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Carlos Bianchi; Fernando Isabella; Anaclara Martinis y Santiago Picasso.

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Resumen

Este trabajo analiza las trayectorias de cambio estructural de los países atrapados en la trampa del ingreso medio (MIT por sus siglas en inglés) de manera integral tanto desde el lado de la oferta como de la demanda. En primer lugar, proporciona evidencia de que existe un mecanismo de trampa regular determinado por la interacción entre las restricciones de la demanda externa y el nivel de complejidad de las economías. La restricción externa opera ya que los países MIT dependen de precios exógenos para crecer. Mientras tanto, esa restricción se relaja a medida que aumenta la complejidad de la producción. En segundo lugar, este artículo utiliza indicadores de complejidad económica y propone una identificación novedosa de las trayectorias de los países. Se construye una tipología de las variedades de MIT de acuerdo con el nivel de complejidad de las economías de los países y la relación entre su estructura productiva actual y bienes más complejos. Se muestra que, una vez alcanzados ciertos niveles, mayores aumentos en la complejidad de la oferta requieren una profundización del cambio estructural a través de una diversificación no relacionada.

Palabras clave: Trampa de ingresos medios; cambio estructural; restricción externa; economía de la complejidad

Clasificación JEL: O14; O40; L16

*Iecon-Udelar, carlos.bianchi@fcea.edu.uy
**Iecon-Udelar, fernando.isabella@fcea.edu.uy
***Iecon-Udelar, anaclara.martinis@fcea.edu.uy
****Iecon-Udelar, santiago.picasso@fcea.edu.uy

Abstract

This work analyses trajectories of structural change of countries trapped in middle-income trap (MIT) in a comprehensive manner from both the supply and the demand sides. First, it provides evidence that there is a regular trapping mechanism determined by the interaction between external demand constraints and the level of complexity of the economies. External constraint operates since MIT countries depend on exogenous prices to grow. Meanwhile, that constraint relaxes as the complexity of production increases. Second, this paper uses indicators of economic complexity and proposes a novel identification of the countries' trajectories. A typology of the varieties of MIT is built according to the level of complexity of country economies and the relatedness between their current productive structure and more complex goods. It shows that having reached certain levels, further increases in supply complexity require a deepening of structural change through unrelated diversification.

Keywords: middle-income trap; structural change; external restriction; economic complexity

JEL classification: O14; O40; L16

1. Introduction

The evolutionary and Schumpeterian literature has substantially contributed to the understanding of development as a process of variety creation in which heterogeneous trajectories are historically determined by mechanisms of adoption and adaptation of novelty through creative destruction processes (Aghion et al., 2021; Malerba and Lee, 2021). These mechanisms generate path dependence effects whose possibilities of evolving into lock-in processes or in virtuous development trajectories depend, as the historical evidence shows, on the social capabilities of the countries and the deliberate public policy efforts that have been implemented (Bell and Pavitt, 1993; Abramovitz, 1995; Cimoli and Porcile, 2009).

Based on these statements, previous research has focused on understanding the processes of diversification and specialisation of economic structures. This has allowed the identification of a general pattern that associates the diversity and sophistication of a country's activities and products with its national income level (Saviotti and Frenken, 2008; Hidalgo, 2021), but in a nonlinear way (Dosi et al., 2022; Pinheiro et al., 2022) and affected by external demand conditions (Cimoli and Porcile, 2014; Mania and Rieber, 2019).

Growth slowdowns within the middle-income thresholds for relatively long periods have come to be known as middle-income traps (MIT), which have been interpreted as a consequence of a double limitation faced by MIT countries. On the one hand, the increase in income level is associated with cumulative changes related to improvements in living standards and higher production costs that prevent the country from competing via prices based on undifferentiated products. On the other hand, MIT countries lack the required capabilities to carry out a process of structural change that may allow them to compete on the basis of diversified and innovative products (Kharas and Kohli, 2011; Vivarelli, 2016; Agénor, 2017).

In the Schumpeterian literature (Saviotti and Pyka 2013), and especially in the post-Keynesian literature and related approaches integrating these theoretical streams (Cimoli et al., 2010; Cimoli and Porcile; 2014), it has been stressed that low- and middle-income countries face severe external restrictions related to the evolution of demand for exportable goods and the price cycles of these goods (Tharnpanich and McCombie, 2013; Alonso and Ocampo, 2020; Bianchi et al., 2023). These restrictions affect economic growth and, in turn, the possibilities for structural transformation.

An analysis of economic growth problems in middle-income countries allows us to focus on a central aspect of economic development; that is, the characteristic of development as an increasingly challenging process in which economic and political aspects coevolve (Saviotti and Pyka, 2013; Bértola, 2015; Porcile and Sánchez-Ancochea, 2021). Our general hypothesis is that the pattern of slowing growth observed in a relevant number of middle-income countries is explained by the interaction between supply and demand factors, both of which are associated with the constraints of the productions structure. The processes of structural change towards more complex economies moderate the restrictive effects of external demand, but escaping the growth trap requires a break with path dependence. This means that a process of creative destruction is needed that involves a sustained transformation of production and requires productive and technological capabilities that allow new combinations of knowledge and resources to be applied by replacing the old productive structure (Bell and Pavitt, 1993; Abramovitz, 1995; Malerba and Lee, 2021).

We aim to contribute to these research streams by integrating both supply side and demand side analysis. With regard to the first, we use economic complexity indicators as a twofold measure that capture both a static perspective (productive capabilities) and a dynamic one (potential structural change) on national economies. The main complexity indicators used are the Economic Complexity Index (ECI), which ranks countries according to the diversification and complexity of their export basket, and an indicator *Rho,* which summarises the prospects for further sophistication through unrelated structural change (Hartmann et al., 2021; Pinheiro et al., 2022). On the demand side, we capture the effect of the external restriction by analysing the effect of national average export margin on economic growth (Bianchi et al., 2023).

Using econometric panel data techniques, we corroborate that there is a demand constraint operating only in those middle-income countries that can be considered to have fallen into a growth trap. However, our results show that the external constraint is moderated as the production complexity of economies increases. We also find that unrelated structural change does not have a positive direct effect on economic growth, but it indirectly acts to enable increases in productive complexity. This corroborates the positive effect of complexity on growth as well as the negative or null effect of unrelated diversification on short-run growth as long as it does not imply an increase in complexity. In other words, at certain levels of complexity, structural change effects are only observed from a long-run perspective given the nonlinear relationship between diversification and complexity that is also found. This may help to understand the reason it is so challenging and so exceptional to maintain these transformation processes over time to escape from MIT.

These results corroborate the heterogeneity prevailing within MIT countries according to the level of economic complexity. Using the method developed by Hartmann et al. (2021) and Pinheiro et al. (2022), we empirically analyse the trajectories of structural change in MIT countries by studying the joint performance of the complexity of the current national productive structure (ECI) and the national prospects for unrelated structural change (*Rho*). Based on these indicators, we build a typology of varieties of MIT according to the evolution of the national production structures. Applying non-hierarchical cluster analysis, we obtain three clusters of MIT varieties, namely: 'Trapped in the bottom' (MIT-1); 'Erratic trajectories of median complexity' (MIT-2); and 'Climbing the ladder of structural change' (MIT-3). MIT-1 groups MIT countries with low-complexity product structures, which is usually associated with dependence on natural resources. It includes mostly Latin American and North African countries. Countries in MIT-2 show a relatively complex product structure. Instead of by the level of product complexity, these countries are characterised by erratic paths that hinder a sustainable trajectory of structural change. This group is larger, and includes cases mostly from Latin America and some countries from North Africa and the European periphery. Finally, countries in MIT-3 seem to be breaking their path dependence on traditional production and climbing the ladder of structural change. These countries, which are mostly from Eastern Europe and Asia, have sustained a path of increasing complexity by building productive capabilities in manufacturing.

Therefore, we confirm both the presence of a general pattern determining MIT situations and a strong heterogeneity in the trajectories followed by middle-income countries according to the development of the national productive capabilities. Analysing these trajectories, we can observe that the trapping situation is associated with erratic trajectories around middle-income thresholds and is based on relatively poorly-diversified economies.

2. Literature review: path dependent trajectories and capability building processes

2.1 The MIT situation: two sides of the same problem

Various methodological approaches have been used in empirical studies to analyse MIT situations, most of which consider supply side growth and institutional determinants (e.g., Eichengreen et al., 2013; Gill and Kharas, 2007, 2015; Glawe and Wagner, 2016, Agénor, 2017; Razafimandimby and Rougier, 2019). In several cases, this literature has focused on the analysis of total factor productivity as a driver of growth, discussing problems related to the limited accumulation of physical and human capital and institutional problems that hinder the proper allocation of resources and skills in middle-income economies.

This perspective analyses the MIT using the tools of classical and neoclassical growth theories, regardless of the historical and geographical context (Lee, 2013; Paus, 2014). However, the concept of MIT does not reflect a homogenous situation affecting many countries. Rather, the national trajectories and the trapping situations are highly heterogeneous according to specific and differentiated historical experiences (Jankowska et al., 2012; Alarco and Castillo, 2018; Cimini et al., 2021). It is thus necessary to define and analyse the MIT as a general pattern that presents contextual and historical specificities.

The widely observed, general pattern refers to slowdowns in growth processes in a significant number of middle-income countries. This is associated with the structural characteristics of these countries, which are usually those typical of developing countries (Cimoli et al., 2010; Radosevic and Yoruk, 2018; Stockhammer, 2022). These are relatively undiversified economies concentrated on the production of low-tech goods and often dependent on commodities based on natural resources. This implies that these countries are essentially price takers in global trade, supplying no differentiated products. Hence, the external specialisation of MIT countries mainly lacks both Schumpeterian and Keynesian efficiencies (Cimoli et al., 2010; Dosi et al., 2022). This means that, in general, low-tech products and natural resource commodities do not use new knowledge to produce innovation and create technological externalities nor do they have access to a growing demand that stimulates productivity. Thus, these countries usually remain dependent on external prices, and their trade insertion shows cyclical shocks that result in steep growth cycles (Ocampo, 2017; Bianchi et al., 2023).

Building on previous findings, we aim to analyse differential situations between MIT and non-MIT countries. From previous works, we find that the export margin as an indicator of external restriction significantly affects economic growth in MIT countries but not in non-trapped countries (Bianchi et al., 2023). We interpret this to mean that trapped countries are price takers in the international market and depend on external conditions to grow (e.g., prices booms). Meanwhile, advanced and/or fast-growing countries do not depend on external conditions because they have developed sophisticated capabilities that allow them to grow based on quality upgrading and productivity increases.

In this paper, we aim to test this interpretation by analysing the demand–supply interactive effect for MIT countries. Hence, proposition 1 states that *the MIT situation is explained by the interactive effects of demand (external constraint) and supply (productive complexity) mechanisms.*

2.2 Varieties of MIT

The MIT situation may also be analysed as the result of a lock-in process (Lectard, 2023) or hysteresis trajectory (Cimoli and Porcile, 2009) associated with the productive structure and the external demand. These trajectories have been deeply studied from different heterodox perspectives on economic development that have converged to explain the trapping situations as the result of an endogenous development process in which micro- and macro-economic factors jointly interact with the institutional environment. A virtuous coevolution of these factors has allowed the required capabilities to pursue structural change processes to be built in both advanced countries and countries that have traversed middle-income thresholds. According to this view, the trapping situation results from a long-standing lack of capabilities and systemic blocks to break path-dependence inertia (Vivarelli, 2016; Cimini et al., 2021; Hartmann et al., 2021; Malerba and Lee, 2021).

From a Schumpeterian perspective, these countries have not built the necessary capabilities to conduct a creative destruction process to gain efficiencies by both intra- and inter-sectoral changes (Saviotti and Frenken, 2008; Saviotti and Pyka, 2013). A typical way to study national capabilities is through an analysis of the current production structure and export basket of countries. The productive structure and trade composition reflect the national capabilities and determine the form of international insertion and the possibility of structural transformation towards more complex activities.

Processes of diversification and structural change in their initial stages are often beneficial in generating the necessary capabilities and in moderating dependence on external prices. However, several studies have pointed out that there is a nonlinear relationship between economic diversification and performance (Dosi et al., 2022; Pinheiro et al., 2022). By using indicators from the literature on product space (Hausmann and Klinger, 2007; Hidalgo et al., 2007), previous works have identified differentiated paths between countries and regions since the second half of the 20^{th} century (Jankowska et al., 2012). The authors of these works have highlighted that highly-industrialised Asian countries have followed structural change processes that started from high diversification and low sophistication and were continued by an upgrading process of concentration in sophisticated exports while less sophisticated products were abandoned. In the same vein, Pinheiro et al. (2022) offered an empirical approximation of the increasing challenges affecting the development of middle-income countries by analysing the timing of related and unrelated diversification along the countries' development paths. They found an S-shaped relationship between the current complexity of the national economies (ECI) and a measure (*Rho*) that captures the relatedness to more complex goods of the current production structure. These authors analysed some national cases and asserted that a key explanation for the MIT situation is the inability of countries to move from a path based on generalised diversification, which is usually based on related diversification, towards a path based on diversification of more sophisticated products and activities, which requires processes of structural change based on unrelated diversification (Hartmann et al., 2021). One of the main challenges for unrelated diversification is the inherent risk and the unexpectedly short time effects on outcomes. A process of unrelated diversification may negatively affect short-run economic growth but generate better prospects for increasing sophistication and higher growth in the medium and long run (Saviotti and Frenken, 2008; Hartmann et al., 2021).

The possibilities for structural change and diversification of economies depend on technological and productive national capabilities. Moreover, the congruence between the current productive and technological capabilities (Bell and Pavitt, 1993; Abramovitz, 1995) and those required by the new activities to be incorporated into the productive structure will determine the transition possibilities for firms operating in those countries and of the national economy as a whole (Breschi et al., 2003). The notion of relatedness is strongly associated with these ideas: two products, industries or knowledge areas are related when they involve the use of similar knowledge or inputs (Hidalgo et al., 2018). In this paper, this refers to the adequacy of the capabilities of a country or region, which are revealed through the products competitively produced by them, to the production of new, not yet produced, products. Hence, we follow Pinheiro et al. (2022) and Hartmann et al. (2021) by using an indicator that captures relative relatedness (*Rho*), which not only considers the general proximity of already-produced products to other products but also considers the complexity of those other products. Sustained increases in this 'relative relatedness' indicator are signals of an important change in the composition of the productive structure of a country, which we interpret in this paper to be a consequence of unrelated structural change.

Moving towards sectors or activities that are more distant from the current productive and technological capabilities of firms and countries entails higher costs and risks. Cases of direct adaptation of technologies are exceptional and always require capacity building. In a nonlinear and cumulative process at very low levels of complexity, diversification per se has initially shown positive effects on short-run growth. However, this process requires later selection efforts to specialise in sophisticated products. As progress is made in more complex products, there is a decrease in the costs of moving towards products less related to national capabilities (Pinheiro et al., 2022). As a result, as economies move to more complex activities, they achieve higher returns from incorporating previously unrelated sectors or activities (Saviotti and Frenken, 2008).

On the basis of this reasoning, proposition 2 states that *within MIT countries, heterogeneous potential growth paths are observed according to production complexity and unrelated structural change options.*

One of the great challenges in the economic development process is the selection of new possible paths (Hirschman, 1958). Therefore, production structure and export content also matter from a political economy point of view. In particular, in MIT countries dependent on commodities based on natural resources, price booms reinforce the inertial tendency (Grancay et al., 2015) and generate strong political coalitions against encouraging processes of structural change (Sen and Tyce, 2019; Bresser et al., 2020). Processes of structural change in these cases imply going against market price signals (Amsden, 1991). It is then necessary to develop capabilities that allow for the initiation of new trajectories and, in particular, to select the paths to follow in order to deviate from the path dependent trajectory (Lee, 2019), even if the current trajectory contributes to growth in the short term.

In all cases, countries that have overcome the MIT or that are crossing the middle-income thresholds without signs of entrapment have implemented selective productive diversification policies oriented to certain sectors and for certain timing and product cycles. In this way, these countries, which are mainly Asian, have built national agreements between private agents and the government (Malerba and Lee, 2021). In contrast, other countries that can be identified as being within the middle-income thresholds for relatively long periods of time and that have experienced growth slowdowns seem to build erratic detours that prevent the necessary capacities from being built (Fajnzylber, 1995; Albuquerque, 2019; Intarakumnerd, 2019).

3. Methods and data

There are several definitions of MIT and different methods and techniques associated with them (Glawe and Wagner, 2016; Agénor, 2017). We argue that relative measures of MIT offer a better approximation to the concept of trapping since these measures capture the relative situation in each historical period (Bianchi et al., 2023). Therefore, using the Catching Up Index (CUI) elaborated by Woo et al. (2012), we consider as middle-income countries those countries whose GDPpc is between 10% and 55% of the United States' GDPpc in the corresponding year. In turn, we consider MIT countries as those that have remained within middle-income thresholds for at least 40 years (Table 1).

Table 1. Middle-income countries according to number of years within 10%<CUI<55% (1971–2017)

Country	Years in: 10%<CUI<55%	Country	Years in: 10%<CUI<55%
Algeria	47	Mexico	47
Argentina	47	Panama	47
Brazil	47	Peru	42
Chile	47	Poland	47
Colombia	47	Portugal	47
Costa Rica	47	Romania	47
Dominican Rep.	47	South Africa	47
Ecuador	47	Thailand	42
Guatemala	45	Tunisia	47
Greece	44	Turkey	47
Hungary	47	Uruguay	47
Malaysia	47	Venezuela	47

Source: Authors based on PWT 9.1.

Once we had identified the MIT countries, we followed a two-step empirical approach. First, we ran econometric panel models to estimate the interactive demand–supply determinants of the MIT situations. Second, we used cluster analysis to inquire about the varieties of MIT. In econometric estimations, we used a dataset containing only middle- and high-income countries.

Thus, it included both MIT countries (Table 1) and non-MIT countries. This last group includes advanced countries and fast-growing middle-income countries.

3.1 On the MIT determinants

We used econometric panel techniques to estimate the determinant effect on MIT of the external restriction, the productive structure and their interactive effects. We also tested whether unrelated structural change has direct effects on growth.

To capture the demand-side effects on MIT, we used the average export margin, which is a proxy for price competitiveness. It is built using price and cost information from the Penn World Table (PWT) 9.1 and measures the average export margin of non-differentiated products of a country *i* in relation to the margin of the United States (Bianchi et al., 2023).

We addressed the supply side through indicators from the new generation of economic complexity measures. The Economic Complexity Index (ECI) is a measure of the structural complexity and production capacities of countries. It ranks countries according to the diversification and sophistication of their export basket of goods. This results from considering both the diversity of goods produced by the country and the ubiquity of those goods (i.e., the number of other countries that also produce them; Hidalgo, 2021). The Product Complexity Index (PCI) is a measure of the same dimensions of ECI but applicable to products; it considers the ubiquity of the product and the average diversity of the countries producing that specific good (Hausmann and Hidalgo, 2014; Hidalgo, 2021; see Appendix 1). To measure unrelated structural change, we used the *Rho* indicator (Hartmann et al., 2021; Pinheiro et al., 2022). It is a measure of the prospects of the economy to engage in an unrelated diversification process, that is, the possibilities to start producing and exporting new and more sophisticated products, and sustained increases in the indicator confirm the verification of such a structural change. *Rho* expresses the Pearson´s correlation coefficient between density to and complexity of (PCI) any products not yet present in a country's productive structure. A high value of this indicator means that the country is 'close' (its productive capabilities are more easily adaptable) to producing more complex products, and a sustained increase in that indicator signals that the country is moving through the product space (see Appendix 1). This means that this country is changing the composition of its exports by incorporating initially distant, more complex products through unrelated diversification.

In addition, we considered several control variables that capture relevant dimensions considered in previous works on MIT determinants (Eichengreen et al., 2013; Bianchi et al., 2023; see Table 2).

Table 2. Variables for econometric estimations

Variable	Definition	Source
	Dependent variables	
ΔGDPpc_{it}	Growth of GDP per capita (supply side), country *i,* year *t* ($\Delta GDPpc_{it}/GDPpc_{it}$).	Authors based on PWT 9.1
	Explicative variables	

MIT_{it}	Dummy variable, takes value 1 if the country falls in MIT definition, 0 otherwise. A country is considered trapped in MIT if it was at least 40 20 years within the thresholds $CUI_{it} \in [10\%; 55\%]$	Authors based on PWT 9.1
$margin_{it}$	Export margin, country *i*, year *t*: $\frac{\frac{nominal\ exchange\ rate\ i,t\ *\ Export\ price\ index\ i,t}{Consume\ price\ index\ i,t}}{\frac{nominal\ exchange\ rate\ US,t\ *\ Export\ price\ index\ US,t}{Consume\ price\ index\ US,t}}$	Bianchi et al. (2023), based on PWT 9.1
ECI_{it}	Economic complexity index: ranking of countries based on how diversified and complex their export basket is in time t.	Atlas of Economic Complexity
Rho_{it}	Corr $_{it}$ (density$_{ipt}$*PCI$_{pt}$), t= year; i=country; p=product; PCI = product complexity index	Authors, based on Atlas of Economic Complexity
	Control variables	
GDPpc_{i1}	Real GDP per capita (supply side) of country *i*, year 1 (initial year of the period covered). Thousands of dollars.	PWT 9.1
$Investment_{it}$	Investment share on GDP, country *i* in the year *t*	PWT 9.1
$Education_{it}$	Average years of education, population country *i*, year *t*.	World Bank
$Crisis_{it}$	Economic or financial crisis country *i*, year *t*.	Authors based on Global crisis data
Population_{it}	Million inhabitants' country *i*, year *t*	PWT 9.1

We ran the regression model of equation (1) using the generalised method of moments (GMM) and the fixed-effects specification. This allowed us to correct potential biases due to the temporal dependence of the dependent variable.

$$\Delta GDP_{it} = \beta_{\Delta GDP-1}.\Delta GDP_{it-1} + \beta_{\Delta GDP-2}.\Delta GDP_{it-2} + \beta_1.margin_{i,t-1}.(noMIT_{it-1}) + \beta_2.margin_{i,t-1}.\text{MIT}_{it-1} + \beta_3 ECI_{i,t-1} + \beta_4 ECI_{i,t-1} * margin_{i,t-1} * MIT_i + \beta_5 ECI_{i,t-1} * margin_{i,t-1} * (noMIT_i) + \beta_6.Rho_{i,t-1} + \vec{\beta}.\vec{X}_{i\,t} + \tau_i + \varepsilon_{it} \quad (1)$$

In a previous work (Bianchi et al., 2023), we showed that $\beta_2 > 0\ and\ \beta_1 = 0$ signals the specific situation of MIT countries that, differently from non-trapped countries, depend on external conditions to grow. In this research, we used the interactive term $ECI_{i,t-1} * margin_{i,t-1} * MIT_i$ in (1) to capture the differential interactive effect of supply (*ECI*) and demand (*margin*) sides in MIT and non-MIT countries. In this way, the effect of an improvement in the supply side (increase in complexity) is:

$$\frac{\partial \Delta GDP_{it}}{\partial eci} = \beta_3 + \beta_4 margin_{i,t-1}.MIT_i + \beta_5.margin_{i,t-1}.(noMIT_i) \quad (2)$$

Based on previous authors (Hartmann et al., 2021; Hidalgo, 2021), it is expected that ECI directly and positively affects growth ($\beta_3 > 0$), but if our proposition 1 holds, the interaction with margin should only affect MIT countries, which should be reflected in $\beta_5 = 0$. If this is corroborated, the effect on MIT countries would be:

$$\frac{\partial \Delta_{GDP_{it}}}{\partial eci} = \beta_3 + \beta_4 margin_{i,t-1} \quad (3)$$

where β_4 measures the effect of the interaction between *ECI* and *margin* given that the country is MIT. We expect β_4 to be negative, expressing the interactions between demand- and supply-side factors, according to which a more sophisticated productive structure relaxes the dependence of MIT countries on external conditions reflected by the export margin. Hence, economic complexity is associated with productive capabilities that allow the country to sustain growth through endogenous factors, such as productivity growth and product differentiation, even under negative external demand conditions. Additionally, β_6 represents the direct effect of unrelated structural change (*Rho*) on growth. Following Hartmann et al. (2021), we expect it will not be positive, reflecting the uncertain effects of unrelated diversification on short-run growth.

These measures allow us to both identify a general pattern and consider specific heterogeneities. Since economic development and structural change are specific historical and geographical processes, we expect different impacts from supply–demand interactions on growth, even within MIT countries. Therefore, the next step aims to capture the varieties of MIT country trajectories.

3.2 Tracking national trajectories and MIT varieties

We used export data to identify the different trajectories followed by MIT countries. We worked with data exports for all middle- and high-income countries (58 countries) for the period 1970–2017 using the Standard International Trade Classification Revision 2 (SITC 2) at four digits of disaggregation, which was obtained from the Atlas Complexity Database (Hausmann et al., 2014). The data was averaged in trienniums to avoid the effects of possible punctual data errors and economic anomalies. The ECI (for each country/year) and PCI (for each product/year) were taken from the same source.

For each triennium, the product space was calculated as the matrix containing the proximities between any possible pair of products. Proximity is a relation between two products that expresses the (minimum) conditional probability that given the presence of one product in a certain country's productive structure (produced with revealed comparative advantages), the other will also be present (Hausmann and Klinger, 2007). This is interpreted as a measure of the similarity in the capabilities needed to produce this product and, thus, as the inverse of the degree of difficulty to start producing the other product given that the other is already being produced (see Appendix 1).

The product space is a basic representation of the technological relations in the world's productive structure. The literature on this topic has shown that products are not randomly located within the product space but tend to cluster according to its sophistication level, defining a dense core where highly sophisticated products show high proximity to each other and a sparse periphery where less sophisticated products are located and show low proximity to most other products (Hausmann and Klinger, 2007; Hidalgo et al., 2007).

Following Hartmann et al. (2021) and Pinheiro et al. (2022), we used the indicator *Rho* to measure unrelated structural change. This indicator can be interpreted in two different but strongly connected ways. On the one hand, given the clustering tendency of goods in the product space, it informs about the current position of a national economy within it. On the other hand, according to density measures, it informs about the prospects for increasing the sophistication of national economies by incorporating more complex products. In this sense, we say that it is an approximation of the notion of productive and technological capabilities of a society (Bell and Pavitt, 1993; Abramovitz, 1995). In addition, a sustained increase in this indicator signals a relevant change in the position of a country in the product space, moving to its sophisticated dense core. This is why it can be interpreted as a measure of effective unrelated structural change.

The relation between economic complexity (ECI) and *Rho* for different countries or regions can be graphed on a pair of axes where world-wide historical data depicts an 'S' curve (Hartmann et al., 2021). This yields a descriptive representation of both current productive structure sophistication levels and future prospects to increase productive structure sophistication at the national level. Hence, it can be interpreted as a route map which informs about the historical trajectories of countries and the possibilities of unrelated structural change towards a more sophisticated productive structure.

3.3 Limitations of the method

The method used in this paper has several strengths but also some limitations. Among the strengths, and perhaps the most important, is the possibility to work with a variety of data sources that allow us to combine aggregate economic measures at the national level with information at the level of goods. Analysis at the goods level allows a better approximation of the processes of structural change than would approaches at the sectoral level (Saviotti and Frenken, 2008; Dosi et al., 2022). Moreover, the use of information on exported goods allows for an empirical approximation to the concept of technological and productive capabilities.

Product space indicators have been developed since the beginning of the 21st century, and their applications in development economics have multiplied; moreover, the way they are calculated and interpreted has improved. This has made it possible to overcome some problems in the initial indicators of economic sophistication, such as tautology problems in GDP-based measures of economic sophistication (Lee, 2020).

However, the indicators of economic complexity used in this paper still have some limitations that need to be highlighted. First, they are partial indicators of productive structure and structural change, and they should not be read as indicators of economic development in general. Second, these indicators approximate the production structure based on the structure of the basket of exports of goods. They do not consider the domestic market or the export of services. This generates an inherent bias as it is an indicator of manufacturing activities that is better suited to open economies. Moreover, these indicators do not capture potential unequal structural transformations in which advanced export-oriented manufacturing sectors cohabit with traditional sectors oriented to the internal market.

Moreover, the use of product space indicators, later known as complexity indicators, has been subject to various criticisms related to the strategic value of the information they provide. As Lee (2020) pointed out, these indicators provide insights about position and distance, but without historical analysis, they would contribute little to analysing where or how countries can break out of trajectories of entrapment. As we are aware of such limitations, we used these indicators as measures of position and distance, proposing interpretations of trajectories that are always supported by specialised literature on specific development processes.

4 Results

4.1 MIT determinants

The results of the econometric estimations are in line with the argument supporting proposition 1. They show an interactive effect between supply and demand factors as a determinant of the MIT situation (Table 3).

First, the direct effect of the external constraint—measured by the average export margin—on growth in MIT countries is corroborated (Bianchi et al., 2023). In line with the literature on economic complexity (Hidalgo, 2021), the positive effect of production structure complexity (ECI) on economic growth is also corroborated.

As a novel result of this paper, a negative effect of the interaction between ECI and margin is observed for MIT countries in the two specifications that were run, always showing higher coefficient and more statistical significance that in non-MIT countries. That is, even when MIT countries depend on external demand conditions to grow, the level of productive sophistication moderates the external restriction. In line with previous results, this effect is not clearly found for non-MIT countries, signalling a weaker dependence of these countries on external conditions. Therefore, there are not only differences between MIT and non-MIT countries but also between MIT countries according to the level of complexity of the economy.

Table 3. Fixed and dynamic GMM models with fixed effects by country. Dependent variable: ΔGDPpc_{it}.

Variables	Fixed Effects			GMM		
$\text{margin}_{t-1} * noMIT$	0.011	0.010	0.008	0.011	0.010	0.007
	(1.257)	(1.530)	(1.084)	(1.109)	(1.202)	(0.792)
$\text{margin}_{t-1} * MIT$	0.015**	0.017**	0.016**	0.027**	0.032**	0.030**
	(2.104)	(2.267)	(2.123)	(2.153)	(2.262)	(2.134)
ECI_{t-1}	0.008	0.025**	0.037***	0.020**	0.048***	0.070***
	(1.215)	(2.015)	(2.734)	(2.016)	(3.495)	(5.197)
$\text{ECI} * \text{margin} * \text{MIT}_t$		-0.011*	-0.013**		-0.023***	-0.025***
		(-1.899)	(-2.060)		(-2.953)	(-3.238)
$ECI * margin * (noMIT)_t$		-0.012	-0.012		-0.012*	-0.013**
		(-1.420)	(-1.389)		(-1.842)	(-2.209)
Rho_{t-1}			-0.028**			-0.052***
			(-2.151)			(-2.970)
Crisis_t	-0.010***	-0.010***	-0.011***	-0.011***	-0.011***	-0.011***
	(-4.444)	(-5.114)	(-5.000)	(-4.755)	(-4.711)	(-4.992)
$Investment_{it-1}$	0.053	0.044	0.042	-0.007	-0.012	-0.005
	(1.264)	(1.238)	(1.145)	(-0.108)	(-0.182)	(-0.089)
$Education_{it-1}$	-0.001	-0.002	-0.001	-0.003	-0.007*	-0.004
	(-0.600)	(-1.112)	(-0.530)	(-0.833)	(-1.780)	(-0.920)
${Education_{it-1}}^2$	0.000	0.000	0.000	0.000	0.000	0.000
	(0.245)	(0.470)	(0.348)	(0.084)	(0.850)	(0.621)
Population_{it-1}	0.000***	0.000***	0.000***	0.000	0.000	0.000
	(4.138)	(3.602)	(3.578)	(1.185)	(1.619)	(1.095)
$\Delta\text{GDPpc}_{it-1}$				0.140*	0.129*	0.120*
				(1.942)	(1.815)	(1.741)
$\Delta\text{GDPpc}_{it-2}$				-0.137***	-0.132***	-0.128***
				(-3.125)	(-3.008)	(-2.804)
Constant	0.004	0.008	-0.014			
	(0.200)	(0.512)	(-0.814)			
Observations	855	855	855	793	793	793
R-squared	0.125	0.133	0.143			
Number of countries	58	58	58	58	58	58
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	No	No	No	No	No
Periods	15	15	15	14	14	14

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Interestingly, but beyond our propositions, it can be observed that *Rho* is negatively associated with growth. We interpret this result in the sense that structural change itself does not directly promote growth, but it is fundamental to allowing a sustained complexity increase. This suggests that the channel through which structural change contributes to economic growth is productive complexity. After running additional estimations, we conclude that unrelated structural change (*Rho*) matters for economic development, but rather than a direct and short-run effect on economic growth, it acts by enabling sustained increases in economic complexity through a nonlinear relationship whose effects on growth would happen in the long run (see Appendix 3).

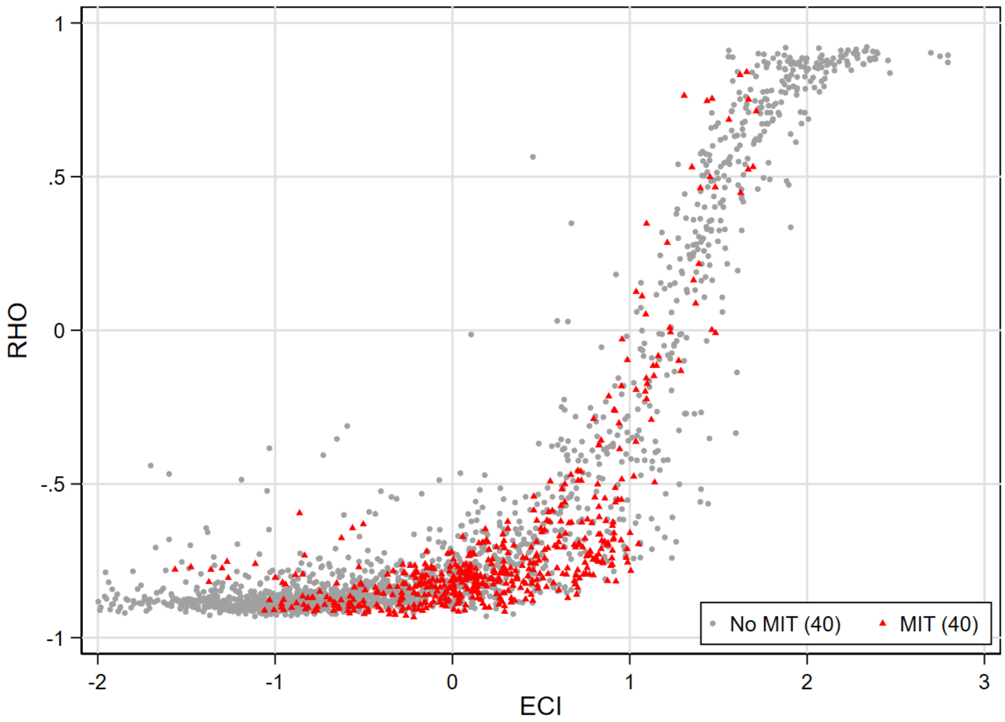
4.2 A typology of MIT varieties

In this paper, MIT is understood as a consequence of the interaction between a non-sophisticated productive structure and an external dependence for growth on special and infrequent demand conditions (e.g., price-booms). To escape this lock-in situation, a process of diversification towards sophistication is needed to reach products and activities that enjoy more dynamic and stable demand characteristics.

The S curve (Hartmann et al., 2021; Pinheiro et al., 2022) captures the trajectories of countries towards more complex productive structures along the abscissa axis (as ECI increases, the complexity of country structure production increases), while the ordinate axis shows the evolution of the *Rho* indicator (as it increases, the prospects for structural change towards more complex products increases).

Figure 1 differentiates between the trajectories of MIT and non- MIT countries along the S curve. The latter can be high-income, low-income or high-dynamic countries that have recently crossed an income threshold. Each spot reflects a country/triennial so that historical trajectories of individual countries can be tracked.

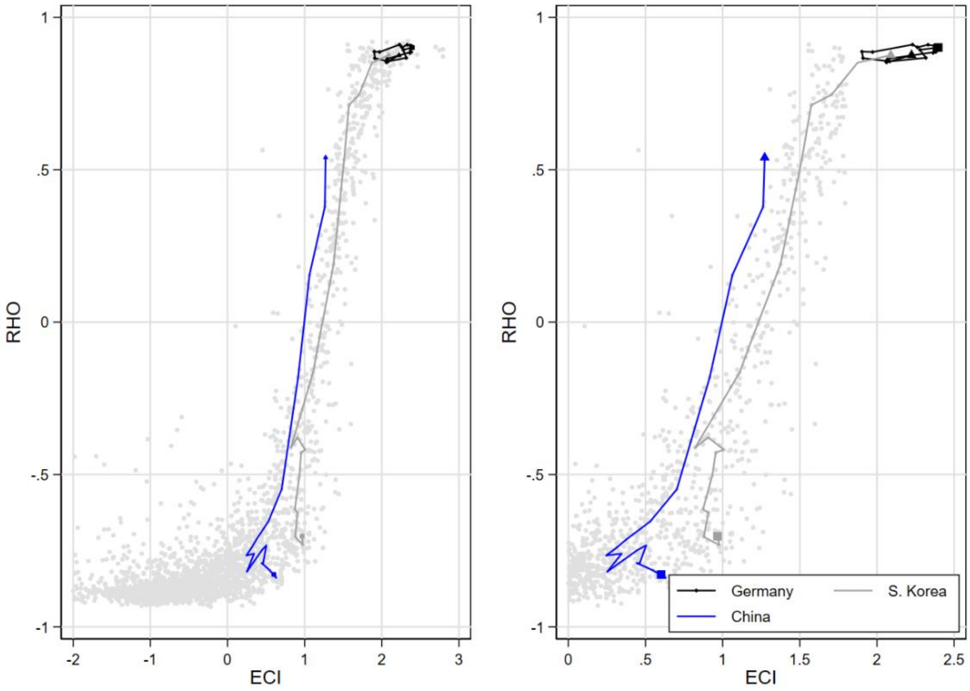
Figure 1. S curve of structural change according to MIT and non-MIT countries



MIT countries are concentrated in the lower part of the S, showing mostly low values of structural change (*Rho*) and low or median values of complexity (ECI). The red spots in the upper part of the S correspond to recent data on certain countries after their structural transitions (mostly Asian and Eastern European countries) that seem to be overcoming MIT, as will be shown later.

This offers a visual example of the structural change rule that MIT countries face: having reached certain intermediate levels of complexity, they cannot continue increasing complexity (moving to the right) without a break in the trajectory towards unrelated diversification (Pinheiro et al., 2022); that is, without a jump in *Rho* levels. Moving along the product space in the direction of its dynamic core would allow them to connect with more complex products. Conversely, moving horizontally (related diversification), which is even useful for the initial stages of economic growth, is a dead path for middle-income countries. From this perspective, MIT can be interpreted as a lock-in situation due to the impossibility to 'go up on the structural change ladder'. Visually, it is represented by the steep (almost vertical) section of the S, which implies a 'big jump' along the product space to get to its dense core. Figure 2 shows a good example of this process in the historical trajectories of Korea and China, which experienced—or are still experiencing—catching-up processes in the 20th and 21st centuries, respectively. In addition, the S curve of Germany, which caught up to England in the 19th century, always remained in the upper right-hand corner of the chart in the period considered.

Figure 2. S curve of catching-up countries



Note: The square signals the first triennial dot for each country (1964–1966), while the triangle signals the last triennial (2015–2017).

We build a typology of MIT varieties (Table 4) to analyse the heterogeneous, sometimes erratic, development path followed by MIT countries. Applying non-hierarchical cluster analysis (k_{means}) as a function of ECI and *Rho*, we obtained three differentiated groups.

Table 4. MIT countries: Production complexity and relative relatedness

Country	Unrelated Structural Change (*Rho*)			Complexity (ECI)			ΔGDPpc
	Min	Max	Mean	Min	Max	Mean	Mean
MIT-1 – Trapped in the bottom							
Algeria	-0.91	-0.63	-0.78	-1.56	0.06	-0.76	0.02
Dominican, Rep.	-0.89	-0.77	-0.83	-0.95	0.04	-0.3	0.03
Ecuador	-0.92	-0.85	-0.89	-1.06	-0.5	-0.85	0.02
Guatemala	-0.86	-0.71	-0.81	-0.43	0.53	0	0.02
Peru	-0.92	-0.88	-0.9	-0.76	-0.06	-0.43	0.03
Venezuela	-0.83	-0.59	-0.77	-1.37	0.01	-0.55	0.01
MIT-2 – Median complexity							
Argentina	-0.92	-0.72	-0.83	-0.22	0.35	0.1	0.04
Brazil	-0.92	-0.62	-0.78	-0.58	0.76	0.3	0.03
Chile	-0.9	-0.79	-0.85	-0.29	0.21	-0.13	0.03
Colombia	-0.9	-0.75	-0.82	-0.12	0.49	0.1	0.02
Costa Rica	-0.86	-0.68	-0.77	-0.39	0.95	0.17	0.02
Greece	-0.91	-0.74	-0.82	0.01	0.47	0.24	0.03
Panama	-0.91	-0.26	-0.7	-0.21	0.92	0.41	0.04
South Africa	-0.93	-0.69	-0.83	-0.36	0.3	0.03	0.01
Tunisia	-0.91	-0.59	-0.78	-0.29	0.46	0.06	0.04
Turkey	-0.9	-0.5	-0.77	-0.67	0.63	0.12	0.03
Uruguay	-0.87	-0.73	-0.81	0.05	0.64	0.29	0.02
MIT – 3 Climbing the ladder of structural change							
Hungary	-0.82	0.53	-0.36	0.79	1.7	1.08	0.03
Malaysia	-0.91	0.13	-0.56	-0.64	1.09	0.31	0.04
Mexico	-0.92	0.16	-0.54	0.29	1.36	0.82	0.02
Poland	-0.8	-0.12	-0.53	0.61	1.15	0.92	0.04
Portugal	-0.78	-0.46	-0.64	0.43	1.05	0.75	0.03
Romania	-0.85	-0.12	-0.57	0.5	1.13	0.79	0.05
Thailand	-0.89	0.29	-0.61	-0.79	1.21	0.2	0.05

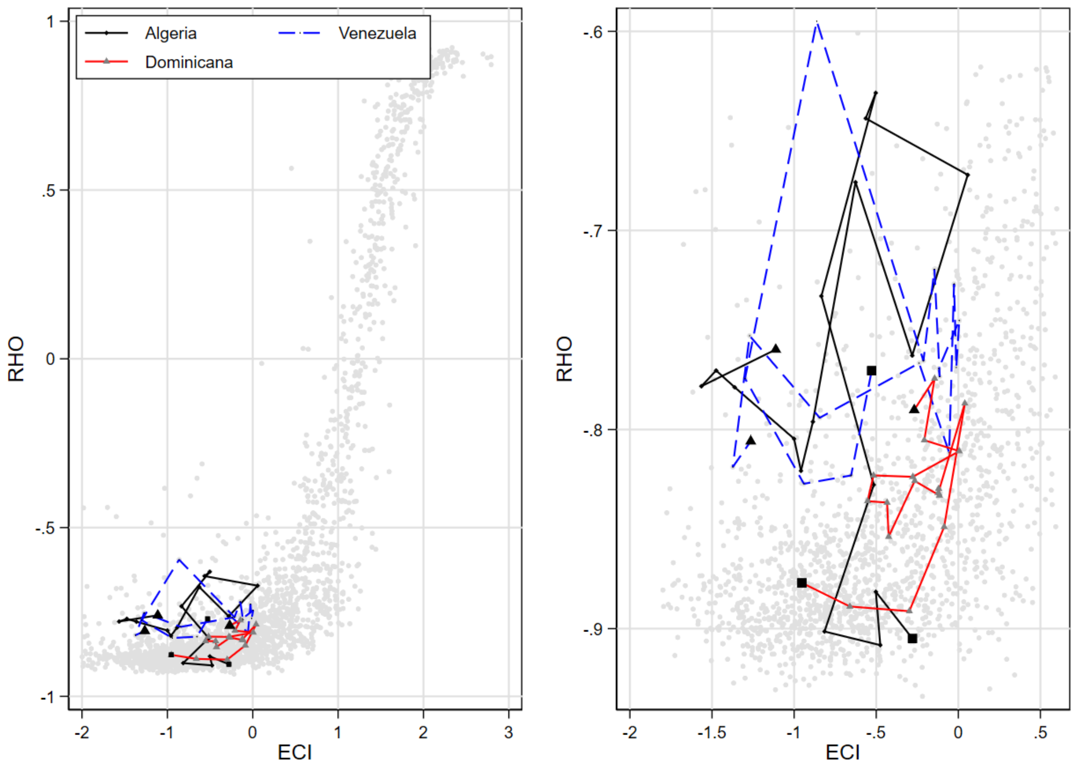
First, in the group MIT-1 'trapped in the bottom', we can identify those MIT countries that mostly have negative ECI means. This variety brings together the cases that neither advance in the diversification process towards complexity nor in the building of productive capabilities that allow prospects for structural changes. Second, MIT-2 gathers a group of MIT countries that have a relatively complex structure (mostly positive ECI means) but were unable to break the trajectory towards more complex prospects of structural change (*Rho* lower or equal than -0.5). Finally, MIT-3 contains those countries that seem to be 'climbing the ladder of structural change' (positive ECI means and *Rho* higher than -0.5), signalling a variety of MIT composed of countries that were able to follow a strategy of diversification and former specialisation, suggesting good prospects to overcome MIT.

These varieties of MIT are not perfectly closed boxes but analytical definitions to capture the heterogeneous MIT trajectories according to the structural change process. Therefore, this classification does not mean that each country remains in the same segment of the S curve during the whole period (see Figure A2, Appendix 2). MIT economies show common patterns associated with problems of structural change, while there are specific historical processes that explain the trajectory of each country and that have been widely documented in many cases. Hence, it is important to emphasise that this paper does not intend to analyse in depth each national case but, rather, to identify common patterns in the MIT countries while interpreting the differences among MIT varieties.

4.2.1 MIT 1: Countries trapped in the bottom of low complexity

The countries identified in this group are middle-income countries—mostly Latin American, except Algeria—that show a productive structure similar to low-income countries. The presence of countries dependent on natural resources, including both agricultural and oil-producing countries, is noticeable. This is in line with the interpretation that Ricardian advantages in natural resources may impose a restriction on structural change, which requires diversification processes (Lectard and Rougier, 2018). In particular, oil exporter countries grouped in MIT-1 (i.e., Algeria, Venezuela and Ecuador) have suffered a strong specialisation in this sector, suffering deindustrialisation processes and facing economic indicators assimilated to Dutch disease situations along different time periods (Chekouri et al., 2015, 2017; Miranda Delgado, 2017; Desfrancois, 2019).

Figure 3. MIT-1: Trapped in the bottom of low complexity. Selected cases



Note: The square signals the first triennial dot for each country (1964–1966), while the triangle signals the last triennial (2015—-2017).

National cases presented in Figure 3 show some common features of this group of countries, such as the erratic trend and the process of reverse complexification of the production structure. It graphically represents how these countries have followed a sort of random walk process (Cimini et al., 2021) in which incipient processes of structural change were reversed by processes of early deindustrialisation in the last decades of the 20th century (Vera, 2009; Chekouri et al., 2015).

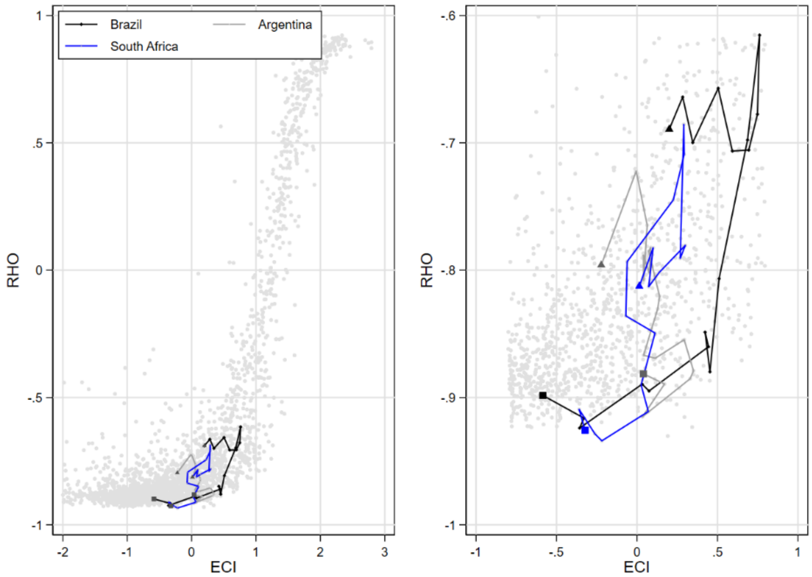
While the cases of Algeria and Venezuela depict the problems of oil specialisation, the Dominican Republic shows a similar situation in the S curve, namely low complexity and an erratic trend, but based on agricultural products and low- and medium-tech manufacturing exports (Sánchez-Ancochea, 2012; Beteta and Moreno, 2014).

4.2.2 MIT-2: Erratic trajectories of median complexity

The variety of MIT of median complexity is the group of our typology that contains more national cases and, arguably, its contents have higher heterogeneity. These countries properly represent the MIT situation and many of them have been widely studied from this perspective (e.g., Jankowska et al., 2012; Paus, 2014; Marouani and Mouelhi, 2016; Alarco and Castillo, 2018; Albuquerque, 2019; Yasar, 2019; Bresser Pereira et al., 2020; Massot and Merga, 2022).

In contrast to the countries grouped in MIT-1, those included in MIT-2 have achieved a relatively high diversification of their economies, in some cases with an important industrial development (e.g., Argentina, Brazil, South Africa, Turkey). Indeed, the economic structure of these countries is significantly more complex than those included in the MIT-1 group, even showing an incipient trend to growth in relative relatedness (*Rho* axis). However, these countries show strongly erratic trajectories along the period considered. As can be seen in Figure 4, large countries with a relatively high development of national industries have not been able to sustain a process of structural change. On the contrary, even at different levels than in the MIT-1 group, a process of decomplexification can also be observed.

Figure 4. MIT-2: Erratic trajectories of median complexity. Selected cases (a)



Note: The square signals the first triennial dot for each country (1964–1966), while the triangle signals the last triennial (2015–2017).

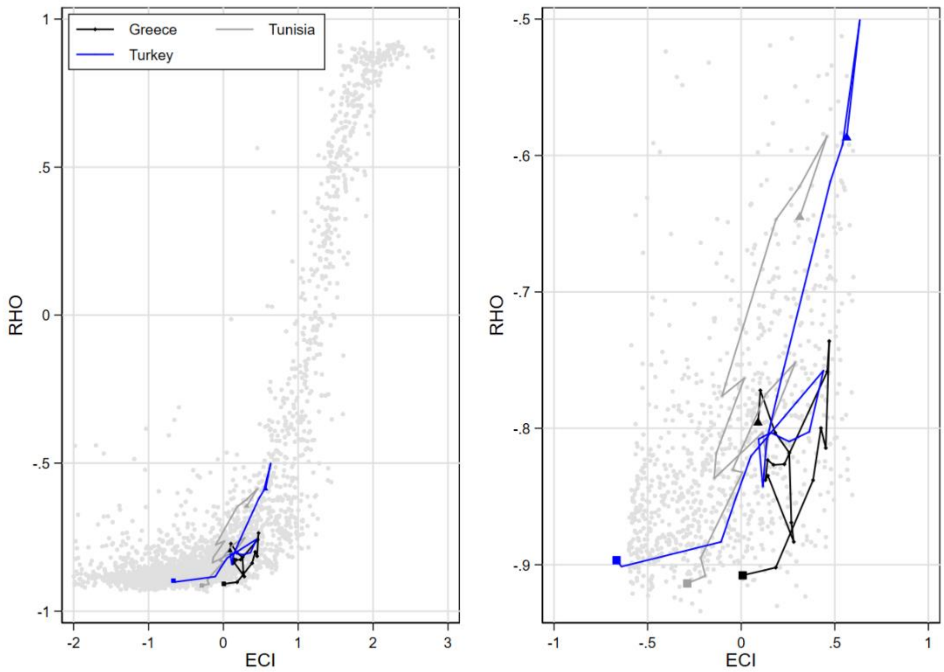
The three countries presented in Figure 4 show a kind of reverse transformation process, reducing the sophistication levels with constant or declining relative relatedness. This is in line with previous research from Latin America concluding that the economic liberalisation process that started in this region around the decade of the 1970s has negatively affected the complexity of these economies, leading them to a strong specialisation in primary related products (e.g., Cimoli et al., 2009; Bresser Pereira et al., 2020). Within Latin America, the case of Brazil stands out because it managed to maintain a trajectory of diversification with increasing complexity, even climbing the ladder of structural change, but in the final third of the period (since the 1990s), it began a process of reversal (Nassif and Castilho, 2020). The development strategies of these countries have been associated with uneven efforts of structural change, marked by the search for the creation of dynamic sectors according to different periods (Kupfer, 2009), and the volatility of price cycles of natural resource-based products (Grancay et al., 2015) as well as sharp changes in public policy agenda (Bresser Pereira et al., 2020).

South Africa and Tunisia (see Figure 5) show an apparently similar process to South American countries. These African countries have also suffered a deindustrialisation process that affects their productivity levels (Marouani and Mouelhi, 2016; Arezki et al., 2021; Zalk, 2021). Moreover, in both African and Latin American countries, structural change processes based in local manufacturing capacities have been seriously affected by the expansion of Asian manufacturing in global trade, mostly Chinese manufacturing, which increases the challenges of shifting structural change towards more sophisticated knowledge-intensive goods (Paus, 2020; Torreggiani and Andreoni, 2023). In spite of the deindustrialisation process, other authors have analysed the experiences of productive changes based on natural resources as virtuous strategies to overcome the MIT in these countries (e.g., Kaplan, 2016; Lebdiou et al., 2021).

Greece's trajectory is also characterised by an erratic path in the complexity axis at low levels of unrelated structural change (Figure 5). In previous works, the structural weaknesses of the Greek economy coincide, in particular, with the internal and external imbalances and the scant diversification of tradable products associated with institutional determinants that reinforce productive and financial trends (Soukiazis et al., 2018; Campos et al., 2019; Pnevmatikos et al., 2019).

Turkey seems to have followed a sustained path of complexity increase jointly with a moderate improvement in the relative relatedness indicator. Recent studies on the Turkish economy have stressed the robust growth trend that this county has enjoyed since the end of the 20th century (Babacan, 2018). However, previous work has pointed out that Turkey's export-led diversification process has not been accompanied by investment in education, science and technology, which could affect the country's ability to move up the ladder of structural change towards the incorporation of increasingly complex goods (Yasar, 2019).

Figure 5. MIT-2: Erratic trajectories of median complexity. Selected cases (b)



Note: The square signals the first triennial dot for each country (1964–1966), while the triangle signals the last triennial (2015–2017).

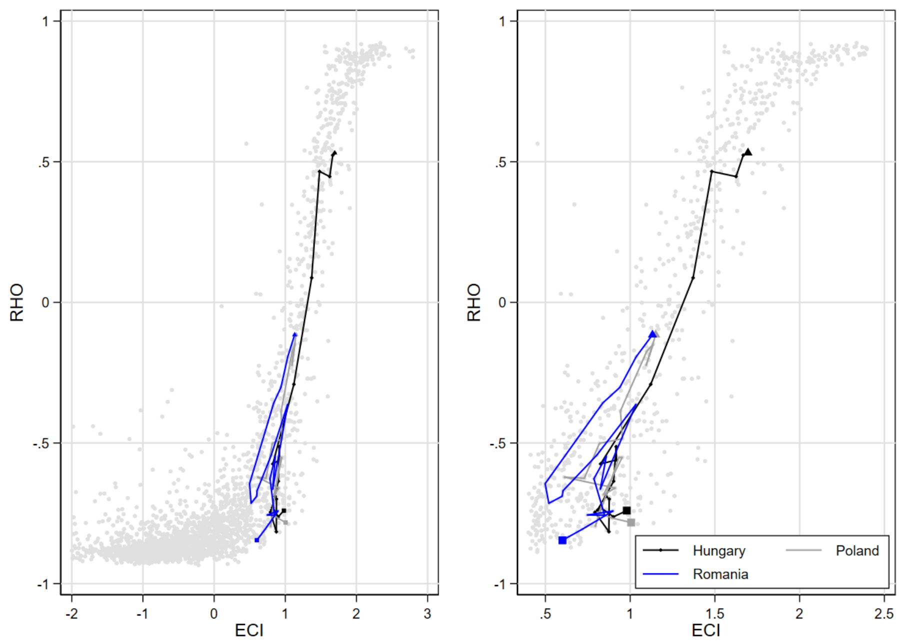
4.2.3 MIT-3: Climbing the ladder of structural change

This group brings together countries characterised by moving up the scale of structural change based on the expansion of manufacturing, usually based on the relative abundance of a labour force and different forms of regional and global trade insertion. Many of these countries start the period from relatively unsophisticated structures and show a sustained upward trend. Comparing this group with respect to MIT-2, MIT-3 countries show a straightforward rather than erratic trajectory of structural change. However, several studies have drawn attention to the particularities of each country, highlighting in many cases problems regarding the sustainability of this type of productive transformation (Sen and Tyce, 2019; Intarakumnerd, 2019; Ruiz Durán, 2019; Da Costa et al., 2021)

Eastern European countries, especially Hungary, seem to follow a complexity-increase trend associated with unrelated structural change (Figure 6). In contrast to the general landscape observed for the countries grouped in MIT-2, the Eastern European countries in MIT-3 that have integrated into the European Union have followed reindustrialisation initiatives after a generalised process of deindustrialisation, with highly heterogeneous results (Chivu et al., 2017; Nagy et al., 2020; Capello and Cerisola, 2023). This process, together with the integration to the European market, contributes to understanding the trajectories observed in Figure 6.

Despite these observations, in-depth studies of economic dynamics in these countries have pointed out some weaknesses in the processes of structural change in Eastern European economies. In particular, the insertion in FDI-dependent value chains could affect the definition of transformation strategies by nation states (Myant, 2018) and increase volatility risks associated with the specialisation in low-wage manufacturing sectors (Michalski, 2018; Leven, 2019).

Figure 6. MIT-3: Climbing the ladder. Selected cases (a)

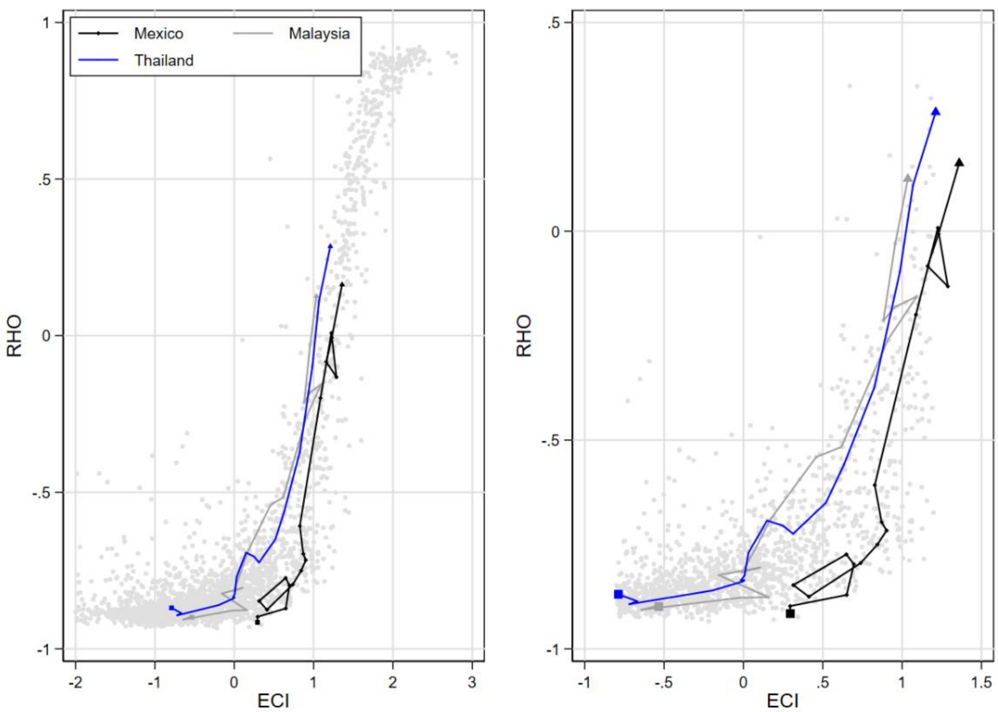


Note: The square signals the first triennial dot for each country (1964–1966), while the triangle signals the last triennial (2015–2017).

Even with large differences, the Asian countries in MIT-3 (Figure 7) show a similar pattern to those from Eastern Europe. In both cases, a straight trajectory of growth in the complexity of production can be observed, and they have managed to climb the ladder of structural change through the expansion of manufacturing. Moreover, as with the European countries, in-depth studies on these Asian countries tend to be cautious in assessing the sustainability of the growth process and the potential outflow of middle-income levels. After the Asian financial crisis at the end of the 20th century, Thailand and Malaysia have remained at slower growth rates than the average of the second half of that century. Previous work that has analysed the causes of this slowdown have highlighted the lack of human resources (Wong and Fung, 2019) and innovation capabilities (Intarakumnerd, 2019; Benyaapikul, 2021) that are critical in achieving the local technology capacities required to maintain the trajectory of economic growth and structural change (Cherif and Hasanov, 2019). A complementary approach to these perspectives was given by Sen and Tyce (2019), who argued that growth problems both in Malaysia and Thailand are due to the existence of government arrangements with natural resource-based productive sectors that block a sustaining expansion of advanced manufacturing sectors.

The case of Mexico in the S-curve reflects the trajectory of the mainly export-oriented manufacturing industry and the successive transformations of this sector with increasing levels of sophistication. Previous authors have highlighted that this transformation of export manufacturing corresponds to the evolution of forms of industrial organisation and trade (*maquila*) in recent decades (Ruiz Durán, 2019). However, it has been pointed out that the growth and transformation of manufacturing has failed to boost aggregate national growth (Aroche Reyes, 2019). It has also been pointed out that along with the development of this sector, a sort of gap has been extended in which traditional sectors mainly oriented towards the domestic market maintain low levels of productivity (Mendoza-Cota, 2021; Iacovone et al., 2022).

Figure 7. MIT-3: Climbing the ladder. Selected cases (b)



Note: The square signals the first triennial dot for each country (1964–1966), while the triangle signals the last triennial (2015–2017).

5. Final considerations

This paper presents novel empirical evidence on both the determinants of the MIT general patterns and the differentiated trajectories of structural change followed by trapped countries. Our results contribute to an identification of the interactive effects of supply and demand factors determining MIT situations. According to recent research streams from Schumpeterian, Structuralist and Post-Keynesian traditions, the MIT situation refers to a kind of lock-in process due to the lack of productive and technological capabilities. Trapped economies are thus not able to process structural changes, and they remain dependent on external demand conditions that are extremely volatile. In this sense, we corroborate previous research on the effect of export margin as determinant of trapped situations and add new research evidence showing that the trapping mechanism relaxes as productive structure becomes more complex.

Moreover, we contribute to the understanding of middle-income trapping processes by tracking differentiated trajectories. Following Hartmann et al. (2021) and Pinheiro et al. (2022), we add evidence on the nonlinear relationship between the complexity of the production structure and unrelated structural change. At low levels of complexity, it is possible to advance in complexity based on related diversification without deep structural change; that is, incorporating new products similar to those already produced but a bit more sophisticated. In these cases, the existing capabilities can be easily adapted to the new activities without complex capabilities-building processes. Therefore, related diversification processes are much less costly and require less transformation of current productive and technological capabilities than unrelated diversification processes. Moreover, structural changes based on related diversification are usually immediately rewarded since increases in complexity positively affect economic growth. This process is usually observed in transitions from low- to middle-income levels or even to medium-high income levels.

However, having reached medium complexity levels, further advances in that dimension are only possible through deep structural changes. This happens by drastically changing the country's position in the product space through unrelated diversification, which is graphically expressed as a steeper, almost vertical, section in the S curve. This transition is more challenging, costly and risky than the progressive changes that characterise the previous structural change steps. This is the reason there are such infrequent successful transitions through this step. As the graphic analysis shows, MIT countries tend to cluster to the left of the vertical section of the S curve. In part, the costs and risks of this process are associated with the fact that a deep structural change does not directly affect growth because, as was econometrically shown, the channel through which it affects growth is productive complexity. Hence, at middle levels, a turning point in structural change is needed, even almost without affecting complexity levels but paving the way for future complexification. In addition to the needed capabilities-building process, there is a lack of short-run reward for those efforts, making long-run planning and sustained political support coalitions necessary to development efforts. In this way, MIT can be understood as the difficulty of climbing a particularly high step in the structural change process. Once this obstacle is overcome, the relationship between these two dimensions tends to smooth again, making it possible to continue advancing in complexity levels based on the capabilities previously built. This could also help to understand why cases of 'descent of the ladder'—that is, of reverse transitions from high to medium or low incomes—are so infrequent.

An analysis of MIT trajectories allows the observation that MIT varieties are highly geographically concentrated. East Asian and Eastern European countries show promising perspectives on structural change by integration to dynamic markets. Moreover, the only case that seems to be climbing the ladder from Latin America, namely Mexico, has also integrated into the North American market. This suggests that geographical location, the availably of a labour force and fluxes in integration in global economics are critical factors to escaping MIT. Conversely, most MIT countries that have no signals to overcome trapping situations are still strongly dependent on external conditions for growth. The global integration of these countries is mostly as suppliers of raw materials, and they are not integrated in dynamic trade agreements.

The evidence provided in this article corroborates that MIT derives from path dependency processes that cannot be avoided without deliberate detours (Lee, 2013, 2019). To break the path dependence trajectories, the processing of structural changes should be towards activities and products of growing demand and increasing sophistication. Such virtuous deviations involve deliberate efforts by national states that in recent economic history have been more of an anomaly than a regularity in middle-income countries (Aghion et al., 2021). On the contrary, several middle-income countries seem to follow a sort of hysteresis-affected trajectory in which national efforts to break it have resulted in erratic detours (Cimoli and Porcile, 2009; Albuquerque, 2019; Cimini et al., 2021; Dosi et al., 2021).

We expect that the results obtained will contribute to future research on the relationship between countries' political capacities to building alternative detours according to the development of their productive and technological capabilities.

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Appendix 1

The formula for the calculation of the **product space** is:

$$\phi_{p_1p_2}(M_{cp}) = min\left(\frac{\sum_c M_{cp_1}M_{cp_2}}{\sum_c M_{cp_1}}, \frac{\sum_c M_{cp_1}M_{cp_2}}{\sum_c M_{cp_2}}\right)$$

where $\phi_{p_1p_2}$ is the proximity between products 1 and 2. M_{cp_i} is a vector for each product "pi" in which each element corresponds to a country 'c', and it takes the value 1 if the country exports with Revealed Comparative Advantage (RCA)>1 and 0 otherwise. The product space is then constructed calculating this relation for any possible pair of products with the data from a certain triennium. It is expressed as a symmetric matrix in which any element informs the proximity between row product and column product.

ECI: ranking of countries according to the diversification and complexity of their export basket.

Diversity: different types of products that the country is able to produce.

$$k_{c,0} = \sum_p M_{cp}$$

Ubiquity: number of countries that are able to produce the product.

$$k_{p,0} = \sum_c M_{cp}$$

The formula for **density** is as follows:

$$\text{Density } \omega_{cp} = \frac{\sum_{p'} Mcp'\phi pp'}{\sum_{p'} \phi pp'}$$

where *p* is the product not yet present in the location *c* and *p'* are the products already present in it.

RHO (ρ_c): The Pearson correlation between the product complexity (PCI) and the density (ω_{cp}) of adjacent products is calculated to estimate the closeness of a country's productive structure to rather complex or simple products.

$$\rho_c = \frac{\sum_{p \in O_c} \left(PCI_p - O_c^{PCI}\right)\left(\omega_{cp} - O_c^{\omega}\right)}{\sum_{p \in O_c} \left(PCI_p - O_c^{PCI}\right)^2 \sum_{p \in O_c} \left(\omega_{cp} - O_c^{\omega}\right)^2}$$

where PCI_p, is the PCI of the product p; O_c are the subsets of products in country c without comparative advantage; and O_c^{PCI} and O_c^{ω} are the average complexity and density.

Appendix 2

Figure A1. Distribution of MIT varieties along S curve

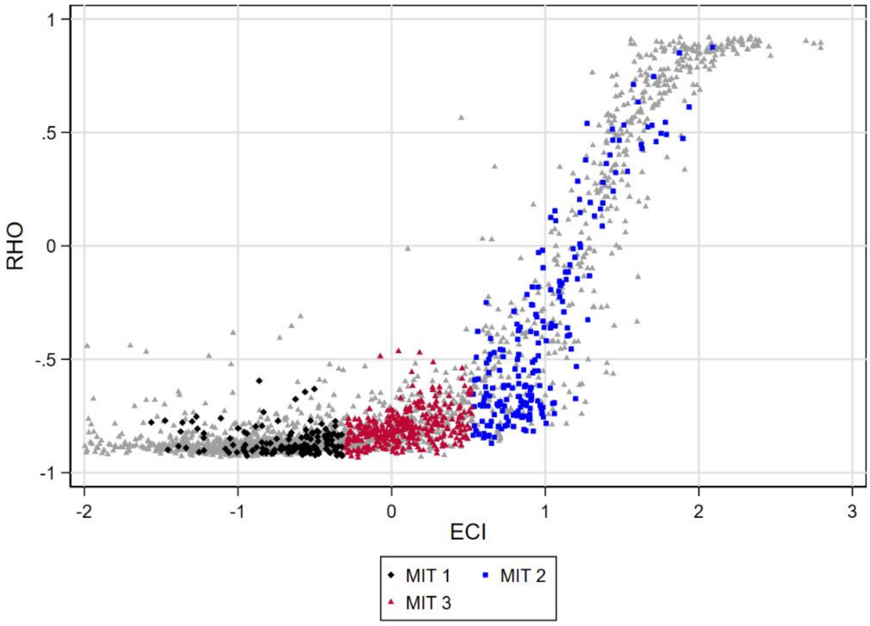
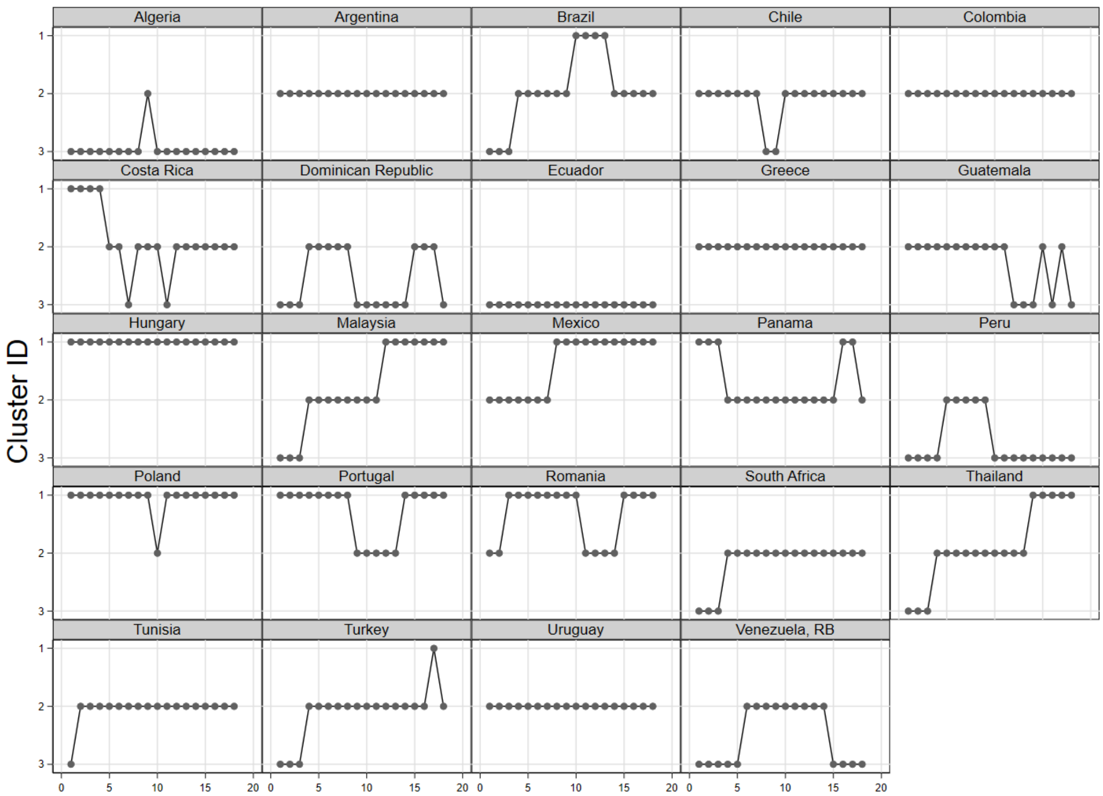


Figure A2 Cluster classification by country.



Appendix 3

To corroborate the interpretation of the effects of relative relatedness (*Rho*) on growth, we tested the following specification:

$$\mathrm{ECI}_{it} = \beta_{ECI-2}.\mathrm{ECI}_{it-1} + \beta_{ECI-2}.\ \mathrm{ECI}_{it-2} + \beta_1 Rho_{t-1} + \beta_2 Rho^2{}_{t-1} + \vec{\beta}.\vec{X}_{i\,t} + \tau_i + \varepsilon_{it} \quad \text{(A1)}$$

We expected β_1 and β_2 to be significant, thereby showing the nonlinear but positive relation between unrelated diversification and complexity (Hartmann et al., 2021; Pinheiro et al., 2022). Table A1 shows that there is a significant and strong quadratic relationship between both variables.

Table A1. Dynamic GMM and fixed effects models. Dependent variable: $\mathbf{ECI}_{it}$.

Variables	Fixed Effects				GMM			
	lag i=0	lag i=1	lag i=2	lag i=3	lag i=0	lag i=1	lag i=2	lag i=3
Rho_{t-i}	0.853***	0.825***	0.784***	0.681***	0.488***	-0.006	0.105	0.070
	(13.629)	(12.349)	(9.623)	(6.513)	(6.780)	(-0.092)	(1.580)	(1.303)
$Rho_{t-i}{}^2$	-0.413***	-0.341***	-0.336***	-0.301**	-0.463***	0.138	-0.165**	0.033
	(-4.090)	(-3.356)	(-3.082)	(-2.341)	(-5.235)	(1.406)	(-2.386)	(0.374)
$\mathrm{margin}_{t-i} * noMIT$	0.075	0.058	0.051	0.039	0.035	-0.020	0.024	0.024
	(1.141)	(0.888)	(0.818)	(0.711)	(0.993)	(-0.519)	(0.685)	(0.606)
$\mathrm{margin}_{t-i} * MIT$	0.009	0.016	0.040	0.023	0.005	-0.021	0.023	-0.052*
	(0.223)	(0.385)	(0.884)	(0.419)	(0.106)	(-0.543)	(0.588)	(-1.696)
$Investment_{it-1}$	-0.198	0.077	0.478	0.756**	0.026	0.147	0.258	0.350
	(-0.560)	(0.284)	(1.555)	(2.004)	(0.116)	(0.672)	(1.228)	(1.236)
$Education_{it-1}$	-0.057*	-0.037	-0.026	-0.011	-0.016	0.101***	0.009	0.056**
	(-1.899)	(-1.019)	(-0.548)	(-0.183)	(-0.505)	(3.368)	(0.289)	(2.395)
$Education_{it-1}{}^2$	0.002	0.001	0.001	0.000	-0.001	-0.006***	-0.001	-0.003*
	(1.230)	(0.688)	(0.373)	(0.095)	(-0.554)	(-2.664)	(-0.645)	(-1.835)
$\mathrm{Population}_{it-1}$	0.000*	0.000	0.001	0.001*	0.000	-0.000	-0.000	-0.000
	(1.906)	(1.648)	(1.555)	(1.732)	(0.671)	(-1.385)	(-0.035)	(-0.059)
Crisis_t	0.022	0.018	0.012	0.004	0.004	-0.009	-0.015*	-0.005
	(1.650)	(1.501)	(0.999)	(0.259)	(0.581)	(-1.204)	(-1.934)	(-0.438)
GDPpc_{t-1}	-0.003	-0.003	-0.003	-0.004	0.002	0.006	0.003	0.001
	(-0.947)	(-1.148)	(-1.140)	(-1.069)	(0.802)	(1.387)	(0.834)	(0.310)
ECI_{t-1}					0.616***	0.766***	0.798***	0.841***
					(6.655)	(6.921)	(7.504)	(7.183)
ECI_{t-2}					-0.114**	-0.103*	-0.107	-0.147***
					(-2.044)	(-1.914)	(-1.523)	(-2.607)
Constant	1.317***	1.143***	0.984***	0.822***				
	(6.332)	(5.829)	(4.988)	(4.055)				
Observations	855	798	741	684	797	740	683	626
R-squared	0.480	0.420	0.365	0.291				
Number of countries	58	58	58	58	58	58	58	58
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	No	No	No	No	No	No	No
Periods	15	14	13	12	14	13	12	11

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1