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Executive Summary

This working paper offers novel evidence and policy discussion that could aid the implementation of the European Union's Open Strategic Autonomy and industrial policies for the twin transition[4]. The analysis draws on theories from the capability-based and structural literature, relying on a methodological approach developed within the literature on economic complexity and geography. Specifically, we explore the relationship between EU countries' proximity to twin transition-related products, their trade dependencies and comparative advantage.

The findings are twofold. First, when we look at what countries have a productive structure that is the most aligned to twin transition products, we find that these are large manufacturing countries such as Germany and Italy. However, when we consider which countries are closest to twin transition products in relative terms – i.e. whether transition products are the closest to their productive structure – we find that it is often smaller countries, notably Sweden and Czechia, that have incentives to specialise in such products.

Second, we find that both the development of comparative advantage or a reduction of trade dependence is not closely related to measures of proximity. Conversely, we also find that distance is a good predictor of the likelihood of losing comparative advantage and increasing trade dependences. This means that on the one hand, policies aiming to develop comparative advantage in twin transition goods should focus on factors beyond proximity alone. On the other hand, such policies should focus on fostering broad and coherent technological and capability ecosystems, taking a systemic approach focused on complementarities in line with the structuralist and capabilities-based theory.

Moreover, and in light of the asymmetries among EU countries in their ability and incentives to diversify towards OSA and twin transition goods, it is necessary coordinate industrial policies across the EU to avoid an exacerbation of pre-existing inequalities that would be contrary to EU cohesion policy principles.

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[4] Part of this working paper draws on Bontadini and Meliciani (2025).

1. Introduction

European trade and industrial policy have undergone considerable changes in the past two decades, in a global context of radical technological and economic transformations. The digital transformation, particularly with the emergence of AI, has substantially accelerated its pace and might have unpredictable effects on economies and societies. The on-going climate crisis has put increasing pressure on governments to reduce emissions and make economic activity more sustainable. A major policy challenge is therefore to steer what is often referred to as the twin transition.

The geopolitical landscape has also profoundly changed over the past few years. While the first two decades of the 21st century have witnessed a steady increase in liberalisation of trade and economic integration among countries, recent years have seen greater turbulence. Trade relationships between China and the US have soured considerably, the COVID-19 pandemic has shown the vulnerability of global supply-chains, the dependence on supplier countries and the introduction of export restrictions for selected products. The Russian invasion of Ukraine has sparked an energy crisis and inflation across the World. This geopolitical turbulence has made the notions of near-/, re-/, back-/ or even friend-/ shoring to gain significant traction in the policy debate around globalisation.

The EU has started to pursue what it refers to as open strategic autonomy (OSA) (Szyszczak, 2023, Evenett et al., 2024), trying to strike a balance between preserving a rules-based open trade system and reducing its own dependences on foreign suppliers of strategic products and technologies for the twin transition (Edler et al., 2023).
To illustrate this, we can adopt a rough, but intuitive, measure of trade dependence:

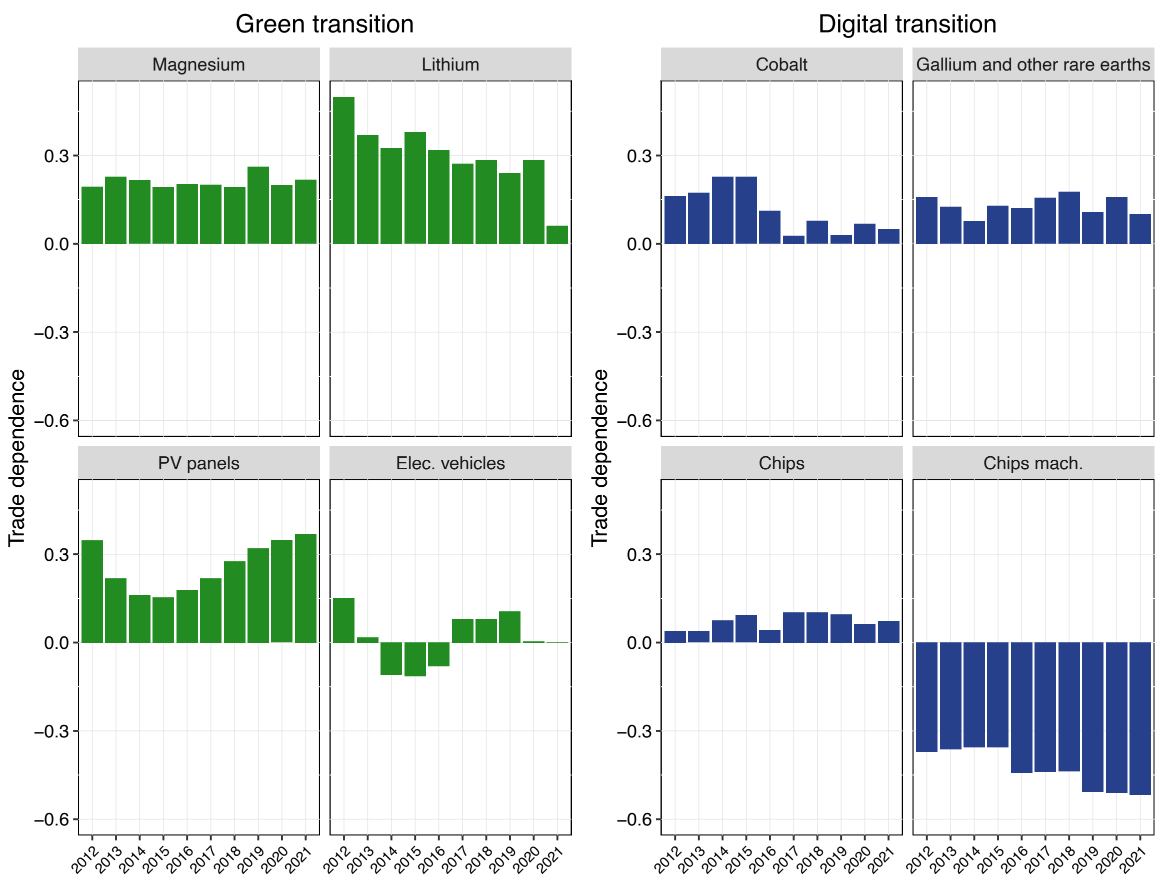
$$Trade\ dependence = \frac{m_{ik} - x_{ik}}{m_{ik} + x_{ik}} \tag{1}$$

Where x_{ik} and m_{ik} are exports and imports, respectively, of country i and product k.
Figure 1 reports this index over time for a selection of eight among raw materials and manufactured products for the green and digital transition. Most European countries are net importers of both raw materials and mid-tech manufactured goods such as PV panels – in which China has become a leader – and microchips (Bulfone et al, 2024). The EU remains however a net exporter of more technologically intensive products. This is the case for machineries to produce microchips, and electric vehicles, although its competitiveness in the latter has been deteriorating in the most recent years.

Looking at the origin of imports of these eight products in Figure 2, we find that EU dependences are rather diversified geographically, although a few key suppliers clearly emerge. Among raw materials, China is by far the largest supplier of magnesium and an important one for gallium and other rare elements. Latin American countries, lumped in the Rest of the World (ROW) group in Figure 2, are also large suppliers of lithium (Chile) and gallium (Brazil), while Africa (especially the Democratic Republic of Congo) is a crucial supplier of cobalt.

Looking at manufactured goods, China is again a major supplier of PV panels and, to some extent, microchips, while both electric vehicles and microchip machineries are mostly sourced from the US or other advanced economies (OAE).

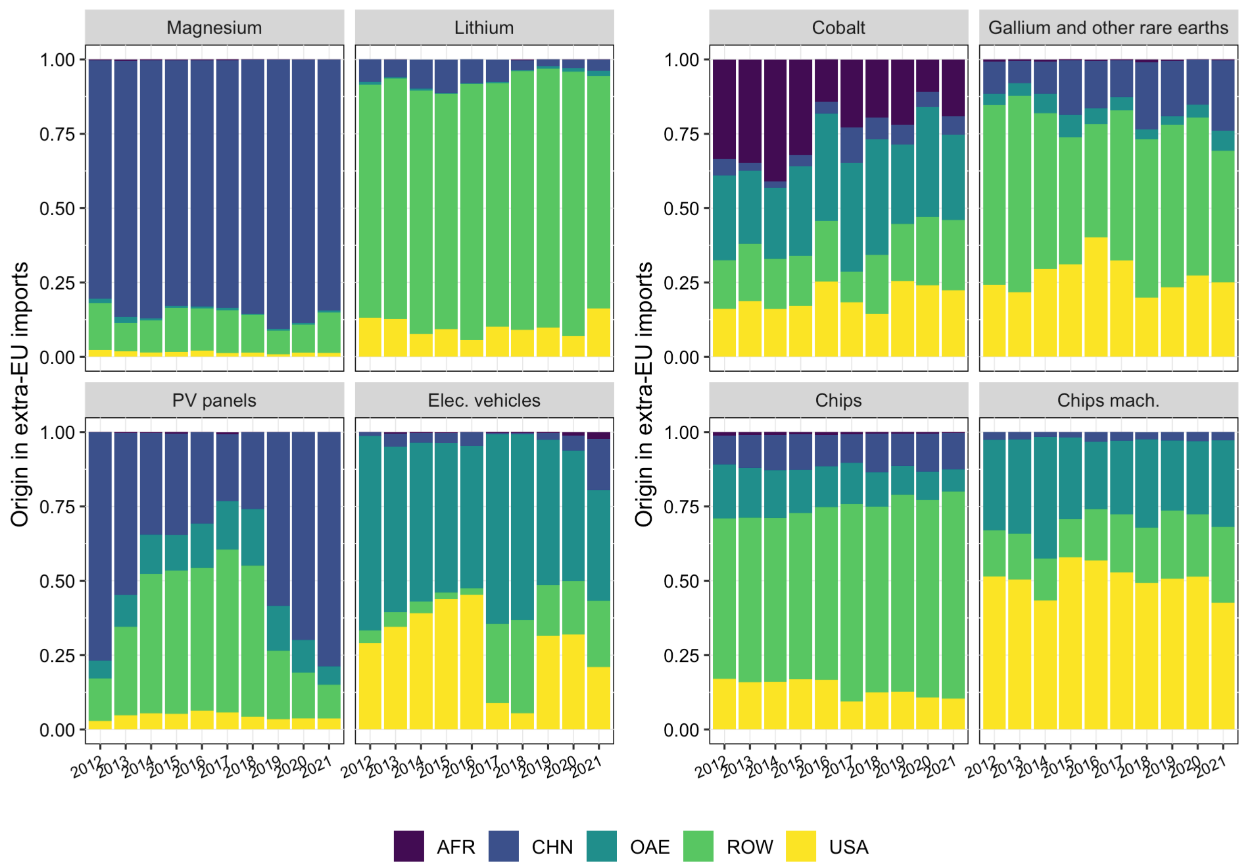
Figure 1: EU trade dependencies in twin transition value chains



Note: Trade dependence is computed here for groups of HS6 codes, grouped through manual procedure to identify the eight broader categories, CRM are identified based on Rietveld et al. (2023). Other advanced economies include Australia, Canada, Iceland, Japan, New Zealand, Norway, Taiwan, and South Korea, Rest of the World (ROW) is a residual category including all remaining countries.
Source: Authors' elaboration on BACI-CEPII data.

Overall, despite some heterogeneity, this preliminary evidence shows that the EU is not self-reliant, which explains the growing policy interest to reduce such dependences to ensure a successful twin transition. A significant challenge in this respect is the fact that such products vary greatly in terms of underlying technology, complexity and capability requirements. Countries might face challenges to pursue strategic autonomy, and, depending on their resources, industry structure and capabilities, they might need to focus on achieving autonomy only in some, rather than all the strategic materials and products for the twin transition. Policy-targeting full autonomy may prove both inefficient and unsuccessful.

Figure 2: Origin of EU trade dependencies in twin transition value chains



Note: Origin of imports is computed here for groups of HS6 codes, grouped through manual procedure to identify the eight broader categories, CRM are identified based on Rietveld et al. (2022). Other advanced economies includes: Australia, Canada, Iceland, Japan, New Zealand, Norway, Taiwan, and South Korea, Rest of the World (ROW) is a residual category including all remaining countries.
Source: Authors' elaboration on BACI-CEPII data.

The aim of this working paper is to provide a general framework and a methodological device that helps to identify the specific products that each country can target. We draw upon the literature on technological capabilities and economic complexity, and ground our work in theories of structural change.

Theories of structural change and technology gap have a long history of policy relevance in the context of industrial policy for development (Lall, 1992; Dosi et al., 1990; see more recently, Chang and Andreoni, 2020; Juhász et al. 2023). The approach of economic complexity – while fairly a-theoretical - has gained significant attention in the policy domain. Specialising in complex products has been found to be consistently associated with economic growth (Balland et al. 2022, and Broekel, 2022) and relevant for the green transition (Mealy and Teytelboym, 2022). A key takeaway of this literature is that countries' productive structure evolves slowly over time and that "jumps" from one specialisation pattern to include products that are very dissimilar are unlikely to happen. In sum, this literature provides country-specific recipes for policy interventions to steer economic specialisation towards complex products.

The methodological toolbox developed within the economic complexity approach (Hidalgo et al., 2007: Boschma et al., 2013) may prove very useful in mapping the position of Europe with respect to strategic products and to identify areas of opportunity to steer production structures towards strategic products that are closer to own extant capabilities.

Recently this methodology has been applied to green capabilities, mainly using patent data (for a review see Caldarola et al. 2024), while few studies have focused on green productive capabilities using trade data (Huberty and Zachmann, 2011; Hamwey *et al.* 2013; Fraccascia et al. 2018; Mealy and Teytelboym 2022; Müller and Eichhammer 2023).[5] Among these studies Fraccascia et al. (2018), using panel data regressions for 141 countries over the period 2005-2013, find support for the hypothesis that the green products with the highest potential for growth among all green products in a given country are those in close proximity to the products a country produces with high Relative Comparative Advantage (RCA). Mealy and Teytelboym (2022) use a similar approach to explore countries' opportunities to increase their green production capabilities and find that the "green complexity potential", which measures each country's average relatedness to green complex products, positively affects changes in green production capabilities (measured by the green complexity index), the number and the share of exported green products.

In sum, our paper offers a framework that builds on theories of structural change and economic development (Lall, 1992), while using the methodological contribution of the economic complexity approach to map productive and technological capabilities, and assess their role in shaping

[5] For a review of the application of EC to sustainability, see Caldarola et al. 2024.

diversification and growth (Hausmann *et al* 2007, 2011; Pugliese *et al* 2017; Sbardella *et al* 2018).[6] It is important to note that this approach is agnostic on what technologies/sectors/value chains offer different opportunities for long term strategic competitiveness and growth. As illustrated in the next section, we complement this approach by selecting areas that are relevant for the purpose of this paper and also complement some of the recent discussions on industrial policy (Chang and Andreoni, 2020; Fontana and Vannuccini, 2024) for European Open Strategic Autonomy (Arjona et al. 2023).

We map the distance across country-product pairs and study its relationship with countries' likelihood to (i) decrease their dependence, as well as to (ii) develop comparative advantage.

2. Data and methods

2.1 Strategic products for EU's twin transition

We focus our empirical analysis on three groups of products, which are relevant for the green transition and then identify subsamples within each of them of both high-complexity and high EU-dependence products.

Green transition products. In line with the policy literature on this topic (Steenblik 2005 and Sauvage, 2014), we follow the output approach[7] and take the list of green products compiled by Bontadini and Vona (2023). This list is essentially a refined version of the OECD Combined List of Environmental Good (CLEG), excluding products with more than one usage, one of which is not green, such as water pipes or other waste management equipment.

Digital transition goods. The construction of digital goods lists has drawn significantly less attention in the literature. Andreoni et al. (2023) put forward a list which encompasses capital goods in relevant 2-digit the Harmonised System and a manual cleaning procedure leading to 127 products.

Critical raw material. The two lists above identify products deploying technologies for the twin transition. Within them, some raw materials have emerged as particularly critical for these technologies. They are referred to as critical raw materials (CRM). The EU has published a CRM

[6] The intuition underlying the measurement of complexity is that complex products require a wide array of capabilities that are rare among countries. Therefore, complex products are those that are exported competitively (i.e. with a revealed comparative advantage) by few *and* highly-diversified countries. To illustrate, natural resources (e.g. lithium) are exported by only few countries (e.g. Chile), but these countries are not very diversified. In contrast complex products such as machinery for the production of microchips are exported by few countries (e.g. the Netherlands) that also export many other products, thanks to their wide range of capabilities.

[7] Broadly speaking, greenness can be identified in terms of production *process*, i.e. products whose production process requires less pollution, e.g. bamboo instead of metal structures. Or it can be defined in terms of *output,* i.e. products whose use has positive remediation effects on the environment, such as wind turbines, filters or photovoltaic (PV) panels.

Act and Eurostat has been compiling a yearly list of CRMs. We rely here on the list published by the European Commission in 2023.

From these three product ecosystems, we identify those products in which the European Commission has found the EU to have strategic dependence, based on Arjona et al (2023). We then also identify within each product ecosystem the top decile for economic complexity, which we consider high-complexity products.

2.2 Measuring distance between countries and products

Based on the methodological procedure specified in the Methodological Appendix to the working paper (henceforth referred to as the Appendix), we identify a matrix of country-product distance. This allows us to map countries in terms of their likelihood/advantage to specialise in the three set of products for the twin transition.

As argued in the section above, this measure reflects not only the difference between a country's export portfolio and the product, but also the difference in terms of technological and capability requirements. Larger countries exporting many products with RCA will have a lower distance with respect to most products.[8] For example, a large, diversified, and manufacturing-based country, such as Germany, will likely have lower distance to all products than, say, a small, service-based economy such as Luxembourg, and will likely be disproportionately benefiting from EU-level support to specialise in twin transition goods. This is important from a policy perspective at the European level, since the pursuit of specialisation in twin-transition products may come at the cost of undermining EU cohesion.

Moreover, there is a tension emerging between policymaking at the EU and the national level. EU policymakers may wish to focus all support to countries that are closest to the strategic products, while national policymakers will each consider what product is closest to their productive structure *regardless* of whether other EU countries have a lower distance.

Let us consider the case of a small country with high absolute distance from all twin-transition products. Other countries will stand a better chance to specialise in twin-transition goods, but from the small country's perspective it might still be reasonable to pursue specialisation in the twin-transition products that are closest to its own productive structure.

In a specular way, large and diversified economies are likely to have relatively low distance with respect to *all* products. This means that twin transition goods may not be the closest products a large, diversified country could specialise in; therefore, while EU level policymakers would want to

[8] See Appendix 1: a country exporting many products with RCA will have y_{ik}, populated with more ones which will decrease distance.

support a large, diversified country's efforts to specialise in twin transition goods, this might not align with the country's own productive structure.

3. Empirical results

3.1 Mapping country-product distance for the twin transition

Some of the twin transition products illustrated above will be more complex than others, requiring different sets of capabilities. First, we plot the density distribution of the three product ecosystems, contrasting it with the distribution of complexity for all products in Figure 3. As expected, we find rather stark differences in terms of complexity.

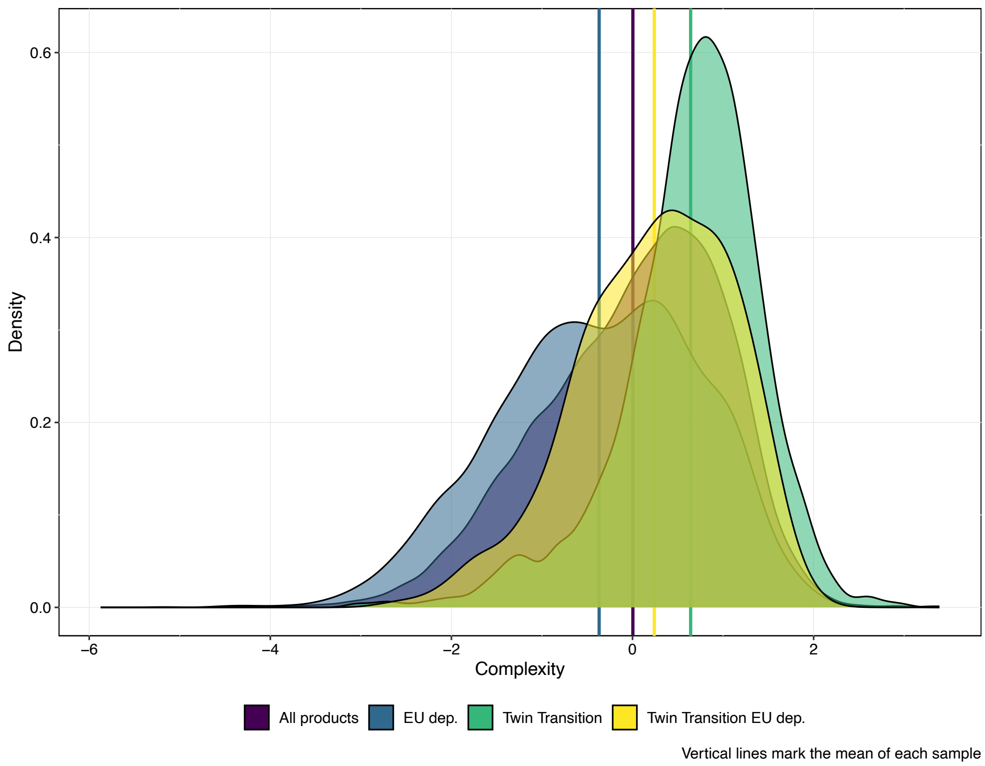
The upper panel of Figure 3 plots the distribution of complexity for (i) all products, (ii) the products where the European Commission (Arjona 2023) finds an EU-level dependence, (iii) the twin transition products that we identified above and (iv) the intersection between (iii) and (ii). Twin transition products are by far more complex than all other groups, especially when looking at all products. However, the subsample of twin transition products on which the EU is most dependent are significantly less complex, while those on which it is less dependent are fairly complex, as mentioned in the introduction (Figure 1).

The lower panel of Figure 3 looks at the three classes of twin-transition products individually. The distribution of all these is skewed towards higher complexity, especially the digital and green ecosystem. Concerning critical raw materials, one would expect them to rank rather low on complexity, since, although rare, they are usually exported by natural resource intensive countries that have low levels of diversification. However, it is worth bearing in mind that critical raw materials are rarely mined as such and often have to be extracted from other ores (Li et al. 2024), therefore requiring some level of technological capability.

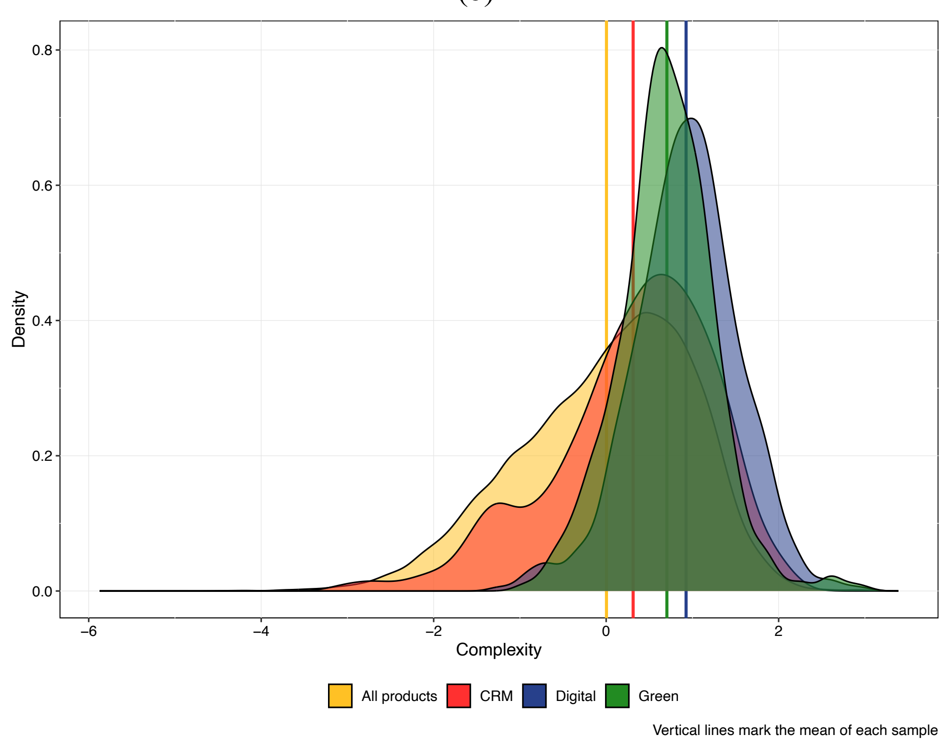
All told, Figure 3 suggests that the twin-transition products are rather complex, which means they are not easy to specialise in, requiring a vast array of capabilities. At the same time, successful specialisation in such complex products may yield a growth dividend (Hidalgo et al. 2007). This lends support to the idea that policy intervention could be helpful in steering countries' productive structure towards such products and that, if successful, this specialisation may be conducive to economic growth.

Figure 3: Distribution of economic complexity across ecosystems

(a)



(b)



Note: Density plot of products' complexity. Complexity is averaged over time to only vary among products.
Source: Authors' elaboration on BACI-CEPII data.

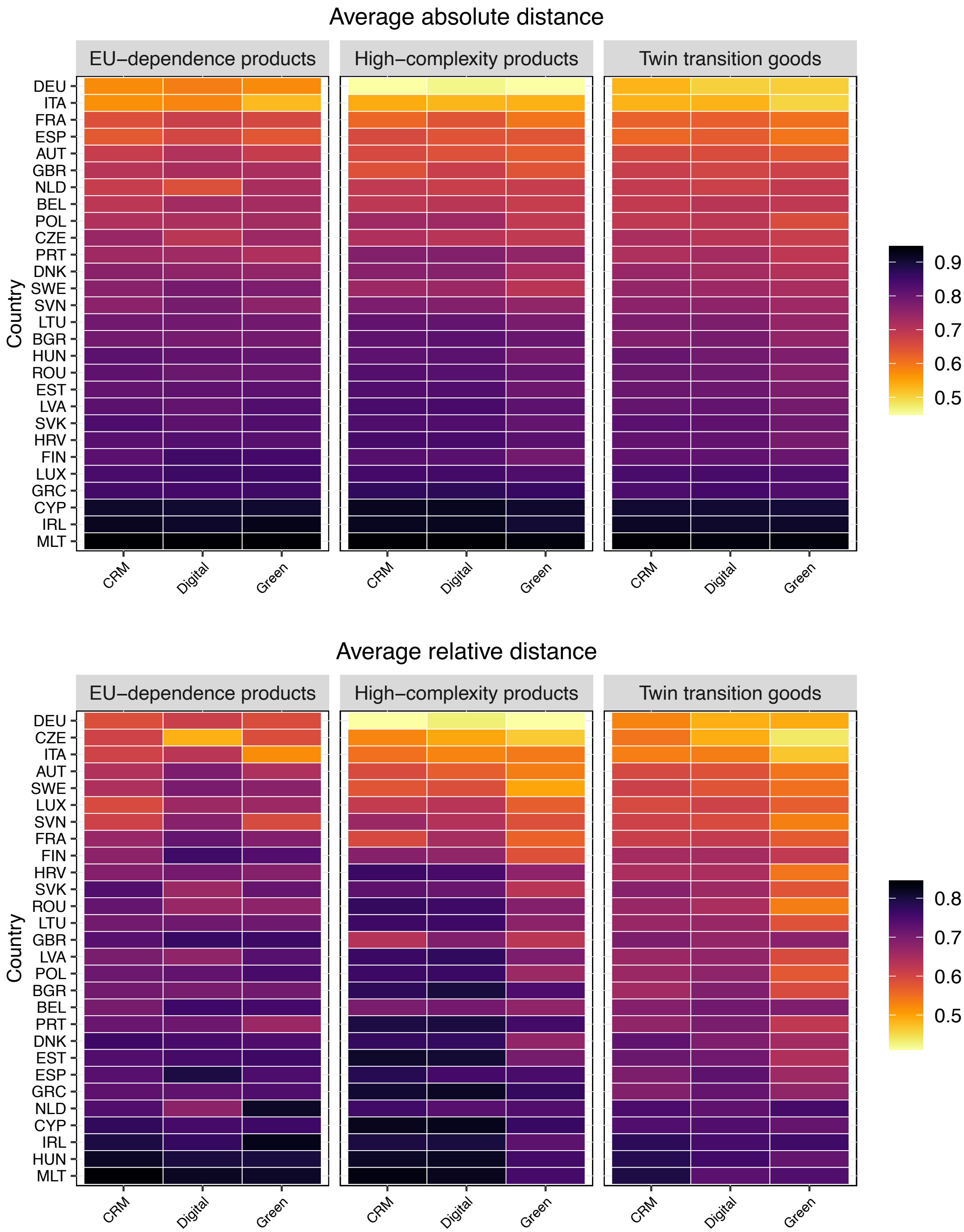
Second, we look at the likelihood of a country specialising in highly complex twin transition products, based on their initial sectoral specialisation and capabilities (i.e. looking and the country-product matrix explained in Section 2). Figure 4 plots unweighted averages of distance for each country-product ecosystem combination looking at all twin transition goods (righthand panel), as well as the high-complexity and EU-dependence subsamples (centre and lefthand panel, respectively).

The upper panel reports *absolute* distance. We find support for our conjecture that large and diversified countries, such as Italy and Germany, have the lowest distance from all products, regardless of their ecosystem. Germany seems to have a productive specialisation that is particularly close to high-complex products. EU-dependence products in contrast exhibit a higher distance, suggesting that those products in which the EU has the highest dependence are also those that lie the farthest from EU countries' specialisation pattern.

When we turn to the lower panel and the *relative* distance, we find a rather different picture. Twin transition products are overall much closer to EU countries' productive structure, especially green ones, while high-complexity and EU-dependence products are significantly farther away.

Looking at individual countries is, however, where the most striking differences emerge. Czechia, Sweden and, remarkably, Luxembourg now appear to have considerably shorter distance than in absolute terms.

Figure 4: Absolute and relative average distance across countries and product ecosystems



Note: Colour refers to unweighted average distance of products in each country-product ecosystem over time. Source: Authors' elaboration on BACI-CEPII data.

This suggests that there might be a misalignment in policy interests between the EU- and the national levels and a high cost of uncoordinated national policies. Were small countries to pursue the twin-transition towards products closest to their productive structure, they would most likely have to compete with larger countries such as Germany and Italy that not only operate at a large scale – and in the case of Germany also with larger fiscal capacity – but also have a technological advantage in absolute terms. This may prove to have detrimental effects not only in terms of doubling up policy efforts across countries but also to exacerbate pre-existing asymmetries across EU Member States and, ultimately, undermine EU cohesion.

3.2 Distance, trade dependence and RCAs

We now explore how countries' distance from twin transition products is related to EU trade dependence on such products, bearing in mind that distance is a measure of similarity between a product and a country's productive structure, built on *export* flows, while trade dependence in contrast is the outcome of *import and export* flows, with no mechanical relationship to distance.

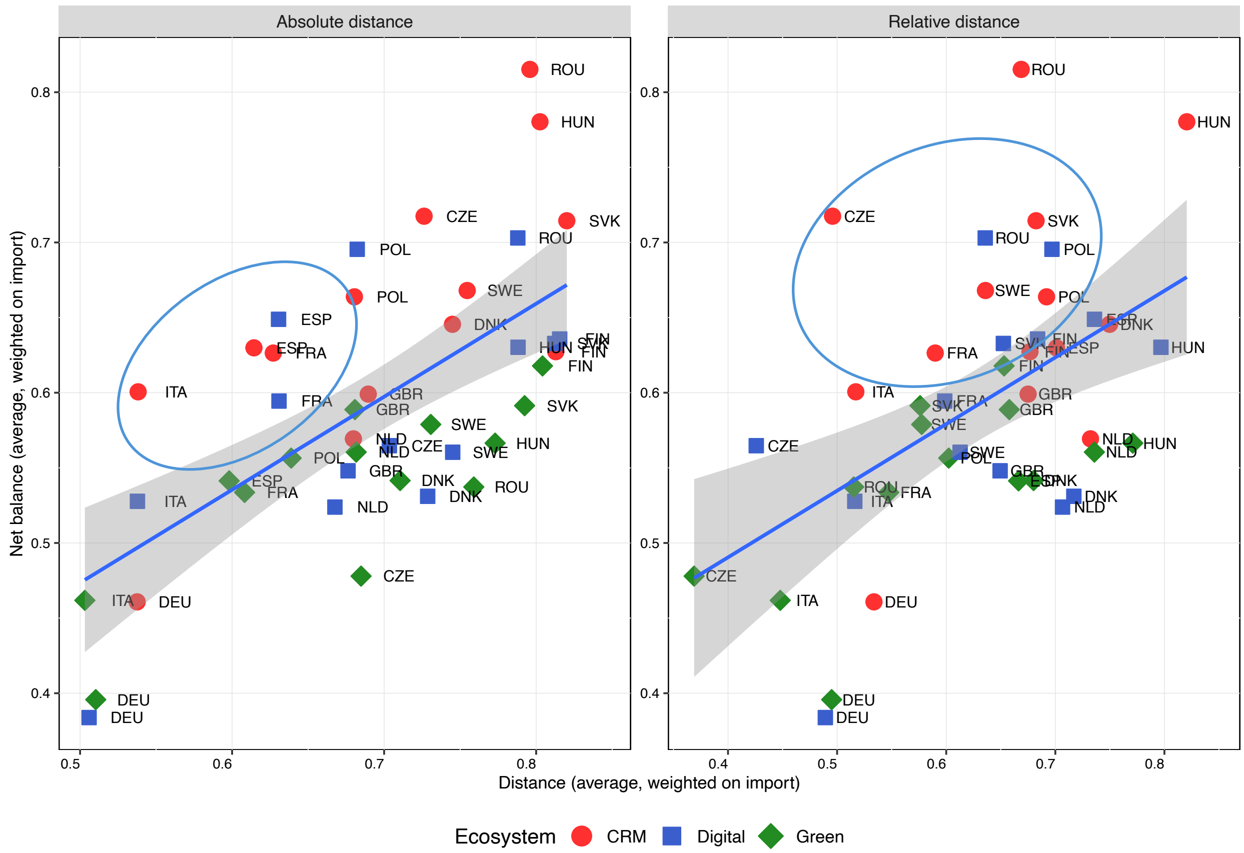
In theory, it is possible for a country to decrease both import and export in distant products, leaving its trade dependence unaltered. In practice however, countries are likely to increase exports of products closer to their productive structure, while resorting to imports of products from which they are farther away. These mechanisms would be consistent with both absolute and relative distance, since the two are related to one another and we therefore expect the relationship between trade dependence and both measures of distance to be the same.

In Figure 5 we plot both the absolute and relative distance, focussing on the average between 2018 and 2021, against trade dependence. The figure looks at country-product ecosystems averages, weighted on imports to give more importance to products that are imported in larger quantities. As expected, we find a positive relationship between distance and trade dependence, suggesting that countries tend to import rather than export products that are distant from their productive structure.

While, as expected, both absolute and relative distance exhibit similar relationships with trade dependence, some differences emerge in terms of position of *individual* country-product pairs along these two variables.

The figure does highlight some difference in between absolute and relative distance. Concerning the former, we see a cluster of country-products that have rather high trade dependence but low distance, circled in blue. This cluster includes only large and diversified countries, such as Italy, France and Spain. In contrast, as a similar cluster of high-dependence but low-distance countries using relative distance we identify a rather different group of countries: Czechia, Poland, Slovakia and Sweden. This again highlights the difference in policy incentives when we consider absolute as opposed to relative distance and the emergence of policy misalignment discussed above.

Figure 5: Trade dependence and distance 2018-21

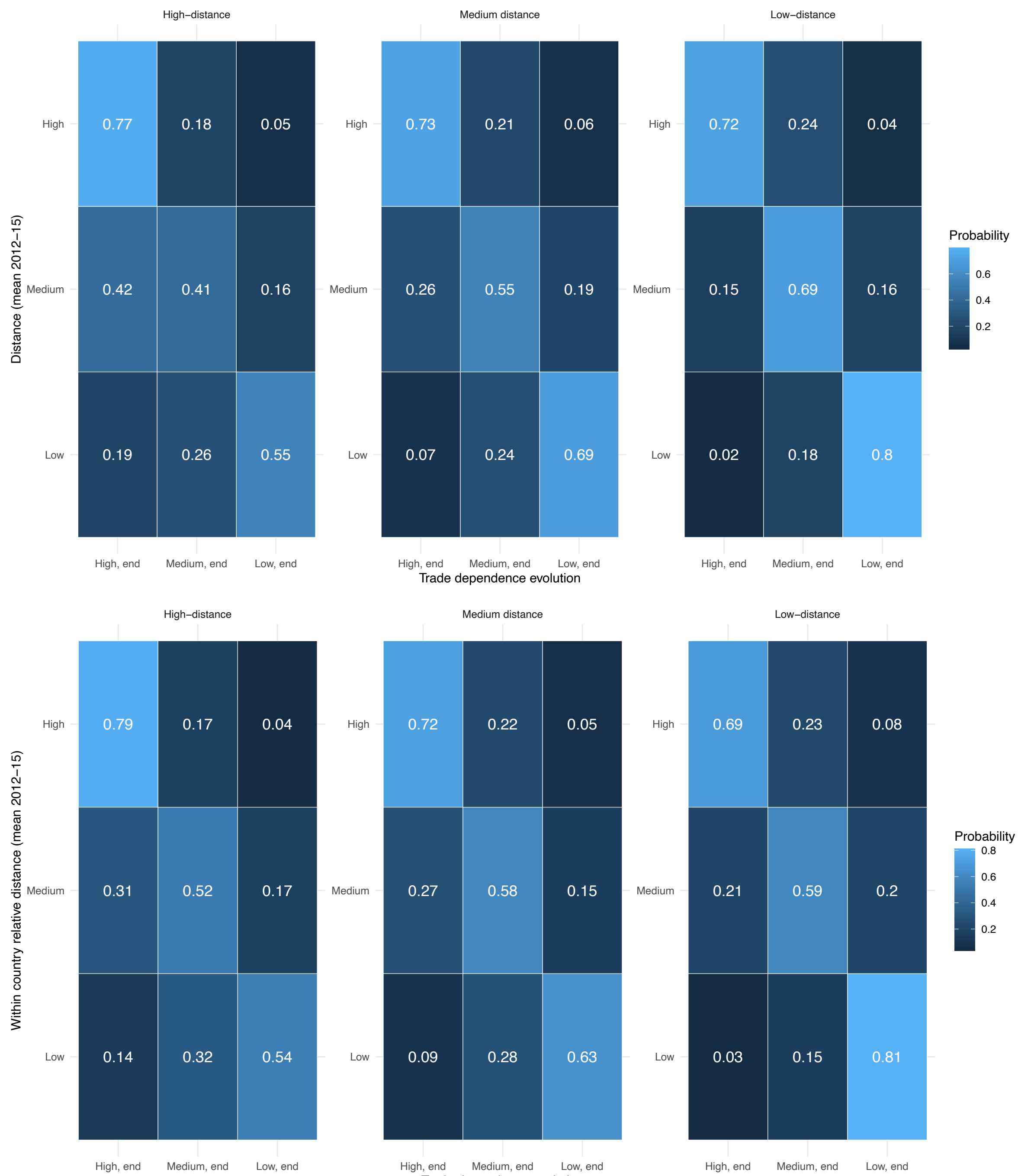


Note: The figure imports averages for distance and trade dependence over the period 2018-21 across product ecosystems. The lefthand panel uses absolute distance, while the right hand panel uses relative distance.
Source: Authors' elaboration on BACI-CEPII data.

Figure 5 relies on averaged values of distance and trade dependence, weighted on imports, to convey the overall relationship between these two variables. Trade data are of course much more granular with high levels of both volatility and heterogeneity. Trade dependence in particular is likely to fluctuate greatly due to changes in relative prices, demand or trade policy among countries. It is therefore hard to gauge clearcut insights from small changes. Hence, we focus on trade dependence in a discrete, rather than continuous way, looking at whether a country's dependence changes widely over time.

In Figure 6 we consider three possible states, binding trade dependence between 0 and 1, with the threshold indicating whether a country is a net importer of a product being 0.5: low dependence (trade dependence below 0.5), medium trade dependence (between 0.5 and .75) and high dependence (above 0.75). Figure 6 shows the transition matrix detailing the probability of a product-country transitioning from one state to another, grouping them by distance tercile.

Figure 6: Trade dependence transition matrix, absolute and relative distance



Note: The transition matrix looks at three possible states: trade dependence above 0.75 (high), between 0.5 and 0.75 (medium) and below 0.5 (low). Each matrix refers to terciles of distance. Top panel uses absolute distance, bottom panel uses relative distance. Source: Authors' elaboration on BACI-CEPII data.

Overall, country-product pairs that start off with a high dependence are very unlikely to see that decrease over time, regardless of their initial level of distance. In contrast, high distance is associated with a higher probability of low dependence products to transition to higher dependence.[9]

In the lower panel of Figure 6 we replicate the results using relative distance; in the Appendix we break down each product class (Figures A.1 and A.2) and find these patterns to be very robust. It therefore appears that the chance of a high-dependence product to see this reduce is unrelated to its distance from a country's production structure. It is likely that such high dependence is driven by the lack of production factors mix, skills or endowment of natural resources.[10]

In contrast, distance is a good predictor of which products are likely to develop trade-dependence. In line with the literature on technology gap and relatedness, these results suggest that countries focus on products closer to their capabilities set, and shed less related products; as a result, countries will decrease exports of distant products, increase imports and see trade dependence rise.

The policy discussion around EU industrial policy and open strategic autonomy is, however, not only focused on reducing the EU's trade dependence but also on the ability to develop specialisation in twin-transition goods. A standard measure to capture specialisation in the literature on trade is based on the notion of revealed comparative advantage, measured with the Balassa index (see Equation 2 in the Appendix). Furthermore, this approach to capturing countries' specialisation is consistent with the economic complexity and capability approach mentioned in Section 1.

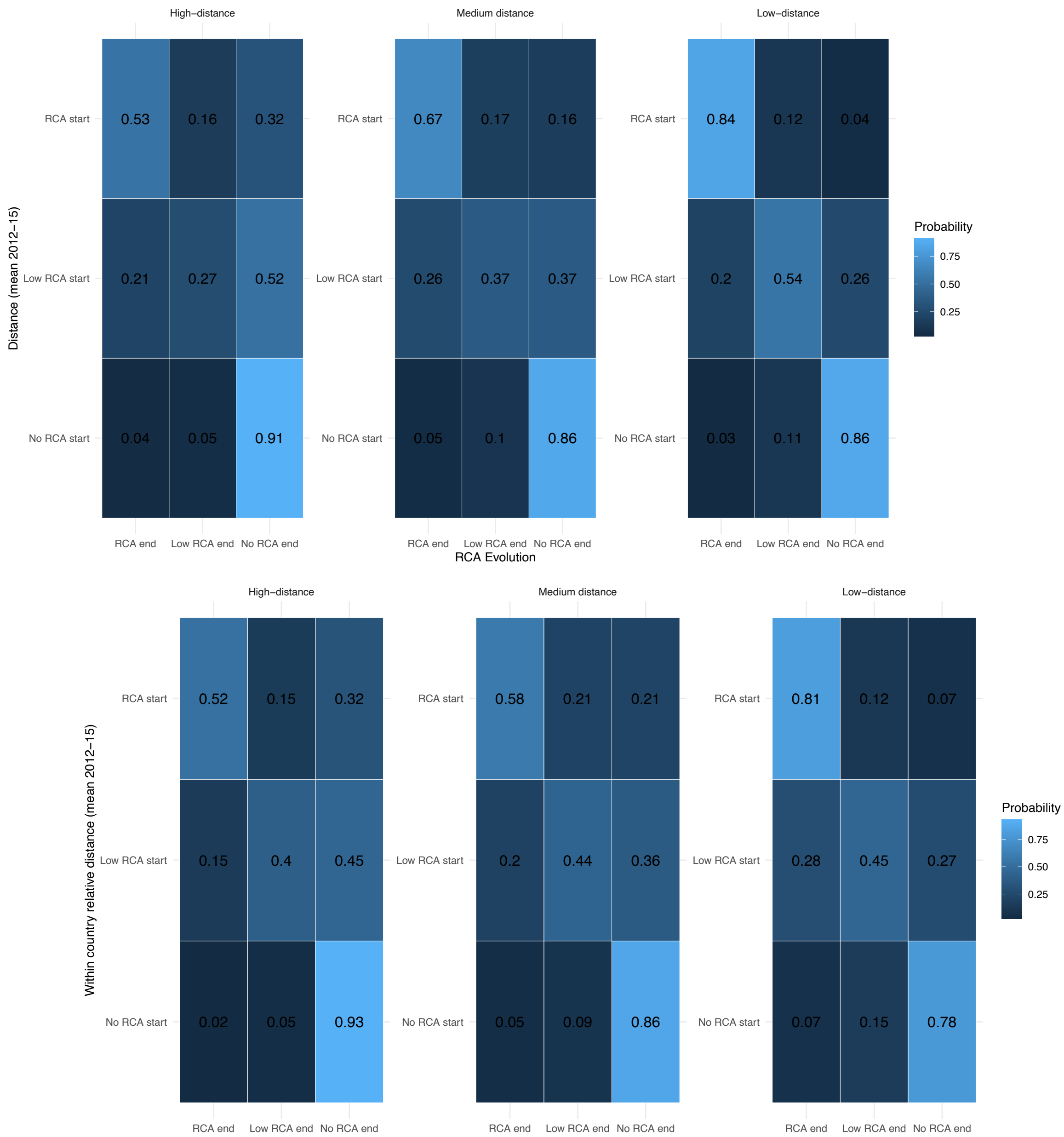
Balassa indexes vary between zero and infinity, but they are usually interpreted in a binary way, with one being the economic significant threshold. This means, however, that small changes at the margin of this threshold can be interpreted as changes in the specialisation pattern of a country in a misleading way. To avoid this, and much like our approach to changes in trade dependence, we focus on large changes in a country-product RCA and identify the three following possible states in the two periods 2012-15 and 2018-21: (i) RCA, with Balassa index above 1, (ii) Low RCA, with a Balassa index between 0.5 and 1, these refer to products that do not have an RCA strictly speaking but are not too far from it and (iii) no RCA, with Balassa indexes below 0.5.

[9] Specifically, high-distance low-dependence products have 45% (= 1-0.55, from the bottom row of the matrix in the top-left matrix) chance of transitioning to higher dependence, while low-distance products only have 20% chance (= 1-0.8, from the bottom row of the matrix in the top-right matrix) of the same happening.

[10] It is worth noting that this cannot be only explained by lacking endowments in natural resources since this pattern is found also among digital and green products which are for the vast majority manufactured goods rather than commodities.

Looking at the top panel for Figure 7, dividing country-products based on absolute distance terciles, we observe that high-distance products that start off with an RCA are less likely (53%) to retain it than low-distance products (84%). In addition, high-distance products with an RCA are also more likely to end up having an RCA below 0.5 (32%) as opposed to low-distance products (4%).

Figure 7: RCA transition matrix for twin-transition products, absolute and relative distance



Note: The transition matrix looks at three possible states: RCA above 1, between 0.5 and 1, and below 0.5, corresponding to RCA, low RCA and no RCA, respectively. Each matrix refers to terciles of distance. Top panel uses absolute distance, bottom panel uses relative distance.
Source: Authors' elaboration on BACI-CEPII data.

Absolute distance does not seem to be related to gain of RCA. Products starting off with no RCA have very little chance to obtain an RCA at the end of the period, regardless of distance. Similarly, this is the case for low-RCA (0 < RCA > 0.5) products, 21% of high-distance products manage to develop an RCA starting from a low-RCA state, and that only goes down to 20% for low-distance products.

Results do not change significantly when we look at relative, rather than absolute distance in the lower panel of Figure 7, suggesting that overall distance is more relevant to explaining retention, rather than acquisition of an RCA.[11]

Therefore, both results on trade dependence and RCA show that distance is relevant only for changes in one direction, i.e. the loss of RCA, but not its gain, and the increase in trade dependence, but not its reduction. While this may be surprising at first glance, it is consistent with the fact that gaining RCA does not only depend on the relationship between a country's capabilities and a product, but also on external factors such as relative prices, global demand and transaction costs. These are also relevant, more in general, to increases in export flows, which are necessary for the reduction of trade dependence.

In contrast, both the loss of RCA and an increase in trade dependence only require a reduction in exports. Ceasing to export a product is significantly easier than starting to export it when a country does not possess a fitting capabilities structure.

The overall result emerging from Figure 7 is important from a policy perspective, for at least two reasons. First, the development of RCA and reduction of trade dependence do not depend in and of themselves only on a country's productive structure: economies are not completely bound in their specialisation possibilities by their initial production structure. While achieving competitiveness in new products is not an easy feat, this can occur irrespective of countries' distance vis-à-vis a given product.

Second, if countries wish to retain any comparative advantage they develop through selective industrial policy, they should bear in mind that if these new specialisations are not coherent with the country's industrial structure, they are likely to disappear and trade dependence will ensue.

This means that, very much in line with the structuralist literature emphasising the importance of inter-sectoral linkages and complementarities, policy efforts to develop new comparative

[11] When we look at twin-transition product classes in Figure A.3 and A.4 in the Appendix, we also find robust results. It is worth noting, here, that CRM have a higher chance of losing RCAs over time, reflecting EU countries' lack of natural resources and suggesting this to be a particularly relevant area for policy intervention.

advantages should not focus only on individual products. Rather, policies should aim at developing a coherent set of industries that can benefit from each other in terms of capability and technological complementarities.

4. Conclusions and Policy recommendations

This working paper offers novel results that might help implement European industrial policies for the twin transition. We rely on a theoretical approach grounded in the capability-based and structuralists approaches to long-term development, and borrow a methodology from the economic complexity approach to relate EU country-product distance from twin transition specific products to their trade dependency.

Our results are two-fold. First, large and diversified manufacturing countries such as Germany and Italy tend to have a productive structure that is closer to most twin-transition products; this however changes when we look at distance in relative terms, i.e. looking at the product that is closest to a country, rather than the country that is closest to a product. Some small, specialised countries – notably Sweden and Czechia – see their prospects to steer their productive structure towards twin transition products improve significantly.

Second, distance is associated with an increase of trade dependence and the likelihood of losing specialisation in twin-transition goods. In contrast, the successful development of a revealed comparative advantage in twin transition products depends on other factors than distance alone. We hence argue that such policies should not focus on individual products, but rather aim to foster broader and coherent technological and capability ecosystem; this requires a systemic approach considering the complementarities across different activities (Hirschman 1958, Lopez Gonzales et al. 2019).

This paper crucially supports this view by claiming and showing that country-product distance and trade dependence are related and that opportunities for export diversification towards twin transition products must consider both absolute and relative distance.

As EU countries are quite asymmetric in their opportunities for export diversification to 'comply' with twin transition policies, it is very likely that uncoordinated policies might have differential benefits across countries and risk exacerbating existing inequalities, in contrast with EU cohesion principles.

While reconciling the EU and the national objectives has always been a delicate matter, this seems even more challenging in the case of OSA and twin transition industrial policy support.

As in many other realms, and as put forward in the very recent Draghi Report for EU competitiveness, it becomes necessary to ensure a high(er) degree of coordination of industrial policies at the European level to prevent duplication of efforts, while at the same time avoiding concentration of industrial activities in only a few countries.

Further analyses may complement the economic complexity approach, that is, a data-driven approach inferring capabilities from actual trade data, with information on actual production structures taken, for example, from input output tables. This would allow for the better measurement of important complementarities and backward and forward linkages that may guide industrial policies for the twin transition within a systemic approach.

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Methodological Appendix

1. Methodology to identify country-product distance

To identify, within the three product ecosystems described in Section 2, those that are closest to each EU country's productive structure, we resort to bilateral trade data from BACI-CEPII (Gaullier and Zignago, 2010). For each country-product we compute Balassa indexes, that take value above one for those products in which a country has a revealed comparative advantage:

$$RCA_{ik} = \frac{x_{ik} / \sum_k x_{ik}}{\sum_i x_{ik} / \sum_i \sum_k x_{ik}} \quad (2)$$

Where x_{ik} is exports of country i in product k. Then we construct a product-by-product matrix $\Phi_{kk'}$ with conditional probability of two products being exported with RCA by the same country. This is our proximity matrix, in line with the complexity and relatedness literature discussed in the previous section (Hausmann et al. 2007):

$$\Phi_{kk'} = \frac{\sum_i y_{ik} y_{ik'}}{\max\left(\sum_i y_k , \sum_i y_{k'}\right)} \quad (3)$$

Where y_{ik} is a vector populated with one for each country exporting product k with RCA, and $y_{ik'}$ is the same for product k'. Starting from this product-by-product matrix, we can derive a country-product matrix, defining difference as one minus relatedness as computed in Boschma et al (2013):

$$dist_{ik} = 1 - Relatedness = 1 - \frac{\sum_{k'} \Phi_{kk'} * y_{ik'}}{\sum_{k'} \Phi_{kk'}} \quad (4)$$

In the equation above $y_{ik'}$ is a vector populated with one for products exported with RCA by a country. This amounts to comparing the proximity between a country-product pair to a hypothetical country exporting all products[12]. We then compute $1 - Relatedness$ and obtain a measure of country-product distance.

The tension across countries with different specialisation mentioned in Section 2 can therefore be synthesised as the difference between a product's distance from a country in absolute terms as opposed to the product's distance relative to all other products a country could produce. To capture this latter concept, we normalise distance as follows:

[12] Note that if a country is exporting all products with RCA then $y_{ik'}$ is a vector of ones and $\sum_{k'} \Phi_{kk'} * y_{ik'} = \sum_{k'} \Phi_{kk'}$ making Relatedness equal to 1 and distance to 0.

$$RelDist_{ik} = \frac{dist_{ik} - mean(dist_{ik})}{sd(dist_{ik})} \quad (5)$$

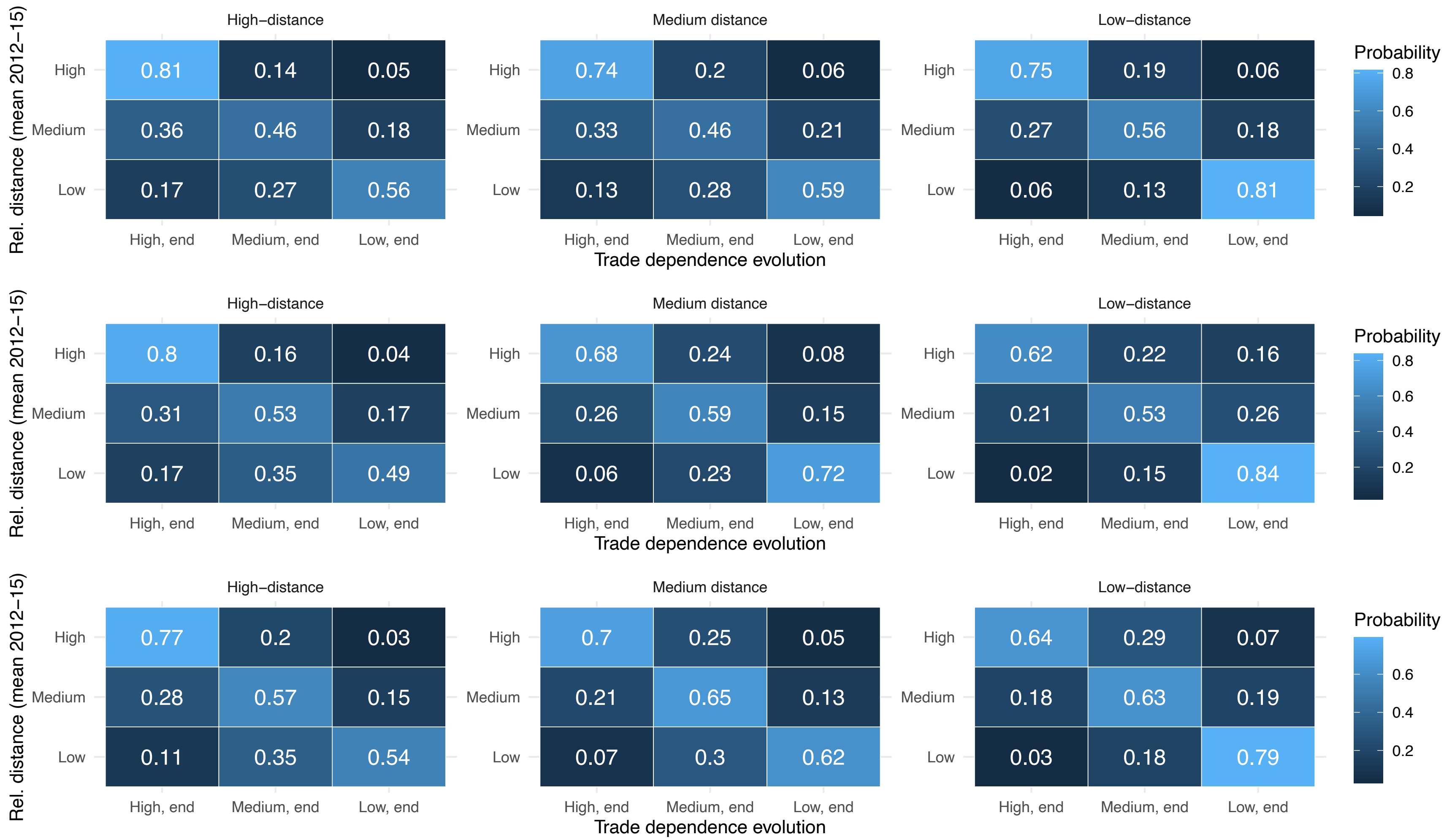
2. Transition matrices

We report below the breakdown of Figures 6 and 7 from the main text, looking at the transition matrices for each twin transition product class, which we comment in the main text.

Figure A.1 – Trade dependence transition matrix for twin-transition products, absolute distance.

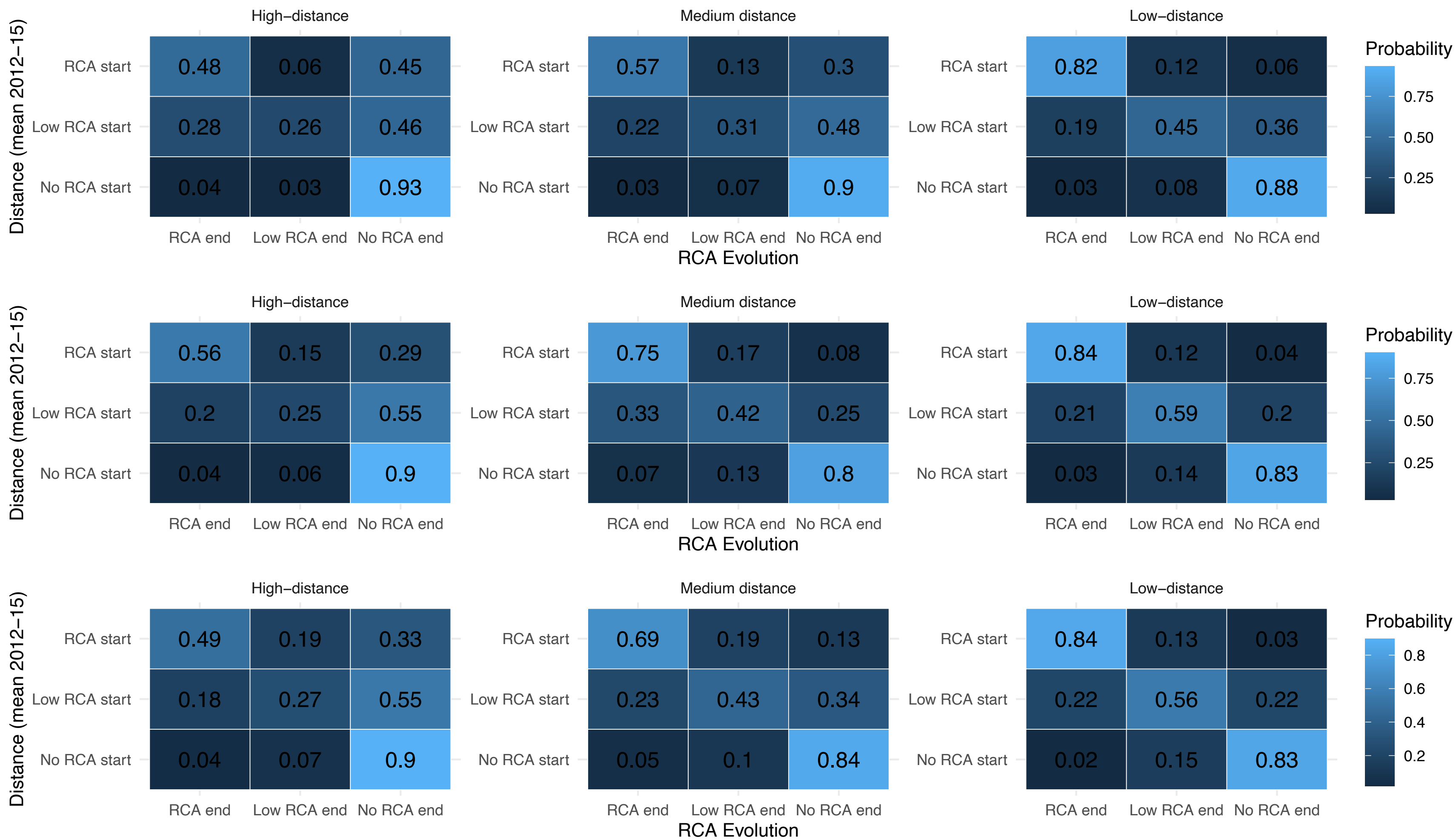
Note: The transition matrix looks at three possible states: trade dependence above 0.75 (high), between 0.5 and 0.75 (medium) and below 0.5 (low). Each matrix refers to terciles of distance. Top panel uses absolute distance, bottom panel uses relative distance.
Source: Authors' elaboration on BACI-CEPII data.

Figure A.2 – Trade dependence transition matrix for twin-transition products, relative distance.



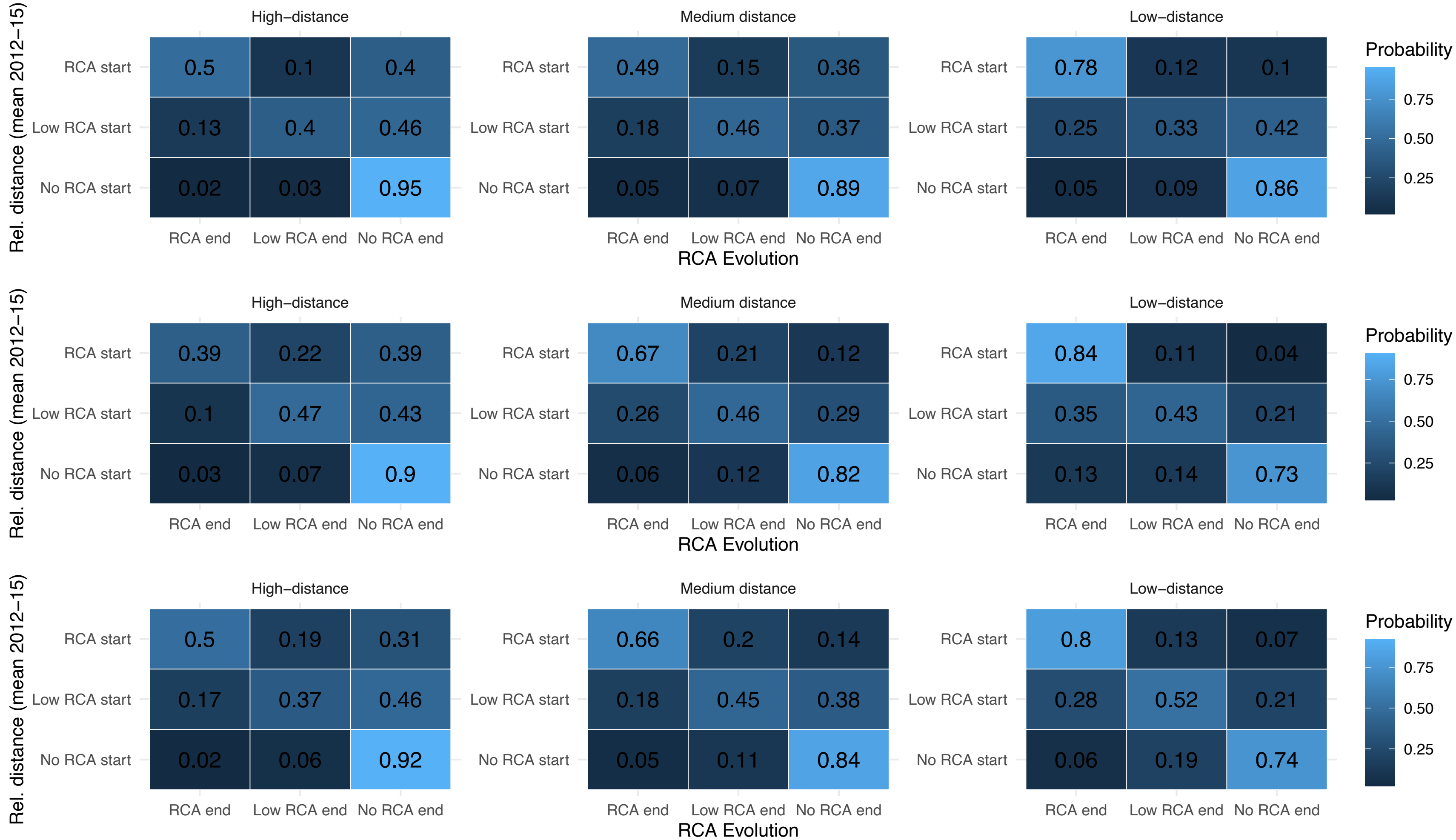
Note: The transition matrix looks at three possible states: trade dependence above 0.75 (high), between 0.5 and 0.75 (medium) and below 0.5 (low). Each matrix refers to terciles of distance. Top panel uses absolute distance, bottom panel uses relative distance.
Source: Authors' elaboration on BACI-CEPII data.

Figure A.3 – RCA transition matrix for twin-transition products, absolute distance.



Note: The transition matrix looks at three possible states: RCA above 1, between 0.5 and 1, and below 0.5, corresponding to RCA, low RCA and no RCA, respectively. Each matrix refers to terciles of distance. Top panel uses absolute distance, bottom panel uses relative distance.
Source: Authors' elaboration on BACI-CEPII data.

Figure A.4 – RCA transition matrix for twin-transition products, relative distance.



Note: The transition matrix looks at three possible states: RCA above 1, between 0.5 and 1, and below 0.5, corresponding to RCA, low RCA and no RCA, respectively. Each matrix refers to terciles of distance. Top panel uses absolute distance, bottom panel uses relative distance.
Source: Authors' elaboration on BACI-CEPII data.