# Factors Influencing $CO_2$ Emission Changes in Iran with Emphasis on the Role of Urbanization; A Decomposition Analysis

**Malihe Ashena[a*], Saeed Hossein Abadi[b]**

[a] *Assistant Professor of Economics, Bozorgmehr University of Qaenat, Qaen, Iran*
[b] *Assistant Professor of Geography and Urban Planning, Bozorgmehr University of Qaenat, Qaen, Iran*

***Received: 19 November 2019***
***Accepted: 11 May 2020***

## 1. Introduction

The need to energy for doing economic activities, and meeting the growing population demand have increased in the recent years. Energy consumption is a prerequisite for economic progress in societies, and its increasing consumption has led to environmental problems, the most important of which is air pollution emissions resulting from fossil fuel combustion. Due to the wide range of effects of air pollution on local to planetary scales, identifying the factors affecting pollution like carbon dioxide and determining the share of each can be a guide for environmental management in any country. Therefore, this study seeks to investigate and analyze the share of factors affecting the emissions of air pollution in Iran. The innovation of this study is emphasizing on the effect of urbanization along with population growth on air pollution. There are many theories about the effect of urbanization on the environment. Some believe that urbanization is an important factor in increasing environmental pollution and climate change. Others believe that urbanization is a factor in improving the quality of the environment due to high efficiency in energy consumption, and can lead to air pollution reduction. In this study, the amount of CO2 emissions is considered as an indicator of air pollution, and the impacts of factors including population change, urbanization growth and energy intensity on CO2 emissions changes in Iran is analyzed during the period 1997 -2016.

## 2. Study Area

In Iran, per capita carbon dioxide emissions in 2014 was equal to 8.4 metric tons, and its emission growth during 1990-2014 was about 127 percent, i.e., more than doubled (World Bank, 2014). Energy consumption and energy intensity in Iran have decreased in some years due to the relatively low increase in energy consumption compared to the urban population and have increased in some other years. Considering increasing energy consumption, carbon dioxide emissions have increased by the whole economy.

*. Corresponding author: Malihe Ashena. Email: Ashena@buqaen.ac.ir Tel: +985631006861

## 3. Materials and Methods

The first method (IPAT) for analyzing the main factors of environmental degradation is determined by the destructive effect on the environment (I), multiplied by population (P), economic prosperity in terms of the level of production or consumption (A), and technology as the environmental effect of economic activity (T). Some studies replaced the concept of IPAT with IMPACT. In IMPACT model, technology is divided into two parts; the term technology (T) and another term in the sense of energy relative to GDP (C). In this study, complete decomposition method was used to analyze the factors affecting the emission changes. Four factors have been selected in this study: the pollution coefficient effect, energy intensity effect, population structure (urbanization) effect, and population effect. The pollution coefficient effect is determined by the rate of carbon dioxide emission and energy consumption, which is called the carbon dioxide emission intensity. This variable evaluates fuel quality, fuel change (fuel replacement), and the installation of pollution reduction technologies. The energy intensity of urban household effect is determined by the rate of energy consumption and urban population. The energy consumption is mostly related to some variables such as economic and urban structure, transportation efficiency and energy systems of the city, energy use technologies, energy prices, energy saving policy and investment to reduce energy consumption. Urbanization effect is determined by the ratio of urbanization to population. This coefficient measures the relative position of the urban and rural population in an economy and changes with the evolution of urban structure. The population effect is expressed in the size of the total population in an economy.

## 4. Results and Discussion

The results show that the effect of carbon intensity is the most important factor influencing on the increase of carbon emissions. This shows that fossil fuels are widely used, and substitution for clean fuels and pollution reduction technologies in the economy are low. During the considered period, the energy consumption of the urban population has decreased. Decreases in the energy intensity can be due to increased energy efficiency, acceptance of new manufacturing technologies, reduced use of fossil fuels, or changes in fossil energy prices. Despite the declining energy consumption of the urban population, there is still great potential for reducing energy intensity due to the gap in the production process, technology, and level of management.

In the whole period of 1997 to 2016, both population and urbanization changes have increased the emissions of carbon dioxide. Urbanization has contributed 52% to carbon emissions change over the entire period. Although urbanization has had a declining effect on carbon emissions between 2007 and 2011, it has had a positive effect throughout the whole period. So, it can be said that the expansion of urbanization in Iran is a factor in increasing air pollution. In previous studies done on Iran, less attention has been paid to the effect of these two variables, and more attention has been paid to the effect of economic growth and the structure of society's products.

## 5. Conclusion

Considering the rapid growth of industrial activities and urbanization, the consumption of different types of energy plays an important role in influencing the local environment and changing the global climate. Increasing environmental degradation at the local, national and global levels has raised policymakers' concerns about the side effects of energy consumption and related social welfare. Recognizing the important factors influencing on pollution emissions, and determining the share of each can help in better dealing with this environmental problem. Therefore, the purpose of this study was to investigate the factors affecting changes in carbon dioxide emissions with emphasis on two important factors of demographic change and urbanization in Iran. For data analysis, the computational model of decomposition analysis has been used. The results show that both population and urbanization have played an important role in increasing energy consumption and carbon dioxide emissions. According to the results, strategies such as reducing pollution by changing fuel and switching to cleaner energy, implementing energy optimization plans and upgrading equipment technology, guiding household consumption toward improving fuel consumption patterns, and enforcing pricing and incentive policies should be considered for carbon decrease and sustainable development.

**Keywords:** Air Pollution, Energy, Carbon Dioxide, Urbanization, Iran.

## References: (in Persian)

Asafu-Adjaye, J. (2002). *اقتصاد محیط زیست برای غیر اقتصاددانان* [ Environmental economics for non - economists]. (S. Dehghanian, & Z Farjazadeh, Trans.). Mashhad: Ferdowsi University of Mashhad.

Energy Planning Office. (1996-2016). ترازنامه انرژی ایران [Energy Balancesheet]. Tehran: Ministry of Energy, Electricity and Energy Macro Planning Office.

Faridzad, A. (2016). تحلیل تجزیه شدت انرژی در صنایع انرژی‌بر ایران با استفاده از روش شاخص لگاریتم میانگین دیویژیا با تاکید بر رویکرد زمانی دو دوره‌ای و رنجیره‌ای [energy intensity decomposition analysis in Iranian energy-intensive industries using the logarithmic mean divisia index with emphasis on the chain-linked and period-wise approach]. *Journal of Iranian Energy Economics, 4*(15), 87-117.

Fotros, M. H., & Barzegar, H. (2013). اثرات برخی متغیرهای کلان بر انتشار گاز دی اکسید کربن در آسیای مرکزی و ایران (۱۹۹۵ تا ۲۰۰۷) [Effects of some macroeconomic variables on carbon dioxide emissions in Central Asia and Iran, 1995-2007]. *Iranian Economics journal, 8*(16), 141-158.

Fotros, M. H., Barati J., & Rasoulzadeh M. (2014). تجزیه انتشار دی اکسید کربن ناشی از مصرف انرژی به بخش‌های اقتصادی ایران؛ یک تحلیل تجزیه شاخص [Structural decomposition analysis of carbon dioxide (CO2) emissions in industry of IRAN: An input-output approach]. *Quarterly Energy Economic Review, 10*(41), 131-152.

Ghadami, M., & Abdollahvand, H. (2019). نمونه )بررسی تأثیر سناریوهای ساختار فضایی شهر بر آلودگی هوا مورد مطالعه: شهر تهـران) [The impact of urban spatial structure scenarios on air pollution (a case study of Tehran)]. *Journal of Geography and Urban Space Development 6*(1), 261-280.

Lotfalipour, M .R., & Ashena, M. (2012). بررسی عوامل مؤثر بر تغییر انتشار دی اکسید کربن در اقتصاد ایـران [An Analysis Of Factors That Influence Carbon Dioxide Emission In Iran's Economy]. *Quarterly Energy Economic Review, 1*(3), 81-109.

Lotfalipour, M. R., Fallahi, M. A., & Bastam, M. (2012). انتشـار پیش‌بینی و محیطی زیست مسائل بررسی ایـران اقتصـاد کـربن در دی‌اکسـید [The environmental issues and forecasting of carbon dioxide emissions in Iran economy]. *Applied Economics Studies, 1*(3), 81-109

Miller, G. T. (2016). *زیستن در محیط زیسـت* [Living in the environment]. (M. Makhdoom, Trans.). Tehran: Tehran University Publications.

Nasrollahi, Z., & Ghaffari Gulak, M. (2010). آلودگی هوا و عوامل موثر بر آن (مطالعـه مـوردی انتشـار SPM و SO2 در صنایع تولیـدی ایـران) **[**Air Pollution and its determinants (The Case Study of SPM, and SO2 Emissions in Iran Manufacturing Industries)]. *Journal of Economic Research, 10*(3), 75-95.

Statistical Center of Iran. (1996-2016). سـالنامه آمـاری ایـران [Statistical Yearbook of Iran]. Presidency of the Iran Plan and Budget Organization.

## References: (In English)

Ang, B. W., & Zhang, F. Q. (2000). A survey of index decomposition analysis in energy and environmental analysis. *Energy*, *25*(12), 1149–1176.

Ang, B. W., Xu, X. Y., & Su, B. (2015). Multi-country comparisons of energy performance: the index decomposition analysis approach". *Energy Economics47*,68-76.

Avtar, R., Tripath, S., Aggarwal, A., & Kumar, P. (2019). Population–urbanization–energy nexus: A Review. *Resources*, *8*(3), 136. doi:10.3390/resources8030136.

Chang, Y. F., Lewis, C., Lin, S. J. (2008). Comprehensive evaluation of industrial CO2 emission (1989–2004) in Taiwan by input–output structural decomposition. *Energy Policy*, *36*(7),2471–2480.

Fan, F., & Lei, Y. (2017). Index Decomposition analysis on factors affecting energy-related carbon dioxide emissions from residential consumption in beijing. Mathematical Problems in Engineering,Volume Article ID 4963907, 14 pages.

Fan, Y., Liu, L.C., Wu, G., Tsai, H.T., & Wei, Y. M. (2007). Changes in carbon intensity in China: empirical findings from 1980–2003. *Ecological Economics*,62(3-4), 683–691.

Gasimli, O., Ihtisham U. H., Gamage, S., Shihadeh, F., Rajapakshe, P., & Shafiq, M. (2019). Energy, trade, urbanization and environmental degradation nexus in Sri Lanka: bounds testing approach. *Energies, 12*(9), 1655; https://doi.org/10.3390/en12091655.

Grossman, G. M., & Krueger, A. B. (1992). Environmental impacts of a North American free trade agreement. *Working Paper*, 3914, National Bureau of Economic Research, Cambridge, MA.

Guan, D. B., Hubacek, K., Weber, C. L., Peters, G. P., & Reiner, D. M. (2008). The drivers of Chinese CO2 emission from1980 to 2030. *Global Environmental Change,18*, 626–634.

Lee, K., & Oh, W. K. (2006). Analysis of CO2 emission in APEC countries: a time-series and a cross sectional decomposition using the log mean Divisia method. *Energy Policy*, *34*(17),2779–2787.

Li, W., Shen, Y. B., & Zhang, HX. (2015). A factor decomposition on China's carbon emission from 1997 to 2012 based on IPAT-LMDI model. *Mathematical Problems in Engineering*, Article ID 943758, 14 pages, https://doi.org/10.1155/2015/943758.

Liang, W., & Yang, M. (2019). Urbanization, economic growth and environmental pollution: Evidence from China. *Sustainable Computing: Informatics and Systems*, 21, 1–9.

Liaskas, K., Mavrotas, G., Mandaraka, M., & Diakoulaki, D. (2000). Decomposition of industrial CO2 emission: the case of European Union. *Energy Economics*, *22*(4), 383–394.

Liu, L. C., Fan, Y., Wu, G., Wei, Y. M. (2007). Using LMDI method to analyze the change of China's industrial CO2 emission from final fuel use: an empirical analysis, *Energy Policy*,*35*(11), 5892–5900.

Nag, B., & Parikh, J. (2000). Indicators of carbon emission intensity from commercial energy use in India. *Energy Economics*,*22*(4),441–461.

Nazeer, M., Uzma, T., & Shaista, S. (2018). Environmental pollution and sustainable development in developing countries. *The Pakistan Development Review, 55*(4), *589–604.*

Paul, S., Bhattacharya, R.N. (2004), CO2 emission from energy use in India: a decomposition analysis. *Energy Policy*, *32*(5), 585–593.

Salim, R., Rafiq, S., & Shafiei, S. (2017). Urbanization, energy consumption and pollutant emission in Asian developing economies: an empirical analysis. ADBI Working Paper Series, 718, Asian Development Bank Institute.

Sari, R., and Soytas, U. (2004). Disaggregate energy consumption, employment, and income in Turkey. *Energy Economics*, *26*(3), 335-344.

Sun, J. W. (1998), Changes in energy consumption and energy intensity: a complete decomposition model. *Energy economics*, 20(1), 85–100.

Wang W. W., Liu R, Zhang, M. & Li, H. N. (2013). Decomposing the decoupling of energy related co2 emissions and economic growth in Jiangsu Province. *Energy for Sustainable Development*.*17*(1),62-71.

Wang, C., Chen, J. N., & Zou, J. (2005), Decomposition of energy-related CO2 emission in China: 1957–2000. *Energy*, *30*(1), 73–83.

Wang, S., Zhao, T., Zheng, H., & Hu, J. (2017). The STIRPAT analysis on carbon emission in Chinese cities: an asymmetric laplace distribution mixture model. *Sustainability, 9*(12), 2237.

Wietze, L. (2006). Decomposition of CO2 emission over 1980–2003 in Turkey. *Energy Policy*, *34*, 1841–1852.

World Bank. (2014). World Development Indicators. Washington, D.C.: The World Bank (producer and distributor). http://data.worldbank.org/data-catalog/world-development-indicators.

Wu, L.b., Kaneko, S., & Matsuoka, S. (2005). Driving forces behind the stagnancy of China's energy-related CO2 emission from 1996 to 1999: the relative importance of structural change, intensity change and scale change. *Energy Policy*, *33*(3), 319–335.

York, R., Rosa, E., & Dietz, T. (2003). STIRPAT, IPAT and ImPACT: analytic tools for unpacking the driving forces of environmental impacts. *Ecological Economics*, *46*(3), 351-/365.

Zhang, F.Q., Ang, B.W. (2001). Methodological issues in cross-country/ region decomposition of energy and environmental indicators. *Energy Economics*, *23*(2), 179–190.