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Balancing green and growth: do innovation and contribution drive sales and environmental performance?

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Abstract
This study examines the impact of industrial innovations and contributions on the new products' sales and environmental performance. The Present study adds to the prior knowledge by incorporating the environmental concerns emanating from the sales of new products. The past literature in this domain is scant, primarily concentrating on overall figures. The impact is analysed using the two-step system Generalised Method of Moments (GMM) regression approaches to analyse 30 provinces' worth of combined data from Chinese firms from 2009 to 2020. The results show that foreign fund flows have a negative effect on new products' sales and environmental performance. Besides, industrial innovation, measured through the effective number of patents, has a positive effect on the sales of new products but a negative impact on their environmental performance. Meanwhile, R&D expenditures positively affect sales and environmental performance of new products. Industrial expenditures positively affect new products' sales and environmental performance by improving manufacturing processes and adopting eco-friendly technologies. The study proposes that policymakers implement policies related to green innovations, sustainable practices and eco-friendly technologies in industrial zones. Adopting efficient R&D strategies can lead to manufacturing products that meet market demands and create less harm to the environment.

Highlights

- Provincial contributions of research and development (R&D) expenditures to product environmental sustainability are examined.
- Industrial expenditures reduce the environmental impact of new product sales.
- The influence of foreign fund flows on the provincial environmental performance of new products is analysed.
- Regional variations in short-run and long-run impacts are explored.

Keywords New product sales · Environmental performance · Industrial innovation · Foreign fund flows · Two-step system GMM · COVID-19

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1 Introduction

In the increasingly evolving industrial landscape, firms must innovate to achieve sustainable growth. New products not only drive economic success but can also contribute to the environmental footprint. The current business environment requires companies to integrate a sustainable strategy for financial gains and ensure environmental conservation while utilising natural resources [1–3]. This is because the current business environment is characterised by volatility, which requires businesses to focus on product innovativeness and sustainable business models if they were to succeed [4, 5]. Therefore, sustainability and innovation research have become a corporate imperative as companies continue to optimise stakeholder and shareholder value [6]. Companies are challenged to devise innovative methods for creating products that meet customers' needs while having minimal negative impact of those products on the environment. New product sales (NPS) play a significant role in industrial growth and competitiveness by meeting customers' demands [7, 8]. It encompasses the different steps and phases of generating new products for sale in the market, including idea generation and screening, development, launch and post-launch assessment. However, this business function has become more prominent in today's world, where companies are constantly competing against each other. To sustain a competitive edge in the market, companies have to create an environment that promotes invention and come up with products and or services that meet the latent demand from the consumers [9]. Proper management of NPS enhances the creation of profits from the untouched market segment, increases sales and revenue, and improves customer satisfaction goals [2, 5].

Similarly, the environmental performance of new products (EPNP) evaluates the impact that companies' new products have on the environment at the usage stage of the new products [10]. EPNP has been a major area of concern in industrial and economic studies, as it becomes crucial to address environmental problems caused by products' manufacturing processes and utilisation [11, 12]. Although new product sales are a vital goal for companies' growth, it has to be realised sustainably without jeopardising the environment [13]. Traditionally, new products' environmental impact has been a concern. This is because production processes require energy consumption and the utilisation of resources that emit pollution and are involved in waste production [10]. However, recent research studies about environmental concerns have highlighted sustainable practices of product production and functionality to minimise ecological impact [14–16]. In addition, utilitarian functions that focus on immediate use could fail to consider environmental aspects such as product disposal and the risk of volatile substances leaching into the environment over the product life cycle. Thus, manufacturing new products with a sustainable perspective should go beyond functional thinking and involve consideration of the life-cycle context and potential environmental impacts [17]. For instance, a newly developed product that holds the potential to enhance energy performance or be less ecologically harmful would contribute positively to the industry's environmental impact.

This research examines the impact of industrial contributions, innovations, and foreign fund flows on the sales and environmental performance of new products. Today's business environment is characterised by continued industrial development, leading to the impact on the natural environment by introducing new products. Several factors affect the sales and the environmental performance of new products, such as the flow of foreign funds being a crucial mechanism for providing the capital required for the research and development of new products and marketing them. These funds also trigger other incentives such as technology transfers and boosting of the managerial capacity [18, 19]. Industrial innovations include the effective number of invention patents and R&D expenditures, which are the main propellers of technology advancement and product differentiation. Patents depict the outcome of the invention and offer legal backing and marketing advantage to newly invented products [20]. Zwolak [21] highlighted that patents also serve not only as signals of innovation competencies of the companies but also their abilities to capitalise on newly emerged opportunities in the market by offering unique products. R&D expenses portray the industrial apportioned effort towards improving technology practices and new product advancement. When companies decide to spend more on R&D, it results in the development of new advanced technologies and the production of unique products [22, 23]. These industrial innovation elements are crucial to sustaining the competitive advantage, especially in today's world characterised by globalisation and technological advancement. In the same way, industrial contributions, including value-added of industry and industrial expenditures, are also significant in the development and appropriate marketing of new products. The value added represents the relative performance and efficiency of the industrial sector's operations [24]. A high value-added signifies the willingness and ability of an industrial division to generate high economic value, which in return provides more funds for the development of new products. Lastly, industrial expenditures include capital costs for infrastructure development and manufacturing facilities, costs of

machinery and equipment, and manufacturing expenses. Large industrial expenditures are signs of a sound investment climate and a capacity to sustain and strengthen industry. This, in turn, facilitates industries to fund large-scale production and commercialisation of new products that can drive sales. In addition, the investments for environmental sustainability concerning industrial expenditures enhance the environmental effectiveness of new products [25, 26]. The resource-based view (RBV) theory postulates that the firm's competitive strategic position is based on the efficient use of a valuable resource stock at its disposal. This theory elaborates that the industrial contributions in terms of R&D expenditure, foreign inflow of funds and the number of new product invention patents are critical in the development of new products and their environmental performance [27]. Therefore, based on RBV, utilising these resources would bring a competitive advantage and thus enhance new product sales and environmental sustainability [28]. Our study focused on the Chinese firms.

China was selected for our study because, as the second-largest economy in the world, it has rapidly industrialised and developed in recent decades, making it a vital case study for examining the relationship between industrial innovation and sustainability. This has led to environmental concerns as more production causes more emissions. Currently, China contributes 27% of emissions worldwide and is the third largest emitter of green gases globally [29]. By 2060, China must invest up to 17 trillion dollars in green infrastructure for the power and transport sectors to achieve carbon neutrality across these key areas. In 2022, the Global Environmental Performance Report indexed China as the 160th-ranked country out of 180 [30]. In the current period, China's economy has shifted to a new normal, where the quality of development has become the key driver of China's economic growth. This implies that each new product introduced in this economy should consider how it would affect ecological footprints. The noticeable growth in the Chinese economy has increased the development and sales of new products in various sectors. Hence, it makes a perfect scenario for this research to measure the environmental performance of new products in China. In addition, past studies have only highlighted the influence of industrial factors, market strategies and product characteristics on NPS [5, 13]. However, the existing literature lacks studies that shed light on the effect of industrial innovations, contributions, and foreign funds flows on the NPS and environmental performance. Moreover, the environmental performance of overall sales has been the focus of existing literature, and a meagre amount of literature exists that focuses particularly on new products. This paper also adds value by exploring the data on the provincial level and comparing eastern, central and western regions of China. Finally, this study aims to bridge this research gap by analysing the impact of industrial innovations, contributions, and foreign fund flows on the sales and environmental performance of new products in China. Such a dual focus in the current study not only meets the research gap but also indicates the industrial strategies for generating substantial sales and eco-friendly products. We applied a range of methodological variations to estimate the causal relationships. Our basic analysis based on two-step GMM regression addresses the endogeneity problem. We decomposed our data into eastern, central and western regions and applied short-run and long-term parameters to capture regional differences.

2 Theoretical developments

In recent years, there has been growing interest in researching the relationship between industrial contribution and innovations as well as sales and environmental performance of new products [18, 20, 31]. The elevated attention is due to the increasing ecological concerns, climate change and mounting pressure from the government for environmental sustainability in industrial operations. This situation makes the companies more cautious in product development [24, 32]. The subsequent sections provide a literature review on the relationship between foreign fund flows, industrial contributions and innovations, sales and environmental performance of new products.

2.1 Foreign fund flows and NPS

Foreign funds refer to foreign investments that promote economic activities in a country. It admits foreign capital and the creation of employment opportunities, as well as the improvement of the purchasing power of consumers. This results in high demand for new products because the consumer has greater disposable income to purchase new products [33]. Foreign investment provides financial support accompanied by efficient management skills, new technologies practices and global standards to ease the manufacturing of new products and availing them to the market [22]. Additionally, Bekmurodova [34] noted that foreign investors usually gain better market experience and established networks of sales channels through which they introduce new products quickly and efficiently into the market. Ezeji et al. [19] stated that the positive impact of foreign funds inflow cannot be generalised since it highly depends on the host country's legal

environment, industrial specialisations, and the capability of domestic companies to absorb such inflows. For instance, countries that provide the right legal framework and an efficient regulatory framework attract FDI, which may be useful in the sale of new products [35]. Additionally, Branstetter and Saggi [36] highlighted that industries open to international competition and technologically advanced receive more significant benefits from foreign funds. Nevertheless, the inflows of foreign funds do not act as a positive factor for new product sales always. Li et al. [37] argued that fluctuations in international investment could cause economic instabilities associated with lower expenditures of customers. This is seen to have hurt the sales of new products, as customers tend to spend less on their consumption patterns. However, another negative impact of FDI relevant to the sale of new products is that foreign investment introduces extra competition in the market, making it difficult for local firms to sell the new products [38].

H1: An increase in foreign fund flow to the industry elevates new product sales.

2.2 Industrial Innovations and NPS

The effective number of invention patents directly influences the potential revenue streams for a new product sale and helps to gain a foothold in the market [21]. Jarchow and Röhm [20] stated that a strong patent could offer the necessary commercial monopoly to guarantee a good return on investment. Chavez and Chen [39] demonstrated that patents are likely to increase the speed with which new products are launched, especially for those marketed internationally, thus bringing higher first-entry prices and higher revenues for multinational firms. In addition, the R&D investment and invention patents catalyse the companies' revenue, profit, and value in the capital market [40]. The extension of patent protection has also boosted U.S. export variety and quantity, with new products driving a substantial portion of the export increase [20]. Conversely, Zwolak [21] studied the Polish industry from 2015 to 2017 and found that the effective number of innovation patents may not directly boost sales as much. However, they improve the effectiveness of innovation spending. This innovative spending ultimately leads to increased sales and revenues of new products. The sales performance of the new product is greatly influenced by the amount spent on R&D. Hariandja [41] indicated that companies with higher R&D investments experience tremendous success in launching and selling new products. According to Kazan and Baydar [42], firms with strong R&D plans perform better than those that need transparent and sustainable R&D strategies. Further, R&D expenditures result in the acquisition of more patents, which upgrade exports to high-technology goods, thus improving innovative development and sale of new products [31].

H2: ncrease in industrial innovations elevates new product sales.

2.3 Industrial contribution and NPS

Industrial expenditures contribute significantly towards the sale of new products in the market. More spending allows firms to develop new products that create new demand and boost sales [43]. Purchase and Volery [44] emphasised that the amount and structure of innovation costs significantly affect the range of new products sold. In addition, the survival and development of companies depend on new product development. Marzi et al. [45] elaborated that new product development makes up a significant share of the overall sales and profits, thus underlining the significance of innovativeness for economic growth and business performance. According to Shen et al. [26], marketing communication, which involves key marketing strategies prepared on sound financial backing, makes it easier to convey the products' value proposition and influences the consumers to make purchases. In addition, the introduction of new products in the market is often accelerated by aggressive promotional strategies of the products, as supported by Rogers [46] in his diffusion of innovations theory. Industrial value added is crucial for boosting new product sales, resulting in substantial returns that foster the growth and progress of companies [45]. Hence, it is essential to identify consumer preferences and market factors that influence the demand for new products, whereby marketing strategies and credence attributes are pivotal to the sales and revenue outcomes [24]. Zawada and Marn [47] argued that subtle features that improve performance, functionality or service delivery give products a competitive edge over their rivals, which is optimally used to support high price tags. Mesa and González [48] emphasised that the value added can be achieved through technologically innovative design and enhanced product life cycle by incorporating additional services and warranties.

H3: Higher industrial contributions elevate new product sales.

2.4 Foreign fund flows and EPNP

Foreign investments often introduce sophisticated technologies, managerial skills and improvements in energy conservation and environmental optimisation. Zilja et al. [49] revealed that MNEs are more environmentally sensitive than domestic firms in the host nation due to corporate responsibilities and the use of advanced technology. This leads to lesser energy consumption in industries and hence less emission of greenhouse gases. However, there is evidence of the pollution haven hypothesis, which indicates that foreign investors take advantage of the inferior environmental standards in developing countries, leading to increased environmental degradation. Kahouli and Chaaben [50] noted that the degree of stringency of environmental regulations and the robust enforcement mechanism, are more likely to attract foreign investment that underpins sustainable industrial practices.

H4 Increase in foreign fund flow to industry lead to the environmental performance of new products.

2.5 Industrial innovations and EPNP

According to Bermúdez et al. [11], there is a positive relationship between the quantity of invention patents and enhanced environmental performance. Oltra et al. [51] showed that areas with a high level of patenting are likely to display higher levels of efficiency while using energy and lower emissions. This is because new invention patents integrate technologies that are energy-efficient and environmentally friendly [52]. New patents have greater economic applications and perform well in commercial operations, and there is a likelihood to have a positive effect indexed by an increase in environmental performance. According to Su and Moaniba [53], the quality of patents contributes to energy efficiency and reduces greenhouse gas emissions. Moreover, patents related to clean technologies have a positive impact in cutting down the adverse energy consumption in industries and its effects on environmental deterioration [11]. RND is vital when introducing innovations and creating new eco-friendly products. Alam et al. [23] studied a positive relationship between R&D investments and the environmental performance of new products, as demonstrated by the energy and carbon efficiency of firms in G-6 countries. Another similar study by Chen et al. [54] established that R&D activities and green technology that reduce various environmental effects have a positive relationship.

Research also shows that significant investment in R&D is associated with innovation in the technologies used in the industries, which have less impact on the environment and conform to high standards of environmental laws [55]. Moreover, it is imperative to point out that the nature of the relationship between R&D and ecological performance is not straightforward, and some of the studies suggest a negative link between R&D and environmental performance, more specifically, eco-innovation and pro-environmental actions of businesses [22].

H5: Increase in industrial innovations lead to the environmental performance of new products.

2.6 Industrial contribution and EPNP

Literature on the relationship between industrial expenditure and environmental performance is scarce. Recent research focuses on environmental regulations and how they help cope with environmental concerns. Liu et al. [56] pointed out that high levels of environmental regulation may lead to increased budgets and practices for sustainable practices, thus benefiting the environmental performance of new products. However, current data supports the link between environmental performance and value addition. Chen et al. [57] referred to a positive impact value addition on environmental performance and inferred that industrial expenditure on energy-efficient equipment and clean technology act as path mechanisms. Similarly, Zhang et al. [58] also made a similar proposition and regarded clean energy consumption as a reason for this phenomenon. MacArthur [59] described the circular economy as a process where products are designed with longer lifespans, re-used, and recycled, and thus add value to how companies work by minimising their environmental footprint. In their study, Negri et al. [60] noted that the integration of environmental factors into a supply chain contributes to enhanced product sustainability. Hence, using mechanisms that enhance green supply chain management, industries can create value that ultimately leads to minimised waste and optimal utilisation of resources. Kumar et al. [61] suggested a global trend where consumers are willing to purchase

products that have environmentally friendly characteristics. This consumer preference drives industries to bring sustainable practices, hence, adding value and improving the environmental efficiency of the products.

H6: Higher industrial contributions lead to the environmental performance of new products.

3 Methodology

3.1 Data, sample and variables

We analysed the influence of foreign fund flows, industrial innovations, and contributions on the sales and environmental performance of new products. Thirty provinces' worth of combined data from Chinese firms was used in the analysis. The data was obtained from the statistical yearbook database of China over the years 2009 to 2020. New product sales and the environmental performance of new products are the two dependent variables in this study. At the same time, the independent variables include foreign fund flows and industrial innovations (including an effective number of patents and R&D expenditure). The industrial contributions composed of value added of industry and industrial expenditures are also among the independent variables. Moreover, we also included COVID-19 to assess the impact of the pandemic during the study period. It is measured as a binary variable; its value is treated as 1 in the years of the pandemic and zero otherwise. Table 1 provides a further description of all study variables.

3.2 Empirical strategy

The empirical strategy of the current study involves examining the relationship among the dependent variables, namely, lnNPS (natural logarithm of new product sales) and EP (environmental performance of new products), along with other independent variables. The independent variables include lnFFF (natural logarithm of foreign fund flows), lnR&D (natural logarithm of research and development expenditures), lnENIP (natural logarithm of an effective number of invention patents), lnIE (natural logarithm of industrial expenditures), and lnAVI (natural logarithm of value added of industry). In addition, the COVID-19 variable is incorporated as a control variable to capture the influence of the pandemic. The econometric model equations are as follows:

$$\mathbf{lnNPS_{it}} = \propto + \boldsymbol{\beta}_1\left(\mathbf{lnFFF_{it}}\right) + \boldsymbol{\beta}_2\left(\mathbf{lnENIP_{it}}\right) + \boldsymbol{\beta}_3\left(\mathbf{lnR\&D_{it}}\right) + \boldsymbol{\beta}_4\left(\mathbf{lnIE_{it}}\right) + \boldsymbol{\beta}_5\left(\mathbf{lnAVI_{it}}\right) + \boldsymbol{\beta}_6\left(\mathbf{COVID-19_{it}}\right) + \boldsymbol{\alpha}_\mathbf{i} + \boldsymbol{\varepsilon}_\mathbf{t} \quad (1)$$

$$\mathbf{EPNP_{it}} = \propto + \boldsymbol{\beta}_1\left(\mathbf{lnFFF_{it}}\right) + \boldsymbol{\beta}_2\left(\mathbf{lnENIP_{it}}\right) + \boldsymbol{\beta}_3\left(\mathbf{lnRND_{it}}\right) + \boldsymbol{\beta}_4\left(\mathbf{lnIE_{it}}\right) + \boldsymbol{\beta}_5\left(\mathbf{lnAVI_{it}}\right) + \boldsymbol{\beta}_6\left(\mathbf{COVID-19_{it}}\right) + \boldsymbol{\alpha}_\mathbf{i} + \boldsymbol{\varepsilon}_\mathbf{t} \quad (2)$$

Equation 1 illustrates the potential impact of β_1, β_2, β_3, β_4, β_5, and β_6 on the new product sales, which is represented as lnNPS. While Eq. 2 depicts the impact of β_1, β_2, β_3, β_4, β_5, and β_6 on EPNP (Environmental Performance of New Products). The subscripts i and t refer to province and year, respectively. The term α_i expresses the systematic influence of individual characteristics, while the error term ε_t reflects random influences within the model. Figure 1 illustrates the main study model.

Table 1 presents the explanation and descriptive statistics of the study variables. It encompasses variables' definitions, sample size, mean, standard deviation, minimum and maximum values. The sample is balanced panel data from 30 provinces' worth of combined data from Chinese firms between 2009 and 2020, and 360 were the total observations. The mean value of lnNPS indicates that companies' new products are moderately successful. However, there is still room for improvement in terms of sales elevation. Similarly, the mean value of EPNP indicates that companies effectively implement eco-friendly product development strategies and processes. These sustainable practices improve companies' product sales figures. The mean value of β_1 shows a moderate flow of foreign funds to the local economic market. There is still a need to improve policies, infrastructure and market stability to boost foreign fund flows. Moreover, the mean values of β_3 and β_5 indicate a need to invest more in research and development, infrastructure enhancement and technological advancement within the industrial sector. These investments are necessary to meet the ever-evolving customers' needs.

Table 1 Descriptive statistics

Variables	Symbol	Definition	Mean	S. D	Min.	Max.	Obs.
New Product Sales	lnNPS	Value of province-wise total sales of new products	14.7562	2.1809	5.3692	19.269	360
Environmental Performance of New Products	EPNP	The environmental efficiency of new products, calculated as NPS divided by total energy consumption in terms of metric tons of coal	697.097	1031.91	0.0836	6769.97	360
Foreign Fund Flows	lnFFF	The inward flow of capital from foreign sources into the industry at the provincial level	13.7059	2.50859	6.0282	17.8965	360
Effective Number of Invention Patent	lnENIP	The measure of innovation that quantifies the impact of the province-wise effective number of patents granted for inventions	7.2628	2.0068	0	12.5106	360
Research and Development Expenditures	lnR&D	Province-wise Industrial investment in innovation and technological advancement	12.3162	1.8551	5.8888	16.4461	360
Industrial Expenditures	lnIE	Province wise Industrial expenditure on new product development	12.4671	1.8653	6.5656	16.9716	360
Added New Value of Industry	lnAVI	High tech Industry contribution through production, innovation and other value-added activities	8.8783	0.9319	6.0945	10.6980	360

The notation 'ln' depicts that the data is transformed into logarithmic form

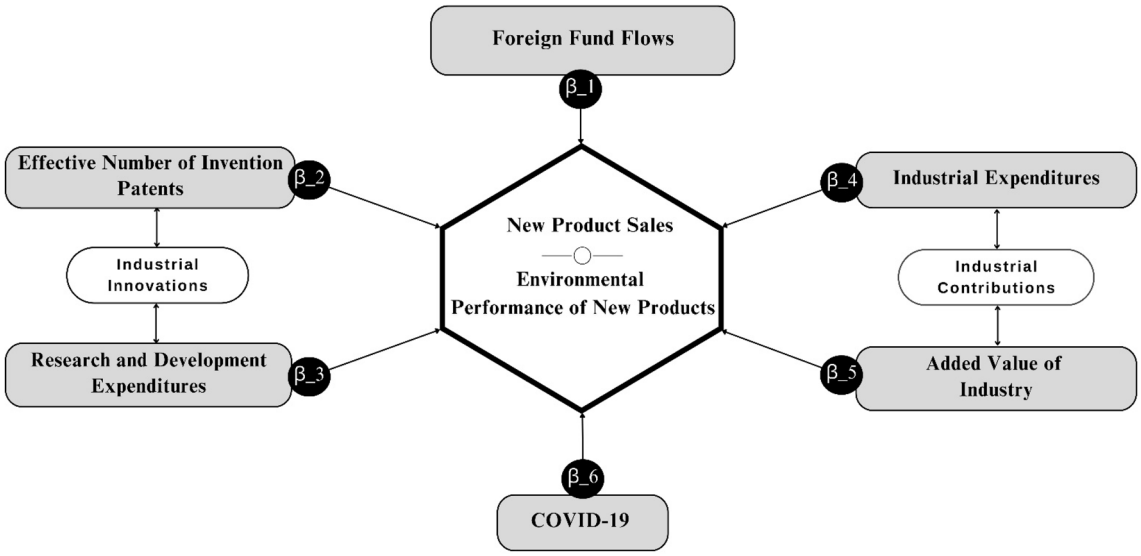

Fig. 1 Visual description of the study model

4 Results and interpretation

We conducted various tests to analyse data and assess model efficacy. These tests are the first and second-generation unit roots tests to determine the stationarity of the data. The two-step system generalised method of Moments (GMM) introduced by Blundell and Bond [62] is used as the primary regression technique. It is a dynamic model, which is far better than static models. Regarding contemporaneous panel data (N > T), the GMM models are better estimators. Moreover, the endogeneity problem is solved, and we do not need to worry about several assumptions of static regression models [63, 64]. The two-step system GMM model is also desirable as it improves efficiency and curtails biases [65]. We applied the short-run and long-run pooled mean group autoregressive distributed lag approach (PMG-ARDL) and dynamic fixed effect (DFE) regressions to check the robustness of the findings. We applied panel ARDL to the regional data, and the number of cross-sections was divided into regions, making the resultant temporal data panels. There is often a preference for ARDL over GMM regressions in region-wise provincial analysis.

4.1 Unit root and multi-collinearity analysis

Table 2 presents the results of unit root tests; Im, Pesaran, and Shin (IPS) and Fisher augmented Dickey-fuller (FADF). Both tests are applied to check the stationarity of the data to avoid erroneous conclusions. The findings in our case show that all variables are significant and stationary at a level with p-values of less than 1%. All variables except EP

Table 2 First-generation panel unit root test

Variables	IPS		FADF	
	I (0)	I (1)	I (0)	I (1)
LnNPS	− 2.12***	–	157.2***	–
EP	5.95	− 3.42***	28.29	138.15***
LnFFF	− 4.54***	–	195.28***	–
lnENIP	− 7.66***	–	316.2***	–
LnR&D	− 5.89***	–	284.86***	–
LnIE	− 4.74***	–	201.96***	–
lnAVI	− 2.48**	–	102.46***	–

***, **, and * represent 1%, 5%, and 10% significance levels, respectively

Table 3 Second-generation panel unit root test

Variables	CIPS		CADF	
	I (0)	I (1)	I (0)	I (1)
lnNPS	− 2.02**	–	− 2.11**	–
EP	− 1.56	− 2.31***	− 1.74	− 2.315**
lnFFF	− 1.63	− 3.6***	− 1.34	− 2.18**
lnENIP	− 2.51***	–	− 2.69***	–
lnR&D	− 1.93	− 3.35***	− 2.28***	–
lnIE	− 2.24***	–	− 2.22***	–
lnAVI	− 0.94	− 2.62***	− 0.74	− 2.01*

***, **, and * represent 1%, 5%, and 10% significance levels, respectively

Table 4 Variance inflation factor

Variables	VIF	1/VIF
LnFFF	3.61	0.277
LnENIP	1.98	0.506
LnR&D	2.72	0.367
LnIE	1.95	0.512
LnAVI	1.78	0.563
Mean	2.41	

are stationary with no lagged difference. Meanwhile, EP is significant and stationary at the first lagged difference. Since the data is stationary, we reject the null hypothesis because there are no unit roots.

Table 3 shows the findings of second-generation unit root tests. IPS and FADF tests are applied to evaluate the stationarity of the data. In the second-generation test, lnNPS, lnENIP, and $\ln IE_{are}$ stationary with significant p-values and no lagged difference. Meanwhile, other variables EP, lnFFF, lnR&D, and lnAVI are significant and stationary at the first lagged difference. The second-generation unit roots tests are relevant to panel data. These tests account for the non-stationarity of the data across both time and cross-section dimensions. The first-generation unit root test assumes cross-sectional independence between observations in the panel data. However, second-generation unit root tests overcome this limitation. These tests consider cross-sectional dependency among observations in the data [66, 67]. This consideration enhances the potency of second-generation tests in determining the unit roots in the data. Table 4 reports the variance inflating factor (VIF) values to estimate the possibility of multicollinearity issues among variables. This situation refers to a high correlation among independent variables. Since we have several VIFS, the mean value is preferred for conclusions. Studenmund [68] stated that a VIF value greater than 10 portrays severe multicollinearity of independent variables. In our case, the VIF estimates are much smaller when compared to the cut-off point.

4.2 Main regression results

Table 5 presents the main results of the two-step system GMM regression. Model 1 highlights the influence of all independent variables on new product sales is a new product sale. In model 1, foreign fund flows have a negative and significant impact on new product sales. This means that when foreign funds flow into the country, it can lead to fluctuations in exchange rates. This situation creates uncertain economic conditions for companies and makes it harder for them to execute and launch new products. Baldwin and Krufram [69] argued that exchange rate fluctuations discourage companies from investing in new products. Foreign funds often increase the competition because foreign firms enter the local market. The presence of foreign companies usually makes it challenging for local companies to introduce and sell new products [70]. The effective number of invention patents has a positive and significant effect on new product sales. It suggests that an increase in the number of invention patents elevates the sale of new products. Patents signify innovation and technological advancement. Therefore, these patents lead to the manufacturing of improved and advanced new products, which ultimately boost sales. Smith [71] noted that holding invention patents enhances companies' competitive edge and makes it possible for them to capitalise on market opportunities and sell more products. Research and Development expenditures have a positive and significant impact on new product sales. This indicates that R & D expenditures

Table 5 Regression results at the National level

Variables	Two-step system GMM regression	
	Model 1	Model 2
LnFFF	– 0.0834***	– 7.3691*
LnENIP	0.0814***	– 40.9634**
LnR&D	0.4814***	99.2845***
LnIE	0.4836***	86.9512***
LnAVI	– 0.3374***	8.9074**
COVID-19	– 0.1360***	107.8465***
Sargan Test	18.9018	18.5248
AR (1)	– 1.9263*	– 1.7092*
AR (2)	0.3579	0.7806

***, **, and * represent 1%, 5%, and 10% significance levels, respectively

enhance the innovative capabilities of the companies. It enables companies to develop more novel products that meet ever-evolving customer needs [72]. Industrial expenditures have a positive and significant impact on new product sales. It shows that high industrial expenditures directly enhance the sale of new products through investments in research and development, production processes, technological advancements, and marketing awareness. Gupta et al. [73] suggested that investing in marketing awareness could interest customers in new products that stimulate sales. Added new value of industry has a positive and significant impact on new product sales. This indicates that the high added value of the industry reflects the advanced market with established players and saturated customer needs. It is challenging in this case to introduce and sell new products. The COVID-19 pandemic had a negative and significant impact on new product sales. This indicates that the pandemic disrupted the global supply chain, resulting in shortages and delays in production of new products. Job losses and reduced incomes dampened product sales.

Similarly, model 2 includes the impact of independent variables on EPNP. Foreign fund flows have a negative and significant impact on the environmental performance of new products at a ten per cent level of significance. This indicates that foreign fund flows often prioritise short-term gains rather than long-term sustainability goals. This prioritisation leads companies to invest funds in other profit-yielding businesses rather than environmentally friendly green innovations [74]. The effective number of invention patents has a negative and significant impact on the environmental performance of new products. This suggests that companies focusing on patenting innovation activities often neglect ecologically friendly innovations in new products [75]. Research and Development expenditures have a positive and significant impact on the environmental performance of new products. This suggests that robust R&D initiatives often integrate green innovations and technologies during product development [76]. Industrial expenditures have a positive and significant impact on the environmental performance of new products. This indicates that increasing resource allocation by the industrial sector to green initiatives often results in the improved environmental performance of products. Added new value of industry has a positive and significant impact on the environmental performance of new products. This suggests that industries with higher added value often produce green products with better environmental performance. Higher-added value industries have better resources and capabilities to invest in research and development. This investment results in innovations that improve the environmental performance of new products. The COVID-19 pandemic had a positive and significant impact on the environmental performance of new products. This indicates that the pandemic heightened the awareness of environmental issues that led companies to adopt eco-friendly practices in product manufacturing [77]. We also applied the Sargan test, and the resulting p-values are *(18.9018 > 0.05)* and *(18.5248 > 0.05)* for both models 1 and 2, respectively. It suggests that instrumental variables are exogenous, and we cannot reject the null hypothesis because all the instruments are valid.

4.3 Robustness check with PMG and DFE approaches

Table 6 presents the long-run and short-run findings of PMG and DFE regressions for new product sales in the eastern, central and western regions. In the Eastern region, the foreign fund flows and the effective number of invention patents have a negative impact on new product sales in the long run, while they have a positive impact in the short run. The finding indicates that the foreign fund flows, the effective number of invention patents and R&D expenditures influence new product sales in the short run due to immediate capital influx and technological advancement [78]. However, the

Table 6 Dynamic analysis for lnNPS

Variable	Eastern Region		Central Region		Western Region	
	PMG	DFE	PMG	DFE	PMG	DFE
Long run parameters						
LnFFF	− 0.1919**	− 0.2223	1.0072***	0.3643**	0.0834*	0.0823
LnENIP	− 0.0968***	− 0.0763	0.6459***	0.2695	0.0114***	0.0704*
LnR&D	− 0.1509	0.5507	0.7099***	− 0.5979**	0.0481	0.5404
LnIE	0.7728***	− 1.2697*	− 0.7402***	− 0.0256	0.1536***	0.0032**
LnAVI	− 0.23693	0.4571	− 0.0549	− 0.3217	− 0.3374	− 0.0073
Average Convergence Parameter						
ECT (i)	− 0.646***	− 0.2980***	− 0.567***	− 0.6912***	− 0.2047**	− 0.6412***
Short run parameters						
LnFFF	0.0812	0.0074	− 0.2748	− 0.5861***	− 0.0834*	− 0.0823**
LnENIP	0.0858	0.0592	− 0.4078***	− 0.1462	0.0114**	0.0704*
LnR&D	0.1948	0.3202*	0.3475	0.0729	0.0481*	0.5404*
LnIE	0.2056	0.1107	0.1426	0.1661	0.1536	0.0032
LnAVI	− 0.2974	− 0.2255	0.6237	0.0948	− 0.3374	− 0.0073
Hausman Test	***0.11***		***0.60***		***0.59***	

***, ** and * represent 1%, 5% and 10% significance levels, respectively

long-term reliance on foreign funds and patents may hinder domestic innovative developments and sustainable growth. From industrial contributions, industrial expenditures have a positive impact on new product sales in the short run and a negative impact in the long run. The positive impact in the short term is due to adoptive innovations and meeting immediate consumer needs. The negative impact in the long run is due to market saturation and increased competition, which reduces sales.

In the Western region, the foreign fund flows and the effective number of invention patents have a positive impact on new product sales in the long run while negative in the short run. The industrial contributions include R&D expenditures, industrial expenditures and added new value of industry negatively impact the new product sales in the long run while positively in the short run. The results demonstrate that the central region relies on foreign funds and innovative patents for unique product success [79]. In the Western region, the findings show mixed impacts on new product sales. The foreign fund flows positively impact new product sales in the long run and negatively in the short run, due to dependence on foreign investments that fuel innovation and production processes [80]. The effective number of invention patents has a positive and significant effect on new product sales in the short and long run. This is because patents protect new and unique products and grant market and product control rights and incentives to companies to invest in product development, resulting in more product sales. The R&D and industrial expenditures have significant and positive effect on new product sales in both the short-run and long-run models. According to Caglar and Nisel [81], industrial and R&D expenditures enhance industries' capability to innovate production processes and technological advancement, improving product development and sales.

Table 7 presents the long-run and short-run findings of PMG and DFE regressions for EPNP in the eastern, central and western regions. In the Eastern region, the foreign fund flows have a negative impact on the environmental performance of new products in the short run and a positive impact in the long run. Foreign investments often prioritise financial gains ahead of environmental concerns. This leads companies to focus on production speed and cost reduction. Therefore, companies neglect environmental laws and forego investment in green technologies [82]. The effective number of invention patents has a negative impact on the environmental performance of new products in the long run and a positive impact in the short run. In the long- run, excessive patents can stifle innovations and competition by creating monopolies. This results in declarations of innovative green technology products, ultimately leading to environmental concerns about new products [83]. The R&D and industrial expenditures positively impact the environmental performance of new products in the long run and negatively in the short run. In the long run, the increased investment in industrial and R&D expenditures positively impacts the environmental performance of new products due to sustainable green practices and processes [84].

Besides, in the central region, the impacts of foreign fund flows, effective number of invention patents, R&D expenditures, industrial expenditures and added new value of industry are the same as in the eastern region in both long and

Table 7 Dynamic analysis for EPNP

Variable	Eastern Region		Central Region		Western Region	
	PMG	DFE	PMG	DFE	PMG	DFE
Long run parameters						
LnFFF	0.1429**	0.1723**	1.025***	0.3243	− 0.8641*	− 0.9122*
LnENIP	− 0.0942**	− 0.1762	0.2349*	− 0.2452	− 0.0243**	0.1344
LnR&D	0.1541*	0.1107	0.6443**	0.0179**	0.9421	− 0.3524
LnIE	0.7628**	1.0097*	0.7242*	0.0258**	0.0414*	0.13532*
LnAVI	− 0.2143*	− 0.4514*	− 0.1549	0.3127	− 0.0134	− 0.1343
Average Convergence Parameter						
ECT (φi)	− 0.426***	− 0.2620***	− 0.0217***	− 0.1242***	− 0.0417**	− 0.6124***
Short run parameters						
LnFFF	− 0.0562	− 0.1714	− 0.0528	− 0.2461*	0.0421*	0.851*
LnENIP	0.0761	0.1362	0.0833**	0.6643	0.0981*	0.0146*
LnR&D	− 0.1751	0.146*	− 0.9715	− 0.0743	0.9862*	0.0145*
LnIE	− 0.2641	− 0.0137	0.6426	− 0.4262	0.7342	0.0641
LnAVI	0.2614	0.8715	0.1467	0.6413	0.7542	− 0.0641
Hausman test	0.61		0.42		0.64	

***, ** and * represent 1%, 5% and 10% significance levels, respectively

short runs. In the case of the western region, the results are contrary to those of the central and Eastern regions. In the Western region, foreign fund flows, the effective number of invention patents, R&D expenditures, industrial expenditures, and added new value of industry have a positive impact on the environmental performance of new products in the short run while negative effects in the long run. Foreign fund flows and industrial expenditures as well as R&D expenditures might initially provide resources for technology and green product development, leading to a temporary improvement in environmental performance of new products [85]. Overtime, industrial activities strain resource availability and lead to environmental concerns if not managed properly. This has the potential to offset the early gains of greener technologies [86]. The Hausman test is applied to select the most efficient estimator between PMG and DFE in both Tables 6 and 7. The p-values of eastern, central and western regions are greater than 0.05, which indicates that we cannot reject the null hypothesis. Therefore, we select the PMG approach as the most efficient estimator for all three regions.

5 Discussion

With the ever-changing industrial landscape, companies must develop sustainable innovations for economic growth. New products not only drive economic success but can also contribute to the environmental footprint [1–3]. Today's business environment requires companies to integrate a sustainable strategy for financial gains and ensure environmental conservation and sustainable utilisation of natural resources [58]. Based on the findings, foreign fund flows harm sales and environmental performance of new products. Wang et al. [87] established that foreign fund flows lower local product sales due to the entry of foreign multinational corporations. Wu et al. [88] suggested that this relationship becomes meaningful if not studied in isolation. Technological capability and market orientation results can help to achieve superior new product sales. Besides, foreign investors seek high returns and pressure companies to concentrate on steep sale volumes. Therefore, sometimes companies overlook sustainable green practices in their processes. To meet the investors' demands, companies sacrifice quality and invent environmentally unsustainable production processes or cheapen merchandise [89]. This results in new product launches with inadequate attention to environmental sustainability and other aspects of value to the consumer [24, 32]. From the industrial innovation domain, this study established that the effective number of patents has a significant and positive effect on the sales of new products but exerts a negative effect on the environmental performance of the new product. Effective innovative patents can provide companies with a temporary monopoly for the new product [90]. It enables them to charge high prices and, in the process, they win market share implying more sales. However, the features that facilitate the saleability and affordability of produce, may dominate environmental considerations. As competitors cannot implement the invention, there is less pressure at the early stages to look for eco-friendly alternatives. This results in new products with a larger environmental footprint [91] Moreover,

R&D expenditures enhance the sales and environmental performance of new products. R&D investment ensures that companies develop unique features and environmentally friendly products, as consumers are now inclined towards buying such products [40]. These innovations attract eco-conscious customers and enhance environmental sustainability by reducing waste production and emissions to meet legal requirements and community values.

Industrial contributions were proxied by industrial expenditures and value-added of the industry. The study findings showed that industrial expenditures enhance sales and environmental performance of new products. Industrial expenditures result in more effective manufacturing technologies and better production processes, which in turn increase the quality of the products and their competitiveness in the market. This, in turn, increases sales figures [24, 25]. However, the value added by the industry negatively impacted sales while positively impacted environmental performance. Elevated competition and strong established players make it harder for new entrants to penetrate the market, which limits sales [92, 93]. However, established industries with well-added value are better equipped to invest in sustainable practices and innovations, resulting in improved environmental performance [94]. New product sales declined during COVID-19, mainly because of the economic pressure and changes in consumer behaviour. Consumers were more inclined to purchase necessities rather than new products, and lockdown measures restricted physical store shopping and sales declined [95]. Additionally, with reduced industrial activities and transportation, emissions and pollution levels dropped, which had a positive effect on reducing environmental impact. The following paragraph cites the limitations of the study.

The study limitations include sensitivity to hyperparameters since a lack of sensitivity analysis may affect the robustness of conclusions. Additionally, computational complexity caused by analysing a large dataset of 30 provinces over 12 years, necessitated complex statistical models and intensive computations. However, the findings remain reliable, since we performed robustness checks with PMG and DFE approaches, and analyses of both long-run and short-run regressions.

6 Conclusion, implications and future research directions

In conclusion, the study examines 30 provinces' worth of combined data from Chinese firms between 2009 and 2020. The study investigates the influence of foreign fund flows, industrial innovations, and industrial contributions on new product sales and the environmental performance of new products. The findings show that foreign fund flows have a negative impact on both new product sales and the environmental performance of new products. While effective number of patents has a positive and significant effect on the sales of new products but a negative and significant impact on the environmental performance of new products. R&D expenditures have a positive and significant effect on new product sales and the environmental performance of new products. Industrial contributions proxied by industrial expenditures have a positive and significant effect on new product sales and the environmental performance of new products. Added value of the industry has a positive and significant effect on the environmental performance of new products but a negative and significant effect on new product sales. The findings also revealed that COVID-19 pandemic had a positive and significant impact on the environmental performance of new products but a negative and significant effect on the new product sales.

Current findings will help policymakers formulate suitable policies to attract foreign investors, support R&D initiatives, and promote industries that create value and positively impact the environment. This will also allow industry participants to make informed decisions about innovation and sustainability in a competitive marketplace. This study posits several implications for practitioners and policymakers; (1) through examination of the adverse effects of foreign funds flows on new sales and environmental performance, it is recommended to adopt the policies that may foster the use of foreign funds in promoting sustainable business practices and innovative product development. Foreign investment screening mechanisms should be prioritised to mitigate the negative impacts of foreign flow funds. There is also a need to tighten environmental screening criteria so that foreign firms ensure compliance with environmental laws and standards. This requires regular audits and penalties for non-compliance with environmental standards. Government officials should enforce rules and policies to promote green patents to encourage innovations and reduce environmental impact such as waste reduction and eco-friendly materials. (2) Given that the effective number of patents has a positive and significant effect on the sales of new products but a negative and significant impact on the environmental performance of new products. It is recommended to streamline the patent application processes and provide legal support such that patents are enforced. Likewise, strategies should be developed to reduce the impacts on sustainability by integrating eco-friendly design principles into patents. (3) It is recommended that firms allocate more resources to Research & Development and boost the development of new products. Governments should assist with R&D projects directed toward environmental

sustainability and invest in eco-friendly innovations. Designing robust R&D policies to support sustainability leads to the production of innovative products that meet market demand without negatively affecting the environment.

(4) Additionally, an increase in industrial contributions to industrial expenditure and green value addition can contribute to the improvement of both economic growth and environmental sustainability. (5) There is a need for the promotion of industry-linked innovation and product innovation in the industry by ensuring that added value supports new product sales. It is recommended to incentivise green industrial parks and promote eco-industrial parks and sustainable processing standards. As a result, firms will be encouraged to develop their value-added and maintain strong environmental performance.

Future research should focus on why foreign fund flows negatively affect new product sales and the environmental performance of new products. Additionally, given that industrial contributions and R&D expenditures positively impact sales and environmental performance, future research should focus on how industrial policies and corporate approaches network to propel green innovation and market success. Future research should focus on the long-term effects of COVID-19 on innovation and market trends. The effects of the pandemic were mixed, with a negative impact on new product sales and a positive impact on the environmental performance of new products. Therefore, there is a need to assess the long-term recovery path and how firms adapted to post-pandemic market environments. Given that an effective number of patents has a positive effect on new product sales but a negative effect on environmental performance, future research should explore how green innovation policies or eco-patent incentives can moderate environmental trade-offs.

Author contributions R.Y.H contributed to the conception and design of the study, as well as data collection and analysis. He was also involved in drafting the manuscript and revising it critically for important intellectual content. He also proofread the manuscript before submission M.A was primarily responsible for the statistical analysis and interpretation of the data. M.A also played a key role in reviewing the literature and compiling the background information for the study. G.N.T contributed significantly to the methodology section and overseeing the implementation of the research design. G.N.T also assisted in editing the manuscript. H.H participated in the data collection analysis. H.H also provided substantial input in the discussion section, offering insights and interpretations of the results. H.I was involved in the data analysis and visualization, creating figures and tables for the article. H.I also contributed to the final proofreading and formatting of the manuscript before submission.

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Declarations

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