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Creative Destruction and the Golden Triangle: Evidence from the PSTR model

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ABSTRACT

This research aimed to investigate the establishment of the golden triangle hypothesis, which emphasizes the importance of a balanced interaction between the state, civil society, and the market in fostering creative destruction and innovation. Data were collected from 107 countries (period 2013-2022) and analyzed using Panel Smooth Transition Regression (PSTR) models. Two primary indexes were developed: the Golden Area Index, representing the area of the golden triangle for each country and year, and the Golden Difference Index, representing the standard deviation of the three indicators (state, civil society, and market) for each country and year. These were combined to create the Golden Threshold Index to comprehensively represent the golden triangle hypothesis. The estimation results, obtained for two groups of countries (all sample of 107 countries and a subset of 78 upper-middle and high-income economies), revealed that an increase in the Golden Area Index is associated with improved innovation growth and enhanced creative destruction. Conversely, an increase in disparity among the three pillars of the golden triangle leads to a decrease in innovation growth and a halt in creative destruction. Additionally, an increase in the Golden Threshold Index correlates with increased innovation growth and the facilitation of creative destruction. The study confirms the significance of the golden triangle hypothesis in promoting innovation and creative destruction. It highlights the necessity of maintaining a balanced interplay among the state, civil society, and market forces to foster an environment conducive to sustainable economic growth.

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1. Introduction

Creative destruction, a concept coined by Joseph Schumpeter in his 1942 work "Capitalism, Socialism and Democracy," refers to the process by which old industries and economic structures are incessantly destroyed and replaced by new ones. This dynamic mechanism is crucial for economic growth and innovation, driving the continuous evolution of markets and industries (Schumpeter, 1942). The mechanism of formation of creative destruction can be introduced as follows: Creative destruction, as conceptualized by Schumpeter (1942), refers to the process by which outdated technologies, industries, and economic structures are replaced by innovative alternatives, driving economic growth and progress. This dynamic is propelled by the interaction of several key mechanisms: Innovation as the Driver: Innovation is at the heart of creative destruction, as it introduces new products, processes, and business models that disrupt existing markets. For instance, advancements in digital technology have transformed industries ranging from retail to healthcare, replacing traditional methods with more efficient alternatives (Aghion and Howitt, 1992). Market Competition: Competition among firms accelerates creative destruction by incentivizing efficiency and the adoption of new technologies. Firms that fail to innovate or adapt to changing market conditions risk obsolescence, as observed in the transition from physical to digital media (Acs, 2006). Resource Reallocation: Creative destruction reallocates resources—capital, labor, and knowledge—from declining sectors to emerging ones, enhancing overall productivity (Bartelsman et al., 2004). This reallocation, while disruptive in the short term, fosters long-term economic resilience. Institutional Support: Effective institutions, such as well-defined property rights and competitive regulatory environments, play a crucial role in facilitating creative destruction. These institutions ensure that innovators reap the rewards of their efforts, reducing the risks associated with entrepreneurship (North, 1990). Emergence of Innovation: New technologies or business models disrupt existing markets, creating a wave of

entrepreneurial activity. For example, the development of the internet sparked a surge in digital startups (Mazzucato, 2013). Adoption and Diffusion: As innovation gains traction, it diffuses across the economy, displacing older structures. This phase often involves significant investment in complementary infrastructure and skills development (Romer, 1990). Creative Destruction at Scale: The widespread adoption of innovation leads to the obsolescence of established firms and industries. This transformation can result in short-term economic dislocation, such as job losses in declining sectors, but also creates opportunities for growth in emerging ones (Schumpeter, 1942). Stabilization and Renewal: Following the initial disruption, the economy stabilizes, incorporating the benefits of innovation. However, this stabilization is temporary, as new cycles of innovation and disruption are initiated (Aghion et al., 2021). Therefore, it can be believed that, the theoretical foundation of creative destruction lies in the interplay between innovation and competition. Innovations disrupt existing market conditions, rendering old technologies and products obsolete while giving rise to new industries. This disruption, although often destructive in the short term, paves the way for long-term economic growth and societal advancement. Understanding the interplay between economic and social factors in driving innovation and creative destruction is essential for comprehending economic development and growth trajectories. A plethora of studies have examined the influence of socio-economic variables on these processes. Economic factors, such as capital accessibility, research and development investment, and market competitiveness, are critical determinants of innovation, as they furnish the requisite resources and incentives for the emergence of novel ideas and technologies (Schumpeter, 1942; Aghion and Howitt, 1992). Concurrently, social factors, including educational attainment, cultural attitudes toward entrepreneurship, and supportive institutional frameworks, significantly impact a region's innovative capacity and its ability to undergo creative destruction (Florida, 2002; Acs, 2006). Aghion et al. (2021) believes that the state, civil society and the market system are the three main pillars for creative destruction and

development of innovation. According to them, these three variables are so important that they introduce the combination of these three variables as the "golden triangle". But in order for these three variables to be able to develop innovation, they must have characteristics. First, each of them should be powerful enough on their own, and secondly, there should be a balance of power between these three variables. So that if there is no balance of power, they cannot cause creative destruction and development. They believe that if the Executive Power is too much, it can lead to autocracy. In other words, over time, an overly powerful executive may evolve into an autocrat, fostering a corrupt environment (Aghion et al., 2021:295). Aghion et al. (2021) assert that for the golden triangle of state, civil society, and market system to effectively foster innovation and creative destruction, each component must exhibit distinct yet complementary strengths. The state should provide robust institutions, enforce property rights, and maintain a stable macroeconomic environment. Civil society must encourage social capital, trust, and norms that facilitate cooperation and collective action (Putnam, 2000). The market system, meanwhile, should promote competition, entrepreneurship, and efficient allocation of resources (Porter, 1990). The interaction between these elements is critical; when they function synergistically, they create an environment where innovation can thrive. Conversely, if one component overpowers the others, it can lead to inefficiencies and stifle creativity (Aghion et al., 2021).

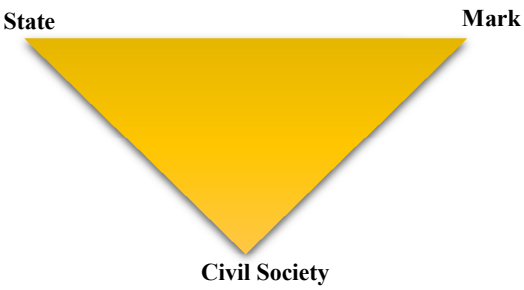

Fig 1. The triangle of state, markets, and civil society, GOLDEN TRIANGLE
Source: Aghion et al., 2021, p. 302

Moreover, Aghion et al. (2021) emphasize the necessity of a balanced distribution of power among the three pillars. When balance is achieved, each pillar can check and support the others, preventing the concentration of power that could hinder innovation. For instance, a dominant market without adequate regulation may lead to monopolies, while an overbearing state can stifle entrepreneurial initiatives through excessive control (North, 1990). Civil society acts as a mediator, ensuring that both the state and market remain accountable and responsive to the needs of the populace. This balance fosters a dynamic and adaptive ecosystem conducive to continuous innovation and creative destruction, as initially proposed by Schumpeter (1942). The interplay of these forces underscores the complexity and interdependence of the elements within the golden triangle framework (Aghion et al., 2021).

Examining the observations of economic data in the countries of the world shows that there is probably a relationship between the three sides of the golden triangle with innovation. Figure 2 to 4 show this relationship in the sample of 107 countries of the world in 2022. But the basic question is that Do experimental studies and statistical estimates also confirm this relationship? Is the central idea of the golden triangle based on the necessity of the simultaneous effect of these three variables on innovation and creative destruction confirmed?

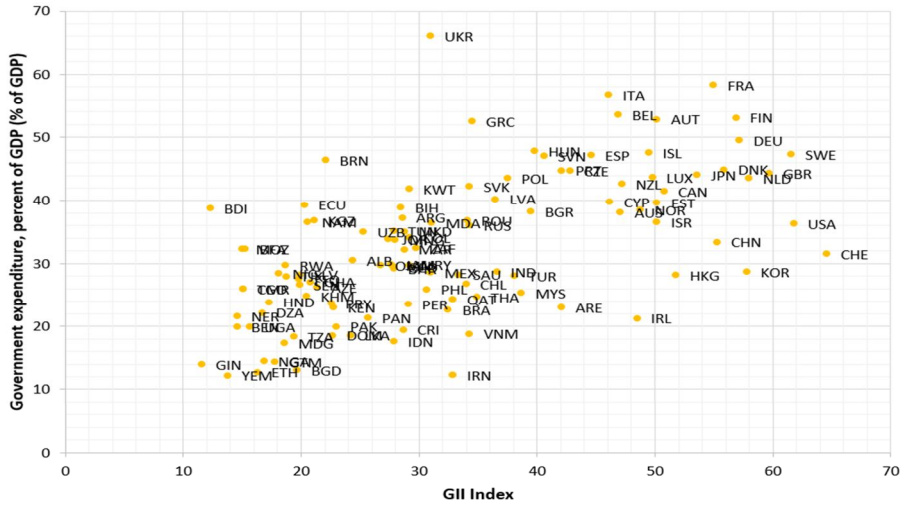

Fig 2. The relationship between innovation index (GII) and State index (year 2022)

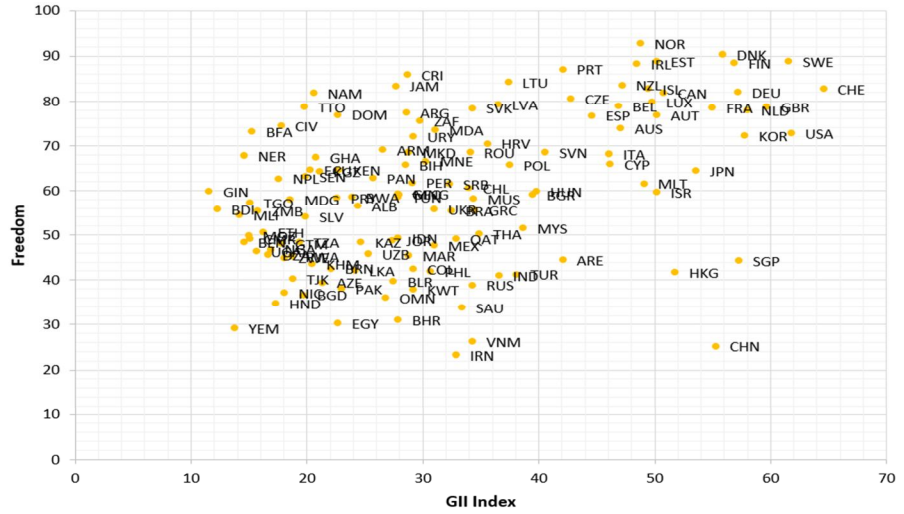

Fig 3. The relationship between innovation index (GII) and Freedom index (year 2022)

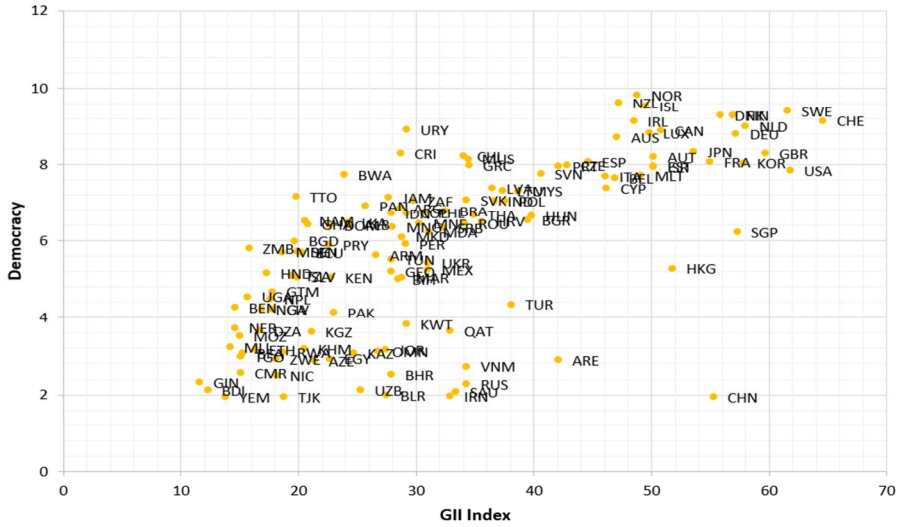

Fig 4. The relationship between innovation index (GII) and democracy index (year 2022)

Source: Research Findings. **Note**: GII is Global Innovation Index [1]

The main purpose of this article is to examine the golden triangle hypothesis and its impact on innovation and creative destruction. Investigating and testing whether the overall size of the golden triangle can improve innovation? And whether the difference between the sides of the golden triangle (disparity among the three variables in the golden triangle) can stop creative destruction and weaken innovation? To test this hypothesis, a panel regression model consisting of 107 countries has been estimated. In the following, a summary of the literature is introduced. Then by introducing the research method, the estimation results will be analyzed.

1. Innovation Index (GII): The data for the innovation index is sourced from the Global Innovation Index (GII), published annually by the World Intellectual Property Organization (WIPO). This index provides a comprehensive measure of innovation performance across countries, incorporating multiple dimensions such as research and development (R&D), human capital, infrastructure, market sophistication, and business sophistication. The data used in this study is publicly available at the following link: *https://www.wipo.int/en/web/global-innovation-index*

2. Literature Review

The Golden Triangle idea believes that the three variables of civil society, the government and the market system can have an effect on the formation of innovation and creative destruction. In the following, an attempt will be made to examine the process of influencing these three variables on innovation and creative destruction. Civil society and democracy, the first side of the golden triangle: Democratic societies have a tendency to prioritize the protection of individual freedoms and property rights. This legal and institutional framework creates a conducive environment for innovation via ensuring that inventors and entrepreneurs can gain the advantages of their efforts without undue interference or expropriation. Democracies often set up institutions that promote scientific discoveries and technological advancements. These institutions, along the safeguarding of intellectual property rights, are vital for fostering an innovative environment. Furthermore, Democratic governance encourages an extra open and competitive environment that could stimulate innovation (Ahmed et al., 2024). Democratic societies often emphasize the protection of individual freedoms and intellectual property rights, growing an environment conducive to innovation. These protections make certain that innovators can benefit from their innovations without fear of expropriation (Sweet and Eterovic Maggio, 2014). The establishment of strong institutions in democracies supports scientific discoveries and technological improvements, in addition fostering innovation (North, 1990). Democracies promote openness and competition, which can be vital for innovation. The freedom to specific ideas, collaborate, and venture existing norms results in a greater dynamic and creative environment. This environment encourages various ideas and answers, driving technological development (Gerring et al., 2005). Democratic regimes often have better-developed institutions that assist education, research and development (R&D), and entrepreneurship. These institutions offer the vital infrastructure and investment for innovation activities, making it simpler for new technology to emerge and be

commercialized (Olson, 1993). Studies propose that the economic freedom and stability provided through democratic governance can decorate productivity and creativity, leading to better higher of innovation. Democracies have a tendency to create situations that facilitate economic activities and investments in new technologies (Sturm and de Haan, 2001).But will democracy always enhance innovation? Ahmed et al., (2024) examined the relationship between democracy and innovation among 61 countries in the world and concluded that no statistically significant relationship among democracy, and innovation in the studied countries (Ahmed et al., 2024). What reasons can cause democracy not to have a significant effect on innovation? They accept as true with that, Innovation is influenced through a myriad of factors beyond political systems, which include economic conditions, education, infrastructure, and cultural attitudes closer to entrepreneurship. The study shows that these other factors would possibly play a more decisive role in using innovation in developing countries. The effectiveness of democratic institutions in promoting innovation can vary broadly among developing countries. Some democracies may not have the necessary institutional power or resources to help significant innovation, which could dilute the overall effect observed in broader analyses. Innovation is influenced by using a multitude of factors beyond political structures, including economic conditions, education, and cultural attitudes toward entrepreneurship. The complexity of these dynamics means that democracy alone may not be enough to drive innovation (Gao et al., 2017). The effectiveness of democratic institutions in promoting innovation can vary broadly. In some developing countries, democratic institutions may lack the essential strength or sources to support significant innovation, leading to combined or non-significant effects in empirical research (de Haan and Sturm, 2003). In a few democracies, political and economic priorities may additionally conflict with the goals of innovation. As an instance, the need to address instantaneous social and economic issues may additionally overshadow long-term investments in

R&D and technological improvement (Sirowy and Inkeles, 1990).

Market and economic freedom, the second one aspect of the golden triangle: economic freedom also can have an effect on innovation through different channels. Economic freedom, characterized by means of ease of doing business, reduces regulatory burdens and boundaries to access, fostering an environment conducive to entrepreneurial activities and innovation. Gwartney, Lawson, and hall (2012) argue that lower regulatory restrictions and more economic freedom facilitate greater dynamic market activities and competition, leading to improved innovation (Gwartney et al., 2012). Secure property rights, a main factor of economic freedom, make sure that innovators can achieve the benefits of their innovations without worry of expropriation. This security incentivizes investment in R&D and the commercialization of recent technology. Property rights safety reduces uncertainty and risks, thereby encouraging long-term investments in innovation (Acemoglu et al., 2001). Openness to trade and investment, often associated with economic freedom, allows for the inflow of new ideas, technologies, and best practices from around the world. This cross-border trade enhances domestic innovation with the aid of exposing firms to worldwide competition and new knowledge. Market openness also helps the spread of new technologies and practices, contributing to overall innovation ability (Görg and Greenaway, 2004). Efficient rules that reduce bureaucratic hurdles and enhance transparency help businesses to innovate greater successfully. in line with Djankov et al. (2006), countries with streamlined regulatory environments experience higher levels of innovation because firms can recognition more on productive activities rather than navigating complex rules (Djankov et al., 2006). But, alternatively, if economic freedom is too much, it can cause the weakening of innovation and creative destruction. Immoderate deregulation in pursuit of economic freedom can sometimes lead to market failures and instability, which may additionally negatively affect innovation. Bénabou (2002) argues that whilst some regulation is essential to prevent monopolies and protect public interests, an

overemphasis on deregulation can stifle innovation through creating uncertainty and decreasing the incentive for firms to invest in long-term R&D (Bénabou, 2002). Economic freedom can sometimes exacerbate inequalities, leading to uneven access to resources necessary for innovation. While economic policies prefer a small elite, broader segments of society may additionally lack the education, infrastructure, and financial resources had to innovate. Such disparities can restrict the overall innovative capacity of an economy (Aghion et al., 1999). High degrees of economic freedom may also lead firms to prioritize short-term profits over long-term investments in innovation. hall and Soskice (2001) highlight that during highly liberalized economies, firms may additionally focus more on immediate financial performance in place of investing in R&D, which typically yields returns in the longer term (hall & Soskice, 2001). Some research propose that the relationship between economic freedom and innovation isn't always straightforward due to measurement challenges and contextual differences. as an example, Bjørnskov and Foss (2008) observe that different dimensions of economic freedom can also have varying influences on innovation, and these consequences can differ across countries and industries (Bjørnskov, & Foss, 2008).

The third variable in the golden triangle is the state. Government spending on R&D can stimulate innovation by means of supplying funding for primary and applied research that the private sector won't adopt due to high risks and long payback periods. Mazzucato (2013) argues that government investments in R&D have been vital in the improvement of groundbreaking technology, such as the internet and biotechnology (Mazzucato, 2013). Large government expenditures on public goods and infrastructure, along with education, transportation, and communication networks, can better the innovation environment. These investments create the necessary environment for innovative activities through enhancing human capital and decreasing transaction costs. By using presenting infrastructure and education, governments can support the improvement of a

skilled workforce able to driving innovation (Romer, 1990). Governments can play a pivotal role in supporting early-stage innovations and startups through grants, subsidies, and tax incentives. These types of aid can help overcome the "valley of death" in which many startups fail because of loss of funding. Through decreasing financial constraints, government help can enhance the survival and increase of innovative firms (Block & Keller, 2009). Here too, if government spending is excessive or if it isn't optimally dispensed in the society, it could cause the weakening of innovation. High levels of government spending can crowd out private investment, decreasing the overall level of resources available for innovation. According to Tanzi and Schuknecht (2000), extensive government intervention in the economy can cause inefficiencies and decrease the incentives for private investment in R&D (Tanzi, and Schuknecht, 2000). Large government size can be associated with bureaucratic inefficiencies and red tape that can stifle innovation by means of slowing down decision-making processes and increasing compliance costs for firms. Djankov et al. (2002) find that excessive regulation and government intervention can restrict entrepreneurial activities and innovation (Djankov, et al., 2002). Governments may not usually allocate resources effectively, leading to suboptimal results for innovation. Public funds may be misallocated due to political concerns or lack of market alerts, resulting in investments that don't necessarily foster innovation. Such inefficiencies can restrict the development of new technologies and slow down economic progress (Alesina and Perotti, 1996). Government policies can be influenced by short-term political cycles instead of long-term innovation goals. This may cause inconsistency in innovation policy and underfunding of projects that require sustained funding over time. The tendency of policymakers to prioritize immediate gains over long-term innovation investments can reduce the overall effect of government size on innovation (Grossman and Helpman, 1994). Up to now, it's been determined that the three variables of civil society, the market and the government can be effective on innovation, some of research have additionally concluded

that those variables need certain conditions to have a positive impact on innovation. In this study, the use of the idea of the golden triangle, I want to check whether or not the requirements for the effect of those variables on innovation are the golden triangle and its sustainability. But what does the golden triangle say? Aghion et al. (2021) introduce the idea of the "golden triangle", a framework that emphasizes the interaction between three essential components: state, market, and civil society. This triangle is posited to be crucial for fostering innovation and permitting the process of creative destruction that is fundamental for economic growth and development. The golden triangle framework underscores the mutual dependencies and interactions among government policies, business practices, and societal norms and values. These interactions create an environment conducive to innovation, characterised by using dynamic competition and the regular renewal of industries thru creative destruction. The state plays a vital role in establishing the legal and institutional framework that supports innovation. This consists of enforcing property rights, supplying public goods such as education and infrastructure, and enforcing policies that inspire research and development (R&D). The state additionally acts as a regulator, making sure fair competition and preventing monopolies that may stifle innovation. Society, via its cultural and social norms, impacts the acceptance and diffusion of innovations. A society that values education, risk-taking, and entrepreneurship is much more likely to foster an environment in which innovation can thrive. Moreover, societal support for social protection nets and mechanisms to mitigate the adverse effects of creative destruction can ensure broader acceptance of change (Aghion et al., 2021). The effectiveness of the golden triangle relies on the harmonious and synergistic interaction between its three components. Whilst the state, market, and society are aligned of their goals and movements, the environment for innovation becomes robust. As an instance, powerful state regulations can enhance firms' ability to innovate, and a supportive society can facilitate the adoption of recent technologies (Aghion et al., 2021). The state and society have

interaction to form the wider socio-economic environment. Powerful governance and inclusive policies can promote social cohesion and public trust, which are essential for the stability needed for long-term innovation. Moreover, public investment in education and healthcare enhances the human capital available to firms, driving innovation. Despite its potential, the golden triangle framework faces numerous challenges. Misalignment among the goals of the state, market, and society can cause suboptimal consequences. As an instance, if government regulations favor incumbent firms, it can reduce competitive pressures and slow down innovation. In addition, societal resistance to change can impede the adoption of latest technologies. Governments can also sometimes fail to provide the sufficient support for innovation because of bureaucratic inefficiencies, corruption, or lack of expertise. Such failures can undermine the effectiveness of state interventions in promoting innovation. Market failures, such as monopolies or oligopolies, can reduce the incentive for firms to innovate. Without competitive pressures, firms can also come to be complacent and recognition on maximizing short-term profits instead of investing in long-term innovation. Cultural attitudes that favor stability over risk-taking, or that are skeptical of recent technology, can slow down the diffusion of innovations and decrease the overall effect of innovative activities. To optimize the golden triangle, policymakers need to make certain that the interactions among the state, market, and society are conducive to innovation. This includes creating a supportive regulatory environment, investing in public goods, and fostering a culture that values education and entrepreneurship. The golden triangle framework highlights the importance of the interplay among state, firms, and society in fostering innovation and enabling creative destruction. By using understanding and optimizing those interactions, policymakers can create an environment that helps sustained economic growth through continuous innovation.

3. Data

According to the above, creative destruction and creation of innovation will happen when the golden triangle sufficiently meets the necessary conditions. The golden triangle consists of three sides: State, Markets and Civil Society. In this research, the index of the State will be measured by the share of government expenditure (%GDP). The market index is measured using economic Freedom Index. EIU Democracy Index[1] has also been used to measure civil society. But it is necessary to create a composite index of these three variables that can show the size of the golden triangle. For this purpose, it is assumed that each of these values (which are between 0 and 100) is the size of one of the sides of the golden triangle for each country in each year. According to the lengths of the three sides (value of three index) of the golden triangle, and using Heron's law[2], the area of the golden triangle has been calculated for each country in each year. In this research, this variable is introduced to show the "golden triangle". Figure 5 shows the area of the golden triangle for different income groups of countries (mean in period 2013-2022). According to the Figure 5 and 6, it can be seen that the largest area of the golden triangle is for high-income economies. It is interesting that with the increase in income (moving from low-income economies to high-income economies), firstly, the area of the golden triangle increases, secondly, the value of civil society grows larger than to the other two sides of the golden triangle (state and markets). Therefore, it is clear that the size of the difference between the three indicators must also be important. Here, by calculating the standard deviation of these three variables, an index will be created that displays the dispersion value of the three sides of the golden triangle. Therefore, a new index was created to

1. The abbreviation "EIU" stands for Economist Intelligence Unit, an organization that publishes the Democracy Index, which evaluates countries based on electoral processes, civil liberties, government functioning, political participation, and political culture. The data is calculated annually and is available on the official EIU website: https://www.eiu.com
2. Heron's formula, formula credited to Heron of Alexandria for finding the area of a triangle in terms of the lengths of its sides. In symbols, if a, b, and c are the lengths of the sides: Area = Square root of$\sqrt{s}(s - a)(s - b)(s - c)$where s is half the perimeter, or $(a + b + c)/2$.

show the degree of imbalance of the three variables for each country, which we call the deviation from the golden triangle. Figure 7 shows this index for different income groups of economies. According to the Figure, there is the lowest deviation in low-income economies and the highest deviation in Upper-Middle-Income Economies.

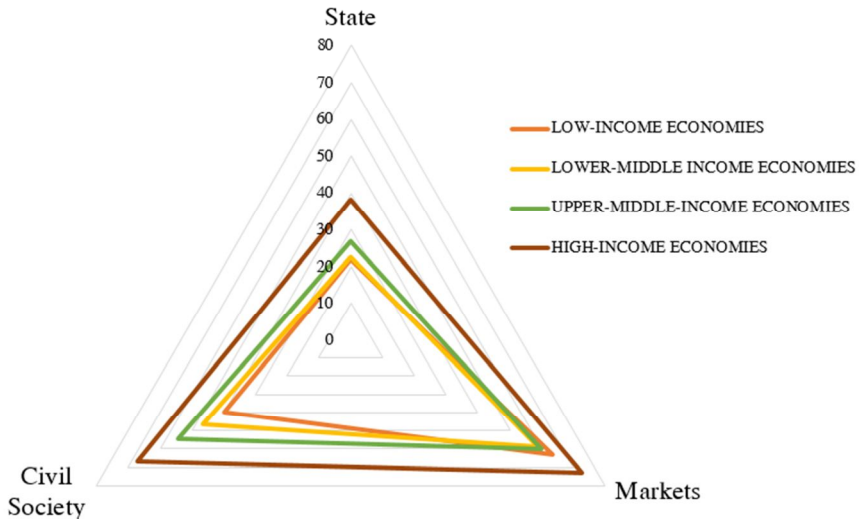

Fig 5. The Golden triangle in income groups of countries

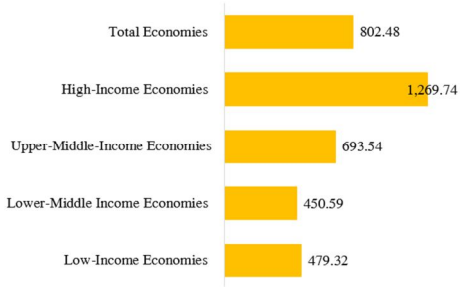

Fig 6. Golden Area

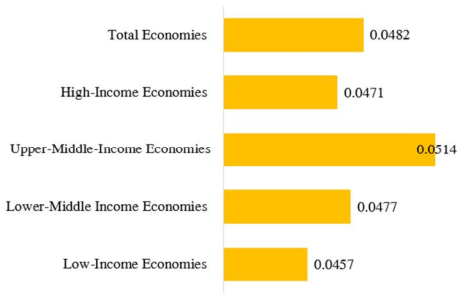

Fig 7. Golden triangle deviation

Comparison of index Golden Area and Golden Difference in income groups of countries

Source: Research Findings

As stated in the previous section, to answer this question, whether the golden triangle is important for creative destruction, we will use PSTR models. The threshold variable should be introduced in such a way that it simultaneously measures both the area of the golden triangle and deviation of the golden triangle. For this reason, a new index will be created which is equal to:

$$Golden\ Threshold = \frac{\text{Area of the Golden Triangle}}{\text{Deviation of the Golden Triangle}} \quad (1)$$

According to this index, the more the golden triangle hypothesis of Aghion is established, the higher this index will be. In other words, the larger the area of the triangle and the smaller the difference in the size of its sides, the higher this index will be.

According to the calculation method of each of the indicators, Table 4 shows a summary of the most important statistical indicators of the research data. In this study, 107 countries were examined, of which 47 countries are from the high-income category and have the highest frequency. As can be seen from the table, in all four Indicators State, Markets, Civil Society and Golden Area, the numerical value of high-income countries is more than other categories[1].

Table 1. Data of The Golden triangle index in income groups of countries (2013-2022)

Income Groups	n	State	Markets	Civil Society	Golden Area	Golden Difference
Low-Income	9	22.21738	65.10752	40.77638	479.3198	0.045721
Lower-Middle Income	22	23.0736	60.35055	47.69817	450.5883	0.04766
Upper-Middle-Income	29	27.32016	61.74926	55.76319	693.5387	0.051443
High-Income	47	39.26706	74.95433	69.00259	1269.743	0.047069
All Economies Sample	107	30.4122	67.21867	57.75674	802.4809	0.048222

Source: Research findings

1. Based on the definition of the World Bank, the countries of the world are divided into four categories in terms of per capita production: A. low-income economies ($1,145 or less), B. lower-middle income economies ($1,146 to $4,515), C. upper-middle-income economies ($4,516 to $14,005), D. high-income economies ($14,006 or more.

4. Methodology

The panel smooth transition regression (PSTR) model is a fixed effect model with exogenous regressors. The fixed-effect panel threshold model builds on the work of Hansen (1999), who developed the econometric techniques for estimating and testing threshold effects in non-dynamic panels. The theoretical basis lies in recognizing that economic relationships can change depending on the regime, reflecting non-linearities that traditional linear models cannot capture. PSTR model is a sophisticated econometric technique designed to capture non-linearities and regime changes in panel data. This model extends the traditional linear panel data models by allowing the relationship between the dependent and independent variables to vary smoothly across different regimes, which are determined by a transition function. The transition function is typically a logistic or exponential function of an observable variable, and it governs how the coefficients change from one regime to another. The single-threshold model is:

$$y_{it} = \mu + X_{it}(q_{it} < \gamma)\beta_1 + X_{it}(q_{it} > \gamma)\beta_2 + u_{it} + e_{it} \quad (2)$$

The variable q_{it} is the threshold variable, and γ is the threshold parameter that divides the equation into two regimes with coefficients β_1 and β_2. The parameter u_{it} is the individual effect, while e_{it} is the disturbance. We can also write (2) as:

$$y_{it} = \mu + X_{it}(q_{it}, \gamma)\beta + u_{it} + e_{it} \quad (3)$$

Where

$$X_{it}(q_{it}, \gamma) = \begin{cases} X_{it} I(q_{it} < \gamma) \\ X_{it} I(q_{it} \geq \gamma) \end{cases} \quad (4)$$

Given γ OLS estimator for β is: $\hat{\beta} = \{X^*(\gamma)'X^*(\gamma)\}^{-1}\{X^*(\gamma)'y^*\}$, where y^* and X^* are within-group deviations. for $i = 1,2 \cdots N$, and $t = 1,2 \cdots T$, where N and T respectively represent the cross-section and time dimensions of the panel. Explained variable y_{it} it is a scalar, and explanatory variable X_{it} it is a k-dimensional column vector. While μ refers to the fixed effect. In

order to investigate that whether the golden triangle exhibits nonlinear changes with innovation , this study takes countries innovation performance as explained variable (global innovation index), golden triangle and golden difference as explanatory variable, Golden Threshold as transition variable, as well as population and gross domestic product per capita as control variables. The hypotheses of this study are formulated to examine the role of the golden triangle—comprising the state, market, and civil society—in fostering innovation and creative destruction. Specifically, we hypothesize the following: H1: A larger golden area, which reflects the overall strength of the three pillars, is positively associated with higher levels of innovation and creative destruction. H2: A higher imbalance among the pillars, as measured by the golden difference index, negatively impacts innovation and creative destruction, highlighting the importance of equilibrium among the three components. H3: The composite golden threshold index, which combines both the size and balance of the golden triangle, has a positive and significant effect on innovation and creative destruction. To empirically test these hypotheses, this study employs the Panel Smooth Transition Regression (PSTR) model, which is well-suited for capturing non-linear relationships and threshold effects inherent in the dynamics of the golden triangle framework. This methodological approach allows us to uncover critical insights into the interactions among these pillars and their collective impact on economic outcomes.

5. Estimation and results

The descriptive statistics for the dataset are presented in Table 2, providing insights into the central tendency and variability of the key variables under study. The mean values indicate the average levels of the variables, with standard deviations reflecting the degree of dispersion around these means. For instance, the mean value for innovation Ln(GII) is 3.6 with a standard deviation of 0.34. The minimum and maximum values, ranging from 2.45 to 4.23, illustrate the breadth of innovation outputs across the sample the distribution and spread of the data, informing subsequent analyzes and interpretations.

Table 2. Summary statistics

Variable		Mean	Std. dev.	Min	Max
$\ln(GII)$	overall	3.559086	.3346855	2.451005	4.225373
	between		.3235844	2.898899	4.197768
	within		.0904932	3.109344	3.906678
$\ln(POP)$	overall	64.63487	6.318966	48.4095	85.2642
	between		6.276612	48.55552	84.23965
	within		.9301297	61.2118	67.96905
$\ln(Gold)$	overall	6.687708	.740326	1.7206	7.848256
	between		.6834011	4.705317	7.78634
	within		.2915092	3.691196	7.913942
$\ln(DiifGold)$	overall	-3.031936	.3711545	-3.704223	-.9036416
	between		.3437245	-3.650822	-1.757943
	within		.1435403	-3.436995	-1.574108
$\ln(thgold)$	overall	4.221188	.3851101	2.029166	4.809362
	between		.3606466	3.002342	4.796312
	within		.1390643	2.959878	4.776174

Source: Research findings

To avoid spurious regression outcomes, González et al. (2005) emphasize the need for stationary variables when estimating PSTR models. According to the results of the Harris-Tzavalis unit-root test, variables “Golden Area”, “Golden Difference” and “Golden Threshold” are found to be stationary, while variables “Innovation Index”, “Population” and “GDP per capita” becomes stationary after first differencing.

As explained before, in model 1, the golden area and golden difference variables are explanatory variables in the model, and in the model 2, these two variables are combined and the golden threshold variable is formed, in the model 2, the Golden Threshold variable has been included in the model as an indicator of Aghion's golden triangle hypothesis. In both models, the threshold value is measured based on the golden threshold variable. Models 1 and 2 are estimated for two categories of countries. a. High-Income Economies including 47 countries and 29 countries with Upper-Middle-

Income Economies b. All sample countries, which include 107 countries. The results of Table 4 show that there is a threshold level in both models and for both categories of countries.

Table 3. Results of panel data unit root test

Variable	Label	D_0		First Differencing	
		Statistic	Z	Statistic	Z
Innovation Index (GII)	$\ln(GII)$	0.8818	5.7977	-0.4679***	-40.0357***
Population	$\ln(POP)$	0.9294	7.5858	0.6178***	-2.8173***
GDP per capita	$\ln(GDP)$	0.8312	3.9004	-0.2046***	-31.0101***
Golden Area	$\ln(Gold)$	0.2112***	-19.3659***	-	-
Golden Difference	$\ln(DiifGold)$	0.6641***	-2.3696***	-	-
Golden Threshold	$\ln(thgold)$	0.2958***	-16.1911***	-	-

Note: *, **, *** refer to statistical significance at the 10%, 5% and 1% respectively.
All variables are calculated logarithmically and entered into the model.
Source: Research findings

Table 4. Threshold estimator and Threshold effect test

	All Economies Sample						
	Threshold estimator (%95)			Threshold effect test			
	Threshold	Lower	Upper	RSS	MSE	Fstat	Prob
Model1	3.3861	3.3361	3.4622	2.4526	0.0029	33.36	0.0033
Model2	3.3861	3.3361	3.4622	2.5442	0.0030	25.24	0.0600
	Upper Middle and high Income Economies						
Model1	3.4168	3.3297	3.4967	0.9998	0.0017	34.48	0.0100
Model2	3.4168	3.3297	3.4967	1.0327	0.0017	20.91	0.0200

Source: Research findings

The estimation results of model (table 4 and figure 4-8), show that the model is divided into high and low regimes in which threshold value is 3.3861 in All Economies Sample and 3.4168 in Upper Middle and high

Income Economies. It is known that there is a structural transition in model at the point of Golden Threshold = 3.3861 in All Economies Sample and Golden Threshold = 3.4168 in Upper Middle and high Income Economies.

Fig 8. LR statistic of thresholds in Upper-Middle- and high Income Economies (Model 1)

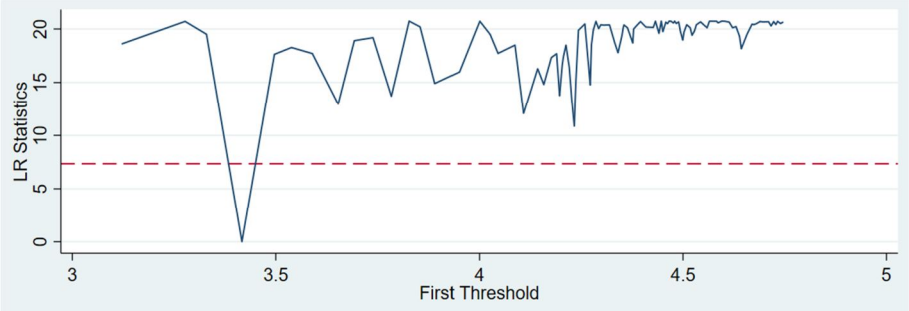

Fig 9. LR statistic of thresholds in Upper-Middle- and high Income Economies (Model 2)

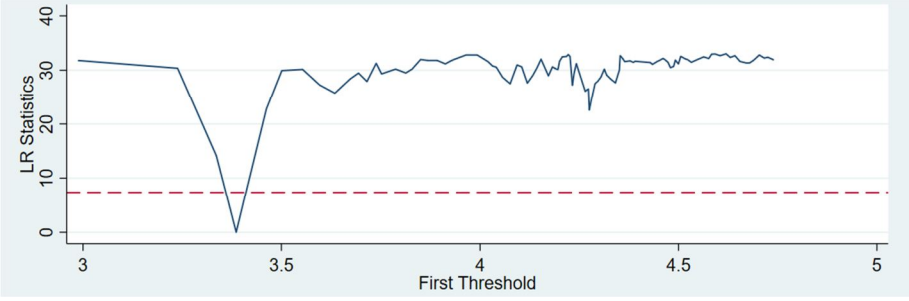

Fig 10. LR statistic of thresholds in All Economies Sample (Model 1**)**

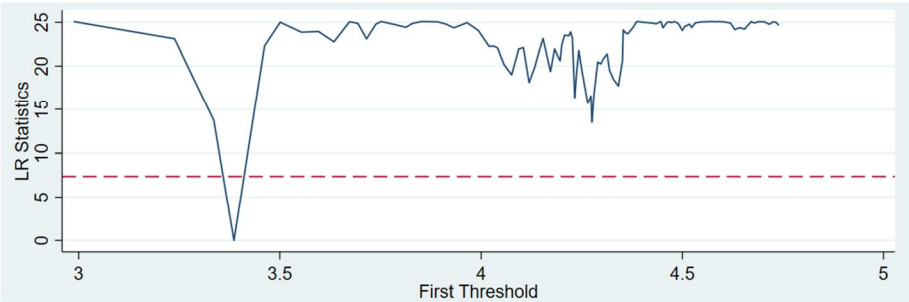

Fig 11. LR statistic of thresholds in All Economies Sample (Model 2)

Consequently, the results in Table 5 lead to the complete PSTR model about the nonlinear relationship between innovation and golden triangle variable. According to the results of Table 5, it can be seen that the golden area variable has a positive effect on innovation growth (The dependent variable is equal to the difference of the logarithm of the innovation index) in the sample of all countries in both regimes. In countries with Upper Middle and high Income, this variable has a positive effect on innovation in values lower than the threshold, that is, in the first regime. In other words, the result of this section shows that if the total area of the golden triangle, which consists of government, civil society and market, is high, innovation growth will increase. In such a way that in values lower than the threshold in the sample of all countries, an increase of one percent in the golden area improves innovation growth by 0.05%, and after the threshold value, this value reaches 0.02%. In the group of high-income countries, an increase of one percent in the golden area can increase innovation growth by more than 0.04% in values less than the threshold, but in values greater than the threshold, the estimated coefficient is not significantly different from zero.

Table 5. PSTR Estimate Results

	All Economies Sample				Upper Middle and high Income			
	Model1		Model2		Model1		Model2	
	Coefficient	prob	Coefficient	prob	Coefficient	prob	Coefficient	prob
$\mathbf{D.ln}(GII)_{t-1}$	-.4219428	0.00	-.435664		-.4997206	0.00	-.4880331	0.00
$\mathbf{D.ln}(POP)_t$	.2853392	0.258	.5638396	0.012	.5290362	0.012	.6995533	0.00
$\mathbf{D.ln}(GDP)_t$	.3078301	0.00	.3347831		.2697216	0.00	.3002454	0.00
$\mathbf{ln}(Gold)_t$								
0	.050697	0.00	-	-	.0435416	0.003	-	-
1	.0204432	0.033	-	-	.0113076	0.428	-	-
$\mathbf{ln}(DiifGold)_t$								
0	-.0964898	0.00	-	-	-.0564363	0.006	-	-
1	-.1218663	0.00	-	-	-.0966174	0.00	-	-
$\mathbf{ln}(thgold)_t$								
0	-	-	.1291621	0.00	-	-	.1316159	0.00
1	-	-	.1018305	0.00	-	-	.1053794	0.00
cons	-.5476096	0.00	-.4754772	0.00	-.4037424	0.00	-.4900112	0.00
F test	1.74	0.00	1.47	0.00	1.94	0.00	1.78	0.00

Source: Research findings

Another important result is that, according to the expectation of the Aghion's golden triangle hypothesis, the increase of the golden difference variable, which is the result of the standard deviation of the three variables in the golden triangle relative to each other, has a negative effect on innovation. According to the estimation results from Model 1, for upper-middle and high-income countries, a 1% increase in the golden difference results in a decrease in innovation growth by more than 0.06% in regimes below the threshold and 0.097% in regimes above the threshold. Similarly, in the sample comprising all countries, a 1% increase in the golden difference leads to a decrease in innovation growth by 0.0965% for values below the threshold and 0.122% for values above the threshold. These findings suggest that for the golden triangle to positively influence innovation and creative destruction, the three components must grow proportionally. Disproportional

increases, while potentially expanding the triangle's overall area, negatively affect the rate of innovation and, in some cases, decrease it. For a more detailed analysis, the two variables were combined to create the secondary variable "Golden Threshold". A larger golden threshold indicates a stronger establishment of Aghion's golden triangle hypothesis, either through a larger triangle area (i.e., larger state, civil society, and market indicators) or smaller differences between the triangle's sides (i.e., lower standard deviation among the state, civil society, and market indicators). Model 2 results for both country groups show that the coefficient for the golden threshold is positive, indicating that improving conditions according to the golden triangle hypothesis enhances innovation. Specifically, a 1% increase in the golden threshold in the upper-middle and high-income sample can increase innovation by 0.131% in the first regime and 0.105% in the second regime. For the sample of all countries, these values are 0.129% and 0.102%, respectively.

6. Conclusion and Recommendations

Creative destruction, a concept introduced by Joseph Schumpeter, refers to the process by which new innovations replace outdated technologies and economic structures, thereby driving economic growth and development. This process is essential for the continuous evolution of markets and the introduction of new products and services. However, for creative destruction to occur, certain conditions must be met, as outlined by the golden triangle hypothesis. The golden triangle hypothesis emphasizes the importance of a balanced interaction between three key pillars: state, civil society, and the market. Each of these pillars plays a distinct and vital role in promoting innovation and facilitating the process of creative destruction. The state provides the regulatory framework and infrastructure necessary for innovation to thrive. It ensures a stable macroeconomic environment, enforces property rights, and invests in public goods such as education and research and development. However, if the government becomes overly

powerful or bureaucratic, it can stifle innovation through excessive regulation and control. Civil society, plays a critical role in fostering innovation by advocating for inclusive policies and holding both the government and market accountable. Civil society organizations can drive social innovation, address market failures, and ensure that the benefits of economic growth are equitably distributed. A vibrant civil society promotes transparency, encourages public participation, and supports the social capital needed for innovative ecosystems to flourish. A dynamic and competitive market environment incentivizes innovation and the efficient allocation of resources. However, if market power becomes concentrated in the hands of a few, it can lead to monopolistic practices and reduce the incentives for innovation. The golden triangle hypothesis asserts that for creative destruction to be most effective, there must be a balance of power among the state, civil society, and the market. If any one of these pillars becomes disproportionately powerful, it can lead to negative outcomes. An imbalance among these three variables can significantly reduce innovation and impede the process of creative destruction. In conclusion, the golden triangle hypothesis highlights the interdependence of government, civil society, and the market in fostering an environment conducive to creative destruction. By maintaining a balance of power among these three pillars, economies can promote sustainable innovation and achieve long-term economic growth.

This research aimed to investigate the establishment of the golden triangle hypothesis. For this purpose, data were collected from 107 countries and analyzed using PSTR models. Prior to estimating the model, it was essential to create indicators to measure the components of the golden triangle. Based on the concepts presented, two primary indexes were developed: the Golden Area Index, which represents the area of the golden triangle for each country and year, and the Golden Difference Index, which represents the standard deviation of the three indicators (state, civil society, and market) for each country and year. By combining these two indicators, the Golden Threshold Index was created to represent the golden triangle

hypothesis comprehensively. The estimation results were obtained for two groups of countries (all sample 107 and Upper Middle and high Income Economies 78 countries) and analyzed using two different models. The most significant findings are summarized as follows: An increase in the Golden Area Index is associated with improved innovation growth and enhanced creative destruction. This suggests that a larger fosters a more conducive environment for innovation. An increase in disparity among the three pillars of the golden triangle (state, civil society, and market) leads to a decrease in innovation growth and a halt in creative destruction. This finding emphasizes the importance of balance among the pillars for sustaining innovation. An increase in the Golden Threshold Index, which encapsulates the golden triangle hypothesis, corresponds with increased innovation growth and the facilitation of creative destruction. In conclusion, the study confirms the significance of the golden triangle hypothesis in promoting innovation and creative destruction. The findings highlight the importance of maintaining a balanced interplay among government, civil society, and market forces to foster an environment conducive to sustainable economic growth. The results of this study provide important insights into the role of the golden triangle—state, market, and civil society—in fostering innovation and creative destruction. Based on these findings, the following policy recommendations are proposed:

1. Promote Balance among the Three Pillars: The study highlights that the balance among the state, market, and civil society is critical for fostering innovation and supporting creative destruction. Policymakers should focus on achieving and maintaining this balance by: A. Strengthening Institutional Quality: Ensure that state institutions effectively enforce property rights, provide stable macroeconomic environments, and support infrastructure development without overstepping into market operations. B. Encouraging Competitive Markets: Create a regulatory environment that fosters competition, discourages monopolistic practices, and incentivizes entrepreneurship. C. Empowering Civil

Society: Support initiatives that enhance social trust, collective action, and participatory governance. This can be achieved through education, community-building programs, and inclusive policy-making.

2. Focus on Reducing Imbalances: The negative impact of the golden difference (imbalance among the three pillars) on innovation underscores the need for policies that address disparities. Specific measures include: A. Reducing over-reliance on any one pillar (e.g., an overly dominant state or market) by ensuring that the other two pillars are adequately empowered. B. Encouraging cross-sector collaboration among government agencies, private sector actors, and civil society organizations to foster mutual accountability and shared goals.
3. The identification of thresholds in the golden triangle dynamics suggests that: Countries below the threshold level of balance should focus on foundational reforms, such as improving institutional capacity, reducing corruption, and ensuring basic freedoms. Countries above the threshold should invest in sustaining their innovation ecosystems by fostering high-value sectors and global competitiveness. By implementing these recommendations, countries can create an environment conducive to sustained innovation, economic growth, and resilience in the face of disruptive changes.

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All authors had contribution in preparing this paper.

Conflicts of interest

The authors declare no conflict of interest.

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