Journal website : https://pse.razi.ac.ir

Razi University

Public Sector Economics Studies Qurterly PSE 16

Department of Economics, Faculty of Economics and Accounting, Razi University

Vol. 5, Issue 16, Summer 2026 | Online ISSN: 2821-2681

The Impact of High-Tech Goods Import on Economic and Environmental Variables in Iran: A Computable General Equilibrium Model*

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Type of Article: **Research**

10.22126/pse.2026.13625.1242

Received: 16 February 2026; Accepted: 27 April 2026

pp. 289-324

Abstract

Achieving sustainable development requires utilizing existing potentials and taking advantage of international opportunities to achieve desired economic growth and achieve appropriate environmental standards. Importing high-tech goods such as ICT goods and using them in the production process can be one of the international opportunities to achieve economic growth. In addition, imports can bring about technology spillovers and thus affect macro and environmental variables. It should be noted that the type of source countries in terms of their level of development and ability to absorb and apply foreign technology in the destination country are important factors in the rate of productivity spillovers. In this study, a general equilibrium model was used to examine the effect of importing high-tech goods on Iran's environmental and economic indicators. The results show that if imports are without spillover effects, the flow of high-tech goods from developing countries increases energy consumption and carbon emissions and improves economic growth. In addition, imports from developed countries increase gross domestic product and reduce energy consumption and carbon emissions. If imports are accompanied by spillover effects, the import of goods from developing countries will lead to a decrease in carbon and energy intensity and increase GDP. While imports from developed countries have a negative effect on GDP and reduce carbon and energy intensity. By improving absorptive capacity in Iran, both economic growths will increase and energy and carbon intensity will decrease further. Especially if imports are from developed countries. Accordingly, investment in improving absorptive capacity indicators and removing trade barriers is recommended.

Keywords: Carbon emissions, economic growth, trade, information and communication technology goods, Computable General Equilibrium Model.

JEL Classification: F14, F18, O33, Q56, O47.

*. This article is derived from Maryam Hajipour Apourvari's doctoral dissertation, supervised by Dr. Mehdi Nejati, at the Faculty of Management and Economics, Shahid Bahonar University of Kerman.

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Citations: Hajipour Apourvari, M., Nejati, M., Jalaee Esfandabadi, S. A., & Bahmani, M. (2026). "The Impact of High-Tech Goods Import on Economic and Environmental Variables in Iran: A Computable General Equilibrium Model". *Public Sector Economics Studies*, 5(16), 289-324.

Homepage of this Article: https://pse.razi.ac.ir/article_4249.html?lang=en

1. Introduction

In recent decades, environmental concerns have led to increased attention being paid to the application of Information and Communication Technology (ICT) in the energy sector. It is widely believed that this technology can influence not only the economic growth of countries but also energy consumption and pollutant emissions. These effects may vary depending on the degree of technology penetration; consequently, both the magnitude and the nature of ICT's impact on the aforementioned variables remain uncertain. Therefore, accurately assessing these effects requires analytical frameworks capable of capturing all direct and indirect channels of influence.

Accordingly, the present study employs a Computable General Equilibrium (CGE) model for two primary reasons. First, CGE models enable a comprehensive examination of the simultaneous impacts on a wide array of economic and environmental variables by accounting for intersectoral linkages and economy-wide feedback effects. Second, Iran's trading partners are classified into two distinct groups—developed countries (the Global North) and developing countries (the Global South)—thereby facilitating a disaggregated analysis of the effects of ICT imports from each group on key economic and environmental indicators.

2. Theoretical Framework

International trade transmits high-technology goods, especially ICT products, into developing economies. Endogenous-growth models argue that liberalization raises productivity by reallocating factors and enabling imports that embody foreign R&D, generating knowledge spillovers that increase domestic TFP. Structuralist critiques counter that North–South trade perpetuates an unequal division of labor, with developing countries specializing in primary commodities facing declining terms of trade while developed countries capture dynamic gains from technology-intensive manufactures. Environmental effects are decomposed into scale, composition, and technique effects, conditioned by the pollution-haven, pollution-halo, and factor-endowment hypotheses. When traded goods are ICT products, technology spillover becomes the pivotal mechanism, with realized productivity gains governed by multi-dimensional absorptive capacity (human capital, domestic innovation, and ICT readiness). Technological distance shapes both the magnitude and character of spillovers: developing-country imports may be more readily absorbed but embody less advanced techniques, while developed-country imports embody frontier techniques yet large gaps may limit absorption. The net impact of ICT imports on GDP, energy demand, carbon emissions, and energy and carbon intensity thus depends jointly on the source region's developmental status, whether productivity spillovers are activated, and the destination economy's absorptive capacity.

3. Methodology

To this end, the present study employs a multi-region dynamic computable general equilibrium model known as Dynamic GTAP-E. While retaining all the standard features of the GTAP model (Hertel, 1997), this framework incorporates environmental extensions and energy substitution capabilities based on the GTAP-E framework developed by Burniaux and Truong (2002). Specifically, the production technology has been modified such that, within the energy substitution nest, elastic substitution is permitted between capital and different energy carriers (oil, gas, coal, electricity, and other energy sources) as well as among the energy carriers themselves.

4. Discussion

The results reveal that imports of ICT goods without technological spillovers increase Iran's real GDP, energy consumption, and CO_2 emissions. However, both carbon intensity and energy intensity decline substantially by 2050, with the reduction being considerably larger than in 2025. The expansion of domestic production is accompanied by a fall in domestic price levels.

When ICT imports are accompanied by productivity spillovers that affect the energy composition and primary factors of production (Scenario DVG2), Iran's real GDP grows at an average annual rate of 35.39% between 2025 and 2050. Energy demand and, consequently, CO_2 emissions also increase. Nevertheless, owing to the presence |presence of technological spillovers, the rise in energy consumption and CO_2 emissions is higher than in Scenario DVG1. At the same time, these spillovers lead to a more pronounced decline in both carbon intensity and energy intensity compared to the no-spillover case. Unlike Scenario DVG1, the domestic price index exhibits an upward trend throughout the simulation period in Scenario DVG2. Exclusive imports of ICT goods from developed countries (Global North) in the absence of technological spillovers exert a positive impact on Iran's real GDP. The increase in aggregate output is associated with a declining trend in domestic prices. Furthermore, CO_2 emissions decrease in line with a reduction in total energy consumption.

When ICT imports from developed countries are accompanied by technological spillovers, they not only fail to stimulate GDP growth but also result in a long-term decline in Iran's real GDP. Under this scenario, energy demand, carbon intensity, and energy intensity all record significant reductions.

The results show that, if imports originate from developed regions, the production technique improves at the macro level, though the industrial composition becomes more emission-intensive. Moreover, it reduces production and shifts the production technique toward cleaner inputs. The findings further suggest that if technology spillovers are accompanied by an enhancement of technology absorptive capacity

in Iran, ICT imports lead to a reduction in energy and carbon intensities and an increase in production both at the macro level.

5. Conclusion and Suggestion

Overall, it appears that ICT imports from developed countries yield more favorable environmental outcomes in Iran and reduce the scale of production in polluting industries. Based on the findings, the following recommendations are proposed: First, to accelerate technological growth, it is necessary to remove barriers to the import of ICT goods, particularly from developed countries. Second, improving and upgrading technology absorptive capacity indicators—such as human capital, institutional quality, and R&D—will accelerate technology spillovers and enhance technological strengthening in Iran.

6. Ethical Considerations

6.1. Compliance with ethical guidelines

Any violation of the copying of this research will be prosecuted.

6.2. Funding

This research does not have the financial support of any organization or person.

6.3. Authors contribution

All Authors Contributed Equally to The Writing of The Article.

6.4. Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

6.5. Financial Support

The authors received no financial support for the research, authorship, and publication of this article.

6.6. Acknowledgements

The authors have no acknowledgments to declare.