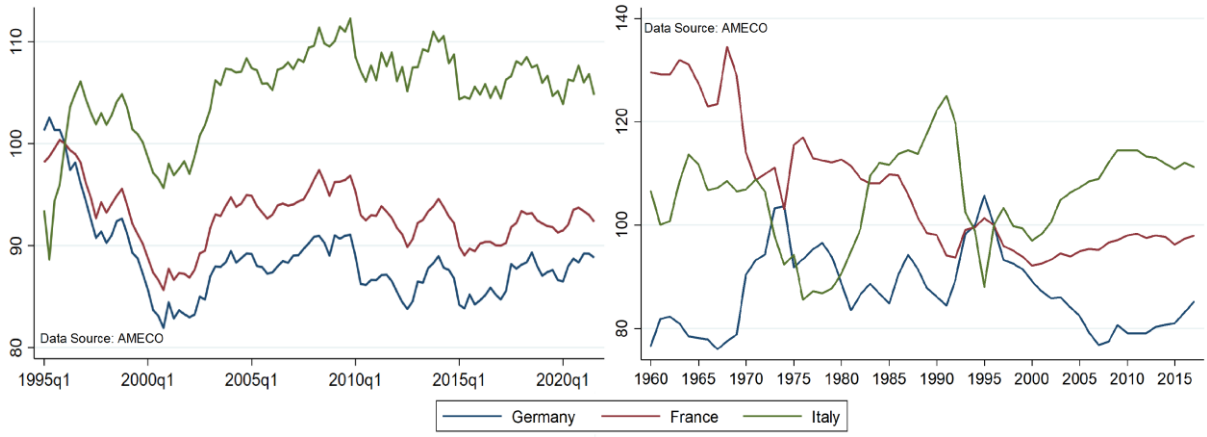
[13] See Table 2 in Neumann (2020) for a survey.

When focusing on the analysis of manufacturing trade flows, which, again, represents the bulk of trade, the market is characterised by monopolistic competition.[14] This is a situation of increasing returns to scale, characterising the supply side, where firms offer their products via mark-up on costs. In this sense, the cost per unit of output is seen as the most important basis of pricing behaviour and therefore a good proxy for the price level of domestic production.[15] Thus, it represents the basis of pricing for domestic and foreign producers, regardless whether their products have been exported or not. Furthermore, the indicator catches the whole cost structure of the national production system, which is not subject to short-term price adjustments due to reasons of competitive pricing policy. This characteristic highlights the need for employing the cost level, too.

2.1.3.4 Price stationarity and cointegration techniques

In a market economy under free trade, the price series put in relation to each other cannot diverge indefinitely due to economic reasons. The underlying question is, whether purchasing power parity (PPP) applies, since its presence implies stationarity of relative prices. As most of the recent literature suggests, the time series is mean reverting, at least in the long run (see Blecker, 2016). Prices, in a common currency, may diverge up to a certain extent for a certain period of time, but the divergence does not last. This should hold true even more in the case of a common market within a currency union without relevant trade barriers. To demonstrate this point more clearly, Figure 2 shows the real effective exchange rates of Germany, France and Italy.

Figure 2 Real effective exchange rate, ULC deflated (double export weights) , quarterly data 1995q1-2021q3, 1996q1=100 (left) and annual data 1960-2018, 1996=100 (right):



Despite periods characterized by REER divergence are significant, the extent of divergence appears to be limited in the short sample as well as in the longer one. Looking closer at the period following the fixation of exchange rates and the onset of the euro in 1998/1999, relative

[14] For instance, in the trade and growth models of Kaldor (1970) and Krugman (1979), world markets are assumed to be imperfectly competitive. The production of tradable goods would be characterised by economies of scale, which render competition monopolistic.

[15] For instance, the Deutsche Bundesbank (2016) reports a higher reliability of the GDP deflator and ULC in comparison to consumer price indices explaining trade flows.

prices have diverged steadily for 10 years.[16] Afterwards the time series partially revert. It can be observed that the single time series aren't characterised by any clear trends.

The fact that the time series of relative prices is not trending has important implications for the econometric treatment of the export equation. The most popular testing methods for long-run relationships among level variables require the involved time series to be trending, namely to be integrated of order one. For instance the Engle Granger test for cointegration or the Johansen approach[17] demand regressors to be purely I(1). While in the majority of cases the time series of exports and foreign income are clearly I(1), it appears not feasible to assume relative prices to be purely trending, either. Only the choice of rather exceptionary time spans where prices diverge, or other particular constructions of the variable, may yield a price time series which exhibits a trending behaviour.[18] It is more likely that relative prices are fractionally integrated; that is neither stationary nor non-stationary.[19] Such time series can be characterised as a long memory and slow mean-reverting process (see Habermeier & Mesquita, 1999).

In order to run a cointegration analysis the order of integration of the variables involved needs to be established. However, unit root tests, like the often used Augmented Dickey Fuller methodology (ADF), suffer from low power, when the time series is a close to, but not exactly a unit root process. Elliot (1998), for instance, reports that the ADF test is only hardly capable to distinguish an I(0.5) process from a unit root process. It is likely that a series is reported to be I(1) when in fact it is not. In order to demonstrate this point more clearly, two different unit root tests are carried out on the ULC deflated real effective exchange rate. First, an ordinary Augmented Dickey Fuller test is employed, to test whether the variable is non-stationary or not. As described above, the Dickey Fuller methodology has low power in the case of partially integrated time series. Therefore, a KPSS test (Kwiatkowski et al., 1992) is carried out to give complementary information on relative prices and whether they are stationary or not. The two methods differ in terms of their respective null hypothesis. While the ADF method tests against a null hypothesis of non-stationarity I(1), the KPSS test has a H0 of an I(0) stationary process. The sample contains the annual (1960-2018) and quarterly (1995Q1-2021Q3) REER (ULC deflated) data of eleven founder states of the Euro area.[20] The annual sample is added to the analysis for the sake of comparison only and is assumed more likely to be stationary. The quarterly sample is the same as the one that will be used later in the empirical analysis. Table 2 presents the rejection share of the respective null hypothesis at 10% confidence level. Analysing

[16] This period rather appears as an exception. In the words of the European Commission: "*The current level of divergence in competitiveness does not appear extremely large by historical standards but its persistence does*" (European Commission, 2009, p.19).

[17] This holds true in the bivariate case.

[18] For instance, Bagnai (2010) utilised the ratio of the GDP deflator and the import deflator, which yields an I(1) time series.

[19] This characterisation of time series behavior was established by Granger & Joyeux (1980) and Hosking (1981)

[20] For theoretical reason deterministic trends of the time series are not assumed. Nonetheless, where statistically significant, deterministic trends were added to the single unit root test (mainly in the quarterly sample). The general outcome was roughly unaffected.

the annual single country results, both tests suggest three cases out of eleven to be clearly stationary. Other five are reported to be non-stationary. In the other three cases the tests yield contradictory results, namely ADF non-stationarity and KPSS stationarity. Hence, the long-term sample suggests that clear non-stationarity for relative prices cannot be assumed. However, the results of the short quarterly sample are even more confusing. The tests report three cases to be clearly non-stationary and two to be clearly stationary. In six cases, the order of integration cannot be detected unambiguously. The results tend to confirm the conjecture that the relative price time series is fractionally integrated.

Table 2: Cases of H0 rejection at 10% confidence level

Method	H0	1960 - 2018	1995q1 – 2021q3
ADF	I(1)	4 / 11	6 / 11
KPSS	I(0)	5 / 11	7 / 11

Note: More detailed results are reported in the appendix in table A1.

Detecting time series spuriously as I(1) can generate spurious evidence of cointegration methods, too. The Engle Granger approach, as the most basic method testing for a long-run relationship, relies strongly on the assumption of I(1) variables. This holds true for a bivariate Johansen cointegration test as well. Considering the contradictory results obtained above, there is no surprise that researchers struggle to find a long-run relationship of the export equation variables. Since the assumption of I(1) processes is not satisfied, the problem of serial correlation of the error term is likely to occur using the cointegrating equations mentioned. Furthermore, spurious cointegration can be another possible pitfall (Gonzalo & Lee, 2000). Thus, an appropriate empirical exercise should take the points mentioned into account.

2.1.4 Inferential Evidence

2.1.4.1 Specification

Regarding the precise specification of the model and the included variables, the work of Breuer & Klose (2015) serves as point of reference. The export variable X_t^i is proxied by real export of goods (data source: EUROSTAT quarterly national accounts), accounted in US-Dollar. The countries considered ($i = 1, \dots, 11$) are Austria, Belgium, Germany, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain which all belong to the currency union of the euro.[21] Foreign income FI_t^i is measured in purchasing power parity dollar (data source: OECD quarterly national accounts) of real gross domestic product of each 45 partner countries.[22] The sample additionally contains the GDP of Australia, Argentina,

[21] The geographic sample choice was made according to obtain the maximum number of quarterly data observations.

[22] The application of the constant purchasing power parity factor (PPP) serves for a better comparability of different national income levels and results in a rescaling of the time series. For the sake of comparability of the variables, real exports have been adjusted by the same PPP factor, too. The PPP adjustment of the export time series does not qualitatively affect the results.

Brazil, Bulgaria, Canada, Columbia, Chile, Costa Rica, Czech Republic, Denmark, Estonia, Greece, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Mexico, New Zealand, Norway, Poland, Romania, Russia, Slovak Republic, South Africa, Sweden, Switzerland, Turkey, the United Kingdom, the United States and ranges from 1995Q1 to 2021Q3. The composition ought to catch the potential demand a single exporter country faces. Since the subtraction of the single-country income from world income has a rather negligible effect and the data is not weighted, the potential foreign demand, or rather foreign income, is similar for each country. On average, the annual foreign income growth rate within the sample is 1.9%, indicating that the process of economic integration was still ongoing in the period considered.[23]

As described in section three, the real effective exchange rate deflated by nominal unit labour costs (data source: European Commission Competitiveness Database) is chosen to proxy relative prices ($REER_t^i$). This includes each domestic ULC in relation to 37 partner country average ULC (annual export weights), both accounted in a common currency. The sample consists of the countries of the EU28 plus Australia, Canada, the United States, Japan, Norway, New Zealand, Mexico, Switzerland, and Turkey. In difference to the foreign income series, the sample should primarily account for the main industrial competitor nations of each country under consideration. Since there is a need for interpreting the estimated coefficients as trade elasticities, all data of the sample is expressed in logs.[24]

2.1.4.2 Methodology

The methodical response to the potential problems described in section 3 is to use various techniques and compare the different outcomes. This setting should help avoiding a pitfall due to the choice of inappropriate single techniques, which are not capable of producing reliable results. As a first step, the necessary unit root test on the variables involved will be performed. A particular test procedure has already been chosen for the case of relative prices and the time series characteristics discussed in the section 3.3. An Augmented Dickey Fuller test is carried out on the time series of exports and foreign income. The test rejects the null hypothesis of non-stationarity of the export variable in the cases of France, Finland and the Netherlands.[25] This is an unexpected result, which possibly leads to further difficulties in the estimation procedure.

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[23] The specification of the foreign income or foreign demand variable represents another sensitive issue, which, however, is beyond the scope of this paper. Nonetheless alterations of the variable are applied to assess the robustness of the results. Inspired by the work of the European Commission (2010b), export weighted metrics of foreign demand (GDP + imports) and of foreign demand for imports (imports of goods and services) will be employed. The latter cannot be interpreted as income elasticity anymore and, since the coefficient is expected to approach unity, the price coefficient estimates may result higher. Due to data availability reasons of the weighting scheme the geographic sample was shortened to 35 countries, which cover on average only 80% (compared to 87% of the 45 country sample) of the export flows of the countries under investigation.

[24] The data employed are publicly available on the national accounts database of the mentioned sources. Processed data that support the findings of this study are available from the corresponding author upon reasonable request.

[25] The stationarity of the time series in these cases is confirmed by an additional KPSS test. Results are available upon request.

However, the variable of foreign income is found to be I(1) in all eleven cases.[26] Since the method of this paper is to replicate the standard approach, single country equations will be preferred over a panel data approach. This allows for different elasticities reflecting the relevant differences in productive structures.

Surveying the empirical literature utilising the export equation, no common additional controls have been established for a variety of reasons. For instance, many studies try to control for quality or the variety of the product range by employing proxies like total factor productivity or economic complexity. The usefulness of such additional control variables can be doubted in many cases as their use gives rise to further problems like endogeneity or multicollinearity, both in statistical and in theoretical terms.[27] The particularity of the methodological setting chosen in this study is to use different estimation approaches and cointegration tests in conjunction.[28] As a first step the Engle-Granger approach is carried out based on an OLS estimation of the long-run coefficients. This method is expected to be particularly problematic since the time series involved do not meet the method's assumptions. Two additional techniques, that are expected to suit better, are chosen. First, a maximum likelihood estimation of the coefficients, within a vector error correction model, is applied. Secondly, an autoregressive distributed lag model is employed since it represents a remedy in case of spurious regression results that are due to non-trending time series of the regressors.[29] This strategy is a reaction to the stationarity issue described above and might help obtaining the long-run evidence required in the context of international trade. Furthermore, it sheds light on time series characteristics and their potential impact on the econometric outcome.

2.1.4.3 The general setting

For purposes of comparison the first task is simply to check for the short-run relationship with differenced variables. The outcome of this simple model might give a first impression how short-run differ from long-run dynamics. In doing so, the already discussed hypothesis of Bairam (1993) will be tested, estimating whether the export equation in first differences is equivalent to its levels form. The model specification is

$$\Delta X_t^i = \theta + \beta_1 \Delta FD_t^i + \beta_2 \Delta REER_t^i + \epsilon_t. \qquad (1.2)$$

Since the time series of exports and foreign income are non-stationary and the pre-differencing of the variables may result in a misspecification due to a potential omission of the long-run relationship, there is a need for employing cointegration techniques. Cointegration exists when non-stationary variables are tied together by a stationary relationship in the long-

[26] Detailed results are reported in appendix tables A1 and A2.

[27] For instance, Paternesi Meloni (2018) mentions the endogeneity issue using nominal unit labour costs and total factor productivity, which both account for national productivity dynamics.

[28] Gonzalo and Lee (1998) recommend using various techniques in order to avoid empirical pitfalls in the case of fractional integration of the time series.

[29] See Ghouse et. al (2018) for further insights on the ARDL method in the context of spurious regression.

run. The general empirical approach can be expressed by the subsequent version of the export equation:

$$X_t^i = \delta_0 + \delta_1 FD_t^i + \delta_2 REER_t^i + EC_t^i, \tag{1.3}$$

where EC denotes the error term, which represents the deviation from the assumed long-run equilibrium. Under cointegration, the whole relationship can be expressed by the following general error correction model:

$$\begin{aligned}\Delta X_t^i = \theta + \alpha EC_{t-1}^i + \sum_{n=1}^{L} \beta_1 \Delta X_{t-n}^i + \sum_{n=1}^{L} \beta_2 \Delta FD_{t-n}^i + \\ \sum_{n=1}^{L} \beta_3 \Delta REER_{t-n}^i + \epsilon_t,\end{aligned} \tag{1.4}$$

where L represents the chosen number of lags of the respective variable. This is basically equation (2) controlling for the long-run information. Since this analysis is focused on the existence of a long-run equilibrium, short-run dynamics out of the error correction model won't be taken further into consideration. The corresponding cointegrating equation is expressed by

$$EC_{t-1}^i = X_{t-1}^i - \delta_1 FD_{t-1}^i - \delta_2 REER_{t-1}^i - \delta_0. \tag{1.5}$$

The potential relationship will be tested using the following econometric techniques:

i. The short-run dynamics within equation (1.2) are estimated by means of ordinary least squares. In line with Storm & Naastepad (2015), the Prais-Winsten AR(1) estimation method will be employed additionally. This technique is capable handling the serial correlation problems.

ii. The Engle-Granger (EG) two-step procedure (Engle & Granger, 1987) is probably the most widespread method testing the empirical export equation. The first step is to estimate equation (1.3) by OLS. The second step is to conduct a unit root test on the residuals of step one. This hypothesis test uses critical values of MacKinnon (2010). One of the most critical assumptions of this method is that it demands all employed variables to be non-stationary. Lag length selection is done by the minimisation of the Akaike criterion (AIC).

iii. The Johansen approach (Johansen, 1988) works differently and is expected to eliminate some shortcomings of the residual based Engle-Granger method. In principle, the critical assumption of non-stationarity of the variables is not relaxed. However, in case of testing the presence of a cointegrating relationship in a multivariate setting among more than two variables the Johansen procedure requires only two series to be I(1), whereas the other variables can differ (Hansen & Juselius, 1995). In general, the method treats all chosen variables of the export equation as endogenous in a VAR system and allows for multiple cointegrating relationships. The long-run information is part of a short-term vector error-correction model. The cointegrating vectors are estimated by the means of maximum likelihood method. Based on Johansen's trace and maximal-eigenvalue tests the rank of the estimated long-run coefficient matrix can be specified. The rank is defined as the number of cointegrating vectors respective relationships. In the case of the export equation, only one cointegrating relationship is expected. As before, AIC was used to specify the number of lags.

iv. The residual based cointegration test within an autoregressive distributed lag model (ARDL) approach by Pesaran et al. (2001) appears to be the preferable choice for the difficult time series properties described above. In a combination of an autoregressive and a distributed lag model, an I(1) variable can be regressed on variables, whether they are I(0) or (1). The condition is that no variable is I(2) and that only one cointegrating relationship can exist. In this setting the chosen dependent variable is regressed on its own lags and contemporary and lagged independent variables via OLS. The so-called bounds test, which basically is an F test, is carried out for testing the presence of a long-run equilibrium using critical values of Kripfganz and Schneider (2018). Again, AIC was used to select the appropriate lag length.

2.1.4.4 Results

Estimating the export equation in its pre-differenced version by means of OLS (i) does not provide any surprises. The model explains on average 60% of the dependent variable's variance. The short-run income elasticity magnitudes, where significant on a 90% confidence level, range from 2 to 3. Short-run price elasticity, however, varies from -0.1 to -1.0. Since the income effect is estimated to be notably higher than the price effect, it seems reasonable to consider exports primarily driven by changes in foreign income and to highlight the importance of non-price competitiveness. Since no long-run information is included, some suspicion against the reliability of the results remains. If cointegration among the levels is detected, the results of (i) would be regarded as spurious evidence.

Table 3: Export of goods, results survey of effects size of f. income (ß1/δ1) and prices (ß2/δ2)

	(i) Δ PW		(ii) EG		(iii) VECM		(iv) ARDL	
	ß1	ß2	δ1	δ2	δ1	δ2	δ1	δ2
Austria	1.823	-0.655	**1.968**	**-1.232**	**1.941**	**-1.367**	**1.918**	**-1.277**
Belgium	1.761	-0.181	1.447	-0.682	**1.406**	**-0.651**	**1.437**	**-0.757**
Finland	1.563	-1.110	1.338	-1.803	1.076	-1.491	0.667	-6.907
France	2.874	-0.252	1.308	-0.866	1.111	-0.725	0.811	-0.039
Germany	2.337	-0.566	**1.983**	**-0.799**	**1.962**	**-1.101**	**1.965**	**-1.060**
Ireland	0.463	-1.014	2.736	-0.824	3.148	-0.985	**1.525**	**-1.862**
Italy	2.954	-0.480	**1.079**	**-0.291**	1.126	-0.305	**1.207**	**-0.460**
Luxembourg	2.348	-0.175	2.122	-0.655	**1.530**	**-0.132**	**2.117**	**-0.780**
The Netherlands	1.028	-0.494	1.941	-0.237	1.860	-0.068	1.809	-0.166
Portugal	3.230	-0.572	**1.803**	**-0.137**	**1.805**	**-0.377**	**1.772**	**-0.581**
Spain	2.863	-0.307	**1.846**	**-0.280**	1.737	-0.305	**1.656**	**-0.331**

Note: 1995q1-2021q3. Bold values in the cases ii, iii, iv signal the presence of cointegration of the underlying equation and the coefficients significance, both at 10% critical value of respective test approach. Caution is needed in case of (ii) since the OLS estimator might not have standard distribution. ß1: short-run income elasticity, ß2: short-run price elasticity, δ1: long-run income elasticity, δ2: long-run price elasticity. Detailed results are presented in appendix tables A3-A6.

Testing the levels equation (1.3) via OLS (ii) yields smaller foreign income coefficients. The magnitude varies from 1.0 to 2.7. The price effect is found to be negative and significant in ten cases and ranges from -0.2 to -1.8. The differences between short-run and long-run coefficients are notable. Different income movements appear to be strongly driving trade flows in the short run. In the long run, however, the effect size moderates and that of cost increases

significantly in most cases. Unfortunately, the evidence obtained is spurious in many cases, since a cointegration relationship is found only for five countries on a 10% confidence level. Furthermore, in all eleven cases the reported Durbin Watson statistic reveals problems of first order autocorrelation of the residuals. The DW statistic is lower than the R^2, hence the spurious regression rule of thumb[30] is violated, too. This is not a surprise considering that the necessary time-series characteristics for the Engle-Granger procedure are not given here. Proceeding to the maximum-likelihood estimation of the long-run coefficients out of a vector-error-correction model (iii) yields more promising results. At least one cointegrating vector was found in six cases on a 90% confidence level. The test statistics of five other cases miss the respective critical value by little. Once further robustness tests are applied, the results appear unstable.[31] Hence, the fact that the Johansen approach is very sensitive to changes in the lag structure holds true in this case, too. However, where cointegration is present, the income effect ranges from 1.4 to 1.9. The price effect is reported to be negative, but only in five out of six cointegrated cases it is statistically significant (Table A5). Its effect size lies between -0.3 and -1.5.

Turning to the ARDL bounds approach (iv) significantly increases the case number of robust long-run relationships (Table A6). For the cases where the null hypothesis of no cointegration is rejected by both the Johansen and the ARDL approach the estimated magnitudes are strikingly similar. The ARDL model detects robust cointegration evidence for Austria, Belgium, Germany, Ireland, Italy, Luxembourg, Portugal and Spain. No cointegration, however, was confirmed for the time series of Finland, France and the Netherlands. At this point it should be recalled, that the simple unit root test was not able to rule out the possibility of stationarity of the dependent variable of exports in exactly the same cases. Since the dependent variable is not trending in the cases mentioned, cointegrating techniques become superfluous and inappropriate. This finding suggests that the result of no cointegration in single cases can be simply due to pure statistical and methodological reasons apart from the general validity of the export equation. This outcome highlights the importance of assessing the time series characteristics carefully before deriving an appropriate estimation model. Since relative prices in most cases are neither clearly I(0) nor I(1) and in some cases exports do not tend to be trending, too, an econometric pitfall is very likely to occur.

The differences in terms of effect size, significance and cointegration among the various methods are highly significant. The Engle Granger two-step procedure does not yield reliable results, since the problem of spurious regression occurs in all eleven cases. The Johansen approach, however, is able to find cointegration in some cases. Where cointegration was detected only on a significance level below 99% the results suffer from a high instability regarding the coefficient magnitudes and the presence of cointegration when the specification is altered. The empiric example shows that the ARDL model is most likely to produce robust results and to detect cointegration among the variables of the export equation in its standard version. Departing from this conclusion, additional robustness tests altering the ARDL model

[30] This refers to the analysis of Granger & Newbold (1974).

[31] Robustness tests were carried out altering the lag length choice, the time periods, the presence of a deterministic trend in the long-run equation, the geographical sample of foreign income and the price variable metric. Results are available upon request.

specification were carried out. Rolling window Dickey Fuller tests[32] showed that in the cases of Finland, France and the Netherland the real export time series is clearly trending until 2009. For the period from 2009 to 2021 the test cannot rule out the possibility of stationarity anymore. Restricting the ARDL estimation for these three countries to the respective 'appropriate' period yields three more cointegrated cases (Table A6). This highlights the tight connection of time-series properties and the estimation outcome again. However, employing different REER deflators (Table A7), namely the GDP deflator and an export price index, offers insights on the suitability of ULC as main indicator of cost competitiveness. Compared to these alternatives, the use of ULC leads to more cointegrating relationships (11/11) than the GDP deflator[33] (6/11). Employing the export price adjusted REER leads to even less cases (5/11) of ARDL cointegration. Additionally, the validity of the general outcome is confirmed by a panel ARDL model yielding an income elasticity of 1.7 and a REER elasticity of -1.0 (Table A8).

The estimated effect magnitudes differ significantly across countries, but the pattern obtained does not fit into some of the established narratives on the causes of the Eurozone trade imbalances. On average, the income elasticity (1.8) corresponds to the foreign income to export growth ratio (1.9). Luxembourg, Austria and Germany show the highest coefficients of beyond or almost 2. Portugal, Spain, Ireland and Belgium have magnitudes from 1.4 to 1.7, whereas Italy yields ambiguous evidence with an effect of 1.2 and of 2.3 when including a trend variable. The single deviations from the average appear limited in most cases and do not allow to deduce a specific country pattern. The differences in the cost sensitiveness of exports, however, are more pronounced across countries. The lowest elasticities (-0.3 to -0.7) can be observed for Spain, Portugal, Italy and Belgium. Austrian, Irish and German exports are far more cost elastic with effect magnitudes below -1.0, confirming that their manufacturing export is significantly driven by favourable cost levels, too. It is a remarkable result that the countries experienced an above average growth of their manufacturing exports (Germany, Austria, Ireland) show the highest REER elasticity magnitudes.[34] This suggests that success on international markets still depends on competitive unit cost levels. Countries having experienced relatively lower export growth (Belgium, Italy) tend to show lower price elasticity estimates. Based on these results, it appears challenging to draw conclusions regarding the economic structure shaping the trade elasticities. The narrative that 'weak' countries suffer from their economic structure, which favours the production of more simple goods with a price sensitive demand, cannot be confirmed. 'Strong' exporting countries, on the other hand, owe their success strongly to competitive cost levels as well as to other non-price factors.

[32] The approach was specified in a way to yield the maximum time span an export series being I(1). Detailed results are available upon request.

[33] This REER metric is relative to 43 competitor countries, including China, Russia and South Korea.

[34] When altering the measure from foreign income to weighted foreign demand for imports (regression results are presented in Appendix Table A9), the outcome is affected significantly, but does notcontradict the obtained baseline results. The export elasticity with respect to foreign demand for imports approaches unity in almost every case. Highest cost elasticity magnitudes (< -2) are estimated for Austria, Ireland and Portugal. The German coefficient rests among the highest, but lacks significance. A lower or even insignificant cost sensitiveness is found for France, The Netherlands., Spain, Finland, Belgium, Italy and Luxembourg.

The sample catches all kinds of potential developments representing a challenge for the identification of a stable statistical long-run relationship: the onset of the Euro currency, divergence in terms of trade performance and cost competitiveness, economic and financial crisis and, lastly, a period characterized by parallel developments or by even convergence. On average, estimating the export equation gives a strong indication that export success in the long run depends on both price and non-price factors. The results presented here do not allow to highlight one specific competitive factor at the expenses of the other. Since the ULC adjusted REER coefficient is significant, negative and even above unity in many cases, the importance of competitive unit labour cost levels for trade success is confirmed.

2.1.5 Conclusion

In this analysis, I identify three central difficulties regarding the estimation of trade elasticities: (1) the pre-differencing of the export equation, (2) the fractionally integrated time series of the real effective exchange rate and (3) inappropriate cointegration techniques. Several studies estimating the impact of foreign income and relative prices on export dynamics have not succeeded in detecting cointegration among the variables. Thus, using pre-differenced variables is commonly considered a remedy for the cointegration pitfall. I substantiate why pre-differencing of the export equation is disputable for methodological and theoretical reasons. The resulting need for employing the equation in its levels version generates difficulties for cointegration analysis due to the time series properties of the variables involved. In case purchasing power parity is valid, the relative price time series cannot expose a clear trending behaviour. Testing the time series of the real effective exchange rate of eleven Euro area countries (by ADF and KPSS tests) confirms the theoretical conjecture: Relative unit costs are fractionally integrated, since they trend over a certain period of time before reverting back. This characteristic violates the assumptions of commonly applied long-run estimation techniques leading to problems of autocorrelation.

By utilising three different econometric techniques, which all work differently regarding the data characteristics, additional evidence is provided. The main findings can be summarised as follows: As expected, the Engle Granger two step procedure produces spurious evidence, since a cointegrating relationship cannot be detected. By having employed the Johansen approach (based on a vector error correction model) at least one cointegrating vector was found in six out of eleven cases. The ARDL model produces the most stable outcome and detects an equilibrium relationship for eight countries. In these cases, the REER elasticity is found to be significant and negative. Robust cointegration is found for Austria, Belgium, Germany, Ireland, Italy, Luxembourg, Portugal and Spain. The export elasticity with respect to foreign income varies from 1.2 to 2.1. The price effect ranges from -0.3 to -1.8. However, the three cases that are not cointegrated possess a dependent variable not clearly trending which renders common long-run estimation techniques superfluous. When considering a different period where the dependent variable is trending, cointegration can be established for Finland, France and Italy, too. Thus, provided that the methodological assumptions are met and that the model is specified with diligence, the use of the differenced export equation is neither necessary nor does it yield robust

empiric evidence. This finding confirms that the pre-differencing of variables can yield misleading spurious results and that controlling for the long-run relationship is indispensable.

Furthermore, there is neither theoretical nor empirical evidence to neglect the importance of relative prices and cost structures for exports as has been argued earlier in the literature. Diverging cost levels represent an important determinant of the observed trade imbalances within the Euro area. A remarkably high and significant cost sensitiveness can be detected, even for the most successful exporters like Germany, Austria and Ireland.

2.2 Article II:

Competing for Manufacturing Value Added: How Strong is Competitive Cost Pressure on Sectoral Level?

2.2.1 Introduction

The European manufacturing sectors have witnessed significant regional divergence in productive activity over the past two decades. This divergence is evident between the flourishing North, the declining South-West, and the catching-up East. Relative losses of manufacturing value added are considered to be particularly concerning, as they may limit future growth potential, hinder productivity progress, and reduce the range of exportable goods (Szirmai & Verspagen, 2015; Storm, 2017). Therefore, strategies aimed at enhancing or sustaining the international competitiveness of manufacturing industries are of utmost importance.

Differences in national levels of unit labour cost are considered one of the main competitive factors driving this divergence (Ederer & Reschenhöfer, 2018). Since manufacturing heavily relies on international trade and involves complex global value chains, cost competitiveness plays a crucial role not only in driving exports (Keil, 2023) but also in making relocation decisions (Da Silveira, 2014; Johannson & Olhager, 2018). Notably, cost competition is believed to primarily impact sectors with lower levels of technological sophistication and innovation (Carlin et al., 2001; Gräbner et al., 2020). Accordingly, upgrading the industrial structure in terms of innovation and enhancing product quality renders cost competitiveness less relevant or even unimportant (Milberg & Houston, 2005; Simonazzi et al., 2013). However, empirical evidence on sectoral level cost elasticities (Carlin et al., 2001; De Nardis & Pensa, 2004; Buisán et al., 2005; Imbs & Mejean, 2008; Paternesi Meloni, 2018) does not provide a conclusive picture supporting this perspective.

This paper aims to investigate the dependency of individual manufacturing industries on internationally competitive cost structures and whether the resulting cost elasticity pattern reflects the average sectoral technological advancement. These insights are crucial for shaping industrial policy considerations, as they provide valuable information on whether cost structures become less relevant or even insignificant as national industries progress and compete in markets with more sophisticated commodities. To generate precise estimates of the cost elasticity of manufacturing value added, an advanced and more appropriate nominal unit labour cost measure is employed, accounting for the cost structure along the entire value chain.

The structure of this contribution is as follows: Firstly, the importance of cost structures for industrial activities and the common interpretation of estimated cost elasticity differences will be discussed. The subsequent chapter will elaborate on the methodological approach, with specific attention to the different datasets and variables utilised. In the results section, the

empirical findings related to the research objectives of this paper will be discussed with particular emphasis on the insights obtained by using the vertically-integrated cost metric. Chapter 5 will further discuss the implications of the results and underscore both the limits and prospects of this research.

2.2.2 Background

2.2.2.1 The cost elasticity of manufacturing activity

The volume of industrial production serves as a crucial indicator, reflecting a country's level of development and economic prosperity. One compelling reason behind this lies in the pivotal role played by the industrial sector as primary driver of productivity progress, with its gains permeating throughout the entire economy (Kaldor, 1967; McCombie, 2002). Therefore, the significance of a thriving and advancing industry cannot be overstated. Notably, the manufacturing sectors within the industrial domain are particularly trade dependent, making the maintenance of international competitiveness a matter of central importance. Strategies aimed at achieving international competitiveness are commonly categorised into two main approaches: policies focused on enhancing cost competitiveness and policies aimed at improving structural factors such as market institutions or fostering an innovative environment. Some scholars consider these two ways to be dichotomous. A notable example of this perspective can be found in the work of Milberg & Houston (2005), who advocate for a high-road approach to international competitiveness through productivity-enhancing strategies rather than cost-reducing measures. Their analysis suggests that such a strategy can make the manufacturing sector highly competitive, even though it may lead to a decline in cost competitiveness due to the increasing relative cost that comes with implementing such policies. The underlying assumption here is that by expanding and upgrading the product range offered by a country's manufacturing sector, their exports become increasingly independent from their cost structures when competing in international markets. This is because industries that produce advanced goods can effectively compete based on the quality and value they offer, rather than relying on competitive pricing (Gräbner et al., 2020).[35]

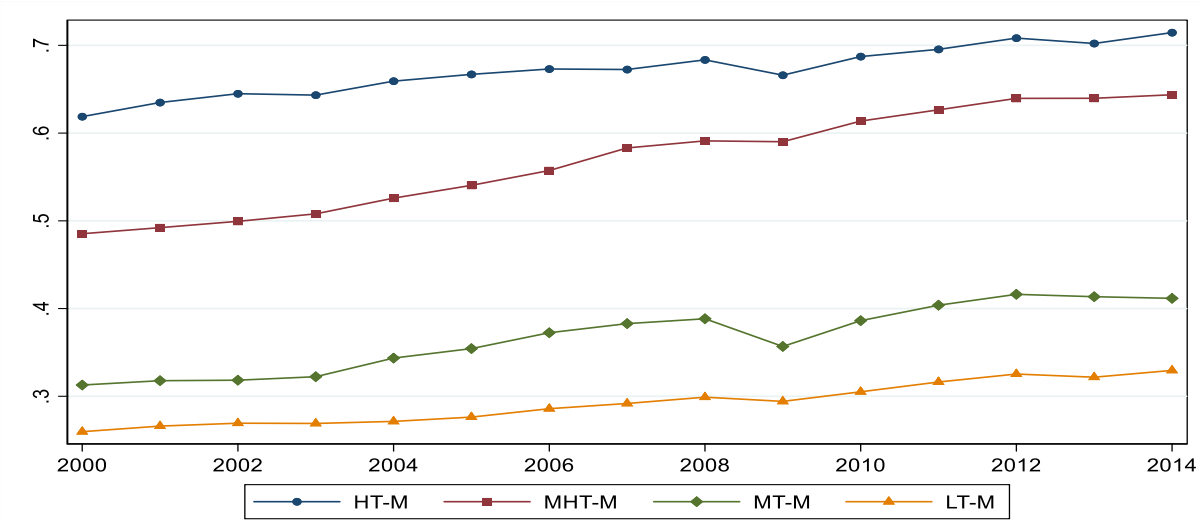
The expressed view is consistent with microeconomic standard theory, according to which cost elasticity differences on product level must be grounded in the underlying product characteristics, given that market conditions are homogenous. According to this substitutability view, a high cost elasticity signals, that the traded product can easily be substituted. A lower cost sensitiveness, however, may result from the outstanding properties (in terms of innovativeness, technology and quality) of the product rendering it very hard to substitute since only few suppliers are capable producing it. This view was confirmed on sectoral level by empirical findings from Carlin et al. (2001), who demonstrated that the sensitivity to labour

[35] The underlying assumption is that the final price setting is predominantly influenced by the unit labour cost structure. In this context, ULC has been found to be a preferable proxy for prices (Keil, 2023).

cost is lower in high-tech industries.[36] However, other studies yielded paradoxical results as a by-product of a differently focussed research. Specifically, De Nardis & Pensa (2004), Buisán et al. (2005), Imbs & Mejean (2008), Paternesi Meloni (2018), and Ederer & Reschenhöfer (2018) surprisingly found higher cost sensitiveness for the high-tech and medium high-tech manufacturing sectors. These findings question the applicability of the microeconomic substitutability view at a more aggregated level of analysis. As evidenced by Romero & McCombie (2018), it remains uncertain which factors primarily determine the magnitude of cost elasticity at the international macroeconomic level.[37]

Indeed, there may be other structural characteristics that could explain the sectoral cost elasticity heterogeneity. The observation that manufacturing activities with high research and development (R&D) intensity are more exposed to international markets (as shown in Figure 3) provides a clue in this regard. It is possible that differing market conditions, such as varying degrees of international competition, might partly explain the elasticity heterogeneity and potentially obscure the technological aspect. This is suggested by Carlin et al. (2001), who discovered that cost sensitivity became more significant for sectors in which import penetration increased substantially. This indication was further corroborated by more recent research by Ederer & Reschenhöfer (2018), who observed higher cost elasticities for sectors with above-average shares of exports in their output, indicating a higher level of export dependence for these sectors.

Figure 3 Sectoral Export Dependence (X/TOT):



Note: Sectoral export dependence = Export/Total Output (current prices). Datasource: WIOD. Sectoral classification of technological advancement: High-tech. (HT-M), Medium-high tech. (MHT-M), Medium tech. (MT-M) Medium-low tech. (LT-M).

An important aspect to consider is that manufacturing production is more and more fragmented (Baldwin & Ito, 2022) and organised in global value chains. Consequently, a low

[36] In this study, the concept of sectoral technological advancement (high-tech vs. low-tech) refers to the levels of innovative activity, (sectoral R&D intensity) as proposed by Galindo-Rueda & Verger (2016).

[37] Even technical reasons can lead to biased estimates, as highlighted by Imbs & Mejean (2015), who point out that aggregate price elasticities may suffer from heterogeneity bias.

price sensitivity for the final high-tech good may not necessarily imply the same for certain stages of its production. It can be assumed that the principle of global cost arbitrage (Palley, 2015) applies equally to the production of advanced goods. Accordingly, multinational corporations manage their value chains and decide where value creation takes place. Offshoring and foreign direct investment decisions are driven by the objective of combining high productivity with low labour costs, leading to the pursuit of monopoly rents (Kaczmarczyk & Flassbeck, 2023). Indeed, micro-level studies based on surveys (Da Silveira, 2014; Johannson & Olhager, 2018) have confirmed that cost differentials play a crucial role in offshoring decisions. This aspect should hold true especially for research-intensive manufacturing sectors, where cost levels are high, and the cost differential with other countries may be substantial.

2.2.2.2 Key inquiries of the study

The primary research question addressed in this study revolves around the degree of dependence of individual manufacturing industries on competitive cost structures. However, when examining data at the level of sectoral aggregation, it is essential to recognise that certain variations in functional specialisation and in the degrees of outsourcing and offshoring within sectors across countries might be concealed. By assessing sectoral cost elasticity heterogeneity, the study aims to test the hypothesis that strategies promoting industrial specialisation towards more advanced manufacturing production can disregard cost competitiveness. This hypothesis needs to be substantiated while considering the broader context of the heightened export dependence observed in more advanced manufacturing sectors, which could suggest a more intense level of international competition in these markets. As demonstrated earlier, the concept of competitiveness exerts its influence on various dimensions of manufacturing productive activity, which underscores the need for comprehensive consideration that goes beyond a mere analysis of exports. Accordingly, this study combines two advanced measures. Firstly, it adopts national shares of sectoral manufacturing value added as the left-hand side variable, as proposed by Ederer & Reschenhöfer (2018). This choice is motivated by the earlier discussed principle of global cost arbitrage acknowledging the vertical dimension of production. The management of value chains by multinational corporations with market power introduces the possibility of relocating or outsourcing individual intermediate production stages, indicating the importance of extending the analysis beyond exports. A central advantage of the measure of value added is that it does not account for the import content integrated within export flows, providing a more accurate representation of sectoral productive activity.

Secondly, the study utilizes vertically-integrated nominal unit labour cost based on input-output data as the main explanatory variable. This metric was originally proposed as a measure of real ULC by Grodzicki & Skrzypek (2020) and effectively reflects the cost situation of an entire sectoral value chain.[38] The productive fragmentation, combined with the general cost differences, such as variations in wages and productivity among sectors and countries, leads to cost structures that differ from those of the sector, where the final production takes place.[39]

[38] See also Marczak & Beissinger (2022) for a detailed documentation and description of the metric.

[39] Indeed, Ahmed et al. (2017) observed that the increasing participation of manufacturing industries in global value chains (GVC) reduces the impact of sectoral and national cost structures on exports. In the context of Germany, the importance of the input structure for the cost metric was emphasised from a different perspective by

Consequently, the vertically integrated indicator considers not only the average sectoral unit labour cost of the sector itself but also the input-weighted unit labour cost of all input sectors. Another distinctive aspect of this study is the pooling of sectoral data across countries. By doing so, manufacturing sectoral activity will be represented more holistically, irrespective of the country-specific functional specialisation.

2.2.3 Empirical approach

2.2.3.2 Dataset

The empirical task of this study involves testing the relationship between sectoral relative value added and vertically integrated unit labour cost using two different panel datasets. The first dataset spans 23 years (1995-2018) but does not include vertically integrated figures. The second dataset covers a narrower period from 2000 to 2014 due to the time dimension of the World Input-Output Database (WIOD; Timmer et al., 2015), whose information was used for calculating the vertically integrated cost measure.[40] Both datasets consist of 18 sectors (as shown in Table 4) and 28 countries (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, The Netherlands), forming the panel unit of a country-sector. Incomplete panels, may caused by the nonexistence of a particular sector in a smaller country in some period, are excluded from the analysis. Furthermore, the sectoral sample is categorised into two subsets: more advanced (research-intensive) sectors in terms of technological sophistication (HT & MHT) and less advanced sectors (MLT & LT).

Ludwig et al. (2010) and similarly later by Herrero & Rial (2022). The authors found that the German industry significantly benefited from cheaper domestic service sector inputs, based on labour cost, in comparison to other European countries. However, when solely considering the relative industrial cost, the advantage of the German industry was not observable.

[40] WIOD comprises data for 56 sectors across 42 countries. The geographic coverage was narrowed down to 28 countries, due to data availability constraints for supplementary data. The analysis excluded the manufacture of coke and refined petroleum products (C19) due to its notably high variability in value-added, which introduced significant distortions in the variables.

Table 4: Sectoral sample (Total sector figures of 28 countries)

Code	Sector description / Manufacturing activity	TC	II	SX	XT
C10C12	Food products, beverages and tobacco products	LT-M	0.01	0.08	0.24
C13C15	Textiles, wearing apparel and leather products	LT-M	0.01	0.04	0.57
C16	Wood and of products of wood and cork	LT-M	0.01	0.01	0.26
C17	Paper and paper products	LT-M	0.01	0.02	0.43
C18	Printing and reproduction of recorded media	LT-M	0.01	0.00	0.09
C20	Chemicals and chemical products	MHT-M	0.07	0.09	0.60
C21	Basic pharmaceutical products	HT-M	0.28	0.05	0.69
C22	Rubber and plastic products	MT-M	0.04	0.03	0.41
C23	Other non-metallic mineral products	MT-M	0.02	0.02	0.24
C24	Basic metals	MT-M	0.02	0.06	0.51
C25	Fabricated metal products	LT-M	0.01	0.03	0.26
C26	Computer, electronic and optical products	HT-M	0.24	0.09	0.78
C27	Electrical equipment	MHT-M	0.06	0.05	0.58
C28	Machinery and equipment	MHT-M	0.08	0.11	0.61
C29	Motor vehicles, trailers and semi-trailers	MHT-M	0.15	0.14	0.60
C30	Other transport equipment	MHT-M	0.20	0.04	0.70
C31C32	Furniture; other manufacturing	MT-M	0.03	0.03	0.48
C33	Repair and installation of machinery and equipment	MT-M	0.02	0.00	0.09

Note: NACE2 two-digit level. TC: Sectoral classification of technological advancement: High-tech. (HT-M), Medium-high tech. (MHT-M), Medium tech. (MT-M) Medium-low tech. (LT-M). II: Investment Intensity (R&D/VA). SX: Sectoral share in total manuf. exports (2000-2014 average). XT: Export dependence (2000-2014 average) calculated as nominal export volume in total output.

2.3.3.2 Specification

$$\mathrm{VAS}_t^i = \mathrm{RGDP}_t^{i\,\delta_1^i} \mathrm{ULC}_t^{i\,\delta_2^i} \qquad (2.1)$$

The variable to be explained in this study is the value-added market share (VAS) of a country-sector combination.[41] As depicted in equation 2.1, VAS will be explained by a measure of the relative size of the domestic economy (RGDP) and relative cost (ULC). Value added is defined as gross output less intermediate consumption of an industrial sector and is expressed in nominal terms in Euro. To calculate the respective shares, the denominator contains the sum of the sectoral value added of the overall country sample for the respective sector.

The relative real domestic GDP (RGDP) captures the domestic market effect not connected to the cost structure. To approximate this effect, the size of the nominal domestic product (C+I+G) relative to the total domestic product of the sample is employed.A change in proper VA market shares can have reasons different from changes in ULC. An important factor may be the pure variety of goods offered on international markets. As countries grow, they upgrade their industrial structures and expand their tradable product range. In doing so, their sectoral value-added market share will rise, and that of other countries will subsequently fall without any change in ULC. As an alternative to RGDP, the nominal GDP per capita (NGDP) was employed in relative terms, which reflects also the strength of the currency.

[41] The dimension chosen is that of a country-sector, such as the French chemical industry. This allows to account for different economic dynamics across countries and, when utilised in a panel structure, to gather general insights on sectoral characteristics, irrespective of the geographic background and its functional specialisation.

ULC depicts the central explanatory variable and serves as a measure of cost competitiveness based on the concept of nominal unit labour cost. It is derived by dividing nominal wages by real labour productivity. Beside informing on the cost situation, the unit labour cost measure also incorporates information on the relative stance in terms of productivity, that is considered an important aspect of non-price competitiveness (Giordano & Zollino, 2016).[42] This combination of cost and non-cost factors gives the ULC variable significant explanatory power in analysing exports or value added in international comparative perspective.

The ULC variable can be expressed in two ways: as the direct sectoral average (SULC) for the longer dataset or as a vertically integrated metric (VULC) for the dataset with a smaller time dimension, limited by the WIOD source. The VULC metric compares the unit labour cost of a vertically integrated system (e.g., the French chemical industry) to its European competitors (e.g., the European chemical industry). Consequently, the cost figure of such a vertically integrated system includes the average unit labour cost of the sector under scrutiny and that of the weighted domestic and foreign input sectors. This approach enhances the accuracy of the ULC measure and enables a comprehensive assessment of the cost competitiveness of manufacturing industries in comparison to their competitors. The calculation approach, which is based on Grodzicki (2014), is described in detail in appendix B.

2.3.3.3 Empirical Setup

The active literature on international competitiveness highlights that estimating the price and cost elasticities is not as straightforward as it may initially seem. Therefore, it is essential to draw insights from the export equation literature and apply them to the value-added equation proposed in this study. Given the similarity in time series properties of the variables involved, it is appropriate to test the relationship in levels while appropriately accounting for serial correlation and being aware of the time series characteristics of the variables (Keil, 2023). Generally, an autoregressive distributed lag model (ARDL; Pesaran et al., 1999) is employed in this study, as it allows for the inclusion of long-run level variables as regressors and provides a solution to address the problems of serial correlation and fractionally integrated variables.[43] The issue of time series characteristics is addressed by a CADF unit root test, and the results in Table 5 indicate a mix of I(0) and I(1) variables that are at least difference stationary.[44]

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[42] Some scholars propose to employ measures as the number of patents, the R&D expenditure or an index of economic complexity (ECI) to control more explicitly for non-price competitiveness. However, the first two options could not be constructed due to data availability constraints. The ECI (Source: Growth Lab at Harvard University) was tested as an additional variable.

[43] To examine the presence of cointegration, an error-correction approach following Westerlund's methodology (2005) was adopted. Results are presented in Tables A4 & A6.

[44] To ascertain the order of integration of the variables under consideration, a series of panel unit root tests were conducted: LLC test (Levin et al., 2002), HT test (Harris & Tzavalis, 1999), CADF test (Pesaran, 2007). The results are presented in Table A3.

Table 5: CADF test statistics

Variable:	VAS	RGDP	NGDP	VULC	SULC	NULC
1995-2018	-1.736	-1.745	-1.531	-/-	-2.008***	-/-
2000-2014	-1.579	-1.669	-1.449	-2.230***	-2.052***	-2.610***

Note: Covariate-Augmented Dickey Fuller test. H(0): Non stationarity. Critical values: 1% ***; 5% **; 10% *. Lag length choice according to AIC min. Detailed results from panel unit root test in Table A3.

The long-run equilibrium (2) of the basic relationship (1) and the respective error correction model (3) are expressed as follows

$$\mathrm{VAS}_t^i = \mathrm{C}^i + \delta_1^i \mathrm{RGDP}_t^i + \delta_2^i \mathrm{ULC}_t^i + \nu_t^i, \tag{2.2}$$

$$\begin{aligned}\Delta\mathrm{VAS}_t^i = {} & \mathrm{C}^i + \alpha^i \mathrm{VAS}_{t-1}^i + \eta_1^i \mathrm{RGDP}_{t-1}^i + \eta_2^i \mathrm{ULC}_{t-1}^i + \beta_1^i \Delta\mathrm{VAS}_{t-1}^i + \\ & \beta_2^i \Delta\mathrm{RGDP}_{t-1}^i + \beta_3^i \Delta\mathrm{ULC}_{t-1}^i + \epsilon_t^i.\end{aligned} \tag{2.3}$$

Since all variables are expressed in logs, δ_1 and δ_2 denote value added elasticities with respect to the domestic-market effect and to cost, respectively. These long-run elasticities are calculated using the estimated coefficients ($\delta = -(\eta/\alpha)$) from the equation (2.3). An important issue to be addressed is the potential heterogeneity across panels. If sector-country heterogeneity of the long-term slope coefficients can be expected, the mean group estimator (MG) proposed by Pesaran and Smith (1995) is employed to produce consistent results. Given that *i* identifies the panel unit, the MG estimator equals

$$\hat{\delta}^{\mathrm{MG}} = 1/\mathrm{N} \sum_{i=1}^{N} \hat{\delta}^i. \tag{2.4}$$

If, however, slope homogeneity is the case among the long-run regressors, the preferable technique is the pooled mean group model (PMG) introduced by Pesaran et al. (1999), which is considered the more efficient estimator in such cases. The short-term dynamics, error variance, and intercepts are allowed to vary.[45] The Hausman test is employed to check whether heterogeneity or homogeneity among the long run regressors prevails. Moreover, to address the issue of cross-sectional dependence (CSD), cross sectional averages (CSA) are introduced to the model.[46] Hence, a dynamic common correlated effects (CCE) model as proposed by Chudik & Pesaran (2015) is estimtad. The ECM (3) in its mean group version then becomes a CCEMG model:

$$\begin{aligned}\Delta\mathrm{VAS}_t^i = {} & \mathrm{C}^i + \alpha^i \mathrm{VAS}_{t-n}^i + \eta_1^i \mathrm{RGDP}_{t-n}^i + \eta_2^i \mathrm{ULC}_{t-n}^i + \beta_1^i \Delta\mathrm{VAS}_{t-n}^i + \\ & \beta_2^i \Delta\mathrm{RGDP}_{t-n}^i + \beta_3^i \Delta\mathrm{ULC}_{t-n}^i + \textstyle\sum_{n=1}^{L} \beta_4^i \mathrm{CSA}_{t-n} + \epsilon_t^i.\end{aligned} \tag{2.5}$$

[45] In contrast to the MG estimator, the long-run coefficients are not unit-specific anymore. Moreover, fixed T adjusted standard errors were calculated to address the issues of autocorrelation and heteroscedasticity, as proposed by Westerlund et al. (2019).

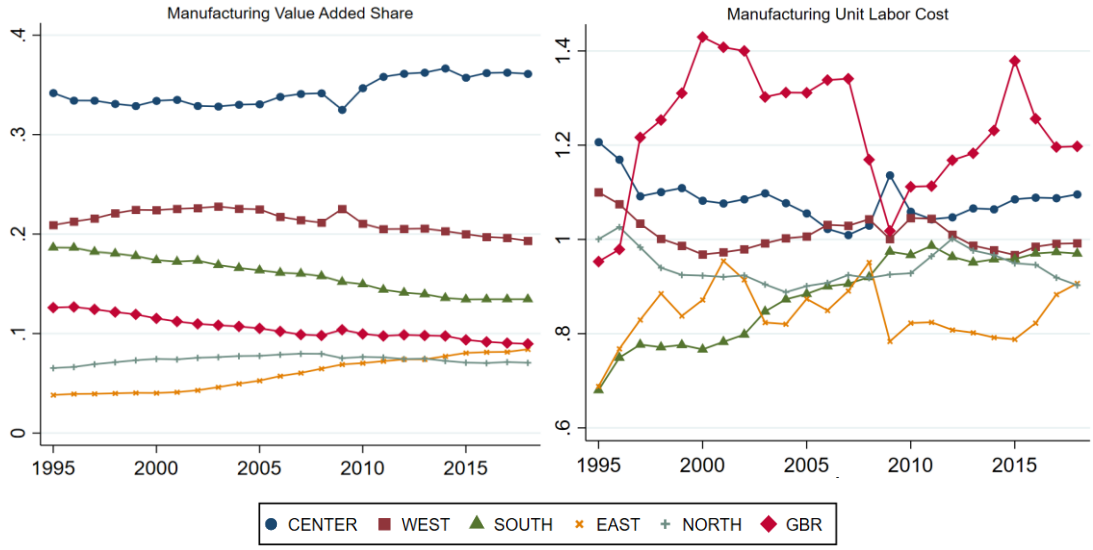
[46] The CD test (Pesaran, 2015) is employed testing for weak cross-sectional dependence (CSD). Furthermore, the exponent of CSD is estimated following Bailey et a. (2019).

2.3.4 Results

2.3.4.1 Descriptive Evidence

The descriptive evidence reveals significant shifts in the manufacturing value added shares across European countries. The left panel of Figure 4 presents the total manufacturing value added share dynamics for exemplary country clusters. Eastern European countries have made substantial progress and demonstrated catch-up growth, doubling their manufacturing value added shares during the period from 1995 to 2018. The central cluster comprising Germany, Austria, and the Netherlands also experienced notable growth, increasing their value added share by 5%. In contrast, Western and Southern European countries faced significant declines in terms of VAS. Notably, Italy and the United Kingdom, lost roughly 20% of their initial market share (detailed figures for 2000-2014 are presented in Table A1).

Figure 4: Manufacturing Value Added Market Shares and ULC of Major Economic Clusters



Note: 1995-2018. Left panel: VAS. Right panel: SULC. CENTER: Germany, Austria, The Netherlands; WEST: France, Belgium, Spain; SOUTH: Italy, Greece, Portugal; EAST: Czechia, Poland, Hungary, Estonia, Lithuania, Latvia. NORTH: Denmark, Sweden, Finland, Norway. GBR: United Kingdom. Datasource: EUROSTAT.

In the right panel of Figure 2, the trends in sectoral unit labour cost (SULC) are displayed. For the catching-up eastern states, clear trends in their SULC are challenging to detect due to the relatively high volatility. In absolute terms, the advantage in SULC was maintained. However, the industrial core, comprising central and western countries, shows much less variation in the cost dynamics. Their industries have managed to maintain or even to increase their sectoral levels of cost competitiveness. Notably, a significant gain in sectoral unit labour cost is recorded for the German industry, particularly up to 2007 (see Table A1 for more detailed figures). On the contrary, the competitive stance of the south, especially Italy and

Greece, significantly worsened. Also the SULC dynamics of the United Kingdom exhibit high volatility, resulting in a net loss of cost competitiveness by more than 25%.[47,48]

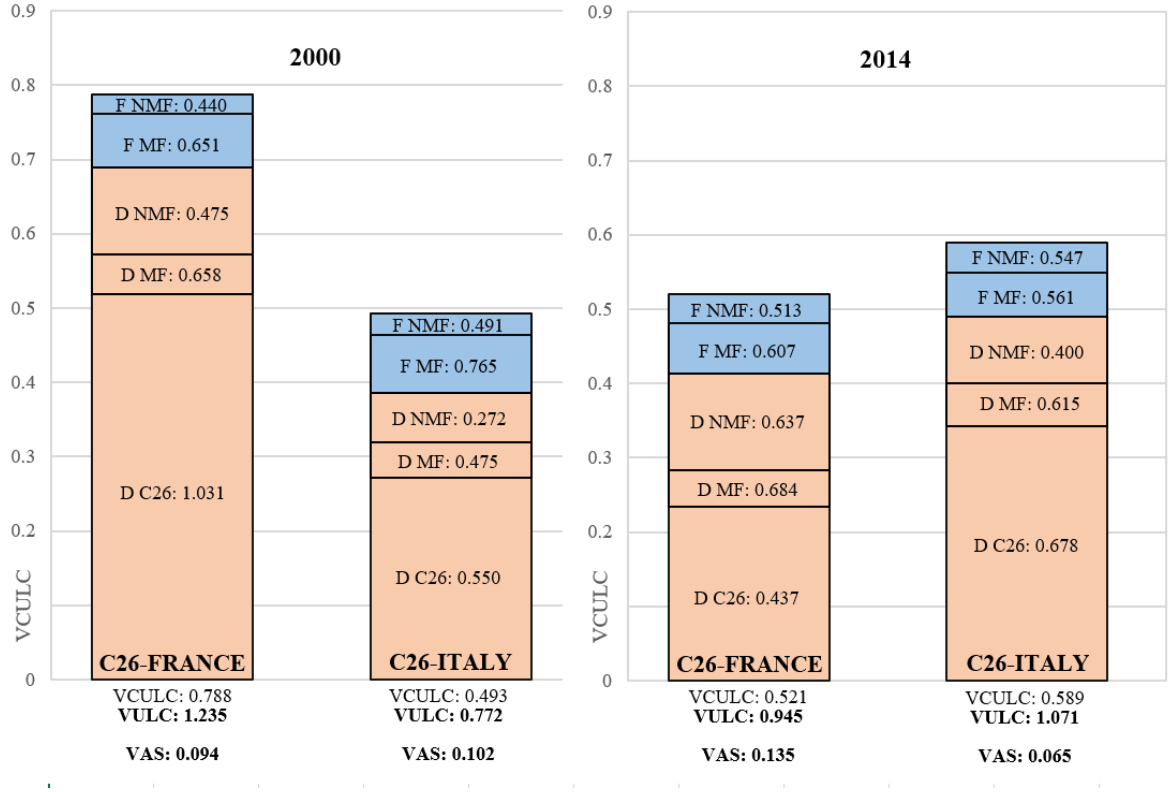
Subsequently, the study aims to extend its analysis beyond the direct sectoral level to uncover additional insights. For the purpose of highlighting the significance of using the vertically integrated metric, the cost situation of the manufacturing of computer, electronics, and optical products (C26) in France will be compared with its Italian counterpart (Figure 5). Notably, both the French and Italian C26 sectors share structural comparability, signifying analogous input compositions within their respective industries. Over the years, there has been a decline in inputs sourced domestically from both manufacturing and non-manufacturing sectors, indicating an increasing reliance on foreign inputs. However, France and Italy exhibit contrasting dynamics regarding their cost competitiveness and market shares throughout the study period. In the year 2000, both France and Italy had similar value-added market shares (VAS) of roughly 10% in the C26 sector. Over the course of the following 14 years, their VAS diverged significantly, with France's market share increasing to 14%, while Italy's share declined to 7% by 2014. The trend in vertically integrated cost (VULC) followed an opposite pattern. France's VULC improved by 23% (1.2 to 0.9), while Italy experienced a deterioration of 38% (0.7 to 1.1) in its cost competitiveness.

The decomposition of the VULC allows to identify the sectoral drivers of these changes in competitiveness. For France, the improvement in competitiveness was fostered by lower input costs of C26 (SULC fell from 1.0 to 0.4) itself and foreign manufacturing (-7%). However, the unit labour cost of non-manufacturing inputs increased. In contrast, for Italy, the input cost increased across all domestic intermediates (C26: +23%; manufacturing: +30%; non-manufacturing: +47%), while the cost of foreign manufacturing inputs decreased (-27%). n 2014, for every Euro of C26 value added, France incurred labour costs (VCULC) of 0.52€, whereas in Italy, it amounted to 0.59€ (see right panel of Figure 5). From a comparative perspective, the Italian cost disadvantage mainly results from the uncompetitive unit cost level of its domestic inputs, while the foreign input cost is comparable to that of France.

[47] The high British SULC volatility can be attributed to fluctuations in the exchange rate between the British Pound and the Euro. The underlying British absolute national and total manufacturing ULC (both expressed in volumes) grew significantly faster than the European average. However, when focussing on the narrower period (2000-2014, Table A2), the British industry appears to have gained competitiveness.

[48] ULC gives an indication whether cost competitiveness changes rather than giving a precise information on the competitiveness level (see Herzog-Stein et al. 2013 for further discussion). This fact might further explain the situation in some Eastern European states. Since their initial competitive stance can be favourable in terms of relative cost due to low labour cost, a subsequent decline in competitiveness can nonetheless coincide with an increase in market shares.

Figure 5: Decomposed VCULC/VULC C26 France-Italy 2000/2014



Date Source: Own elaboration of data from EUROSTAT and WIOD. D: Domestic. F: Foreign. MF: Manufacturing Sectors. NMF: Non-manufacturing Sectors. VCULC: Vertically integrated Unit Labour Cost (absolute values). VULC: VCULC in relation to VCULC of European competitors.

Table 6 shows the dynamics of the central variables for 5 selected countries (the dynamics of the entire sample of countries is shown in Table A2). The representative selection of advanced sectors (C20, C21, C26, C28, C29) accounts for more than 50% of total manufacturing exports. From the data, the close relationship between cost and market shares becomes evident. When cost competitiveness deteriorates, industries lose value-added shares, indicating that cost plays a critical role in determining competitiveness. On the other hand, industries that maintain or improve a favourable cost structure of their value chain are more likely to see an increase in their market shares. One striking observation is the significant difference in value chain cost (VULC) dynamics compared to their sectoral (SULC) and national counterparts (NULC). The variation in VULC is less pronounced. This shows that the productive fragmentation affects the cost situation of the production significantly and demands to take this fact into account. Notably, the data reveals distinct patterns for Italy and Germany. Italy is experiencing a decline in market shares and competitiveness in many sectors, with the exceptions of mechanical engineering (C28) and chemicals (C29). On the contrary, Germany is seeing an increase in market shares and competitiveness in most sectors.

Table 6: Sectoral value-added shares, sectoral SULC and sectoral vertically integrated VULC

	VAS			SULC			VULC		
	2000	2014	+/-	2000	2014	+/-	2000	2014	+/-
BEL-C20	0.070	0.062	-11.2%	0.893	1.034	15.7%	0.954	1.011	6.0%
DEU-C20	0.337	0.350	3.7%	1.017	1.054	3.6%	1.018	1.041	2.23%
ITA-C20	0.111	0.083	-24.8%	0.733	1.041	41.8%	0.807	0.970	26.9%
ESP-C20	0.086	0.078	-27.7%	0.799	0.972	21.6%	0.858	0.933	8.7%
CZE-C20	0.006	0.008	24.6%	0.745	0.923	23.7%	0.769	0.915	18.9%
BEL-C21	0.040	0.059	47.2%	1.060	0.955	-9.1%	1.127	1.063	-5.7%
DEU-C21	0.203	0.221	8.7%	1.069	1.018	-4.7%	1.121	1.082	-3.5%
ITA-C21	0.101	0.081	-19.5%	1.324	1.287	-2.7%	1.125	1.134	0.7%
ESP-C21	0.057	0.078	37.4%	1.042	1.021	-0.1%	1.018	0.942	-7.4%
CZE-C21	0.006	0.007	18.3%	0.318	0.617	93.8%	0.597	0.875	46.5%
BEL-C26	0.016	0.013	-21.3%	1.283	1.023	-20.2%	1.176	0.993	-15.5%
DEU-C26	0.176	0.363	105.4%	1.469	0.987	-32.8%	1.335	1.000	-25.0%
ITA-C26	0.102	0.065	-36.0%	0.738	1.293	75.2%	0.772	1.070	38.4%
ESP-C26	0.036	0.017	-57.8%	1.022	1.107	8.3%	0.952	1.011	6.1%
CZE-C26	0.003	0.019	404.0%	0.949	0.636	-33.0%	1.004	0.766	-23.6%
BEL-C28	0.019	0.015	-20.0%	0.853	0.995	16.5%	0.942	1.003	6.4%
DEU-C28	0.454	0.411	-9.5%	0.966	1.109	14.7%	1.004	1.075	7.0%
ITA-C28	0.156	0.160	2.4%	0.872	0.927	6.25%	0.825	0.906	9.8%
ESP-C28	0.041	0.031	-24.7%	0.893	0.894	0.0%	0.889	0.868	-2.2%
CZE-C28	0.007	0.018	157.6%	1.030	0.802	-22.1%	0.857	0.848	-1.0%
BEL-C29	0.030	0.014	-54.1%	0.979	1.561	59.5%	0.996	1.232	23.7%
DEU-C29	0.438	0.554	26.5%	1.113	0.964	-13.3%	1.066	0.989	-7.2%
ITA-C29	0.103	0.052	-48.7%	0.776	1.186	52.8%	0.767	1.012	31.8%
ESP-C29	0.076	0.051	-33.5%	0.971	1.065	9.7%	0.941	0.988	5.0%
CZE-C29	0.010	0.031	200.2%	0.784	0.800	1.9%	0.819	0.872	6.4%

Note: More results available upon request. Data Source: Own elaboration of data from EUROSTAT and WIOD. More detailed results in appendix Table A2.

2.3.4.2 Long-run evidence: The general relationship

The empirical analysis begins with the sectoral sample covering the years 1995 to 2018, accounting only for the direct sectoral ULC (SULC). The outcomes for various samples are summarised in Table 7. As the Hausman test indicates heterogeneity in the long-run coefficients across all specifications (see Table A4), the results reported in this section are solely those obtained through the MG estimator (PMG estimates are reported in Tables A4 & A6). An increment of 1% in the relative domestic GDP corresponds to a 1.3%-1.6% rise in manufacturing value-added shares (models 1.1 & 1.2). Reducing the sectoral unit cost level compared to its competitors by 1% leads to a gain of 0.7%-0.9% in value-added shares in the long run (Models 1.1 & 1.2; differing lag structures). Incorporating the nominal GDP as an alternative control for the domestic market effect (Model 1.3) does not substantially alter the results. The economic complexity index, introduced as a control for structural competitiveness (Model 1.4), is observed to be statistically significant only in isolated instances, and does not impact the magnitude of cost elasticity. A notable distinction emerges when the sample is stratified into more and less advanced manufacturing sectors (models 1.5 & 1.6). Sectors classified as medium to high-tech manufacturing (MHT), which are characterised by being strongly export-oriented industries, demonstrate a cost elasticity of -0.9. Conversely, sectors with lower advancement (MLT) and a stronger focus on the domestic market exhibit a cost coefficient of -0.6.

Table 7: long-run estimates (MG) from panel ARDL model (5). Sample I

	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)
DV:	VAS	VAS	VAS	VAS	VAS	VAS
ULC:	SULC	SULC	SULC	SULC	SULC MHT	SULC MLT
δ1	1.579***	1.292**		0.298	1.351	1.686*
	(0.369)	(0.645)		(0.346)	(0.851)	(0.940)
δ2	-0.867***	-0.698**	-0.539***	-0.699***	-0.876***	-0.659**
	(0.099)	(0.342)	(0.151)	(0.102)	(0.117)	(0.321)
δ3			1.215***			
			(0.349)			
δ4				0.308*		
				(0.054)		
α	-0.707***	-0.856***	-0.950***	-0.723***	-0.713***	-0.720***
	(0.017)	(0.026)	(0.248)	(0.021)	(0.031)	(0.031)

Note: 1995-2018. Critical values: 1% ***; 5% **; 10% *. Adjustment coefficient α and long-term coefficients δ1 (RGDP), δ2 (SULC), δ3 (NGDP) from ARDL equation (2.5). The ECI coefficient is denoted by δ4. Standard errors in brackets. MHT: Sectors classified HT-M and MHT-M. MLT: Sectors classified MT-M and LT-M.

Using the second dataset that incorporates VULC is anticipated to yield more precise effect sizes, as it more accurately captures the actual sectoral cost pressure of sectoral production. Nonetheless, the narrower time span of this dataset (2000-2014) presents challenges to the estimation process due to low degrees of freedom. However, the hypothesised cointegrated relationship between VAS and VULC generally holds across all specifications (Table 8 and Table A6). The VULC coefficients are higher (-1.3) than those associated with sectoral (-1.0) cost levels (Models 2.5/2.6). Notably, the national ULC metric (Model 2.4) does not significantly impact the performance of individual industries. The trends concerning the sensitivity of different sector groups to cost are reaffirmed using the new metric, and in fact, the distinctions are even more accentuated when compared to sample I. Specifically, the cost coefficient is higher for advanced export-oriented industries (-1.8) than for medium low-tech and low-tech domestic-oriented industries (-1.0). To more explicitly account for the potential influence of international competition on the magnitude of cost elasticity, an interaction term is introduced (Model 2.7).[49] However, its coefficient does not yield statistical significance. Therefore, variations in the sectoral export share do not seem to elucidate the magnitude of cost elasticity within a specific country-sector context.

[49] The interaction term is formed by multiplying VULC with the export share in the overall sectoral output and is considered in the long-run relationship. As the export share (XT) is derived from WIOD, its temporal scope is limited to the timeframe from 2000 to 2014 (Sample II).

Table 8: Long-run estimates (MG) from panel ARDL model (5). Sample II

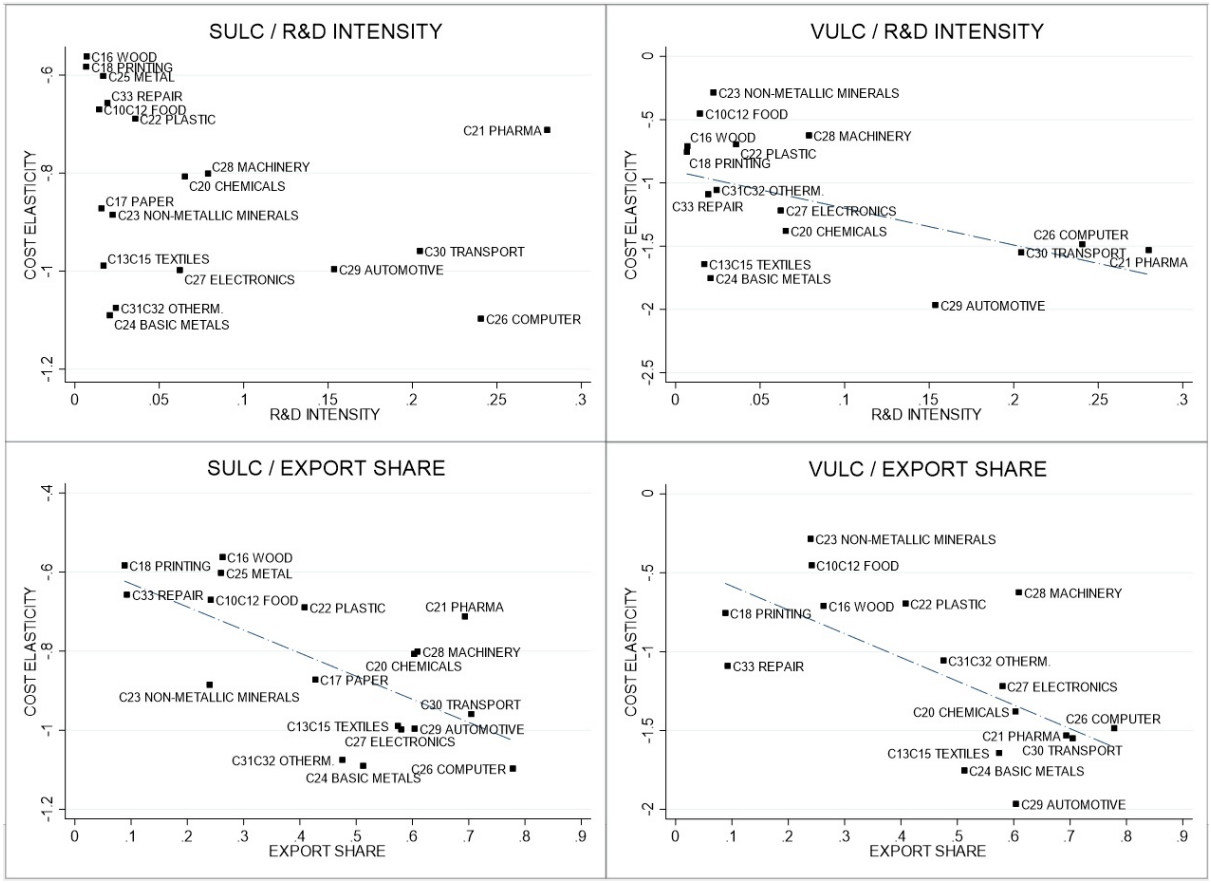
	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)
DV:	VAS	VAS	VAS	VAS	VAS	VAS	VAS
ULC:	VULC	VULC	SULC	NULC	VULC MHT	VULC MLT	VULC
δ1	1.426***		0.215	2.166	1.228	0.281	1.747**
	(0.519)		(1.051)	(1.152)	(2.441)	(0.576)	(0.804)
δ2	-1.299***	-2.031**	-1.056***	-0.968	-1.816***	-1.046*	-0.918***
	(0.240)	(1.030)	(0.376)	(1.343)	(0.847)	(0.594)	(0.345)
δ3		3.392					
		(2.176)					
δ4							0.053
							(0.061)
α	-0.751***	-0.514***	-0.732***	-0.561***	-0.621***	-0.759***	-0.471***
	(0.020)	(0.019)	(0.021)	(0.017)	(0.026)	(0.033)	(0.181)

Note: 2000-2014. Critical values: 1% ***; 5% **; 10% *. Adjustment coefficient α and long-term coefficients δ1 (RGDP), δ2 (VULC/SULC/NULC), δ3 (NGDP), from ARDL equation (2.5). The coefficient of the interaction term (VULC multiplied by export share) is denoted by δ4. Standard errors in brackets. MHT: Sectors classified HT-M and MHT-M. MLT: Sectors classified MT-M and LT-M.

2.3.4.3 Long-run evidence: The sectoral pattern

The next phase involves analysing elasticity magnitudes for individual manufacturing sectors. Pooling these sectors across European countries offers a more accurate representation of manufacturing activity, regardless of the country-specific functional specialisation. Coefficients estimated for the domestic-market effect vary considerably across sectors (see Table A6). Industries significantly impacted by the size of the domestic economy include producers of vehicles, basic metals, mineral products, chemicals, food, and wood. In contrast, key export sectors like automobiles and mechanical engineering show little dependence on the relative size of the domestic economy. SULC effect sizes in the first sample range from -0.5 to -1.1, with the strongest cost effect seen in highly export-oriented industries. To explore whether sectoral R&D intensity or the degree of openness can explain elasticity variations between manufacturing sectors, the respective values are plotted against the sectoral elasticities. Concerning SULC estimates (Figure 6, left panels), no correlation with technological advancement levels is detected. However, a negative relationship exists between sectoral cost elasticity and the export share of sectoral output. More export-dependent sectors are significantly more sensitive to changes in relative cost.

Figure 6: Cost elasticities, R&D intensity, export dependence, left: SULC, right: VULC



Note: long-run cost elasticities from ARDL regression. Detailed results in Table A5 and A7. Export share: Export in total output 2000-2014 average.

Despite the smaller time dimension of the VULC sample, leading to less precision as evidenced by higher standard errors (see Table A7), the overall pattern consistently confirms that of sample I (right panels of Figure 6). The value added elasticity with respect to VULC changes increases with the level of export orientation and R&D intensity in manufacturing sectors. A simple regression shows that a 10pp. increase in export share corresponds to a 0.15pp. rise in cost elasticity magnitude. The most cost-sensitive activities include the manufacturing sectors for automobiles, computers, basic metals, transport equipment, and textiles. Conversely, the production of food, wooden commodities, plastic products, and printing is less sensitive to cost changes. Interestingly, the highly export-dependent and R&D-intensive machinery production consistently exhibits only moderate cost elasticity. However, the significance of the domestic-market effect can only be confirmed for the manufacturing of basic metals.

2.3.4.4 Discussion

Cost competitiveness is commonly attributed a minor role in strategies promoting industrial upgrading, since more advanced manufacturing activities are expected to exhibit reduced or negligible reliance on competitive cost structures. Nevertheless, the analysis conducted in this study challenges this prevailing assumption. The examination falls short of establishing a positive correlation between technological advancement and the cost elasticity magnitude on

sectoral level. Paradoxically, numerous manufacturing sectors distinguished by elevated levels of innovation (C20, C26, C29, C30) reveal a marked sensitivity to changes in relative cost levels. This outcome is in line with recent findings from Paternesi Meloni (2018) and Ederer & Reschenhöfer (2018). One compelling explanation for this counterintuitive observation is that these high-tech sectors are more deeply intertwined with international markets, exposing them to heightened international competitive pressures.

This outcome underscores a critical point: policy considerations, such as the high vs. low road argument by Milberg & Houston (2005), must not disregard the significance of international cost competitiveness as a foundational attribute in the pursuit of industrial competitiveness. This significance is particularly pronounced for the manufacturing sectors characterised by high innovative efforts, which are subject to more intense international competition.[50] By contrast, low-tech manufacturing production, which is predominantly oriented towards the domestic market, is less exposed to international cost competition as indicated by lower elasticity magnitudes. However, this does not inherently imply that their product-level elasticity is lower than that of high-tech goods. Rather, it underscores that the international dimension of cost competition is less pertinent for these sectors. Consequently, scholars should be aware that the microeconomic product-level logic concerning the cost elasticity determinants cannot be directly applied to sectoral or national aggregates.

The detected negative relationship between the cost elasticity magnitude and the degree of openness does not manifest within individual sectors, but rather between sectors. Accordingly, future research should explore whether a functional specialisation towards more advanced activities within sectors can alleviate the cost sensitiveness. While the central impact of cost competitiveness is on exports, the effect on business relocation decisions warrants closer examination from a global value chain perspective. High-tech manufacturing operating at the technological frontier may provide more opportunities to combine advanced production methods with lower labour costs through offshoring and outsourcing compared to less advanced and domestic market-oriented sectors. This is also expected to contribute to a higher significance of cost competition.

In this context, the constructed VULC measure proves to be a superior proxy for assessing cost competitiveness. VULC comprehensively accounts for the cost of the entire sectoral value chain. Consequently, manufacturing value-added market shares (VAS) demonstrate greater responsiveness to changes in the vertically integrated cost measure (VULC) compared to the sectoral unit labour cost (SULC). This discovery underscores the importance of maintaining cost competitiveness in terms of the input cost structure along the entire value chain.

[50] The outcome also prompts the question of whether heightened sectoral innovation intensity affects negatively the degree of cost competition. May the more intense international competition in high-tech manufacturing renders a higher R&D spending a necessity.

2.3.5 Conclusion

The extent to which manufacturing activities are subject to international cost competition and whether this significance wanes when upgrading the industrial profile remains a challenging topic. Unit labour cost assumes a dual role in shaping industrial outcomes. It notably influences export sales and stands as a pivotal determinant in decisions concerning business relocation and the reconfiguration of value chains, yielding profound implications for the geographical distribution of manufacturing value generation. To derive precise estimations of cost elasticities on sectoral level, an analysis beyond sectoral unit labour cost is imperative, since this measure does represent only the cost situation of the final production stage. Addressing this limitation, the present study employs an advanced nominal unit labour cost metric that comprehensively encompasses unit cost levels across all stages of the production process.

The results confirm the general importance of unit labour cost for manufacturing activity. The cost sensitiveness of manufacturing value added ranges from -0.7 to -1.3. When employing the vertically integrated instead of the direct sectoral cost metric, the elasticity magnitude is consistently higher indicating its higher relevance due to the productive organisation in value chains. The examination of the estimated sectoral elasticity patterns reveals a striking paradox: Industries characterised by elevated levels of innovative production, such as the manufacturing of vehicles, pharmaceuticals, electronics and computers demonstrate greater cost sensitivity compared to sectors with products considered less technologically advanced, such as food, wood, and printing. The discrepancy in elasticity appears to primarily reflect the differing degrees of openness to international markets of manufacturing sectors. This challenges the view of technological characteristics as main determinant of the aggregated cost elasticity magnitude.

The empirics presented in this article show that high-tech manufacturing sectors are subject to a heightened international cost competition. Consequently, industrial policies that seek to specialise in more advanced manufacturing sectors cannot assume that such specialisation inherently diminishes the significance of cost competitiveness. Being cost competitive is not merely a helpful condition for industrial success; it appears to be an essential prerequisite.

2.3 Article III:

Assessing the Role of Non-Price Factors: Shedding New Light on the European Competitiveness Puzzle

2.3.1 Introduction

Large trade imbalances represent one of the key symptoms of the economic crisis in the Eurozone starting back in 2008.[51] One of the central reasons are substantial differences in export competitiveness of countries such as Germany, France and Italy. A battle of narratives regarding the primary competitive factors driving the individual export performances has taken place and revived the already long-standing competitiveness debate (Krugman, 1994). On a macroeconomic level, competitiveness is divided into two parts: The first one is price competitiveness expressed by the real effective exchange rate adjusted by export prices or by unit labour cost (D'Adamo, 2017). The second component is referred to as non-price competitiveness (NPC), which encompasses "the sum of all factors other than prices and cost that impact on trade performance" (Balta et al., 2009, p. 21). This concept, which represents the core of the present contribution, covers manifold supply and demand side characteristics, which, in their entirety, cannot be observed in a direct way. Since there is no single overarching indicator, NPC is mostly considered as that residual part of export dynamics, that cannot be explained by changes in price competitiveness (Karadeloglou and Benkovskis, 2015; Emlinger et al., 2019).

Given that the conceptualisation and the empirical assessment of NPC are not straightforward, the factor of non-price competitiveness has frequently been neglected (Xifré, 2021). Researchers are often left to narratives built around indirect evidence obtained from the standard income-and-price-elasticity framework, which does not explicitly account for the factors upon which conclusions should be drawn. Such indirect NPC indicators include income elasticities (Thirlwall, 1986; Bottega and Romero, 2021) and residual-based measures (Żogola, 2010; Xifre, 2021). Other more direct attempts to account for NPC focus on identifying statistically powerful proxy measures (Fagerberg, 1988; Athanasoglou and Bardaka, 2010; Giordano and Zollino, 2016; Romero and McCombie, 2018; Bottega and Romero 2021). Although these approaches provide additional information in specific cases, the overall evidence appears to be scattered and far from conclusive. Moreover, methodological contributions on how to systematically approach the matter are scarce.

In this paper, I address this topic by reviewing different indicators and generating comparative evidence. For this purpose, I reproduce several established macroeconomic measures of non-price competitiveness for a set of 10 Eurozone countries over the period 1995-2019. The study generates new evidence on how the export performance of individual countries has been influenced by differences in non-price competitiveness. By doing so, I show how

[51] The various interpretations of the Eurozone crisis are already well documented and described. For an overview see, for instance, Xifré (2020) or the introductive section in Xifré (2021).

single NPC approaches contribute to form a consistent narrative and how valuable these measures are in the overall assessment. The specific contribution is to analyse whether there are preferred methods to account for a country's non-price competitiveness in empirical tasks.

The paper is divided into five sections. Following this introduction, section two surveys how NPC is conceptualised and operationalised in recent empirical literature and checks the conceptual consistency of the individual approaches. Section three presents econometric evidence. The first part of this section focusses mainly on estimated and calculated indirect measures of NPC on a country basis while direct proxies of NPC and their statistical power are analysed in part two. Section four aims to connect the outcomes of the different empirical tasks, providing an extensive survey on the NPC stance of major European countries and a final assessment of the validity of the single NPC indicators. A recap of the main findings and an outlook are presented in the concluding section five.

2.3.2 Non-price competitiveness: Meaning, proxies and procedural Issues

2.3.2.1 Conceptualisation

Non-price competitiveness is defined as the multi-dimensional entirety of factors not connected to prices that shapes the demand as well as the supply side of the economy.[52] Many researchers identify the technological dimension as the decisive one (Fagerberg, 1996; D'Adamo, 2018). For example, McCombie and Thirlwall (1994) report survey findings indicating that technological factors are the most important features of non-price competitiveness, particularly for the export of manufactured goods. These factors include product and production-related characteristics such as quality, durability, practicality, reliability, design, innovativeness, adaptivity, uniqueness, efficiency, and after-sales services. The underlying assumption is that importers and foreign consumers have a preference for superior technological attributes. Thus, the idea of NPC is directly connected to the concept of utility and the resulting willingness to pay. It is pretty clear that many of the factors contributing to non-price competitiveness are subjectively valued and are challenging to directly observe at an aggregated macroeconomic level. [53] Another dimension of non-price competitiveness encompasses structural factors that affect productive activities positively, such as research and development expenditure (both public and private), management capabilities, human capital, infrastructure, education and financial conditions (German Council of Economic Experts, 2022). Unlike prices and costs, non-price competitiveness cannot be *directly* observed and no single statistically effective indicator has been identified to capture the entirety of relevant factors. Thus, inferences about the level of non-price competitiveness or its effect on exports are often drawn from indirect approaches.

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[52] Though highlighting different dimensions and features, NPC is commonly defined only in contrast to price competitiveness. For a standard definition see, for instance, D'Adamo (2017).

[53] Product quality, as a key characteristic of NPC,

2.3.2.2 Established indicators

Before focussing on how (the role of) NPC is generally evaluated, let us introduce the traditional procedure to assess the main drivers of export. The standard export demand functions commonly serve as empirical workhorse model to analyse the trade performance and its main determinants. This model considers the impact of foreign income and relative prices but does not explicitly incorporate non-price factors. Intuitively, it can be formulated as follows:

$$X_t^i = FI_t^{i\,\delta_1^i} * REER_t^{i\,\delta_2^i}. \tag{3.1}$$

Accordingly, δ_1 and δ_2 denote country i's export elasticities with respect to foreign income (FI) and to prices or cost measured in a common currency (REER), respectively. An established regularity from econometric applications is that the average long-run export elasticity of major European countries with respect to prices changes is roughly -0.8 (D'Adamo, 2017). Estimates for the income elasticities, however, range from 1.0 to 2.0 (Keil, 2023) in the European context. Authors such as Thirlwall (1986), Krugman (1989) and Bottega and Romero (2021) argued that NPC factors are reflected in the income elasticity. The relative income elasticity can be seen as a country's ability to intercept demand from abroad independently of prices. Therefore, a higher level of non-price competitiveness would result in a higher magnitude of income elasticity, and a country's exports would benefit more from increases in foreign income.[54]

The idea that the standard export equation accounts for a country's non-price competitiveness in an indirect way is not limited to the interpretation of estimated elasticities. For instance, Żogola (2010) argues that the regression's residual catches non-price effects provided that for relative prices and for foreign demand is appropriately controlled. On similar logical lines, Xifre (2021) proposes a mathematical factor for NPC by rearranging an export equation and solving for an unknown non-price factor given an exogenous price elasticity.[55] Other scholars, however, state that the standard export equations may suffer from omitted variable bias (Bottega and Romero, 2021; Tober, 2023), which renders the simple interpretation of the estimated trade elasticities and resulting residuals insufficient. As a remedy, NPC proxy measures are introduced to the export function next to foreign income and prices. For instance, Fagerberg (1988, 1996) as well as Gustavsson et al. (1999) argue that technological competitiveness is of utmost importance and employ measures such as R&D spending or the number of patents as suitable proxies, reflecting the sense of innovative ability and adaptive

[54] Some authors claim that the price and cost elasticity magnitude gives an indication of the NPC, too. According to Gräbner et al. (2020), more advanced high-tech industries face lower price competition compared to low-tech industries. Empirical evidence contests this claim, since the exports of sectors producing high technological content are found to possess a relatively high price elasticity. See, for instance, Ederer and Reschenhöfer (2018) and Keil (2024).

[55] Though methodologically different, this can be considered as a macroeconomic variant of the export quality indicator calculated by Hummels and Klenow (2005) and later by Benkovskis and Wörz (2016) which both share the core concept using micro data. The idea is that the export dynamics not explained by changes in price competitiveness must be due to changes in NPC factors such as quality. Furthermore, Xifre (2021) tested his approach using both macroeconomic and product-level data, concluding that the findings exhibit broad consistency.

capacity. More recently, Bottega and Romero (2021) used a patent stock measure to explicitly account for innovativeness and technological competitiveness. Athanasoglou and Bardaka (2010) consider a capital stock measure based on investment in machinery and buildings as an appropriate proxy for product quality and variety. Along similar lines, Giordano and Zollino (2016) and Romero and McCombie (2018) focus on multi-factor productivity, which is considered a measure of the efficiency of the economic system including the effectiveness of R&D, innovations and the quality of the business environment. Aside from these proxies, the economic complexity index (ECI), a rather generic export competitiveness indicator, became popular. This index reflects the ubiquity and the diversity of a country's product range and is conceptually based on the concept of revealed comparative advantage (for a summary, see Hidalgo, 2021). It is considered to be an extensive proxy for non-price competitiveness and was recently introduced in the standard export equation by Pariboni and Paternesi Meloni (2022).

In the individual setting, all presented indicators provided additional insights into the importance of NPC and were statistically significant.[56] In some cases, the introduction of additional non-price competitiveness arguments has led to the insignificance of the price variable, indicating that non-price factors are of higher importance than price factors (Romero and McCombie, 2018). The general evidence, however, remains scattered and not conclusive. There is no consensus on whether a preferable proxy exists for empirical exploration or on the strength of the non-price competitiveness impact on exports compared to the price effect.

2.3.2.3 The challenging detection of individual effects

The challenge of determining genuine causal effects is reflected in the divergent empirical results, particularly regarding the price elasticity. Hence, a significant body of literature has emerged discussing this price vs. non-price conundrum, which represents one of the major unresolved questions in the field.[57] Summarizing the earlier debate, McCombie and Thirlwall (1994, p. 300) state that "non-price factors are of much greater importance than price competition", and consider the price impact to be relevant only in the short-run. This rationale aligns well with the Schumpeterian emphasis on the power of innovation rather than lower prices (Schumpeter, 1934). Detecting the relative importance of NPC compared to price competitiveness is particularly relevant for industrial policy considerations. For instance, Milberg and Houston (2005) contrast different ways to industrial success on international markets.[58] Focussing economic policy on structural improvements instead of seeking price competitiveness appears to be appealing, since such an industrial upgrading strategy promises

[56] An exception is Frenkel and Zimmermann (2020), who could not find a significant effect of R&D spending on German exports.

[57] For an overview on the earlier debate see McCombie and Thirlwall (1994). Over the recent decade, significant efforts have been made to establish narratives regarding the main determinant of the trade performance of single countries. An emblematic case is the discussion on the Eurozone trade imbalances and their determinants. For a survey see the overview section in Pariboni and Paternesi Meloni (2022).

[58] According to Milberg and Houston (2005), price competition is considered the *low road* towards industrial success in the international economy. Policies strengthening a country's productivity and fostering high-quality production represent the *high road*. Another salient example is the contribution by Krugman (1994), who called the focus on (cost) competitiveness a dangerous obsession.

far-reaching welfare gains. By contrast, the enhancement of price competitiveness considered as a policy substitute bears the risk of wage squeezes, an international race to the bottom and, thus, welfare losses. From this simplistic point of view, the former way of industrial upgrading appears to be preferable. Regardless of how desirable this would be, empirical evidence still detects significant long-run price elasticities of a considerable magnitude, even for industries and countries characterized as competing based on quality and innovativeness.[59] Therefore, none of the factors can be disregarded when seeking international competitiveness.

Another important point to consider is the potential interdependency of NPC and price factors, which further complicates the determination of individual effects. One potential direct connection is that prices and cost already account for technological differences, since a higher technological level, for instance in terms of product quality, implies higher production cost.[60] Furthermore, operationalising the price variable by the REER deflated by unit labour cost already takes into account differences in labour productivity, which is considered an important aspect of non-price competitiveness (Giordano and Zollino, 2016). Technological advantages reflected by high productivity keep unit labour cost low. The intricate relationship between price and non-price factors is underscored by the ongoing debate on the economic conditions for industrial upgrading, i.e. in enhancing non-price competitiveness, where cost structures often play a central role.[61]

Moreover, the potential presence of increasing returns to scale poses a significant challenge in disentangling price and non-price effects. Suppose that a non-price advantage leads to significantly higher export sales, which accelerates productivity growth over time. In turn, this would result in slower growth rates of unit labour cost and subsequently improve price competitiveness. In other words, a non-price advantage can effectively translate into a price advantage. Conversely, higher demand for a country's exports due to gains in price competitiveness may translate into macroeconomic improvements in non-price factors, such as increased innovative efforts. These processes make it difficult to estimate 'true' long-run causal effects, particularly when one factor, such as non-price competitiveness (NPC), cannot be comprehensively accounted for. Accordingly, estimation results should be interpreted with caution acknowledging this complexity.

[59] For instance, Ederer and Reschenhöfer (2018) detected relatively high cost elasticities among the most innovative manufacturing sectors.

[60] See D'Adamo (2018) for a survey and discussion on how quality shapes prices. Beside the interrelation with the price factor, the survey underscores the difficulty in assessing product quality in a comparative way useful for macroeconomic analysis. Since quality cannot be objectively quantified, the common approaches are of rather indirect and interpretative nature.

[61] See for an informative literature survey on the potential effect of labour cost, as a major cost and, thus, price factor, on technological upgrading in the introductive section of Chen et al. (2023).

2.3.3 Empirical Evidence

2.3.3.1 Indirect measures of non-price competitiveness

2.3.3.1.1 Setup

With this challenges in mind, the paper now proceeds with an econometric exploration of the effectiveness of several NPC indicators. This empirical section is divided into two separate parts based on their data structure and research goals. The objective of this first part is to obtain evidence on the NPC stance of different European countries within a framework, that accounts only indirectly for it. The second part (3.2) focuses on examining whether individual NPC factors can contribute to explaining export volumes within a panel setting. Both attempts rely on versions of the empirical export equation in levels:

$$X_t^i = C^i + \delta_1^i FI_t^i + \delta_2^i REER_t^i + \epsilon_t^i. \qquad (3.2)$$

In equation 3.2, X represents the volume of the real export of goods expressed in Euro (Data source: Eurostat) . The foreign income or demand variable FI represents the volume of the real GDP of 34 partner countries denoted in fixed PPP Euro (Data source: OECD).[62] The variable of the real effective exchange rate (REER) stands for price competitiveness, which is the nominal exchange rate adjusted by nominal unit labour cost differences (Data source: European Commission).[63] All variables are expressed in logs. To handle the time series characteristics of the variables involved, autoregressive distributed lag (ARDL) models (Pesaran et al., 2001) are employed.[64] Using this combination of an autoregressive and a distributed lag model, a non-stationary variable can be regressed on stationary or non-stationary variables via OLS. The general reliability of the estimation is examined by structural and residual-based cointegration tests. However, the outcome has to be interpreted with caution, since the estimation procedure and estimates are affected by the data properties, which often cannot be detected unambiguously by standard unit root tests. Thus, different tests will be used in conjunction. Special attention is given to the left-hand side variable of exports, as cointegration techniques strongly require the dependent variable to have a unit root.

The assumed long-run relationship can be represented by the cointegrating equation (3.3) employing the level variables. The long-run coefficients (δ) are calculated using the estimated coefficients ($\delta = -(\eta/\alpha)$) from the corresponding unrestricted error correction mechanism, which in (4) is expressed as an exemplary ARDL (2.1.1):

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[62] Due to the objective of comparability of FI measures and the limited availability of double export weights, the country sample is restricted to 35 mostly OECD countries. Several tests showed, that the use of the FI accounting for 35 countries increased the coefficient of determination in comparison to a broader measure (FI of 43 or 46 countries with smaller time dimension). The most severe caveat against this measure is the absence of quarterly data from China. The geographical composition of single variables is reported in the statistical Appendix B.

[63] The choice is motivated by the comparative analysis conducted by Keil (2023), who identifies ULC-adjusted REER as the preferred proxy for price competitiveness in empirical applications. This preference arises from ULC's superior macroeconomic representation of firms' cost situations compared to export price measures.

[64] This implies the non-stationarity of exports as dependent variable and the potential fractional integration of the REER.

$$X_t^i = C^i + \delta_1^i FI_t^i + \delta_2^i REER_t^i + \nu_t^i, \tag{3.3}$$

$$\begin{aligned}\Delta X_t^i = {} & C^i + \alpha^i X_{t-1}^i + \eta_1^i FI_{t-1}^i + \eta_2^i REER_{t-1}^i \\ & + \beta_1^i \Delta X_{t-1}^i + \beta_2^i \Delta FI_t^i + \beta_3^i \Delta REER_t^i + \epsilon_t^i.\end{aligned} \tag{3.4}$$

The sample consists of the European countries of Austria, Belgium, Finland, France, Germany, Ireland, Italy, Spain and Portugal, spanning from 1995q1 to 2019q4.[65] Additionally, the empirical exercise considers two subperiods, 1995q1 to 2008q3 and 2009q3 to 2019q4. This division is due to the potential structural break reflected in the sharp export contraction from 2008q4 to 2009q2. Since the dynamics before and after this slump differ, the long-run relationship is expected to change as well. The geographical and time period restrictions are chosen to ensure data comparability.[66]

In many cases, the assessment of a country's NPC is conducted by interpreting key parameters of the standard export function, which does not directly account for NPC factors. In this section, there are three different approaches which will be applied to a common quarterly dataset. Firstly, estimated income elasticities may incorporate information on the level of a country's competitiveness not ascribed to price variations. Secondly, a residual-based approach aims at quantifying the NPC contribution to past export growth. Thirdly, the export equation is rearranged and a simple measure of NPC is obtained by calculation. Here, the results will be commented briefly in this section, while its implication will be discussed more thoroughly in section four.

The general validity of the ARDL estimation will be determined by the bounds procedure with critical values for the F-test and t-test derived from Kripfganz and Schneider (2018). The Akaike information criterion (AIC) is used for selecting the optimal lag structure. Additionally, it is crucial to determine the order of integration of the three variables involved. Specifically, it needs to be clarified whether the dependent variable has a clear unit root or not. If not, cointegration techniques are not appropriate. Problems arise when a time series is not an exact but close to unit root process. In this case, the Augmented Dickey Fuller (ADF) test suffers from low power. Thus, a Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test is additionally employed to assert that the left hand side variable is non-stationary. The results of the ADF test,

[65] The case of Ireland raises doubts on the reliability of the its macroeconomic data (see Honoham, 2021). Though omitted from the verbal analysis, the respective empirical evidence is kept in the results survey.

[66] NPCF is constructed as a relative variable that serves as a proxy for assessing competitive relations. However, the availability of data on competitor countries varies depending on the chosen indicator. Each variant of NPCF includes the maximum number of competitor country data based on the availability specific to that indicator. The maximum possible number of competitor countries included in the analysis is determined by the availability of double export weights provided by the Directorate-General for Economic and Financial Affairs of the European Commission, which is 42. However, in this study I did not prioritize achieving overall harmonisation of the country sample for each variable. If such harmonization were pursued, it would result in a significant reduction in the number of countries considered (maximum of only 12 countries), which would represent a significant loss of information.

as reported in Table 9, show ambiguous indications of a unit root process in four cases.[67] However, according to the KPSS test, the hypothesis that the export time series are stationary can be rejected for all countries except Finland during the second period. With few ambiguous cases, the dependent variables are determined to be integrated of order 1, while the independent variables are not integrated of a higher order than 1. All in all, this makes the ARDL approach feasible.

Table 9: Test statistics of unit root test, real exports of goods

	ADF			KPSS		
	95-19	95-08	09-19	95-19	95-08	09-19
AUT	-2,67*	-2.28	-2.41+	1,93***	1,26***	1,11***
BEL	-1,76	-3.60**	-1.79	1,90***	1,27***	1,05***
ESP	-2,37+	-2.15	-3.21**	1,97***	1,23***	1,27***
FIN	-2,95**	-2.08	-2.32+	0,99***	0,86***	0,23
FRA	-2,36+	-1.24	-2.37+	1,36***	0,86***	0,82***
GER	-1,93++	-2.44	-3.60**	1,47***	0,90***	0,83***
IRE	-0,84	-0.88	-0.02	1,36***	0,93***	0,83***
ITA	-1,58	-2.24	-3.06**	1,33***	0,78***	0,70**
NDL	-1,66	-2.50	-2.84*	1,42***	0,82***	0,89***
PRT	-1,58	-4.10**	-1.78	1,47***	0,88***	0,90***

Note: quarterly data. Timespan: 1995–2019: 1995q1–2019q4. Subperiods: 1995–2008: 1995q1–2008q3; 2009–2019: 2009q2–2019q4. For the ADF test (with constant), the null hypothesis is non stationarity. For the KPSS test, the null hypothesis is stationarity. Lag length selection criteria: AIC.

2.3.3.1.2 Income elasticities (IE)

The estimation of reliable income elasticities is based upon the export function turned into an ARDL model (Equation 3.4). The standard export equation specification (SEE) employed uses unweighted foreign income as measure of foreign demand. In 8 out of 10 cases a long-run relationship of the three variables was detected (Table 10).[68] As can be observed in Figure 7, the estimated income coefficients closely align with the ratio of the growth rates of exports to foreign income (henceforth: X/FI). As evidenced by the help of the 45-degree line, the elasticity magnitudes are slightly below the X/FI ratio in most cases. This pattern reminds of Krugman's (1989) observation that the ratio of income elasticities for exports and imports corresponds to

[67] The possibility of trend stationarity of the export variable is taken additionally into consideration. Detailed results are presented in the Appendix A. The presence of a deterministic trend in the long-run, however, causes difficulties, which will be discussed below.

[68] When improving the outcome in terms of the cointegration robustness and the R^2, the REER relative to 27 partner countries was employed instead of that relative to 37 partner countries (see Table A3 in Appendix A). This indicates, the actual relevance for individual countries can differ across countries. The number of partner countries was not harmonized with the FI variable since the variables capture different phenomena. FI serves as a proxy for potential demand, while the REER represents a competitive relation. As a result, the geographic composition of relevant target markets differs from that of competitors.

the growth ratio of domestic and foreign income.[69] In relative terms, X/FI reflects the overall competitiveness, a result built upon price and non-price factors. Accordingly, the estimated coefficients may reflect a confounding of competitiveness and income effects.

Table 10: Long-run estimates (ARDL) from standard export equation (SEE) specification

SEE	X/FI	δ_1^i (FI)		δ_2^i (REER)		F	t	ARDL
AUT	2.12	2.088***	(0.034)	-1.279***	(0.132)	8.550***	-4.904***	3.1.3
BEL	1.51	1.478***	(0.043)	-2.468***	(0.633)	6.404**	-4.184***	3.3.3
ESP	2.12	1.900***	(0.071)	-0.384**	(0.171)	5.620**	-3.885**	1.3.0
FIN	1.64	1.114**	(0.506)	-3.868**	(1.938)	2.239	-1.780	3.2.0
FRA	1.55	1.436***	(0.053)	-1.020***	(0.206)	5.734**	-4.020**	2.2.1
GER	2.22	2.025***	(0.119)	-1.057***	(0.306)	5.186***	-2.634	3.3.2
IRE	3.66	1.953***	(0.584)	-1.328***	(0.477)	4.164*	-2.058	2.0.2
ITA	1.05	1.276***	(0.081)	-0.216	(0.167)	6.108**	-3.924**	1.4.0
NDL	2.05	2.012***	(0.056)	-0.181	(0.222)	3.568	-3.071	4.4.1
PRT	2.11	1.906***	(0.043)	-0.526***	(0.134)	9.512***	-5.244***	2.2.2

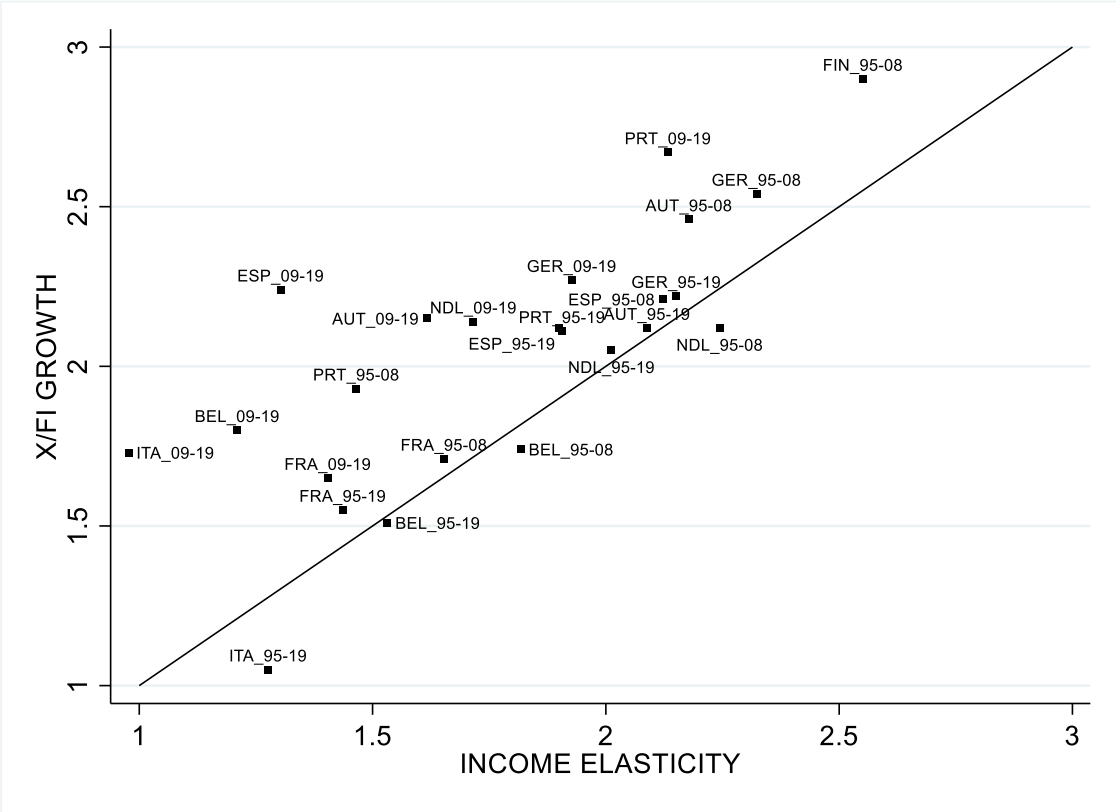
Note: 1995q1-2019q4, n=100-l. Bounds procedure (F-test and t-test) for cointegration test. Null hypothesis: no long-term relationship. Critical values: 1% ***; 5% **; 10% *. Model lag length (l) according to AIC minimisation. Standard errors in brackets.

However, price competitiveness was found to be important in all cointegrated cases, except for Italy. The price elasticity magnitudes range from -0.4 to -2.5.[70] However, no cointegration was found for the Netherlands and Finland according to the F and t tests. It should be recalled that the Finnish exports are not clearly a unit root time series (see Table 5). Conversely, a robust cointegrating relationship was observed for the Dutch case in both subperiods (see Table A3), indicating the relevance of the structural break in 2008/09.

[69] A prominent explanation of this pattern represents Thirlwall's law. According to Thirlwall (2011), high income elasticities reflect high international competitiveness. Subsequently faster growing exports allow for higher growth rates of the entire economy, given the validity of the balance of payments constraint. See Romero & McCombie (2016) for an assessment of the law for European manufacturing.

[70] Where significant, the introduction of a deterministic trend distorts the trade elasticities in an unrealistic way and impedes comparability. For instance, the income elasticity of Belgium jumps from 1.5 (matching exactly its X/FI ratio of 1.5) to 2.5 in the trend specification. Though being reported in the results (Appendix Table A3) for the sake of transparency, the further analysis and discussion will refrain from the trend specification, since comparability of the results is a major objective.

Figure 7: Income elasticities versus export growth (X/FI)



2.3.3.1.3 Export equation residual (RS)

The residual of an export equation interpreted as the contribution of NPC represents another indirect approach (Monteagudo, 2010; Żogola, 2010).[71] For logical consistence, an important condition should be met: the foreign income coefficient should estimate the true long-run income elasticity and no competitive effects. Thus, a commonly applied theoretical constraint, based on the logic underlying gravity models of trade, is that this elasticity equals unity (Ca'Zorzi and Schnatz, 2010).[72] Consequently, if exports grow faster or slower than foreign income, this deviation must be fully attributed to competitiveness effects.[73] Within a gravity model export equation (GEE) an export-weighted volume of real foreign imports (FID) is chosen as foreign demand variable instead of foreign income. Due to its construction, the FID time series grows roughly in a one-to-one relation to the export time series, under the condition that export market shares are stable. Thus, the corresponding regression coefficient (which, however, is not a genuine income elasticity anymore) will approach unity and meets the

[71] The investigation in the European Commission's Quarterly Report on the Euro Area by Żogola (2010) serves as model case and their specification will be followed as closely as possible. For a more recent application of this approach to the case of France see Cezar and Cartellier (2019).

[72] The theoretic reference of this empirical approach are Gravity trade models incorporating the Armington hypothesis. For an introduction see Costinot and Rodríguez-Clare (2014).

[73] Analytically, this approach is tantamount to a market share analysis of the form $X/FI_0^i = \delta_0^i + REER_0^i + \epsilon_0^i$ given that the FID elasticity out of GEE estimations is unity.

theoretical constraint. Once the price competitiveness effect is controlled for appropriately, the residuum is likely to catch the effects on exports not explained by movements in foreign demand or relative prices.

Turning to the results of the ARDL estimation for the entire period (Table 11), a robust long-run relationship is less likely than in the SEE case mentioned above. At a significance level of 10% of the F-test or the t-test respectively, cointegration was found in 6 cases (excluding Ireland). However, cointegration can be unambiguously detected at a high level of significance in only three cases. Similar to the SEE estimation, the export elasticity with respect to foreign import demand (FID) approaches the respective X/ID growth ratio. If exports grew faster or slower than FID, which is the case when the growth ratio is not unity, the elasticity will also deviate from unity. Consequently, obtaining a 'true' long-run 'income' elasticity of unity in some cases runs the risk of being a statistical artefact caused by the construction of the FID time series, which coincidentally grows 1:1 with exports. This makes interpretation difficult, and casts doubt on the entire approach, as the assumption that the FID coefficient captures only the income effect is not met. It appears that the coefficient also accounts for competitive effects. However, the price elasticity is found to be significant in all cointegrated cases. Effect sizes are detected in a range from -0.5 to -2.8.

Multiplying the estimated coefficients by the growth rates of the variables, yields the individual factor's contributions to export growth (Table 12). The remaining part of export growth not explained by movements in foreign demand and the REER is attributed to the influence of NPC. Positive values indicate a positive NPC contribution to the export dynamics expressed in percentage points. Over the entire 1995–2019 period, Spain demonstrates a strong improvement in NPC, while Finland, Ireland, and Italy experience deterioration. In the cases of Austria and Portugal, the growth contribution of non-price factors seems to be negligible. However, it's important to note that due to a significant number of cases with non-robust or insignificant estimates, this pattern is only partially confirmed by the results of subperiods (Table A5).

Table 11: Long-run estimates (ARDL) from gravity model export equation (GEE) specification

GEE	X/I	δ_1^i (FID)		δ_2^i (REER)		F	t	ARDL
AUT	0.98	0.976***	(0.013)	-0.597***	(0.119)	8.007***	-4.758***	4.1.0
BEL	0.80	0.829***	(0.018)	-0.709	(0.541)	4.696*	-3.614**	1.1.2
ESP	1.01	0.886***	(0.022)	-0.681***	(0.136)	9.239***	-4.550***	3.1.0
FIN	0.90	0.785***	(0.044)	-2.847***	(0.522)	7.023***	-4.099	4.2.0
FRA	0.84	0.813***	(0.023)	-0.638	(0.174)	2.654	-2.782	1.3.2
GER	1.17	1.258***	(0.079)	-0.603	(0.556)	3.461	-2.179	1.1.1
IRE	2.25	2.755***	(0.537)	-1.940***	(0.488)	11.782***	-3.678*	2.0.1
ITA	0.52	0.751***	(0.108)	-0.641**	(0.302)	5.528**	-2.533	3.1.1
NDL	1.08	1.043***	(0.036)	-1.216**	(0.585)	1.931	-2.096	2.2.3
PRT	1.04	1.139***	(0.063)	-1.424***	(0.314)	5.324**	-2.965	4.1.2

Note: 1995q1-2019q4, n=100-l. Bounds procedure (F-test and t-Test) for cointegration test. Null hypothesis: No long-term relationship. Critical values: 1% ***; 5% **; 10% *. Model lag length (l) according to AIC minimisation. Standard errors in brackets.

Table 12: Contribution of trade determinants to export growth, quarterly data

	Quarterly growth rates			Export growth contributions		
	X	FID	REER	FID	REER	UNEXPL
AUT	+1.10%	+1.14%	-0.07%	+1.11pp	+0.04pp	-0.04pp
BEL	+0.88%	+1.12%	-0.05%	+0.93pp	+0.04pp	-0.07pp
ESP	+1.11%	+1.10%	+0.04%	+0.98pp	-0.03pp	+0.17pp
FIN	+1.02%	+1.14%	-0.08%	+0.90pp	+0.24pp	-0.10pp
FRA	+0.92%	+1.11%	-0.08%	+0.90pp	+0.05pp	-0.02pp
GER	+1.27%	+1.10%	-0.17%	+1.38pp	+0.11pp	-0.20pp
IRE	+2.47%	+1.11%	-0.26%	+3.06pp	+0.51pp	-1.06pp
ITA	+0.57%	+1.12%	+0.10%	+0.84pp	-0.06pp	-0.20pp
NDL	+1.18%	+1.10%	+0.03%	+1.15pp	-0.03pp	+0.07pp
PRT	+1.14%	+1.09%	+0.07%	+1.24pp	-0.11pp	+0.00pp

Note: 1995q1-2019q4. Underlined values signal not reliable figures due to the absence of cointegration and/or insignificant coefficients.

2.3.3.1.4 Reinterpretation of trade frictions (TF)

On similar conceptual lines as the residual-centred NPC approach, Xifré (2021) proposed a measure of NPC calculated by rearranging an NPC augmented export function. This is derived from a gravity trade model, where a trade friction variable is interpreted as NPC with the opposite sign. The Xifré approach to NPC has been adapted to the general specification of this study and the respective export function can be formulated and rearranged as follows:

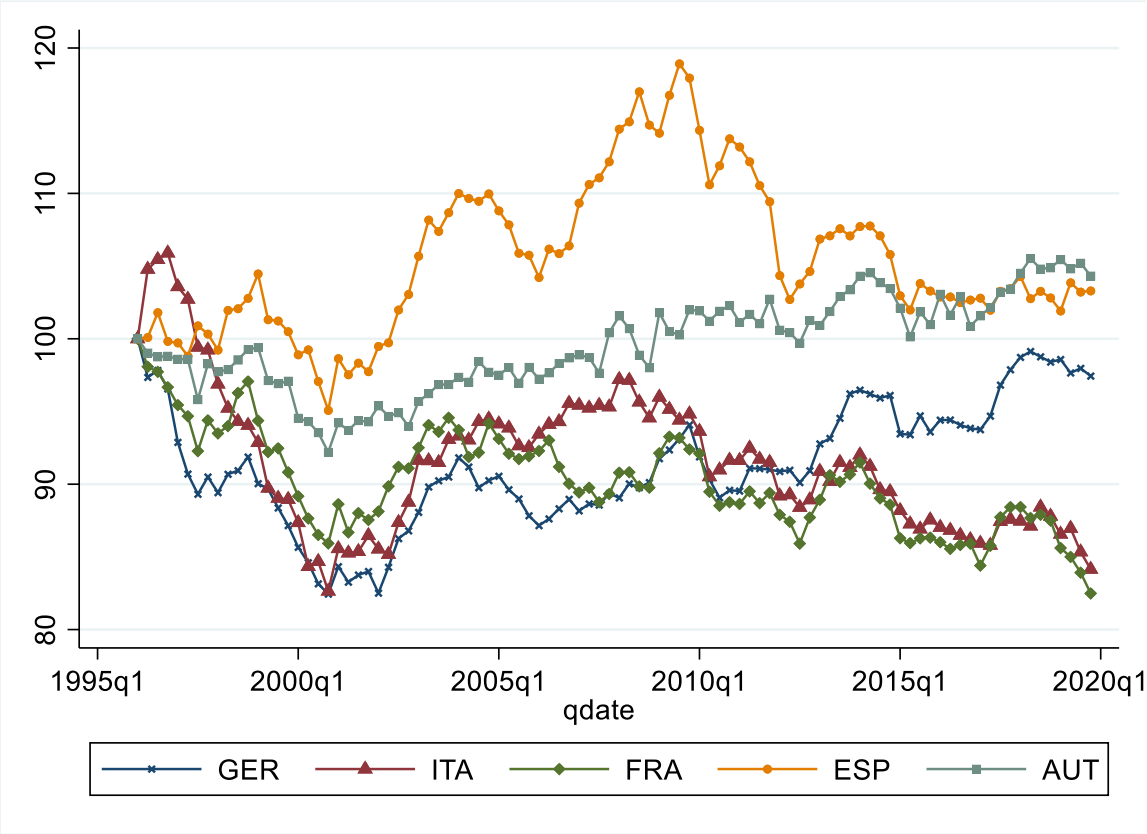
$$X_t^i = FID_t^i * REER_t^{i\,-\delta} * NPCF_t^{i\,\delta}, \tag{3.5}$$

$$NPCF_t^i = (XS_t^i * REER_t^{i\,\delta})^{\frac{1}{\delta}} \text{ with } XS_t^i = X_t^i / FID_t^i \tag{3.6}$$

In this case, the variables are expressed as linear quantities rather than logarithms. By assuming that non-price competitiveness (NPC) has the same effect magnitude as price competitiveness, the export function can be rearranged so that the unknown NPC factor becomes the explained variable (Equations 3.5 and 3.6). Given an exogenous price elasticity δ, export market share movements not explainable by changes in price competitiveness are attributed to NPC. [74]

[74] An implicit assumption stemming from the underlying utility function is that price and non-price factors have the same elasticity magnitude. This assumption implies that consumers perceive these factors as substitutes. If the magnitude of the NPC elasticity is lower, it indicates that importers are more responsive to changes in relative prices. Conversely, a higher NPC coefficient would suggest a strong incentive for technological upgrading and quality enhancement, even if it results in higher production costs and subsequent price competitiveness losses. Therefore, in empirical tasks, an appropriate and realistic NPC proxy should not only make a statistically significant contribution but even possess a comparable elasticity magnitude as the price variable.

Figure 8: NPC indicator – reinterpretation of Trade Frictions (TF)



Note: 1996q1=100. An enlarged version of this chart (encompassing all 9 countries) is provided in Appendix A1.

The crucial exogenous parameter is the price elasticity, which, for simplicity and in accordance with recent estimates, is set to unity.[75] The approach was adopted for the quarterly dataset used in this paper and, hence, a purely macroeconomic version of it has been calculated for nine European countries.[76] Figure 8 depicts the development of the NPC factor (relative to its entire range of competitors), where the calculated value of the year 1996 was set as the baseline (equal to 100). According to the calculations, Italy, France and Belgium suffered significant losses in terms of NPC (values below 100). The trajectories of other countries are more ambiguous, in particular with respect to the different periods. For instance, the NPC of the German and Austrian economy declined until 2001 and improved steadily afterwards. The Netherlands, Spain, Portugal and Finland recorded strong improvements until 2008. After that, performances differ. An outstanding example is Finland (see Figure A1 in Appendix A), whose NPC deteriorated strongly from 2008 to 2019.

[75] Altering the elasticity δ leads to a re-scaling of the explained variable, but does not change the outcome. Similarly, the introduction of different elasticities for prices and for NPC does not qualitatively affect the results.

[76] The dynamics of Irish exports have a significant impact on the export market shares of the other nine countries, leading to distorted results and changing the signs of the NPC measure. Therefore, Ireland was excluded from the TF sample.

2.3.3.2. Accounting for NPC factors

2.3.3.2.1 NPC factors

In contrast to the indirect approaches discussed above, this section focuses on various proxy measures of non-price competitiveness (NPC) that can be used as additional controls in the export function.[77] The factors used are measures proposed in recent literature and expressed as a relative measure. Information on the calculation details and data sources are given in in the Appendix B. Their calculation was done following the original source's schemes and the original idea as closely as possible, with adaptations made to accommodate the characteristics of the geographical sample and the availability of data. By doing so, a comprehensive survey is conducted to determine if different NPC measures are mutually correlated and whether the overall European picture derived from these measures is coherent from a descriptive perspective. When these NPC factors are added as arguments in the standard export function, the analysis examines whether they contribute to explaining export dynamics and whether they have an impact on the significance and effect size of the other coefficients.[78]

Macroeconomic and structural NPC indicators can be considered as the tide that lifts or lowers the position of all businesses, belonging to a country and affecting their product range. The first category of NPC factors includes investment-related indicators: the investment-to-GDP ratio (II41) and the capital stock (CS29). The second category comprises innovation and capital-related indicators, including the number of patents (PS41) and the gross R&D-expenditure-to-GDP ratio (RD28). Lastly, a category of more generic indicators covers measures such as multi-factor productivity (MFP24) and the index of economic complexity (ECI). While the ECI metric is inherently relative in its nature, all other factors are computed in a manner similar to the REER. Consequently, each NPC measure is presented in relation to a geometric average of values from major competitor countries, employing a fixed double export weighting scheme.

By observing the correlation matrix (Table 13), a strong positive correlation of +0.64 is noticeable between the innovation-related variables, PS41 and RD28. They also exhibit positive correlations with the ECI, with coefficients of +0.66 and +0.71, respectively. Additionally, a strong positive relationship is observed between CS29 and PS41, with a correlation coefficient of +0.92. Furthermore, the export volume (X) demonstrates positive correlations with CS29 (+0.73) and PAT41 (+0.79).

[77] Only measures which can be expressed as continuous variables suitable for the quantification of marginal long-run effects will be considered. This excludes rank measures such as the export quality rank employed by Vandenbussche (2014) and D'Adamo (2018), which is based on product-level data.

[78] The econometric exploration in this paper primarily aims to identify relationships in terms of correlations. This initial exploration provides a foundation from which further topics, such as causal analysis, can be investigated.

Table 13: Correlation matrix on panel level, 10 European countries

	ECI	PS41	RD28	CS29	II41	MFP24	X
ECI	+1.00	+0.66*	+0.71*	+0.56*	-0.05	-0.19*	+0.33*
PS41		+1.00	+0.64*	+0.92*	-0.33*	+0.07	+0.79*
RD28			+1.00	+0.45*	-0.11*	-0.20*	+0.18*
CS29				+1.00	-0.33*	+0.17*	+0.73*
II41					+1.00	-0.01	-0.32*
MFP24						+1.00	-0.03
X							+1.00

Timespan: 1995-2019. Significance level of 10% is indicated by (*).

2.3.3.2.2 Specification

The relevance of individual NPC indicators is tested using the NPC augmented price-and-income-elasticity framework. Apart from the option of interpolation used by Giordano and Zollino (2016), the construction of relative NPC indicators on macroeconomic level is viable on an annual base only. This limitation significantly restricts the time dimension (t=24) for this empirical exercise and virtually impedes the use of approaches to test for long-run relationships on single country basis. To obtain reliable and efficient results in this case, pooling becomes a necessity. Thus, a multi-country panel ARDL estimation method is chosen. However, there is a central caveat with pooling: it potentially ignores structural differences across the panel units. To address this concern, two intermediate estimators that allow for a certain degree of heterogeneity without losing the general pooling advantage are employed in conjunction.

A dynamic fixed effects model (DFE) is employed first. This estimator allows for heterogeneous intercept and adjustment terms while long as well as short-run coefficients are homogenous (Weinhold, 1999). If, however, slope heterogeneity is the case among the short-run regressors, the preferable technique is the pooled mean group model (PMG) introduced by Pesaran and Smith (1995). The long-term coefficients are assumed to be homogenous, the short-term dynamics, error variance as well as intercepts are allowed to vary.[79] Both models share the same long-run equation:

$$X_t^i = C^i + \delta_1 FI_t^i + \delta_2 REER_t^i + \delta_3 NPCF_t^i + \nu_t^i. \qquad (3.6)$$

The estimation of the DFE and PMG will be carried out by means of ordinary least squares. In addition, the maximum likelihood method will be used to estimate a PMG model. This can enhance the efficiency of the outcome in case heteroscedasticity and serial correlation are present. To address these issues in the PMG-OLS model, robust standard errors were calculated as suggested by Westerlund et al. (2019). However, an important issue when using macro-panels is that of unobservable common factors across panel units (i) leading to cross sectional

[79] If total panel heterogeneity is assumed, the Mean Group estimator (MG), allowing for heterogeneity of all regression parameters in the error correction model, is the efficient one. However, in this case, the MG estimator is equivalent to simply averaging the coefficients of individual countries, neglecting the advantages of panel data. When full heterogeneity is considered, the panel approach loses its advantages, and estimates may become less precise due to the limited degrees of freedom. Therefore, the MG estimator will not be considered in this analysis.

dependence (CSD). If they are correlated to the explanatory variables, estimates become biased and inconsistent.[80] As a remedy, cross-sectional averages (CSA) were added to the error correction model. Consequently, the general baseline model becomes a dynamic common correlated effects model (CCEPMG) as proposed by Chudik and Pesaran (2015). The ECM in its pooled mean group version including a lagged CSA then can be formulated as follows:

$$\Delta X_t^i = C^i + \alpha X_{t-1} + \eta_1 FI_{t-1} + \eta_2 REER_{t-1} + \eta_3 NPCF_{t-1} + \beta_1^i \Delta X_{t-1}^i + \beta_2^i \Delta FI_t^i + \beta_3^i \Delta REER_t^i + \beta_4^i \Delta NPCF_t^i + \beta_5^i CSA_t + \epsilon_t^i. \quad (3.7)$$

Choosing an appropriate lag structure of the ARDL model is carried out by applying a general to specific approach starting from an ARDL (2.2.2.2). To assess the validity of the estimated long-run relationship, two different cointegration techniques will be used. The first one is the residual-based approach by Pedroni (2004) using the following types of unit root tests: The Augmented Dickey Fuller test and the Phillips-Perron test. The second approach is the Westerlund test (Westerlund and Edgerton, 2007), which can take heterogeneity and CSD into account. This test bases on the t statistics of the individual coefficients out of an error correction framework.

2.3.3.2.3 Results

Table 14 summarizes the results of this task and shows the estimated long-run trade elasticities (indicated with δ). The tested models (rows) differ according to their NPC variable, their estimator and the ARDL lag structure. The long-run coefficients from the baseline panel specification (SEE) without an NPC variable confirm the results of the time-series estimation in section 3.2. The income elasticity estimates approach 1.6 and are, thus, below but close to the sample X/FI ratio of 1.8. However, the price elasticity magnitude is -1.5. Notably, these effect magnitudes are not affected fundamentally when introducing various NPC arguments. The economic complexity (ECI) variable consistently shows a positive correlation with the export volume across all estimation techniques. The estimated semi-elasticities range from 0.1 to 0.3, which aligns with recent findings by Pariboni and Paternesi Meloni (2022). To give an idea, improving a country's ECI by 10 index points (which can be considered a sizable change) results in only a modest increase in export volume, ranging from 1% to 3%. Counterintuitively, the consideration of the ECI increases the income elasticity magnitude towards 1.8. Moreover, the ECI incorporates the concept of revealed comparative advantage, which measures observed export success and can result from both price and non-price competitiveness. Accordingly, the ECI is not capable separating price from non-price effects, which limits its explanatory power.

However, in the PMG setting, two other indicators that are mutually correlated and also correlated with the ECI show significant results: the patent stock (PAT41) and the expenditure for research and development (RD28). The estimated elasticities approach 0.1, indicating a

[80] The CD test by Pesaran (2015) is employed to test for the presence of weak CSD. Given the small time dimension of the sample, the addition of further controls, such as cross sectional averages and their lagged values, may introduce problems due to the limited degrees of freedom available. Therefore, the model specification process should carefully consider cross-sectional dependence while also taking into account the potential loss of test power and estimation precision.

modest impact on the export volume. However, the indicators of capital stock (CS29), investment intensity (II41), and multi-factor productivity (MFP24) do not contribute in a clear-cut way, as the results are not robust across estimation techniques, different specifications, or lag length structures. Notably, the multi-factor productivity measure shows negative signs, and its consideration inflates the price elasticity magnitude in two specifications. Since the ULC-adjusted real effective exchange rate already incorporates information on productivity levels, this outcome does not surprise. This potential endogeneity issue is addressed by employing the lagged REER variable. This robustness test (results are shown in Table A7) generally reaffirms the previously discussed insights. The estimated elasticity of the lagged REER varies significantly among different estimators, ranging from -1.1 to -1.9. In this context, the PAT41 measure also emerges as a robust predictor of exports. However, the effect magnitudes (ranging between 0.05 and 0.2) are relatively modest. The signs of the CS29 effect become consistently positive, but not significant in every model. Moreover, the ECI is confirmed as a statistical powerful variable with similar coefficients as in the baseline specification.

Table 14: Long-run estimates (Panel ARDL) from standard export equation (SEE) specification

MODEL	ESTIMATOR	δ_1 (FI)	δ_2 (REER)	δ_3 (NPCF)	α	ARDL
SEE	DFE (OLS)	+1.696***	-1.584***	-/-	-0.181***	2.2.2
		(0.134)	(0.286)		(0.051)	
	PMG (MLM)	+1.513***	-1.495***	-/-	-0.274**	2.2.2
		(0.015)	(0.083)		(0.120)	
	PMG (OLS)	+1.674***	-1.459***	-/-	-0.204***	1.1.1
		(0.000)	(0.000)		(0.000)	
ECI	DFE (OLS)	+1.837***	-1.680***	+0.279*	-0.168***	2.1.2.1
		(0.132)	(0.261)	(0.164)	(0.030)	
	PMG (MLM)	+1.693***	-1.452***	+0.179***	-0.283***	1.1.1.1
		(0.031)	(0.131)	(0.046)	(0.081)	
	PMG (OLS)	+1.891***	-1.689***	+0.359**	-0.204***	2.1.2.2
		(0.052)	(0.023)	(0.026)	(0.024)	
PAT41	DFE (OLS)	+1.700***	-1.589***	-0.005	-0.186***	2.2.2.2
		(0.096)	(0.270)	(0.072)	(0.032)	
	PMG (MLM)	+1.608***	-1.510***	+0.088***	-0.333***	2.1.1.2
		(0.023)	(0.104)	(0.019)	(0.006)	
	PMG (OLS)	+1.771***	-1.165***	+0.098***	-0.117***	2.2.2.2
		(0.018)	(0.012)	(0.002)	(0.008)	
RD28	DFE (OLS)	+1.688***	-1.588***	+0.069	-0.176***	2.1.2.1
		(0.103)	(0.260)	(0.105)	(0.030)	
	PMG (MLM)	+1.617***	-1.595***	+0.095***	-0.365***	2.1.1.2
		(0.022)	(0.100)	(0.025)	(0.112)	
	PMG (OLS)	+1.642***	-1.313***	+0.133***	-0.174***	2.1.2.2
		(0.029)	(0.016)	(0.015)	(0.015)	
CS29	DFE (OLS)	+1.816***	-1.841***	-0.044	-0.149***	1.1.1.1
		(0.119)	(0.325)	(0.174)	(0.031)	
	PMG (MLM)	+1.527***	-1.298***	-0.129*	-0.309***	2.1.1.1
		(0.023)	(0.150)	(0.065)	(0.092)	
	PMG (OLS)	+1.710**	-1.362***	-0.349	-0.189	1.1.1.2
		(0.054)	(0.015)	(0.352)	(0.026)	
II41	DFE (OLS)	+1.718***	-1.562***	0.185+	-0.181***	2.1.2.1
		(0.100)	(0.253)	(0.124)	(0.030)	
	PMG (MLM)	+1.607***	-1.635***	-0.156***	-0.288***	1.1.1.1
		(0.022)	(0.144)	(0.050)	(0.086)	
	PMG (OLS)	+1.676***	-1.448***	+0.071**	-0.229***	2.1.1.1
		(0.068)	(0.019)	(0.032)	(0.031)	
MFP24	DFE (OLS)	+1.574***	-1.850***	-0.945	-0.154***	2.1.1.1
		(0.172)	(0.346)	(0.767)	(0.033)	
	PMG (MLM)	+1.535***	-2.137***	-0.692***	-0.243***	1.1.1.1
		(0.032)	(0.160)	(0.247)	(0.066)	
	PMG (OLS)	+1.712***	-1.440***	0.034	-0.136***	2.2.2.2
		(0.051)	(0.011)	(0.057)	(0.020)	

Note: 1995-2019, n=24-l. MDL: Model specification with notion of non-price competitiveness factor (NPCF). EST: Estimator. Critical values: 1% ***; 5% **; 10% *. Long term coefficients FI (foreign income) and REER (Price competiveness) from cointegrating equation (3.2). α denotes the adjustment coefficient. Standard errors in brackets below the coefficient.

2.3.4 Discussion

2.3.4.1 European evidence

The paper now moves to a discussion of the main findings. Over the past two decades, the export growth trajectory of European countries has exhibited significant fluctuations. Until 2008q3, real exports of the European country sample experienced strong growth, with a quarterly growth rate (weighted average) of 1.51%. In comparison, the potential demand proxied by the real GDP of the 35-country sample grew at an average quarterly rate of 0.70% (X/FI: 2.16). By the second quarter of 2009, an initially strong recovery began, but soon entered a phase of comparatively slower growth (X/FI: 2.00; export growth: 1.05%; GDP growth: 0.52%).[81] Among the countries with stronger export growth in relation to foreign demand throughout the period 1995-2019 were Germany (X/FI: 2.22), Austria (2.12), Portugal (2.11), Spain (2.10) and the Netherlands (2.05). However, Finland (1.64), France (1.55), Belgium (1.51) and, in particular, Italy (1.05) recorded below average export dynamics. This classification is reflected by the country ranks according to the levels of several competitiveness indicators (Table 15).[82]

Table 15: Sample rank matrix

	AUT	BEL	ESP	FIN	FRA	GER	IRE	ITA	NDL	PRT
X/FI	3	9	5	7	8	2	1	10	6	4
IE	2	7	5	10	9	1	5	8	3	4
ECI	2	7	9	3	4	1	5	6	8	10
RD28	3	5	8	1	4	2	7	9	6	10
II41	2	4	3	5	7	9	1	10	8	6

Note: Rank built upon arithmetically averaged (1995-2019) values per country.

How can these different export performances, which reflect fundamental differences in international competitiveness, be explained? To evaluate the coherence of the different direct and indirect indicators analysed in this paper, I will compare them with the observed dynamics and the findings from the estimations presented in the previous section. This analysis seeks to provide insights and determine whether these individual factors contribute to forming a comprehensive and cohesive assessment of the competitive stance of major European economies. Table 16 provides a comparative survey of the developments and potential contributions of a variety of competitiveness indicators. For each factor of competitiveness, a simplified indication of weak or strong changes across the different periods is given.[83]

[81] The strong export contraction in the period from 2008q3 – 2009q1 is not considered in the two subperiods, but in the sample covering the entire time span.

[82] Only normalised (for economy size) measures suitable for a country ranking will be considered. This excludes the use of the levels of PAT41, CS29 and MFP24.

[83] Table 8 serves as a simplified summary of the results. Regarding the single factors of competitiveness, the signs can be interpreted in terms of contributions to exports. More detailed results of the estimations can be found in Table A3 and A4. Additionally, Table A5 presents the quarterly growth rates of exports, import demand, and relative prices and the respective export growth contributions.

Table 16: Results Survey

	AUSTRIA			BELGIUM			SPAIN			FINLAND			FRANCE		
	95-19	95-08	09-19	95-19	95-08	09-19	95-19	95-08	09-19	95-19	95-08	09-19	95-19	95-08	09-19
X/FI	2.12	2.46	2.15	1.51	1.74	1.80	2.10	2.21	2.24	1.64	2.90	0.97	1.55	1.71	1.65
IE	2.09	2.18	1.16	1.53	1.82	1.21	1.90	2.12	1.30	1.11	2.55	0.13	1.44	1.65	1.40
XS	++	++	-	--	--	-	++	0	++	--	++	--	--	--	-
REER37	--	--	+	--	--	0	-	++	--	--	--	+	--	-	-
RS	-0.04	-0.13	0.00	-0.07	-0.03	0.00	0.17	0.34	-0.02	-0.10	0.12	0.08	-0.02	0.06	-0.20
TF	+	+	+	--	--	-	+	++	--	--	++	--	--	--	--
ECI	--	--	+	--	--	0	--	--	--	--	--	--	--	--	--
RD28	++	++	-	++	--	++	+	++	--	--	++	--	--	--	--
PAT41	+	--	++	--	--	--	++	++	++	--	++	--	--	--	--
CS29	0	+	-	++	++	++	++	++	--	++	++	-	++	++	+
II41	--	--	++	++	++	0	--	++	--	++	++	0	++	++	+
MFP24	+	+	0	--	--	-	--	--	+	++	++	-	-	-	0

	GERMANY			IRELAND			ITALY			NETHERLANDS			PORTUGAL		
	95-19	95-08	09-19	95-19	95-08	09-19	95-19	95-08	09-19	95-19	95-08	09-19	95-19	95-08	09-19
X/FI	2.22	2.54	2.27	3.66	2.82	4.04	1.05	1.21	1.73	2.05	2.12	2.14	2.11	1.93	2.67
IE	2.03	2.32	1.93	1.95	3.67	0.90	1.28	1.96	0.98	2.01	2.24	1.72	1.91	1.47	2.13
XS	++	++	+	n.a.	n.a.	n.a.	--	--	--	++	0	++	++	--	++
REER37	--	--	++	--	++	--	++	++	-	-	-	0	+	++	--
RS	-0.20	-0.12	0.41	-1.06	0.54	-1.27	-0.20	-0.02	0.00	0.07	-0.09	-0.12	0.00	0.03	-0.01
TF	-	--	++	n.a.	n.a.	n.a.	--	-	--	++	0	++	++	++	+
ECI	--	--	+	+	++	--	--	--	-	--	--	+	++	++	--
RD28	--	--	-	--	--	--	0	-	+	--	--	++	++	++	--
PAT41	--	--	--	++	++	++	--	--	--	--	-	--	++	++	++
CS29	--	--	+	++	++	++	--	+	--	++	++	-	--	++	--
II41	--	--	++	++	++	++	--	+	--	--	0	--	--	--	--
MFP24	+	-	+	++	++	++	--	--	-	-	+	-	--	--	-

Note: ++/-- denotes changes >5%; +/- denotes changes 1%-5%, 0 denotes changes <1%. In case of the ECI, changes are considered in index points instead of percentages. Underlined values signal not reliable figures due to the absence of cointegration and/or insignificant coefficients (observable in Tables A3 and A4).

Austria: Austria belongs to the group of strong exporters, recording a X/FI ratio of 2.12 and experiencing gains in export market shares and price competitiveness. This high export growth is in line with the high ranks in major competitiveness indicators. According to the SEE estimation, Austria exhibits an income elasticity of 2.1 and a price elasticity of -1.3 translating the REER gains into additional exports. However, surveying the NPC factor dynamics does not allow to draw clear conclusions on how the structural position changed. Improvements in innovation-related factors contrast the worsening of the investment intensity and of the economic complexity index. Nevertheless, the generic TF indicator suggests a consistent but modest improvement in NPC over time. In summary, Austria's strong export performance is attributed to a strong and partly improving competitive industrial structure and gains in price competitiveness.

Belgium: The low-ranked competitive position of the Belgium economy is reflected by one of the weakest export performances (X/FI: 1.51) among the sample countries. Throughout the period, improvements in terms of the REER as well as in investment-related factors and R&D

intensity are contrasted by losses in patents, productivity, and the economic complexity index. The TF measure indicates a strong negative NPC contribution to export growth underscoring the further worsening of structural competitiveness.

Finland: The competitiveness ranks of the Finish economy do not provide clear-cut insights into the overall competitive situation of its economic structure. The export dynamics differ substantially across the two subperiods. The export to foreign demand growth ratio of 2.90 coincided with strong gains in price competitiveness as well as in almost all NPC dimensions from 1995q1 to 2008q3. After the economic shock of 2008, however, the Finish stance in terms of the entire range of price and non-price factors worsened and the X/FI ratio consequently fell to 0.97.

France: The exports of the French economy grew at a relatively slow rate (X/FI: 1.55) through the entire period, which is reflected by a low income elasticity of 1.4. Even though recording a REER improvement, France lost export market shares to a considerable extent. According to the SEE estimation and the resulting price elasticity of -1.0, these relative price gains acted as an important pillar supporting the overall slow export competitiveness. Except from the investment-related factors, France recorded a strong decline of its overall NPC, which is consistently reflected by the negative TF and ECI dynamics.

Germany: The fast-growing exports (X/FI: 2.22) underscore the high level of international competitiveness of the German economy as indicated by the leading ranks in several dimensions of competitiveness. The estimated SEE income elasticity of 2.03 (2.32 and 1.93 for the subsamples) approaches the X/FI ratio. The REER decreased on average by 0.17% on quarterly base and the highly significant price elasticity of –1.05 indicates that those price competitiveness gains are translated into strong additional export growth. The importance of price competitiveness was high or even increasing over time according to the estimates (see Table A3). This indicates that the slight REER appreciation in the second period lowered the competitive advantage of German exports significantly, which is reflected by reduction in X/FI and IE. The different German NPC indicators, however, show opposite dynamics. Until 2008, Germany suffered losses in all relevant NPC categories. Accordingly, the outstanding export competitiveness is based on high but declining levels of structural competitiveness and has been fuelled by considerable gains in price competitiveness in this first period. This fact is reflected in the quarterly export growth contribution by relative price of +0.58pp (see Table A5). However, in the period following 2008, improvements in non-price competitiveness are indicated.

Italy: The Italian economy experienced the slowest export growth by far and is almost at the bottom of the competitiveness ranking. From 1996q1 to 2008q3 (as data for Italian goods exports is available only from 1996q1) exports grew at a rate of only 1.21 times that of potential foreign demand, while simultaneously recording substantial losses in price competitiveness. However, the Italian price elasticity does not appear to be of considerable magnitude until 2008 (see Table A3). Following the 2008/09 crisis, price competitiveness moderately improved, leading to a substantial increase in the X/FI ratio to 1.73. Throughout the entire period, these dynamics were accompanied by a significant decline across almost all NPC factors, as evidenced by the TF indicator depicting strong negative trends.

Spain: An ambiguous case is that of the fast-growing Spanish exports, whose economy shows low competitiveness ranks according to the ECI and the R&D intensity. Despite a fast growth rate (X/FI: 2.10) and overall market share gains, there was a worsening of price competitiveness until 2008, contrasted by significant improvements in the post-crisis period. The main NPC indicators exhibited opposite dynamics in the two subperiods indicating a significant improvement until 2008 and a decline afterwards. However, overall, the NPC contribution to export growth was beneficial, as indicated by the positive signs of the TF and ECI measures. In summary, the rapid growth in exports is challenging to explain comprehensively using the factors examined in this study.

The Netherlands: The volume of the Dutch exports of goods grew at a comparatively high rate (X/FI: 2.05) which is reflected by export market share increases. A slight and steady improvement in terms of the REER supported this performance given the price elasticities of about -0.7. However, the dynamics exhibited by NPC factors differ. In the first period, innovation-related measures indicate a fall behind, but a reversal can be observed afterwards. Taking the TF indicator as the most comprehensive proxy, the overall Dutch NPC improved and represented an important pillar of the strong export performance.

Portugal: Evaluating Portugal's export competitiveness reveals similarities to the Spanish case and necessitates a separate analysis for distinct subperiods due to differing trends. Until 2008q3, exports grew at a ratio of 1.93 in relation to foreign income. During this period, export market shares and price competitiveness deteriorated, while the relative position in terms of several NPC factors improved significantly. However, during the second subperiod characterized by very strong export growth rates (X/FI: 2.67), most NPC factors show a negative contribution, indicating a decline in non-price competitiveness, while the price position improved. Although low competitivess ranks in terms of the ECI and R&D intensity, the NPC contribution appeared strongly positive throughout the entire period, as indicated by the positive values of the holistic TF measure and the improvement in innovation-related factors.

2.3.4.2 Assessment of non-price competitiveness indicators

Indeed, a comprehensive analysis of a country's non-price competitiveness necessitates the consideration of multiple indicators, each offering distinct insights. Since the quantification of NPC effects is not feasible, scholars must assess the consistency of the picture generated by different indicators in a descriptive manner. Some metrics provide insights on the level of overall competitiveness, while others may inform on the periodical NPC changes and, thus, potential contributions to exports dynamics. A useful starting point can be a descriptive analysis of relative export growth, changes in export market shares and movements in price competitiveness. Notably, price competitiveness proxied by unit labour cost is not solely a robust indicator of the relative price stance but also encapsulates information about the structural factor of productivity, making it a comprehensive measure of international competitiveness. Through the integration of diverse indicators and approaches, researchers can achieve a more holistic comprehension of a country's global standing, enabling a more nuanced analysis of its export performance and the contributing factors. In the following, a short

evaluation of the single NPC approaches is formulated based on the insights from the conceptual and empirical assessment in the previous sections.

Income elasticity (IE): The income elasticity compared to that of other countries is considered an indirect reflection of non-price competitiveness. However, as the estimation results have shown, its effect size closely approximates the observed X/FI growth ratio, which reflects the overall export competitiveness of a country. Accordingly, the income elasticity represents a confounding of income and different competitiveness effects. This raises doubts about whether the indicator exclusively captures non-price effects.

Export equation residual (RS): The residual-based NPC assessment by estimating a gravity model export function, did not proved valuable. Again, the income elasticity represents a confounding of income and competitiveness factors. Accordingly, whether non-price effects are not solely reflected by the estimation residual is open to discussion. Furthermore, a cointegrating relationship for the underlying export function specification has been detected only in single cases providing very few comparable evidence.

Trade frictions indicator (TF): Based on a gravity model export function, the mathematically derived TF indicator provides consistent insights on how NPC factors affect export growth. This is hardly surprising, since a) its calculation approach is capable of separating price from non-price effects and b) strong co-movements with other NPC measures can be observed. Export market share changes not explained by changes in price competitiveness are attributed to shifts in terms of NPC. This conceptual rigour distinguishes it from other NPC measures, making it a valuable generic indicator.

Economic complexity index (ECI): The index of economic complexity makes a robust econometric contribution to explaining exports. Though proving its significance in statistical terms, the ECI semi-elasticity (0.1-0.3) appears too low for ECI serving as a universal NPC indicator. Moreover, the same caveat as for the IE indicators applies: The ECI is conceptually not capable separating price from non-price effect.

Other 'direct' NPC proxies: All other measures did econometrically contribute in a less conclusive or in some cases even unambiguous way. The innovation-related factors RD28 and PAT41 yield significant and positive coefficients in single settings. Since their dynamics are similar to the ECI as well as the TF indicator, they provide very useful additional information in the descriptive analysis. The same applies to the investment-related factor CS29, albeit to a minor extent. In contrast, both investment intensity II41 and multi-factor productivity MFP24 did not exhibit robust econometric contributions. In the case of MFP24 it should be acknowledged that the price competitiveness variable expressed by unit labour cost does already account for labour productivity within the income-and-price-elasticity framework.

2.3.5 Conclusion

At a theoretical level, non-price competitiveness is an elusive concept, which can only be defined in contrast to price-related factors that shape export dynamics. The present paper focused on the assessment of non-price competitiveness and its relevance for export performance and shows that a comprehensive assessment of international competitiveness

necessitates the use of different indicators in conjunction. The analysis refers to 10 European countries and spans from 1990 to 2019. By checking the conceptual consistency and mutual correlation of single established approaches to NPC, this investigation provides insights on how to assess a country's international competitiveness.

The estimated income elasticity, one of the most popular indicators, represents a valuable analytical starting point. However, the coefficient can be seen as a confounding factor, blending income and competitiveness effects. Likewise, the residual-based approach to NPC does not prove useful in separating effects and providing evidence on the impact of non-price factors. In this context, a more reliable indicator is the calculated trade frictions measure, which is derived from the rearrangement of a gravity trade model export equation. This indicator attributes changes in export market shares not explainable by movements in price competitiveness to changes in the non-price stance and its results are in line with the indications given by other single NPC measures such as the R&D intensity.

Despite introducing 'direct' additional NPC arguments to the standard export equation, this empirical analysis did not identify a single overarching NPC proxy that significantly enhances explanatory power in assessing exports. Consequently, quantifying the NPC impact on exports remains challenging. The economic complexity index coefficient, despite robust statistical significance in the export equation, exhibits only modest effect sizes and reveals conceptual weaknesses. In certain scenarios, the R&D intensity, patent as well as capital stock indicators also exhibit significant effects. However, the measures of investment intensity and multi-factor productivity did not yield consistent and significant effects. It is noteworthy that the inclusion of these additional factors did not significantly alter the income and price elasticities in terms of effect magnitudes and significance. Nevertheless, despite their limited statistical significance in the econometric exercise, these factors offer valuable descriptive insights into changes within the economic macro structure, enabling the development of coherent narratives.

Beside the methodological contribution, this analysis provides evidence how the exports of European countries have been shaped by non-price factors. For example, Germany, often regarded as having a competitive edge, surprisingly exhibits a decline in residual-based NPC indicators, the index of economic complexity, and other innovation-related measures, indicating a significant decrease in non-price competitiveness, particularly during the period marked by the build-up of trade imbalances until 2008. A steady deterioration of major non-price competitiveness factors can also be observed for France and, particularly, Italy. On the other hand, Portugal stands out as a country that has consistently improved its structural non-price stance throughout the period. The evidence for Belgium, Finland, Spain, and the Netherlands, however, is less conclusive.

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Appendix I

Table A 1: Unit root tests of relative prices / Real effective exchange rate deflated by ULC

	REER_ULC37 (q)				REER_ULC37 (a)			
	ADF	l, t	KPSS	l, t	ADF	l, t	KPSS	l, t
Austria	-3.314*	2, t	0.282***	7, t	**-1.734**	1	**0.705****	5
Belgium	-3.141**	2	0.248	7	-3.386**	1	0.0995	5, t
Finland	-3.068*	2	0.151**	7, t	**-1.977**	2	**0.588****	5
France	-2.721*	2	0.181	7	**-1.795**	2	**0.932*****	5
Germany	-3.447**	2	0.292***	7	-2.503*	1	0.182	5
Ireland	**-0.254**	2	**0.328*****	7	-1.017	1	0.231	5
Italy	**-2.483**	2	**0.124***	7	-2.461*	1	0.170	5
Luxembourg	-3.613**	2, t	1.350***	7, t	**-0.357**	0	**0.589****	4
The Netherl.	**-2.187**	2, t	**0.118***	7, t	-2.988**	1	0.261	5
Portugal	-1.965	2	0.234	7	-1.604	2	0.150	5
Spain	-1.561	3	0.283	7	**-1.927**	4	**0.926*****	5

Note: Quarterly data (q) 1995q1-2021q3, annual data (a) 1960-2018. ADF: Augmented Dickey-Fuller test with constant, H0: I(1) non stationarity. KPSS: Kwiatkowski–Phillips–Schmidt–Shin test, H0: I(0) stationarity. Lag length choice (l) according to AIC minimisation. The presence of a deterministic trend is denoted by (t). Bold value indicate consistent non-stationarity of the single country time series. Critical values: 1% ***; 5% **; 10% *.

Table A 2: Unit root test (ADF) of real export of goods, foreign income and relative prices

	EXPORTG		FI37		REER_ULC37	
	ADF	l, t	ADF	l, t	ADF	l, t
Austria	-1.981	1	-2.395	2, t	-3.314*	2, t
Belgium	-2.956	1, t	-2.393	2, t	-3.141**	2
Finland[1]	-3.032**	2	-2.399	2, t	-3.068*	2
Finland	-1.997	2, t	-2.126	2,t	-2.784*	1
France	-2.626*	4	-2.400	2, t	-2.721*	2
France[2]	-2.274	1	-2.214	2, t	-2.207	2
Germany	-1.985	1	-2.333	2, t	-3.447**	2
Ireland	-0.178	2	-2.364	2, t	-0.254	2
Italy	-1.484	1	-2.376	2, t	-2.483	2
Luxembourg	-2.770	1, t	-2.394	2, t	-3.613**	2, t
The Netherl.	-3.186*	1, t	-2.392	2, t	-2.187	2, t
The Netherl.[3]	-1.883	1	-2.131	2, t	-2.829	2, t
Portugal	-3.112	4, t	-2.391	2, t	-1.965	2
Spain	-2.417	3	-2.467	2, t	-1.561	3

Note: Quarterly data 1995q1-2021q3, ADF: Augmented Dickey-Fuller test with constant, H0: I(1) non stationarity. Lag length choice (l) according to AIC minimisation. The presence of a deterministic trend is denoted by (t). Critical values: 1% ***; 5% **; 10% *. Different sample length in 1: 1995q1-2009q1; 2: 1995q1-2009q1; 3: 1995q1-2009q4.

Table A 3: Export of goods, short-run estimates, equation (1.2)

	OLS			OLS Prais-Winston AR(1)		
	δ1	δ2	R2	δ1	δ2	R2
Austria	1.922***	-0.732***	0.707	1.823***	-0.655**	0.710
	(0.287)	(0.187)		(0.119)	(0.229)	
Belgium	1.813***	-0.190	0.615	1.761***	-0.181	0.609
	(0.399)	(0.200)		(0.138)	(0.210)	
Finland	1.017**	-0.938**	0.091	1.563***	-1.110***	0.257
	(0.448)	(0.420)		(0.357)	(0.308)	
France	2.877***	-0.241*	0.878	2.874***	-0.252*	0.876
	(0.165)	(0.129)		(0.105)	(0.134)	
Germany	2.353***	-0.573***	0.791	2.337***	-0.566***	0.795
	(0.124)	(0.128)		(0.120)	(0.138)	
Ireland	0.469	-1.002***	0.147	0.463	-1.014***	0.250
	(0.894)	(0.227)		(0.349)	(0.167)	
Italy	2.959***	-0.483***	0.866	2.954***	-0.480***	0.864
	(0.102)	(0.131)		(0.116)	(0.138)	
Luxembourg	2.348***	-0.178	0.295	2.386***	-0.175	0.300
	(0.321)	(0.547)		(0.352)	(0.498)	
The Netherl.	1.078***	-0.500***	0.575	1.028***	-0.494***	0.567
	(0.163)	(0.160)		(0.096)	(0.170)	
Portugal	3.307***	0.509	0.679	3.230***	-0.572*	0.674
	(0.214)	(0.347)		(0.218)	(0.300)	
Spain	2.863***	-0.324**	0.779	2.863***	-0.308	0.777
	(0.148)	(0.211)		(0.149)	(0.207)	

Note: 1995q1-2021q3, n=106-l. δ1: Short-run income elasticity. δ2: Short-run price elasticity. Critical values: 1% ***; 5% **; 10% *. Lag length choice according to AIC minimisation. Standard errors in brackets.

Table A 4: Export of goods, long-run estimates (OLS) from model ii.

	δ 1	δ2	α	DF	DW	R2	l
Austria	1.968***	-1.232***	-0.165	-4.562**	0.386	0.991	1
	(0.018)	(0.072)	(0.111)				
Belgium	1.447***	-0.682***	-0.197**	-2.989	0.294	0.972	2
	(0.023)	(0.124)	(0.095)				
Finland	1.338***	-1.803***	-0.074	-0.551	0.248	0.789	4
	(0.071)	(0.247)	(0.054)				
France	1.308***	-0.866***	-0.147	-1.608	0.255	0.942	3
	(0.031)	(0.141)	(0.101)				
Germany	1.983***	-0.799***	-0.317**	-4.397**	0.461	0.995	1
	(0.018)	(0.049)	(0.153)				
Ireland	2.736***	-0.824***	-0.077*	-2.131	0.252	0.945	1
	(0.083)	(0.076)	(0.044)				
Italy	1.079***	-0.291***	-0.306***	-3.766*	0.506	0.929	1
	(0.035)	(0.089)	(0.100)				
Luxembourg	2.122***	-0.655***	-0.215***	-3.050	0.421	0.931	1
	(0.117)	(0.019)	(0.081)				
The Netherl.	1.941***	-0.237***	-0.016***	-3.378	0.408	0.990	1
	(0.025)	(0.107)	(0.079)				
Portugal	1.803***	-0.137	-0.299**	-4.087**	0.611	0.973	1
	(0.028)	(0.102)	(0.123)				
Spain	1.846***	-0.280***	-0.189**	-3.654*	0.252	0.972	1
	(0.030)	(0.087)	(0.092)				

Note: 1995q1-2021q3, n=107-l. Engle-Granger two-step procedure for cointegration test. Null hypothesis: No long-term relationship exists. Critical values: -4,433 - 1%***; -3,822 - 5%**; -3,511 - 10%*. Long term coefficients δ1 (foreign income) and δ2 (REER) from cointegrating equation (1.5). Adjustment coefficient α from error correction model. Model lag length (l) according to AIC minimisation. Standard errors in brackets.

Table A 5: Export of goods, long-run estimates (MLM) of VECM, model iii.

	δ1	δ2	α	Trace	l
Austria	1.941***	-1.367***	-0.321***	58.619***	3
	(0.025)	(0.097)	(0.009)		
Belgium	1.406***	-0.651**	-0.188**	28.164*	1
	(0.059)	(0.304)	(0.078)		
Finland	1.076***	-1.491**	-0.162***	23.883	1
	(0.184)	(0.635)	(0.044)		
France	1.111***	-0.725	-0.187***	15.809	1
	(0.106)	(0.475)	(0.064)		
Germany	1.962***	-1.101***	-0.156***	40.455***	2
	(0.042)	(0.110)	(0.127)		
Ireland	3.148***	-0 .985***	-0.094***	23.592	1
	(0.252)	(0.238)	(0.037)		
Italy	1.126***	-0.305	-0.312***	24.378	2
	(0.081)	(0.204)	(0.096)		
Italy^{trend}	1.974***	-0.391***	-0.369**	28.414*	2
	(0.291)	(0.140)	(0.151)		
Luxembourg	1.530***	-0.132	-0.194***	28.684**	1
	(0.287)	(0.462)	(0.065)		
The Netherl.	1.860***	-0.068	-0.067	26.002	2
	(0.063)	(0.267)	(0.075)		
Portugal	1.805***	-0.377**	-0.303**	39.822***	2
	(0.377)	(0.158)	(0.119)		
Spain	1.737***	-0.305*	-0.224***	26.363	2
	(0.065)	(0.181)	(0.085)		

Note: 1995q1-2021q3, n=107-l. Johansen trace statistic for cointegration test. Null hypothesis: No long-term relationship exists. Critical values: 35,65 - 1%***; 29,68 - 5%**; 26,79 - 10%*. Long term coefficients δ1 (foreign income), δ2 (REER) from vector error correction model. Adjustment coefficient α obtained from export equation (1.4) (Exports as dependent variable) within VECM. Model lag length choice (l) according to AIC minimisation. Standard errors in brackets.

Table A 6: Export of goods, long-run estimates (OLS) of ARDL model iv.

	δ1	δ2	α	F	t	l
Austria	1.918***	-1.277***	-0.384***	13.128***	-5.941**	3,3,3
	(0.031)	(0.119)	(0.064)			
Belgium	1.437***	-0.757*	-0.181***	5.643***	-3.977***	3,4,0
	(0.068)	(0.385)	(0.045)			
Finland	0.667	-6.907	-0.063	2.523	-1.418	4,2,3
	(0.647)	(4.312)	(0.044)			
Finland[1]	2.471***	-1.302***	-1.502***	12.309***	-6.037***	2,4,3
	(0.038)	(0.077)	(0.248)			
France	0.811	0.039	-0.031	1.409	-1.051	3,1,4
	(0.541)	(1.559)	(0.030)			
France[2]	1.616***	-1.156***	-0.462***	9.682**	-4.476***	4,4,1
	(0.056)	(0.110)	(0.103)			
Germany	1.965***	-1.060***	-0.305***	8.990***	-4.815***	2,1,1
	(0.037)	(0.118)	(0.063)			
Ireland	1.525*	-1.862**	-0.075*	3.994**	-1.807	2,0,2
	(0.823)	(0.725)	(0.041)			
Italy	1.207***	-0.460*	-0.130***	4.556*	-3.459*	1,1,1
	(0.115)	(0.262)	(0.037)			
Italy[trend]	2.305***	-0.548***	-0.241***	5.058**	-4.104**	1,1,1
	(0.314)	(0.142)	(0.058)			
Luxembourg	2.117***	-0.780	-0.212***	4.233*	-3.484*	1,1,0
	(0.434)	(0.663)	(0.060)			
The Netherl.	1.809***	-0.166	-0.128**	2.452	-2.332	2,1,1
	(0.109)	(0.413)	(0.054)			
The Netherl.[3]	2.188***	-0.970***	-0.329***	4.476*	-3.347*	3,4,3
	(0.099)	(0.265)	(0.098)			
Portugal	1.772***	-0.581**	-0.278***	6.220**	-3.783**	4,2,2
	(0.058)	(0.230)	(0.073)			
Spain	1.656***	-0.331***	-0.178***	6.924***	-3.831**	4,1,4
	(0.080)	(0.186)	(0.046)			

Note: 1995q1-2021q3, n=107-l. Bounds procedure (F and t Test) for cointegration test. Null hypothesis: No long-term relationship exists. Critical values depend on lag structure choice: 1% ***; 5% **; 10% *. Adjustment coefficient α and long-term coefficients δ1 (foreign income), δ2 (REER) from ARDL equation (1.5). Individual lag length choice (l) according to AIC minimisation. Standard errors in brackets. Different sample length in 1: 1995q1-2009q1; 2: 1995q1-2009q1; 3: 1995q1-2009q4. The presence of a significant deterministic trend in the long-run equation is signalled by *trend*.

Table A 7: Export of goods, l.-r. estimates (OLS) of ARDL model iv, different REER metrics

	ULC37		GDP43		XPI37	
	δ1	δ2	δ1	δ2	δ1	δ2
Austria	**1.918*** **	**-1.277*** **	**1.773*** **	**-1.564*** **	1.802***	-1.219
Belgium	**1.437*** **	**-0.757***	**1.376*** **	**-0.166**	**1.443*** **	**-0.404**
Finland	0.667	-6.907	0.280	-0.335	0.153	-0.674
Finland[1]	**2.471*** **	**-1.302*** **	2.036***	-0.636	**1.847 *** **	**-1.404*** **
France	0,811	0.039	0,634	-1.469	0.984***	-0.231
France[2]	**1.616*** **	**-1.156*** **	1.449***	-1.583***	1.114***	-1.570***
Germany	**1.965*** **	**-1.060*** **	**1.646*** **	**-1.398*** **	1.523***	-2.406*
Ireland	**1.525***	**-1.862** **	5.732	-12.798	3.383*	-9.302
Italy	**1.207*** **	**-0.460***	**1.051*** **	**-0.403**	**1.222*** **	**-0.829***
Italy[trend]	**2.305*** **	**-0.548*** **	**2.304*** **	**-0.853*** **	**2.313*** **	**-1.116*** **
Luxembourg	**2.117*** **	**-0.780**	1.624***	-0.003	2.031***	-0.369
The Netherl.	1.809***	-0.166	1.788***	-0.259	1.830***	-0.657
The Netherl.[3]	**2.188*** **	**-0.970*** **	2.221***	-0.964*	2.145***	-1.145***
Portugal	**1.772*** **	**-0.581** **	**1.862*** **	**-0.865*** **	**1.908*** **	**-1.697*** **
Spain	**1.656*** **	**-0.331***	**2.092*** **	**-0.525***	**1.918*** **	**-0.775***

Note: 1995q1-2021q3, n=107-l. ULC37: ULC based REER, GDP43: GDP deflator-based REER, XPI37: Export price-based REER. Bold values indicate the presence of cointegration according to the bounds procedure (F and t Test) at respective 10% critical values. Null hypothesis: No long-term relationship exists. Critical values depend on lag structure choice: 1% ***; 5% **; 10% *. Long term coefficients δ1 (foreign income), δ2 (REER) from ARDL equation (1.5). Individual lag length choice (l) according to AIC minimisation. Different sample length in 1: 1995q1-2009q1; 2: 1995q1-2009q1; 3: 1995q1-2009q4. The presence of a significant deterministic trend in the long-run equation is signalled by *trend*.

Table A 8: Export of goods, Panel data long-run estimates (MLM) of ARDL model iv.

	ARDL (iv)				Hausman-Test	
	δ1	δ2	α	l	$p> \chi^2$	χ^2
Mean Group	1.693***	-1.055***	-0.171***	1,1,2		
	(0.114)	(0.207)	(0.025)			
Pooled Mean Group	1.800***	-0.571***	-0.097***	1,1,2	0.019	7.94
	(0.037)	(0.115)	(0.028)			
Westerlund Cointegration Test	Statistic: -1.803	p-value: 0.035				

Note: 11 Panels, 1995q1-2021q3, 107-l observations per panel. Critical values: 1% ***; 5% **; 10% *. Adjustment coefficient α and long-term coefficients δ1 (foreign income), δ2 (REER) from ARDL equation (1.5). Lag length choice (l) according to AIC minimisation. Standard errors in brackets. Panel unit root test: Im-Pesaran-Shin. Null hypothesis of Westerlund Test: No long-term relationship exists.

Table A 9: Export of goods, l.-r. estimates (OLS) of ARDL model iv, different FI/FD metrics

	GDP45 (XG)		GDPIMP35 (XGS)		IMP35 (XGS)	
	δ1	δ2	δ1	δ2	δ1	δ2
Austria	**1.918*** **	**-1.277*** **	**0.146**	**-2.223*** **	**0.979*** **	**-2.286*** **
Belgium	**1.437*** **	**-0.757***	0.608***	-0.453	0.817***	-0.355
Finland[1]	**2.471*** **	**-1.302*** **	**0.909*** **	**-1.096*** **	**1.053*** **	**-1.511*** **
France[2]	**1.616*** **	**-1.156*** **	**0.661*** **	**-0.828*** **	**0.769*** **	**-1.710*** **
Germany	**1.965*** **	**-1.060*** **	**0.877*** **	**-0.864*** **	1.198***	-3.167
Ireland	**1.525***	**-1.862****	**0.834*** **	**-1.354*** **	**1.559*** **	**-2.734*** **
Italy	**2.305*** **	**-0.548*** **	**0.561*** **	**-0.475*** **	0.939***	-1.774**
Luxembourg	**2.117*** **	**-0.780**	**0.819*** **	**-0.236**	1.171***	-0.026
The Netherl.[3]	**2.188*** **	**-0.970*** **	**0.872*** **	**-0.193**	**0.933*** **	**-0.447****
Portugal	**1.772*** **	**-0.581****	**0.777*** **	**-0.804*** **	**1.097*** **	**-2.801*** **
Spain	**1.656*** **	**-0.331***	**0.767*** **	**-0.317*** **	**1.222*** **	**-1.248*** **

Note: 1995q1-2021q3, n=107-l. GDP45: Real income (GDP) of 45 countries, GDPIMP35: Export weighted domestic demand (GDP + imports) of 35 countries, IMP35: Export weighted demand for imports of goods and services of 35 countries, Price metric: Export price-based REER. XG: Real exports of goods as dependent variable. XGS: Real exports of goods and services. Bold values indicate the presence of cointegration according to the bounds procedure (F and t Test) at respective 10% critical values. Null hypothesis: No long-term relationship exists. Critical values depend on lag structure choice: 1% ***; 5% **; 10% *. Long term coefficients δ1 (foreign income or foreign demand), δ2 (REER) from ARDL equation (1.5). Individual lag length choice (l) according to AIC minimisation. Different sample length in 1: 1995q1-2009q1; 2: 1995q1-2009q1; 3: 1995q1-2009q4. Where significant, a deterministic trend was included.

Appendix II

Appendix A

Table A 1: Descriptive statistics of key variables

	National VAS				National ULC				Manufacturing VAS				Manufacturing SULC			
	2000	2007	2014	+/-	2000	2007	2014	+/-	2000	2007	2014	+/-	2000	2007	2014	+/-
AUT	0.022	0.022	0.022	2.33%	1.001	0.938	1.030	2.93%	0.023	0.025	0.027	16.51%	0.984	0.920	0.981	-0.35%
BEL	0.026	0.026	0.027	4.11%	1.027	1.036	1.084	5.62%	0.025	0.024	0.024	-0.40%	1.091	1.122	1.089	-0.13%
BGR	0.002	0.002	0.003	36.45%	0.528	0.651	0.910	72.32%	0.002	0.002	0.003	46.82%	0.733	0.762	0.957	30.43%
HRV	0.002	0.003	0.003	3.04%	0.878	0.991	0.985	12.15%	0.003	0.003	0.003	-6.06%	0.725	1.001	1.056	45.64%
CYP	0.001	0.001	0.001	2.94%	0.758	0.903	0.926	22.08%	0.000	0.000	0.000	-29.74%	0.635	1.032	1.235	94.38%
CZE	0.010	0.011	0.012	19.64%	0.554	0.768	0.789	42.38%	0.012	0.016	0.018	54.33%	0.658	0.846	0.825	25.45%
DEN	0.019	0.018	0.017	-7.10%	0.985	1.093	1.117	13.38%	0.020	0.017	0.016	-17.73%	0.738	0.911	0.8696	17.79%
EST	0.000	0.001	0.001	35.37%	0.661	0.946	1.110	67.73%	0.001	0.001	0.001	66.91%	0.722	0.985	1.029	42.52%
FIN	0.013	0.014	0.013	-3.41%	0.983	0.966	1.113	13.18%	0.014	0.018	0.014	-0.79%	1.030	0.851	0.951	-7.74%
FRA	0.154	0.150	0.153	-0.96%	1.033	1.056	1.072	3.77%	0.111	0.109	0.110	-1.29%	1.110	1.089	1.076	-3.08%
GBR	0.139	0.143	0.148	6.79%	1.344	1.299	1.098	-18.28%	0.130	0.113	0.107	-17.56%	1.274	1.210	1.155	-9.39%
GER	0.204	0.194	0.201	-1.31%	1.167	1.005	1.087	-6.89%	0.241	0.246	0.273	13.30%	1.244	1.130	1.145	-7.98%
GRE	0.016	0.018	0.013	-17.71%	0.572	0.702	0.677	18.38%	0.012	0.012	0.008	-32.81%	0.602	0.752	0.788	30.94%
HUN	0.006	0.007	0.007	10.90%	0.723	1.025	0.891	23.29%	0.008	0.010	0.009	15.57%	0.726	0.878	0.871	19.92%
IRL	0.011	0.013	0.013	17.47%	0.782	0.948	0.791	1.22%	0.014	0.016	0.016	17.97%	0.554	0.583	0.476	-14.17%
ITA	0.136	0.126	0.114	-16.60%	0.712	0.792	0.816	14.59%	0.137	0.126	0.109	-20.47%	0.821	0.964	1.030	25.57%
LTU	0.001	0.002	0.002	50.53%	0.469	0.686	0.606	29.08%	0.001	0.002	0.003	86.53%	0.464	0.470	0.404	-12.88%
LUX	0.002	0.003	0.003	17.87%	0.836	0.919	1.094	30.94%	0.001	0.001	0.001	-32.53%	0.826	0.974	1.372	66.10%
LVA	0.001	0.001	0.001	39.76%	0.992	1.239	1.457	46.83%	0.001	0.001	0.001	10.30%	1.121	1.598	1.867	66.57%
MAL	0.001	0.000	0.000	26.51%	0.874	0.894	0.922	5.47%	0.000	0.000	0.000	-19.42%	0.987	1.064	0.996	0.95%
NED	0.048	0.047	0.048	-1.07%	0.992	0.990	0.995	0.32%	0.040	0.039	0.041	2.77%	0.830	0.808	0.820	-1.22%
NOR	0.024	0.024	0.025	1.44%	0.680	0.824	1.007	48.18%	0.048	0.042	0.040	-16.21%	0.271	0.424	0.578	113.36%
POL	0.021	0.023	0.028	35.98%	0.771	0.785	0.779	1.05%	0.020	0.027	0.038	86.42%	1.014	0.961	0.815	-19.58%
POR	0.014	0.013	0.012	-13.66%	0.924	0.994	0.906	-1.94%	0.012	0.011	0.011	-10.13%	0.937	0.961	0.867	-7.46%
ROM	0.007	0.009	0.010	40.56%	0.468	0.746	0.702	49.95%	0.010	0.013	0.015	46.06%	0.473	0.908	0.632	33.56%
SLO	0.077	0.083	0.077	-0.65%	0.864	0.982	0.893	3.32%	0.071	0.071	0.062	-12.62%	0.891	1.007	0.879	-1.43%
SPA	0.003	0.004	0.005	48.50%	0.524	0.668	0.767	46.40%	0.003	0.006	0.007	143.82%	0.735	0.686	0.723	-1.62%
SVK	0.002	0.002	0.002	11.75%	1.008	1.027	1.030	2.18%	0.002	0.003	0.003	27.58%	1.161	1.146	1.139	-1.89%
SWE	0.026	0.027	0.028	10.62%	1.038	0.953	1.057	1.80%	0.028	0.031	0.028	2.36%	0.894	0.777	0.866	-3.17%

Table A 2: Percentage changes of key variables (2000-2014), exemplary manufacturing sectors

	National		C		C20			C21			C26			C28			C29		
	RGDP	NULC	VAS	SULC	VAS	SULC	VULC	VAS	SULC	VULC	VAS	SULC	VULC	VAS	SULC	VULC	VAS	SULC	VULC
AUT	4.2	2.9	16.5	-0.3	76.6	-26.0	-12.0	1.9	45.8	20.3	-25.9	12.3	2.3	45.4	-15.7	-7.1	5.3	2.5	4.6
BEL	9.4	5.6	-0.4	-0.1	-11.2	15.7	6.0	48.3	-9.9	-5.7	-25.5	-20.2	-15.5	-20.1	16.5	6.4	-54.1	59.5	23.7
BGR	95.0	72.3	46.8	30.4	51.8	2.3	18.7	24.6	52.1	47.2	-0.7	175.1	99.9	59.6	3.5	18.5	124.8	70.0	58.9
HRV	21.5	12.1	-6.0	45.6	-52.0	203.6	64.5	-59.3	216.0	55.7	-7.6	65.7	28.1	-22.9	48.8	21.5	-8.0	-2.6	-2.2
CYP	11.6	22.0	-29.7	94.3	-81.0	814.6	152.4	-40.9	503.4	121.6	128.8	-65.9	-34.3	-20.1	22.1	15.7	-73.1	2.2	4.7
CZE	47.6	42.3	54.3	25.4	24.7	23.8	18.9	19.2	93.8	46.5	377.1	-33.0	-23.6	157.5	-22.1	-1.0	200.3	1.9	6.4
DEN	1.5	13.3	-17.7	17.7	38.8	-16.3	-6.5	49.6	78.2	23.4	4.0	8.9	1.8	-3.0	-3.6	-1.2	-34.0	-11.3	-4.3
EST	107.0	67.7	66.9	42.5	3.5	114.5	53.2	-52.9	549.5	195.3	331.8	-11.9	-12.9	240.3	-10.5	-7.3	179.1	44.9	26.1
FIN	15.1	13.1	-0.7	-7.7	6.3	4.6	8.1	63.5	-27.2	-14.4	-30.5	-7.3	-1.8	11.4	-0.6	3.9	-24.2	19.4	10.4
FRA	1.6	3.7	-1.2	-3.0	12.9	-6.2	1.9	-0.9	-9.4	-3.3	44.1	-39.7	-23.5	-7.3	-9.3	-3.7	-56.6	58.8	24.8
GBR	-12.6	-18.2	-17.5	-9.3	-11.3	-22.8	-20.9	-33.4	17.0	-3.9	-56.9	79.1	28.4	-10.9	-24.2	-20.3	-16.8	-6.36	-9.2
GER	-11.5	-6.8	13.3	-7.9	3.7	3.6	2.2	9.5	-4.7	-3.5	94.4	-32.8	-25.0	-9.6	14.7	7.0	26.6	-13.3	-7.2
GRE	-22.7	18.3	-32.8	30.9	44.6	-14.3	1.2	-34.9	35.3	39.8	-67.3	293.2	122.6	22.9	-9.0	2.9	-78.9	109.2	67.6
HUN	28.4	23.2	15.5	19.9	-65.6	226.3	68.9	-11.7	80.6	43.6	84.0	-6.6	-9.5	333.3	-55.0	-29.8	97.6	25.7	12.4
IRL	16.5	1.2	17.9	-14.1	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-55.5	94.8	33.6
ITA	-12.5	14.5	-20.4	25.5	-24.8	41.8	26.9	-19.0	-2.7	0.7	-36.0	75.2	38.4	2.4	6.2	9.8	-48.7	52.8	31.8
LTU	84.8	29.0	86.5	-12.8	122.2	0.2	13.7	50.3	170.7	34.9	51.5	-33.7	-36.9	420.0	-46.8	-41.7	91.5	26.9	4.9
LUX	35.1	30.9	-32.5	66.1	367.1	-66.7	-35.3	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
LVA	77.9	46.8	10.3	66.5	56.5	43.1	21.8	4.1	75.7	41.1	92.2	67.3	7.0	8.8	35.8	16.4	438.7	34.5	7.9
NED	-3.7	0.3	2.7	-1.2	34.6	-17.0	-9.2	-5.5	-14.3	-7.9	18.9	15.4	7.6	40.2	-21.1	-10.5	-51.8	59.5	27.3
NOR	50.3	48.1	-16.2	113.3	-/-	-/-	-/-	-/-	-/-	-/-	-22.1	79.3	37.8	126.3	-23.1	-8.9	7.7	-20.5	-10.3
POL	38.8	1.0	86.4	-19.5	40.6	-5.4	-1.4	41.4	2.2	0.5	580.4	-75.5	-65.7	135.7	-45.4	-30.4	269.2	-34.1	-18.6
POR	-17.4	-1.9	-10.1	-7.4	-28.5	16.0	5.2	-15.3	-14.9	-9.1	-0.2	-22.5	-18.3	-14.9	-6.8	-4.4	-20.4	-10.0	-6.0
ROM	141.2	49.9	46.0	33.5	66.1	-36.5	-17.2	-34.3	239.8	107.4	-42.5	600.0	121.3	35.2	-3.2	3.0	211.6	77.3	31.6
SLO	5.5	3.3	-12.6	-1.4	65.4	-25.4	-14.0	54.1	16.7	8.2	34.9	-33.9	-28.0	99.1	-11.2	-3.5	30.4	57.6	27.4
SPA	2.2	46.4	143.8	-1.6	-27.7	21.7	8.7	38.4	-24.8	-7.4	-54.4	14.7	6.1	-24.7	0	-2.2	-33.5	9.6	4.9
SVK	115.4	2.1	27.5	-1.8	32.4	7.3	9.0	-35.3	85.2	50.6	208.7	-82.9	-65.8	203.7	-23.7	-8.5	491.6	28.2	9.6
SWE	6.5	1.8	2.3	-3.1	-/-	-/-	-/-	-/-	-/-	-/-	-38.6	-12.6	-9.3	-13.8	10.7	5.7	0.3	1.6	2.7

Table A 3: Panel unit root test statistics

URT:	LLC	HT	CADF	LLC	HT	CADF
	1995-2019	1995-2019	1995-2019	2000-2014	2000-2014	2000-2014
VSHARE	-11.494***	0.906	-1.736	-13.523***	0.850	-1.579
ΔVSHARE	-67.184***	-0.051***	-2.643***	-48.686***	-0.084***	-1.956***
RGDP	-9.770***	0.957	-1.745	-16.009***	0.906	-1.669
ΔRGDP	-55.042***	0.354***	-2.455***	-33.862***	0.308***	-1.786*
NGDP	-10.970***	0.921	-1.531	-18.097***	0.915	-1.449
ΔNGDP	-45.101***	0.120***	-2.250***	-40.908***	0.224***	-1.985***
VULC	-/-	-/-	-/-	-15.671***	0.753***	-2.230***
ΔVULC	-/-	-/-	-/-	-50.893***	-0.189***	-2.101***
SULC	-15.558***	0.818***	-2.008***	-15.958***	0.745***	-2.052***
ΔSULC	-74.159***	-0.134***	-2.545***	-50.313***	-0.164***	-1.972***
NULC	-/-	-/-	-/-	-20.334*	0.838	-2.610***
ΔNULC	-/-	-/-	-/-	-40.742***	0.160***	-2.113***

Note: H(0): Non stationarity. Critical values: 1% ***; 5% **; 10% *. Lag length choice according to AIC minimisation.

Table A 4: Long-run estimates from ARDL model (2.5), Sample I

	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)
DV:	VAS	VAS	VAS	VAS	VAS	VAS
ULC:	SULC	SULC	SULC	SULC	SULC MHT	SULC MLT
	MG	MG	MG	MG	MG	MG
	1,2,1	1,2,1	1,2,1	1,1,1,1	1,1,1	1,1,1
δ1	1.579***	1.292**		0.298	1.351	1.686*
	(0.369)	(0.645)		(0.346)	(0.851)	(0.940)
δ2	-0.867***	-0.698**	-0.539***	-0.699***	-0.876***	-0.659**
	(0.099)	(0.342)	(0.151)	(0.102)	(0.117)	(0.321)
δ3			1.215***			
			(0.349)			
δ4				0.308*		
				(0.054)		
α	-0.707***	-0.856***	-0.950***	-0.723***	-0.713***	-0.720***
	(0.017)	(0.026)	(0.248)	(0.021)	(0.031)	(0.031)
n	11601	10095	10095	10559	4972	4494
R^2	0.83	0.86	0.87	0.83	0.86	0.79
CSA(l)	1,1,1 (1)	1,1,1 (2)	1,1,1 (2)	1,1,1,1 (1)	1,1,1 (2)	1,1,1 (2)
	PMG	PMG	PMG	PMG	PMG	PMG
	1,2,1	1,2,1	1,2,1	1,1,1,1	1,1,1	1,1,1
δ1	0.970***	1.083***		0.953***	0.962***	1.558
	(0.027)	(0.035)		(0.028)	(0.290)	(2.899)
δ2	-0.811***	-0.710***	-0.761***	-0.752***	-0.733***	-0.846
	(0.008)	(0.009)	(0.009)	(0.010)	(0.080)	(1.740)
δ3			1.197***			
			(0.035)			
δ4				0.062***		
				(0.018)		
α	-0.315***	-0.425***	-0.588***	-0.447***	-0.515**	-0.252
	(0.011)	(0.011)	(0.008)	(0.010)	(0.094)	(1.481)
n	11601	10095	10095	10559	4972	4494
R^2	0.20	0.18	0.15	0.20	0.19	0.30
CSA(l)	1,1,1 (1)	1,1,1 (2)	1,1,1 (2)	1,1,1,1 (1)	1,1,1 (2)	1,1,1 (2)
Hausman-Test						
$p> \chi^2$	0.000	0.000	0.000	0.000	0.000	0.000
χ^2	305.10	316.42	148.51	254.30	31.66	158.01
Westerlund Cointegration Test						
Stat.	1.307	1.307	-1.898	4.659	2.556	1.935
p.-v.	0.095	0.095	0.028	0.000	0.005	0.026

Note: 1995-2018. Critical values: 1% ***; 5% **; 10% *. Adjustment coefficient α and long-term coefficients δ1 (RGDP), δ2 (SULC), δ3 (NGDP) from ARDL equation (2.5). The ECI coefficient is denoted by δ4. Standard errors in brackets. MHT: Sectors classified HT-M and MHT-M. MLT: Sectors classified MT-M and LT-M.

Table A 5: Sectoral long-run coefficients from ARDL model (2.5), Sample I

DV: VAS	1995-2018				
	δ1	δ2	α	ARDL	CSA
C10_C12	0.792***	-0.674***	-0.686***	1,2,1	1,1,1
MG	(0.203)	(0.080)	(0.056)		
C10_C12	0.495	-0.643***	-0.518***	1,2,1	1,1,1
PMG	(0.476)	(0.162)	(0.180)		
C13_C15	0.023	-0.989***	-0.451***	1,1,1	0,1,1
	(0.579)	(0.163)	(0.051)		
C16	1.410**	-0.562	-0.211***	1,1,1	0,0,0
	(0.695)	(0.877)	(0.060)		
C17	0.183	-0.872***	-0.533***	1,1,1	1,1,1
	(0.338)	(0.205)	(0.059)		
C18	1.576*	-0.583***	-0.551***	1,1,1	0,0,0
	(0.884)	(0.168)	(0.061)		
C20	1.848**	-0.807***	-0.335***	1,1,1	0,0,0
	(0.799)	(0.210)	(0.051)		
C21	1.269	-0.712***	-0.594***	1,1,1	0,1,1
	(0.774)	(0.085)	(0.057)		
C22	0.784	-0.689***	-0.530***	1,1,1	1,1,1
	(0.536)	(0.174)	(0.547)		
C23	1.566***	-0.885***	-0.539***	1,1,1	1,1,1
	(0.226)	(0.164)	(0.050)		
C24	1.761***	-1.090***	-0.485***	1,1,1	1,1,1
	(0.430)	(0.108)	(0.045)		
C25	0.923**	-0.602***	-0.763***	1,1,1	1,1,1
	(0.358)	(0.114)	(0.048)		
C26	1.840**	-1.097***	-0.502***	1,1,1	1,1,1
	(0.776)	(0.193)	(0.052)		
C27	0.581	-0.998***	-0.515***	1,1,1	1,1,1
	(0.131)	(0.087)	(0.040)		
C28	0.571*	-0.801***	-0.614***	1,1,1	1,1,1
	(0.310)	(0.160)	(0.066)		
C29	0.020	-0.996***	-0.498***	1,1,1	0,1,1
	(0.860)	(0.208)	(0.061)		
C30	1.747***	-0.959**	-0.336***	1,1,1	0,0,0
	(0.612)	(0.401)	(0.038)		
C31_32	0.172	-1.075***	-0.320***	1,1,1	0,0,0
	(1.160)	(0.345)	(0.044)		
C33	0.256	-0.657***	-0.619***	1,1,1	1,1,1
	(0.594)	(0.244)	(0.052)		

Note: 1995-2019. Critical values: 1% ***; 5% **; 10% *. Adjustment coefficient α and long-term coefficients δ1 (RGDP), δ2 (SULC) from ARDL equation (2.5). Standard errors in brackets. PMG model results reported only in case Hausman-test confirmed slope homogeneity.

Table A 6: Long-run estimates from ARDL model (2.5), Sample II

	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)
DV:	VAS	VAS	VAS	VAS	VAS	VAS	VAS
ULC:	VULC	VULC	SULC	NULC	VULC MHT	VULC MLT	VULC
	MG	MG	MG	MG	MG	MG	MG
ARDL	1,1,1	1,2,1	1,1,1	1,1,1	1,1,1	1,1,1	1,1,1
δ1	1.426***		0.215	0.853	1.228	0.281	1.747**
	(0.519)		(1.051)	(1.528)	(2.441)	(0.576)	(0.804)
δ2	-1.299***	-2.031**	-1.056***	-0.009	-1.816***	-1.046*	-0.918***
	(0.240)	(1.030)	(0.376)	(0.796)	(0.847)	(0.594)	(0.345)
δ3		3.392					
		(2.176)					
δ4							0.053
							(0.061)
α	-0.751***	-0.514***	-0.732***	-1.003***	-0.621***	-0.759***	-0.471***
	(0.020)	(0.019)	(0.021)	(0.028)	(0.026)	(0.033)	(0.181)
n	6814	6301	6329	6329	2966	2845	6784
R^2	0.75	0.69	0.83	0.62	0.74	0.76	0.68
CSA (l)	0,1,0 (1)	0,0,0	0,1,0 (1)	0,1,0 (1)	0,1,0 (0)	0,1,0 (0)	0,0,0
	PMG	PMG	PMG	PMG	PMG	PMG	PMG
ARDL	1,1,1	1,2,1	1,1,1	1,1,1	1,1,1	1,1,1	1,1,1
δ1	1.378**		1.737***	0.682	1.531	0.938**	1.206***
	(0.635)		(0.359)	(0.722)	(1.784)	(0.448)	(0.223)
δ2	-0.874***	-1.066***	-0.836***	-0.197	-0.633	-0.782**	-1.073***
	(0.298)	(0.394)	(0.269)	(0.732)	(0.971)	(0.311)	(0.182)
δ3		1.035					
		(0.771)					
δ4							-0.016
							(0.024)
α	-0.317**	-0.134	-0.343***	-0.727***	-0.234	-0.231*	-0.121*
	(0.123)	(0.241)	(0.137)	(0.189)	(0.666)	(0.120)	(0.071)
n	6814	6301	6329	6329	2966	2845	6784
R^2	0.24	0.30	0.19	0.34	0.30	0.26	0.35
CSA (l)	0,1,0 (1)		0,1,0 (1)	0,1,0 (1)	0,1,0 (0)	0,1,0 (0)	0,0,0
	Hausman-Test						
$p> \chi^2$	0.000	0.000	0.000	0.000	0.000	0.000	0.000
χ^2	354.43	290.64	257.33	70.26	336.41	183.73	331.47
	Westerlund Cointegration Test						
Stat.	1.873	-4.189	-3.215	3.546	1.327	1.593	4.513
p.-v.	0.031	0.000	0.001	0.000	0.092	0.055	0.000

Note: 2000-2014. Critical values: 1% ***; 5% **; 10% *. Adjustment coefficient α and long-term coefficients δ1 (RGDP), δ2 (SULC), δ3 (NGDP) from ARDL equation (2.5). The coefficient of the interaction term (VULC multiplied by export share) is denoted by δ4. Standard errors in brackets. MHT: Sectors classified HT-M and MHT-M. MLT: Sectors classified MT-M and LT-M.

Table A 7: Sectoral long-run coefficients from ARDL model (2.5), Sample II

DV: VAS	2000-2014				
	δ1	δ2	α	ARDL	CSA
C10_C12	0.468	-0.452*	-0.876***	1,1,1	0,1,1
	(0.361)	(0.270)	(0.075)		
C13_C15	-0.780	-1.642**	-0.722***	1,1,1	0,1,1
	(1.657)	(0.636)	(0.064)		
C16	0.254	-0.710*	-0.686***	1,1,1	0,1,1
	(0.862)	(0.429)	(0.100)		
C17	0.729	0.520	-0.699***	1,1,1	0,1,1
	(1.477)	(1.447)	(0.103)		
C18	4.514	-0.755**	-0.679***	1,1,1	0,1,1
	(2.996)	(0.349)	(0.091)		
C20	0.602	-1.379***	-0.958***	1,2,1	0,1,1
	(0.615)	(0.262)	(0.144)		
C21	0.526	-1.531***	-0.876***	1,2,1	0,1,1
	(1.349)	(0.409)	(0.125)		
C22	0.487	-0.695***	-0.889***	1,1,1	0,0,0
	(0.540)	(0.244)	(0.086)		
C23	-0.107	-0.285	-0.732***	1,1,1	0,1,1
	(1.228)	(0.896)	(0.092)		
C24	1.852***	-1.753***	-0.440***	1,1,1	0,0,0
	(0.550)	(0.241)	(0.045)		
C25	0.647	-1.911	-0.465***	1,1,1	0,0,0
	(1.239)	(1.323)	(0.070)		
C26	-0.550	-1.485***	-0.481***	1,1,1	0,0,0
	(0.548)	(0.322)	(0.058)		
C27	1.171*	-1.218***	-0.884***	1,1,1	0,1,1
	(0.728)	(0.264)	(0.092)		
C28	0.289	-0.624*	-0.860***	1,1,1	0,1,0
	(0.708)	(0.369)	(0.072)		
C29	0.826	-1.965***	-0.778***	1,2,1	0,1,1
	(2.840)	(0.781)	(0.104)		
C30	2.211	-1.549***	-0.749***	1,1,1	0,1,1
	(4.011)	(0.454)	(0.077)		
C31_32	1.060	-1.056*	-0.647***	1,1,1	0,1,1
	(0.925)	(0.555)	(0.086)		
C33	0.946	-1.090**	-0.716***	1,1,1	0,1,1
	(2.729)	(0.455)	(0.094)		

Note: 2000-2014. Critical values: 1% ***; 5% **; 10% *. Adjustment coefficient α and long-term coefficients δ1 (RGDP), δ2 (VULC) from ARDL equation (2.5). Standard errors in brackets. PMG model results reported only in case Hausman-test confirmed slope homogeneity.

Appendix B

Table B 1: Variables, sources and description

Var.	Variable description
VAS	Value Added Market Share Individual country-sector shares on total sample value added (nominal) of a manufacturing sector Data Source: WIOD World Input Output tables
RGDP	Relative Real Gross Domestic Product (C+G+I) Individual Country share on total sample GDP (real PPP $) Data Source: OECD National Accounts
NGDP	Relative Nominal Gross Domestic Product (C+G+I+(X-M)) per capita Individual Country share on total sample GDP ($) Data Source: OECD National Accounts
VULC	Relative Unit Labour Cost (value chain base) Vertically integrated unit labour cost of an industrial sector relative to its competitors (weighted by the value added share) Data Source: Own Calculations based on EUROSTAT (Sectoral real value added and nominal sectoral earnings) and WIOD (Sectoral input structure)
SULC	Relative Unit Labour Cost (sectoral base) Unit labour cost of an industrial sector relative to its competitors (weighted by the value added share) Data Source: Own Calculations based on EUROSTAT (Sectoral real value added and nominal sectoral earnings)
NULC	Relative Unit Labour Cost (national base) Unit labour cost on national scale relative to its competitor countries (weighted by the value added share) Data Source: Own Calculations based on EUROSTAT (National real value added and national sectoral earnings)

Calculation of Unit Labour Cost Measures

he basis for calculating the relative variables of sectoral unit labour cost (SULC) and vertically-integrated unit labour cost (VULC) is the absolute unit labour cost of a sector. This measure is obtained by dividing the sectoral nominal wage bill by the sectoral real value added:

$$\mathrm{SCULC} = \mathrm{W}/\mathrm{VA}^{\mathrm{real}}. \tag{A1}$$

The $\mathrm{SCULC}_{c,s}$ variable is calculated by comparing the sectoral unit labour cost (SCULC) of the sector under scrutiny to a weighted average of the SCULC values of the same sector in competitor countries ($\mathrm{AVSCULC}_s$). The weighting scheme used takes into account the country's share in the total sectoral value added ($\tau_{c,s}$).

$$\mathrm{AVSCULC}_s = \sum_{c=1}^{k} \tau_{c,s} \mathrm{SCULC}_{c,s} \tag{A2}$$

$$\mathrm{SULC}^i = \frac{\mathrm{SCULC}^i}{\mathrm{AVSCULC}_s} \tag{A3}$$

As discussed in chapter 2, the paper aims to move beyond sectoral analysis and consider not only the average unit labour cost of a sector but also the cost situation of all sectors involved in the final value creation process. The WIOD input-output tables provide information on how much a sector uses inputs from other sectors, both domestically and internationally, to produce its output. However, for the production of these intermediate inputs, additional inputs are used, which should be taken into account to obtain a comprehensive picture of the productive structure. To address this, the method used involves utilising Leontief coefficients, which reflect the upstream transactions of the economic process involved in creating a product for final use.

Building upon a similar approach as Grodzicki (2014), I calculate VA, which is the (following the Leontief logic) sectoral value added utilised in producing a final product within a specific sector:

$$\mathrm{A} = \frac{\mathrm{IC}}{\mathrm{TOT}} \tag{A4}$$

$$\mathrm{VA} = \mathrm{SVA}\,(\mathrm{I} - \mathrm{A})^{-1}\,\mathrm{FD}. \tag{A5}$$

Matrix A contains the input coefficients derived from the ratio of intermediate consumption (IC) to total output (TOT). The central equation (2.5) includes the Leontief coefficients matrix $(\mathrm{I} - \mathrm{A})^{-1}$ as well as the diagonal matrices of final demand FD and the share of value added in output (SVA). The resulting $\mathrm{VA}^{\mathrm{i}}_{\mathrm{c,s}}$ values of the VA matrix indicate how much value added sector s in country c contributed to the production of final goods in the country-sector combination i. This structural information, expressed in relative terms ($\mathrm{VS}^{\mathrm{i}}_{\mathrm{c,s}}$), is then multiplied with the respective sectoral unit cost ($\mathrm{SCULC}_{\mathrm{c,s}}$) resulting in the (vertically integrated) nominal unit labour cost of a manufacturing sector (7). The sector-country $\mathrm{VCULC}^{\mathrm{i}}$ s compared to the average unit cost (weighted by the country share in total sectoral VA: $\tau_{\mathrm{c,s}}$) of its competitor value chains in the same industry, denoted as $\mathrm{AVCULC}_{\mathrm{s}}$. The resulting $\mathrm{VULC}^{\mathrm{i}}$ provides insight into the vertically integrated unit labour cost of a country-sector i in relation to the foreign competitor unit cost.

$$\mathrm{VS}^{\mathrm{i}}_{\mathrm{s}} = \frac{\mathrm{VA}^{\mathrm{i}}_{\mathrm{s}}}{\sum_{\mathrm{c}=1}^{\mathrm{k}} \mathrm{VA}_{\mathrm{c,s}}} \tag{A6}$$

$$\mathrm{VCULC}^{\mathrm{i}} = \sum_{\mathrm{c}=1}^{\mathrm{k}} \sum_{\mathrm{s}=1}^{\mathrm{n}} \mathrm{VS}^{\mathrm{i}}_{\mathrm{c,s}} \mathrm{SCULC}_{\mathrm{c,s}} \tag{A7}$$

$$\mathrm{AVCULC}_{\mathrm{s}} = \sum_{\mathrm{c}=1}^{\mathrm{k}} \tau_{\mathrm{c,s}} \mathrm{VCULC}_{\mathrm{c,s}} \tag{A8}$$

$$\mathrm{VULC}^{\mathrm{i}} = \frac{\mathrm{VCULC}^{\mathrm{i}}}{\mathrm{AVCULC}_{\mathrm{s}}} \tag{A9}$$

Appendix III

Appendix A

Table A 1: Time series unit root test (ADF)

	FI 95-19	FI 95-08	FI 09-19	FID 95-19	FID 95-08	FID 09-19	REER 95-19	REER 95-08	REER 09-19
AUT	-1.861	-1.298	-2.140	-2.245	-1.290	-2.245	-2.659*	-3.030**	-1.774
BEL	-1.862	-1.321	-2.144	-2.382+	-1.356	-2.382+	-3.070**	-2.353	-3.251**
ESP	-1.824	-1.288	-2.039	-2.370+	-1.411	-2.370+	-1.507	-0.490	-1.382
FIN	-1.856	-1.289	-2.156	-2.276	-1.312	-2.276	-2.997**	-3.049**	-2.910**
FRA	-1.836	-1.291	-2.101	-2.442+	-1.743	-2.442+	-2.758*	-2.049	-2.511
GER	-1.993	-1.358	-2.201	-2.488+	-1.915	-2.481+	-3.388**	-2.576	-3.472**
IRE	-1.887	-1.289	-2.199	-2.605*	-2.141	-2.605*	-0.602	-0.558	-0.616
ITA	-1.861	-1.285	-2.155	-2.422+	-1.564	-2.442+	-2.433	-1.906	-2.392
NDL	-1.863	-1.301	-2.103	-2.314+	-1.294	-2.314	-1.848	-1.726	-2.130
PRT	-1.859	-1.289	-2.199	-2.554+	-1.354	-2.554+	-1.753	-1.250	-1.774

Note: Quarterly data. 95-19: 1995q1-2019q4. 95-08: 1995q1-2008q3. 09-19: 2009q2-2019q4. Augmented Dickey-Fuller test with constant, H0: I(1) non stationarity. Lag length selection criteria: AIC.

Table A 2: Panel unit root test (IPS)

Variable	Z-t-tilde-bar	p-value	Variable	Z-t-tilde-bar	p-value
X	-1.512	0.065	ΔX	-7.915	0.000
FI	2.924	0.998	ΔFI	-6.246	0.000
REER	-2.194	0.014	ΔREER	-9.058	0.000
PAT41	3.448	0.999	ΔPAT41	-4.245	0.000
RD28	-0.318	0.375	ΔRD28	-3.588	0.000
II41	-1.164	0.122	ΔII41	-5.648	0.000
CS29	-0.034	0.486	ΔCS29	-1.425	0.077
MFP24	-1.488	0.068	ΔMFP24	-5.465	0.000
ECI	-0.070	0.472	ΔECI	-8.456	0.000

Note: 1995-2019. Annual panel data. Im-Pesaran-Shin test, H0: I(1) non stationarity of all panels.

Table A 3: Long-run elasticities from standard export equation (SEE) specification

SEE	X/FI	δ_1(FI)		δ_2(REER)		F	t	ARDL	REER
1995q1-2019q4									
AUT	2.12	2.088***	(0.034)	-1.279***	(0.132)	8.550***	-4.904***	3.1.3	ULC37
BEL	1.51	1.532***	(0.078)	-0.486	(0.379)	3.423	-3.180	3.1.0	ULC37
BEL (t)	1.51	2.468***	(0.075)	-0.136	(0.156)	9.501***	-5.171***	2.1.0	ULC37
BEL	1.51	1.478***	(0.043)	-2.468***	(0.633)	6.404**	-4.184***	3.3.3	ULC27
ESP	2.12	1.900***	(0.071)	-0.384**	(0.171)	5.620**	-3.885**	1.3.0	ULC37
FIN	1.64	1.114**	(0.506)	-3.868**	(1.938)	2.239	-1.780	3.2.0	ULC37
FIN (t)	1.64	5.923***	(0.819)	-0.788	(0.517)	4.243	-3.244	3.2.0	ULC37
FRA	1.55	1.436***	(0.053)	-1.020***	(0.206)	5.734**	-4.020**	2.2.1	ULC37
GER	2.22	2.151***	(0.081)	-1.093***	(0.282)	4.847*	-2.709	2.2.4	ULC37
GER	2.22	2.025***	(0.119)	-1.057***	(0.306)	5.186***	-2.634	3.3.2	ULC27
IRE	3.66	1.953***	(0.584)	-1.328***	(0.477)	4.164*	-2.058	2.0.2	ULC37
IRE (t)	3.66	7.647***	(1.272)	-1.584***	(0.248)	7.856***	-3.937*	2.2.2	ULC37
ITA	1.05	1.276***	(0.081)	-0.216	(0.167)	6.108**	-3.924**	1.4.0	ULC37
ITA (t)	1.05	1.957***	(0.288)	-0.289**	(0.127)	6.677**	-4.468***	3.4.0	ULC37
NDL	2.05	2.012***	(0.056)	-0.181	(0.222)	3.568	-3.071	4.4.1	ULC37
PRT	2.11	1.906***	(0.043)	-0.526***	(0.134)	9.512***	-5.244***	2.2.2	ULC37
1995q1-2008q2									
AUT	2.46	2.178***	(0.070)	-1.036***	(0.166)	5.115**	-3.620**	1.3.0	ULC37
BEL	1.74	1.818***	(0.024)	-0.164**	(0.068)	15.338***	-6.114***	2.2.2	ULC37
ESP	2.21	2.122***	(0.189)	-0.917***	(0.262)	6.046**	-2.983	2.2.0	ULC37
FIN	2.90	2.551***	(0.036)	-1.113***	(0.084)	26.821***	-8.923***	1.1.0	ULC37
FRA	1.71	1.653***	(0.037)	-1.035***	(0.080)	10.824***	-5.115***	1.3.1	ULC37
GER	2.54	2.323***	(0.090)	-0.393***	(0.139)	7.497***	-4.493***	1.0.1	ULC37
IRE	2.82	3.672***	(0.256)	-1.698***	(0.267)	8.133***	-3.920**	2.0.0	ULC37
ITA	1.21	1.959	(0.875)	-0.527	(0.730)	1.727	-0.939	1.2.1	ULC37
NDL	2.12	2.244**	(0.057)	-0.706***	(0.162)	7.156***	-4.591***	2.0.1	ULC37
PRT	1.93	1.465***	(0.274)	0.464	(0.573)	6.020**	-3.529*	2.3.3	ULC37
2009q2-2019q4									
AUT	2.15	1.616***	(0.211)	-1.021*	(0.590)	8.382***	-3.816**	1.2.1	ULC37
BEL	1.80	1.210***	(0.178)	-1.981**	(0.763)	7.037***	-3.674**	1.1.3	ULC37
ESP	2.24	1.303***	(0.239)	-1.087***	(0.279)	5.599**	-4.080**	2.3.3	ULC37
FIN	0.97	0.132	(0.392)	-1.302***	(0.366)	12.954***	-6.179***	1.1.1	ULC37
FRA	1.65	1.404***	(0.934)	-0.237	(0.577)	6.924**	-3.855**	1.4.4	ULC37
GER	2.27	1.927***	(0.195)	-1.242***	(0.340)	6.194**	-3.469*	2.3.3	ULC37
IRE	4.04	0.903	(2.275)	-2.698**	(1.064)	1.595	-1.663	2.0.1	ULC37
ITA	1.73	0.977***	(0.218)	-0.951*	(0.549)	5.202*	-3.135*	1.2.1	ULC37
NDL	2.14	1.716***	(0.095)	-0.663**	(0.280)	5.964**	-3.755**	3.2.2	ULC37
PRT	2.67	2.133***	(0.048)	-0.698***	(0.071)	17.090***	-7.066***	1.2.3	ULC37

Note: Bounds procedure (F and t Test) for cointegration test. Null hypothesis: No long-term relationship exists. Critical values depend on lag structure choice: 1% ***; 5% **; 10% *. Long term coefficients FI (foreign income) and REER (Price competiveness) from cointegrating equation (1.5). REER: Real effective exchange rate adjusted by unit labour cost relative to 27 or 37 countries. Model lag structure (l) according to AIC minimisation. Standard errors in brackets. The presence of a deterministic trend (significant on 95% confidence level) is signalled by (t).

Table A 4: Long-run elasticities from gravity model export equation (GEE) specification

GEE	EX/FID	δ_1(FID)		δ_2(REER)		F	t	ARDL	REER
1995q1-2019q4									
AUT	0.98	0.976***	(0.013)	-0.597***	(0.119)	8.007***	-4.758***	4.1.0	ULC27
BEL	0.80	0.829***	(0.018)	-0.709	(0.541)	4.696*	-3.614**	1.1.2	ULC27
ESP	1.01	0.886***	(0.022)	-0.681***	(0.136)	9.239***	-4.550***	3.1.0	ULC27
FIN	0.90	0.785***	(0.044)	-2.847***	(0.522)	7.023***	-4.099	4.2.0	ULC27
FRA	0.84	0.813***	(0.023)	-0.638	(0.174)	2.654	-2.782	1.3.2	ULC37
GER	1.17	1.258***	(0.079)	-0.603	(0.556)	3.461	-2.179	1.1.1	ULC37
IRE	2.25	2.755***	(0.537)	-1.940***	(0.488)	11.782***	-3.678*	2.0.1	ULC27
ITA	0.52	0.751***	(0.108)	-0.641**	(0.302)	5.528**	-2.533	3.1.1	ULC37
NDL	1.08	1.043***	(0.036)	-1.216**	(0.585)	1.931	-2.096	2.2.3	ULC27
PRT	1.04	1.139***	(0.063)	-1.424***	(0.314)	5.324**	-2.965	4.1.2	ULC37
1995q1-2008q3									
AUT	1.04	0.901***	(0.049)	-1.055***	(0.290)	14.458***	-6.171***	1.0.1	ULC37
BEL	0.80	0.798***	(0.022)	-0.517	(0.610)	7.787***	-4.293***	3.0.1	ULC37
ESP	0.97	0.973***	(0.123)	-1.012*	(0.546)	6.640**	-3.278*	2.1.0	ULC37
FIN	1.19	1.073***	(0.023)	-0.543**	(0.136)	12.737***	-6.153***	1.4.0	ULC37
FRA	0.81	0.773***	(0.011)	-0.699***	(0.058)	15.372***	-6.430***	1.1.1	ULC37
GER	1.15	0.865***	(0.075)	-0.970***	(0.237)	14.801***	-6.031***	2.0.4	ULC37
IRE	1.71	1.896***	(0.114)	-1.346***	(0.268)	13.068***	-4.708***	2.0.0	ULC37
ITA	0.46	0.795***	(0.230)	-1.306	(1.150)	3.558	-1.863	4.1.2	ULC37
NDL	0.87	0.933***	(0.016)	-0.163*	(0.092)	6.122**	-4.276**	1.3.1	ULC37
PRT	0.79	0.856***	(0.064)	-0.497	(0.323)	6.087**	-4.258	2.0.0	ULC37
2009q2-2019q4									
AUT	0.95	1.040***	(0.023)	-0.796***	(0.132)	75.500***	-14.555***	1.0.0	ULC37
BEL	0.91	0.875***	(0.037)	-1.664***	(0.552)	4.594*	-3.242*	1.1.2	ULC37
ESP	1.07	0.956***	(0.036)	-0.389***	(0.076)	27.241***	-8.923***	3.0.2	ULC37
FIN	0.74	0.486***	(0.039)	-1.508***	(0.184)	21.299***	-7.925	1.2.3	ULC37
FRA	0.87	1.013***	(0.043)	-0.304	(0.230)	16.402***	-6.432***	1.3.0	ULC37
GER	1.17	0.813***	(0.072)	-1.108***	(0.232)	2.544	-2.561	1.0.1	ULC37
IRE	2.30	0.796	(1.521)	-2.174*	(1.211)	3.820	-1.714	2.1.1	ULC37
ITA	0.85	0.780***	(0.360)	-0.377*	(0.204)	5.605**	-3.606**	3.1.0	ULC37
NDL	1.06	1.164***	(0.044)	-0.109	(0.299)	6.073**	-4.160**	1.3.3	ULC37
PRT	1.43	1.391***	(0.050)	-0.452**	(0.173)	6.310**	-4.314**	1.3.2	ULC37

Note: Bounds procedure (F and t Test) for cointegration test. Null hypothesis: No long-term relationship exists. Critical values depend on lag structure choice: 1% ***; 5% **; 10% *. Long term coefficients FID (foreign import demand) and REER (Price competiveness) from cointegrating equation (1.5). REER: Real effective exchange rate adjusted by unit labour cost relative to 27 or 37 countries. Model lag structure (l) according to AIC minimisation. Standard errors in brackets.

Table A 5: Contributions to export growth

	Quarterly growth rates			Export growth contributions		
	X	FID	REER	FID	REER	UNEXPL
1995q1-2019q4						
AUT	1.10%	1.14%	-0.07%	+1.11pp	+0.04pp	-0.04pp
BEL	0.88%	1.12%	-0.05%	+0.93pp	+0.04pp	-0.07pp
ESP	1.11%	1.10%	0.04%	+0.98pp	-0.03pp	+0.17pp
FIN	1.02%	1.14%	-0.08%	+0.90pp	+0.24pp	-0.10pp
FRA	0.92%	1.11%	-0.08%	+0.90pp	+0.05pp	-0.02pp
GER	1.27%	1.10%	-0.17%	+1.38pp	+0.11pp	-0.20pp
IRE	2.47%	1.11%	-0.26%	+3.06pp	+0.51pp	-1.06pp
ITA	0.57%	1.12%	0.10%	+0.84pp	-0.06pp	-0.20pp
NDL	1.18%	1.10%	0.03%	+1.15pp	-0.03pp	+0.07pp
PRT	1.14%	1.09%	0.07%	+1.24pp	-0.11pp	+0.00pp
1995q1-2008q3						
AUT	1.65%	1.59%	-0.33%	+1.43pp	+0.35pp	-0.14pp
BEL	1.27%	1.58%	-0.08%	+1.26pp	+0.04pp	-0.04pp
ESP	1.51%	1.56%	0.35%	+1.52pp	-0.36pp	+0.35pp
FIN	2.00%	1.68%	-0.14%	+1.80pp	+0.08pp	+0.12pp
FRA	1.29%	1.59%	0.00%	+1.23pp	-0.00pp	+0.06pp
GER	1.88%	1.63%	-0.60%	+1.41pp	+0.58pp	-0.12pp
IRE	2.75%	1.60%	0.62%	+3.04pp	-0.84pp	+0.55pp
ITA	0.81%	1.78%	0.44%	+1.41pp	-0.58pp	-0.02pp
NDL	1.47%	1.69%	0.06%	+1.57pp	-0.01pp	-0.09pp
PRT	1.27%	1.61%	0.29%	+1.38pp	-0.14pp	+0.03pp
2009q2-2019q4						
AUT	1.09%	1.14%	0.13%	+1.18pp	-0.10pp	+0.00pp
BEL	0.99%	1.10%	-0.02%	+0.96pp	+0.03pp	+0.00pp
ESP	1.16%	1.08%	-0.38%	+1.03pp	+0.15pp	-0.02pp
FIN	0.81%	1.10%	-0.13%	+0.53pp	+0.20pp	+0.08pp
FRA	0.95%	1.09%	-0.18%	+1.10pp	+0.06pp	-0.21pp
GER	1.21%	1.04%	0.05%	+0.84pp	-0.05pp	+0.42pp
IRE	2.46%	1.07%	-1.34%	+0.85pp	+2.91pp	-1.30pp
ITA	0.95%	1.11%	-0.22%	+0.87pp	+0.08pp	+0.00pp
NDL	1.18%	1.11%	-0.09%	+1.29pp	+0.01pp	-0.12pp
PRT	1.50%	1.05%	-0.10%	+1.46pp	+0.05pp	-0.01pp

Note: Underlined values signal not reliable figures due to the absence of cointegration and/or insignificant coefficients (observable in Table A4).

Table A 6: Panel cointegration test (Westerlund test)

	SEE	PAT41	RD28	II41	CS29	MFP24	ECI
statistic	-1.746	-1.797	-2.228	-1.205	-1.935	-1.921	-1.31
p-value	0.040	0.036	0.012	0.114	0.026	0.027	0.095

Note: Westerlund test for cointegration. H0: No cointegration Ha: Some panels are cointegrated. AR parameter and cointegrating vector are panel specific.

Figure A1: NPC indicator – Reinterpretation of Trade Frictions (TF)

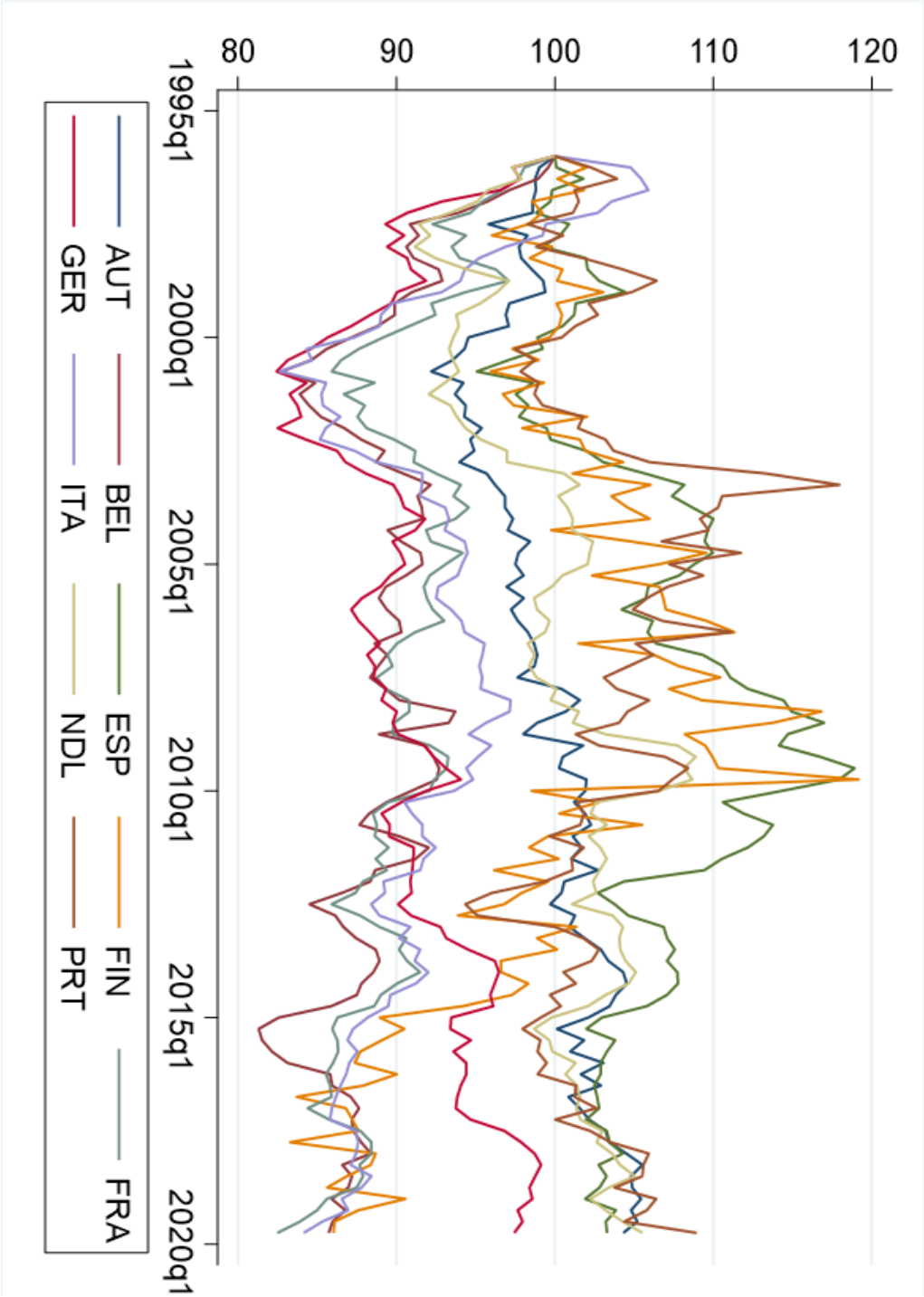

Table A 7: Long-run estimates (Panel ARDL) from standard export equation (SEE) specification

MDL	EST	δ_1 (FI)	δ_2 ($REER_{t-1}$)	δ_3 (NPCF)	α	ARDL
SEE	DFE (OLS)	+1.690***	-1.251***		-0.189***	(2.1.2)
		(0.129)	(0.192)		(0.062)	
	PMG (MLM)	+1.496***	-1.406***		-0.254**	(2.2.2)
		(0.018)	(0.099)		(0.035)	
	PMG (OLS)	+1.801***	-1.791***		-0.209	(1.1.1)
		(0.534)	(0.313)		(0.273)	
ECI	DFE (OLS)	+1.888***	-1.299***	+0.412*	-0.170***	(2.1.2.1)
		(0.167)	(0.316)	(0.217)	(0.038)	
	PMG (MLM)	+1.681***	-1.316***	+0.114*	-0.301***	(1.1.1.1)
		(0.048)	(0.144)	(0.065)	(0.066)	
	PMG (OLS)	+1.983***	-1.868***	+0.424***	0.279***	(2.1.2.2)
		(0.081)	(0.044)	(0.025)	(0.035)	
PAT41	DFE (OLS)	+1.718***	-1.130***	+0.194***	-0.241***	(2.2.2.2)
		(0.100)	(0.258)	(0.072)	(0.045)	
	PMG (MLM)	+1.718***	-1.238***	+0.205***	-0.205***	(2.1.1.2)
		(0.037)	(0.106)	(0.041)	(0.125)	
	PMG (OLS)	+1.820***	-1.586***	+0.052***	-0.373***	(2.1.1.1)
		(0.072)	(0.040)	(0.007)	(0.037)	
RD28	DFE (OLS)	+1.668***	-1.087***	+0.129	-0.164***	(2.1.2.2)
		(0.143)	(0.346)	(0.146)	(0.038)	
	PMG (MLM)	+1.633***	-1.384***	+0.129***	-0.332***	(2.1.1.2)
		(0.036)	(0.112)	(0.039)	(0.100)	
	PMG (OLS)	+1.758***	-1.854***	+0.071***	-0.095***	(2.1.2.2)
		(0.032)	(0.011)	(0.009)	(0.017)	
CS29	DFE (OLS)	+1.743***	-1.105***	+0.039	-0.183***	(1.1.1.1)
		(0.130)	(0.332)	(0.179)	(0.042)	
	PMG (MLM)	+1.382***	-1.049***	+0.665***	-0.279***	(2.1.1.1)
		(0.037)	(0.167)	(0.086)	(0.095)	
	PMG (OLS)	+1.786***	-1.588***	+0.112***	-0.290***	(1.2.1.1)
		(0.078)	(0.028)	(0.014)	(0.039)	
II41	DFE (OLS)	+1.655***	-1.218***	-0.140	-0.177***	(2.1.2.1)
		(0.136)	(0.324)	(0.141)	(0.039)	
	PMG (MLM)	+1.600***	-1.137***	-0.175	-0.324***	(1.1.1.1)
		(0.025)	(0.156)	(0.041)	(0.078)	
	PMG (OLS)	+1.740***	-1.794***	-0.185***	-0.257***	(2.1.1.1)
		(0.077)	(0.031)	(0.011)	(0.034)	
MFP24	DFE (OLS)	+1.690***	-1.317***	+0.043	-0.155***	(2.1.1.1)
		(0.192)	(0.371)	(0.805)	(0.041)	
	PMG (MLM)	+1.194***	-1.508***	-0.382*	-0.287***	(1.1.1.1)
		(0.024)	(0.099)	(0.185)	(0.106)	
	PMG (OLS)	+1.997***	-1.953***	+0.929***	-0.240***	(1.1.2.1)
		(0.149)	(0.035)	(0.166)	(0.058)	

Note: 1995-2019, n=23-l. MDL: Model specification with notion of non-price competitiveness factor (NPCF). EST: Estimator. Critical values: 1% ***; 5% **; 10% *. Long term coefficients FI (foreign income) and $REER_{t-1}$ (Price competiveness) from cointegrating equation (1.5). α denotes the adjustment coefficient. Standard errors in brackets below the coefficient.

Appendix B

Export equation variables

Export volume (X_i): Real export of goods expressed in € (base year 2015, export price deflator) from the Eurostat national accounts database.

Price competitiveness (P_i): Real effective exchange rate adjusted by nominal unit labour cost. The REER is relative to 37 partner countries. The weighting scheme is based on fixed export weights. Data is taken from the Price and Price competitiveness database of the European Commission.

Foreign income ($FI35_i$): Real gross domestic product (base year 2015, GDP deflator, fixed PPP adjusted) of 34 OECD partner countries expressed in €. Data is taken from the OECD national accounts database.

Foreign import demand ($FID35_i$): Real imports of goods (base year 2015, GDP deflator, fixed PPP adjusted, export weighted) of 34 OECD partner countries. Data is taken from the OECD national accounts database.

Non-price competitiveness variables

Patent stock ($PS41_i$): Patent stock relative to 40 competitor countries. Patent stock calculation according to the perpetual inventory method (depreciation rate $\delta = 0{,}15$) as applied by Bottega & Romero (2021). Number of patent grants (P_t) at the USPTO taken from the OECD Patents statistics database.
Formula $PST_t = P_t + (1 - \delta)PST_{t-1}$.

R&D intensity ($RD28_i$): Gross domestic expenditure on R&D (GERD) as a percentage of GDP relative to 27 competitor countries (see Fagerberg, 1988). GERD time series taken from OECD Main Science and technology indicators database.

Capital stock ($CS29_i$): Capital stock relative to 28 competitor countries. Calculation according to the perpetual inventory method (assumed $N = 20$ years of service life for machinery: $\delta = 2{,}5/N$) as applied by Athanasoglou and Bardaka (2010). Real gross capital formation in € (base year 2015) taken from Eurostat national accounts database.
Formula: $CST_t = INV_t + (1 - \delta)CST_{t-1}$.

Investment intensity ($II41_i$): Gross fixed capital formation to GDP ratio relative to 40 competitor countries. Time series expressed in current prices in the national currencies. Data taken from the OECD national accounts database.

Multi-factor productivity ($MFP24_i$):
MFP volumes relative to 23 competitor countries as proposed by Giordano and Zollino (2016). MFP growth rates for 23 countries were taken from the OECD database. The source of Chinese MFP is FRED.

Economic complexity index (ECI_i): ECI taken from the Harvard Growth Lab. No transformation in logs.

Trade Friction NPC (TF_i): Unexplained factor within an Gravity Model export equation accounting for the Armington Hypothesis. Cost elasticity is assumed to be -1. Alterations of this price elasticity affect the strength of the NPC effect, but not the relative tendencies.

General weighting scheme: Weights calculated on individual shares of export partner countries (95-19 average). Data is taken from the Price and Price competitiveness database of the European Commission.

The calculation scheme for the indicators of Patents, R&D intensity, capital stock, investment, multi-factor productivity follows the approach of the REER: A weighted geometric average. $NPC_i = \prod_{j=1}^{n} (\frac{T_i}{T_j})^{\omega}$.

Table B 1: Geographical composition of variables

FI35, FID35	AUS, AUT, BEL, BUL, CAN, CHE, CZE, DNK, ESP, EST, FIN, FRA, GBR, GER, GRC, HUN, IRE, ITA, JAP, KOR, LTU, LTV, LUX, MEX, NDL, NEZ, NOR, POL, PRT, ROM, RUS, SVK, SWE, TUR, USA
REER27	AUT, BEL, BUL, CYP, CZE, DNK, ESP, EST, FIN, FRA, GER, GRC, HRV, HUN, IRE, ITA, LTU, LTV, LUX, MAL, NDL, POL, PRT, ROM, SLO, SVK, SWE
REER37	AUS, AUT, BEL, BUL, CAN, CHE, CYP, CZE, DNK, ESP, EST, FIN, FRA, GBR, GER, GRC, HRV, HUN, IRE, ITA, JAP, LTU, LTV, LUX, MAL, MEX, NDL, NEZ, NOR, POL, PRT, ROM, SLO, SVK, SWE, TUR, USA
PAT41	AUS, AUT, BEL, BRA, BUL, CAN, CHE, CHI, CYP, CZE, DNK, ESP, EST, FIN, FRA, GBR, GER, GRC, HRV, HUN, IRE, ITA, JAP, KOR, LTU, LTV, LUX, MAL, MEX, NDL, NEZ, NOR, POL, PRT, ROM, RUS, SLO, SVK, SWE, TUR, USA
RD28	AUT, BEL, CAN, CHI, CZE, DNK, ESP, FIN, FRA, GBR, GER, HUN, IRE, ITA, JAP, KOR, LTU, LTV, MEX, NDL, POL, PRT, ROM, RUS, SLO, SVK, TUR, USA
CS29	AUT, BEL, BUL, CHE, CYP, CZE, DNK, ESP, EST, FIN, FRA, GBR, GER, GRC, HRV, HUN, IRE, ITA, LTU, LTV, LUX, NDL, NOR, POL, PRT, ROM, SLO, SVK, SWE
II41	AUS, AUT, BEL, BRA, BUL, CAN, CHE, CHI, CYP, CZE, DNK, ESP, EST, FIN, FRA, GBR, GER, GRC, HRV, HUN, IRE, ITA, JAP, KOR, LTU, LTV, LUX, MAL, MEX, NDL, NEZ, NOR, POL, PRT, ROM, RUS, SLO, SVK, SWE, TUR, USA
MFP24	AUS, AUT, BEL, CAN, CHE, CHI, DNK, ESP, FIN, FRA, GBR, GER, GRC, IRE, ITA, JAP, KOR, LUX, NDL, NEZ, NOR, PRT, SWE, USA