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Investigating the Relationship between Economic Growth, Traffic Volume and Environmental Stress in Iran: A Decoupling Approach

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EXTENDED ABSTRACT

INTRODUCTION

One of the requirements of economic growth is the development of the transport sector and its related services. But the transportation development, in addition to the positive economic effects, has an undeniable impact on the pollutants emission. Now the question is "what should be done to reduce carbon dioxide emissions in the transport sector so that economic development is not Disrupted". Decoupling carbon dioxide emissions from economic growth in the transport sector is the key to providing a practical solution to achieve low-carbon economic development.

The decoupling concept refers to conditions in which economic growth increases but environmental Stress decreases over the same period. The Organization for Economic Co-operation and Development (OECD) was the first organization which developed decoupling concept (OECD, 2000). Then Vehmas et al. (2003) described different aspects of decoupling and Tapio (2005) presented a elasticity-based decoupling model. Subsequently, the decoupling of carbon dioxide emissions from economic growth Was considered by many researchers (e.g., Loo & Banister, 2016; Zhang, 2018; Riti et al., 2017; Wu et al., 2018; Wang et al., 2018). But in this field no study has been done in Iran so far. Therefore, this study is going to investigate this issue in Iran to contribute to identifying appropriate measures to achieve decarbonization in the transport sector.

METHODOLOGY

Many decomposition techniques are used to decompose the CO2 emissions changes into various driving factors, such as Structural Decomposition Analysis (SDA) and Index Decomposition Analysis (IDA). However, nowadays decoupling analysis is a novel concept that requires less data and calculation, and provides more details on the relationship between economic growth and carbon emissions. There are three approaches to do decoupling analysis: OECD, Vehmas et al. (2003) and Tapio (2005). The OECD approach has several disadvantages, such as inaccurate measurement and unclear criteria that caused to develop this method by Vihmas et al. (2003) and finally Tapio(2005) by modifying the classification of Vehmas et al. (2003) improved their method. To doing so, Tapio (2005) at first changed the six possible linking and de-linking states introduced by Vehmas et al. (2003) to eight possible logic states; Second, he introduced the concept of negative decoupling, and third, he defined specific intervals for the environmental stress elasticity of economic growth, and he specified each decoupling and linking states more accurate. Accordingly, in this paper, we use the Tapio approach to investigate the decoupling of environmental stress from economic growth (Tapio, 2005). A summary of this approach is given in Table (1).

Table 1. Degrees of the coupling and decoupling process based on Tapio(2005) approach
Source: Researcher Conclusion Based on Tapio(2005) Classification

Degrees of the linking and decoupling	ΔVOL		ΔGDP		$\%\Delta VOL/\%\Delta GDP$
	< 0	**> 0**	**< 0**	**> 0**	
Weak decoupling		*		*	*[0-0.8]*
Weak negative decoupling	*		*		*[0-0.8]*
Strong decoupling	*			*	$\%\Delta VOL/\%\Delta GDP < 0$
Strong negative decoupling		*	*		$\%\Delta VOL/\%\Delta GDP < 0$
Expansive negative decoupling		*		*	$\%\Delta VOL/\%\Delta GDP > 1.2$
Recessive decoupling	*		*		$\%\Delta VOL/\%\Delta GDP > 1.2$
Expansive coupling		*		*	*[0.8-1.2]*
Recessive coupling	*		*		*[0.8-1.2]*

The Research data have been extracted from the Statistical Center of Iran and the Iran energy balance sheets during the period 2000-2018. The period is seleted so that it covers the ten years before and after the implementation of the targeted subsidies law, because changes in energy prices in this period can affect the activities of the transport sector, energy consumption and carbon dioxide emissions. The variables of this research include the value added of the sub-sectors of the transport (road, rail, air and sea transport), non–oil real GDP , the total volume of freight and passenger in the transport sector and its sub-sectors and the amount of carbon dioxide emissions of transport sector and its sub-sectors.

FINDINGS

The Decoupling results of freight and passenger transport from economic growth and carbon dioxide emissions are given in Tables (2) and (3), respectively. In these tables the symbols TG, TP, GDP and CO2 are used to represent freight transport, passenger transport, GDP and carbon dioxide emissions, respectively.

The decoupling results of passenger and freight transport from economic growth in Table (2) show that the increase in energy prices in the early years of targeted subsidies law implementation (2010-2014) has led to a strong decoupling of freight and passenger transport growth from economic growth, this means that despite the positive economic growth, the growth of transport has been negative. But the affectability level of passenger transport has been significantly greater than freight transport. After that, the decoupling state in the freight transport sector has changed to a expansive negative decoupling, while in the passenger transport sector, there is still a strong decoupling.

Table 2. Decoupling of transport volume growth from economic growth
Source: Research Findings

Decoupling of passenger transport volume growth from economic growth				
Period	(ΔTP)	(ΔGDP)	$\%\Delta TP/\%\Delta GDP$	Decoupling State
2000-2004	2.04	29.64	0.07	Weak decoupling
2005-2009	23.68	25.74	0.92	Expansive coupling
2010-2014	-15.17	2.28	-6.66	Strong decoupling
2015-2018	-10.16	13.97	-0.73	Strong decoupling
Decoupling of freight transport volume growth from economic growth				
Period	(ΔTG)	(ΔGDP)	$\%\Delta TG/\%\Delta GDP$	Decoupling State
2000-2004	42.37	29.64	1.43	Expansive negative decoupling
2005-2009	22.61	25.74	0.88	Expansive coupling
2010-2014	-7.06	2.28	-3.10	Strong decoupling
2015-2018	21.13	13.97	1.51	Expansive negative decoupling

Table 3. Decoupling of transport volume growth from co2 emission
Source: Research Findings

Decoupling of passenger transport volume growth from CO2 emission				
Period	(ΔTP)	$(\Delta CO2)$	$\%\Delta CO2/\%\Delta TP$	Decoupling State
2000-2004	2.04	27.25	13.34	Expansive negative decoupling
2005-2009	23.68	27.29	1.15	Expansive coupling
2010-2014	-15.17	12.19	-0.80	Strong negative decoupling
2015-2018	-10.16	3.92	-0.39	Strong negative decoupling

Decoupling of freight transport volume growth from CO2 emission				
Period	(ΔTG)	$(\Delta CO2)$	$\%\Delta CO2/\%\Delta TG$	Decoupling State
2000-2004	42.37	27.25	0.64	Weak decoupling
2005-2009	22.61	27.29	1.21	Expansive negative decoupling
2010-2014	-7.06	12.19	-1.73	Strong negative decoupling
2015-2018	21.13	3.92	0.19	Weak decoupling

Based on Table (3) which shows the decoupling state of freight and passenger transport from carbon dioxide emissions, we can say that the increase in the energy price in the period 2010-2014 has led to
Significant reductions in passenger and freight transport, But ,although the carbon dioxide emission growth has decreased compared to the previous period, it is still positive. Therefore, the carbon dioxide emission growth has occurred along with the reduction of passenger and freight transport, reveals the need for complementary policies implementation. In 2015-2018 period, although the freight transport sector is still affected by the implementation of this law, but this effect is not observed in the passenger transport sector.

CONCLUSION

Based on the results, Although the reform of energy prices in 2010, is caused to change the relationship between economic growth and traffic volume from an expansive coupling (economic growth with increase in traffic volume) to a Strong decoupling (economic growth with decrease in traffic volume), but due to the lack of a Strong decoupling between traffic volume and carbon emissions, energy price reform has not reduced carbon emissions. Therefore, low carbon development in the transport sector does not achieved only by energy prices reform and requires the implementation of appropriate energy efficiency policies and using related technologies to reducing carbon emissions. Based on the findings of this study, the following suggestions are recommended to define appropriate carbon reduction strategies for the transport sector, First, the energy prices of the transport sector should be corrected. Second, ban traffic of high-carbon vehicles while promoting new technologies and energy sources proportionate with modern transportation. Third, improving transport infrastructure, especially road transport, should be on the agenda. Fourth, the share of non-road transport (rail, air and sea), especially rail transport in the freight transport sector, should be substantially strengthened so that a large volume of goods can be moved with less energy consumption and less pollution.

Reference

Abolhasani, A., Motaghi, S. & Saffarzadeh, S. (2019). Investigating the relationship between investment in transport infrastructure and economic growth of Iran (Application of VAR pattern). *Journal of Transportatin Engineering, 11(1), 239-255. 20.1001.1.20086598.1398.11.1.12.2*[In Persian]

Ahmadian, M., Abdoli, G., Jabalameli, F., Shabankhah, M. & Khorasani, S.A.(2019). Extracting The Dynamic Curve of the Kuznets Environment. *Quarterly Journal of Quantitative Economics(JQE), 16 (2),* 1-36. https://doi.org/10.22055/jqe.2019.25839.1873[In Persian]

Andreoni, V. & Galmarini, S. (2012). Decoupling economic growth from carbon dioxide emissions: A decomposition analysis of Italian energy consumption. *Energies, 44, 682–691*.

Boqiang, L. & Liu, K. (2017). Using LMDI to Analyze the Decoupling of Carbon Dioxide Emissions from China’s Heavy Industry. *Sustainability, 9, 1198.*

Borghesi, S. (1999).The environmental Kuznets curve: a survey of literature. *Fondazioni Eni Enrico Mattei, Working Papers 85.99.*

Daii Karimzadeh, S., Emadzadeh, M. & Kamkar Delakh, H. (2009). Public Investment in the Transportation Sector and Economic Growth in Iran (1970-2008). *Quarterly Journal of Economic Modelling, 3(10), 63-82. http://eco.iaufb.ac.ir/article_555594.html#ar_info_pnl_cite*[In Persian]

De Bruyn, S.M. (2000). Economic growth and the environment. *Dordrect: Kluwer Academic Publishers.*

De Bruyn, S.M. (2002). Dematerialization and rematerialization as two recurring phenomena of industrial ecology, in: Ayres, R.U., Ayres, L.W. (Eds.), A Handbook of Industrial Ecology. *Edward Elgar, Cheltenham, pp. 209–222.*

De Bruyn, S.M. & Opschoor, J.B. (1997). Developments in the throughput-income relationship: theoretical and empirical observations. *Ecological Economics; 20:255e68.*

De Bruyn, S.M., van den Bergh, J.C.J.M. & Opschoor, J.B. (1998). Economic growth and emissions: reconsidering the empirical basis of environmental Kuznets curves. *Ecological Economics 25 (2), 161–175.*

Dinda, S. (2004). Environmental kuznets curve hypothesis: a survey. *Ecological Economics; 49:431e55.*

Delangizan,S., Khanzadi,A. & Heidarian,M. (2015). Studying the effects of fuel price changes on greenhouse gas emissions in the road transportation sector of Iran; approach of Robust Least Squares. *Quarterly Journal of Quantitative Economics(JQE), 11(4*), 47-77. https://jqe.scu.ac.ir/article_11873.html?lang=en [In Persian]

Engo, J. (2019). Decoupling analysis of CO2 emissions from transport sector in Cameroon. *Sustainable Cities and Society 51,101732.*

Fan, F.Y. & Lei, Y.L. (2017). Responsive relationship between energy-related carbon dioxide emissions from the transportation sector and economic growth in Beijing—Based on decoupling theory. *Int. J. Sustain. Transp., 11, 764–775.*

Grossman, G.M. & Krueger, A.B. (1995). Economic growth and the environment. *Quarterly Journal of Economics; 110:353e77.*

Hinterberger, F. & Schmidt-Bleek, F. (1999). Dematerialization, MIPS and Factor 10: physical sustainability indicators as a social device. *Ecological Economics 29 (1), 53–56.*

International Energy Agency (IEA). World Energy Outlook (2021). *IEA Publication: Paris, France.*

International Energy Agency (IEA). CO2 Emissions from Fuel Combustion (2021). *IEA Publication: Paris, France.*

Janicke, M. (1988). Okologische Modernisierung, Optionen und Restriktionen praventiver Umweltpolitik, in: Simonis, U.E. (Ed.), Praventive Umweltpolitik. *Campus, Frankfurt am Main, pp. 13–26.*

Kharbach, M. & Chfadi, T. (2017). CO2 Emissions in Moroccan Road Transport sector: Divisia, Cointegration, and EKC analyses. *Sustainable Cities and Society http://dx.doi.org/10.1016/j.scs.2017.08.016.*

Loo, B.P.Y. & Banister, D. (2016). Decoupling transport from economic growth: Extending the debate to include environmental and social externalities. *J. Transp. Geogr, 57, 134–144.*

Ma, M. & Cai, W (2019). Do commercial building sector-derived carbon emissions decouple from the economic growth in tertiary industry? A case study of four municipalities in china. *Sci. Total Environ, 650, 822–834.*

Maddah, M., jafari, A. (2019). Factors Affecting Air Pollution Created in the Transportation Sector of Iranian Provinces. *Journal of Environmental Studies, 45(1), 77-86. 10.22059/JES.2019.263277.1007714*[In Persian]

Magnani, E. (2001).The environmental Kuznets curve: development path or policy result?. *Environmental Modelling & Software; 16:157e65.*

Muradov, N. (2013). Decarbonization at crossroads: The cessation of the positive historical trend or a temporary detour?. *Energy Environ. Sci., 6, 1060–1073.*

Naqvi, A. & Zwickl, K. (2017). Fifty shades of green: Revisiting decoupling by economic sectors and air pollutants. *Ecol. Indic., 133, 111–126.*

Organization for Economic Cooperation and Development (OECD) (2000). Indicators to Measure Decoupling of Environmental Pressure from Economic Growth. *OECD: Paris, France.*

Organization for Economic Co-Operation and Development (OECD) (2001). Decoupling: A Conceptual Overview. *OECD Pap, 5, 1–31.*

Pahlavani, M., Mehrabi Boshrabadi, H., Afshar pour, M. (2014). The Study of Transportation Infrastructures Development's Effect on Economic Growth in Iran's Provinces .The Journal of Economic Modeling Research (JEMR), 4(16), 99-127. 20.1001.1.22286454.1393.4.16.7.6[In Persian]

Panayotou, T. (1993). Empirical Test and Policy Analysis of Environmental Degradation at Different Stages of Economic Development. *World Employment Research Programme, Working Paper. Geneva: International Labour Office.*

Riti, J.S., Song, D.Y., Shu, Y. & Kamah, M. (2017). Decoupling CO2 emission and economic growth in China: Is there consistency in estimation results in analyzing environmental Kuznets curve?. *J. Clean. Prod., 166, 1448–1461.*

Rothman, D.S. & De Bruyn S.(1998). Probing into the environmental Kuznets curve hypothesis. *Ecological Economics; 25:143e5.*

Sajadi, M., Taghvaee, M. (2016). Evaluation and Analysis of Sustainable Urban Transport Indicators. Journal of Sustainable Architecture and Urban Design, 4(1), 1-18. 20.1001.1.25886274.1395.4.1.1.8[In Persian]

Schmidt-Bleek, F. (2000) Luonnon uusi laskuoppi, Gaudeamus, Helsinki. [Finnish translation of two books: Wieviel Umwelt braucht der Mensch? MIPS—das Mass fu¨r o¨kologisches Wirtschaften (orig. 1994) and Das MIPS-Konzept. *Weniger Naturverbrauch—mehr Lebensqualita¨t durch Faktor 10 (orig. 1998).*

Sharify, N. (2012). Transport Position and Its Effect on the Other Economic Sectors in Iran: An Input-Output Analysis. *Quarterly Journal of Economic Growth and Development Research, 2(5), 207- 238. 20.1001.1.22285954.1390.2.5.7.6*[In Persian]

Talbi, B (2017). CO2 emissions reduction in road transport sector in Tunisia. *Journal of Renewable and Sustainable Energy Reviews. 69: 232 -238.*

Tapio, P. (2002a). The Limits to Traffic Volume Growth, The Content and Procedure of Administrative Futures Studies on Finnish Transport CO2 Policy, Acta Futura Fennica 8, Finnish Society for Futures Studies & Finland Futures Research Centre, Turku, Doctorate thesis. *Summary (148 p.) available at http://ethesis.helsinki.fi/julkaisut/maa/limno/vk/ tapio.*

Tapio, P. (2005). Towards a theory of decoupling: degrees of decoupling in the EU and the case of road traffic in Finland between 1970 and 2001, *Transport Policy 12 . 137–151*

Vehmas, J., Malaska, P., Luukkanen, J., Kaivo-oja, J., Hietanen, O., Vinnari, M. & Ilvonen, J (2003). Europe in the Global Battle of Sustainability: Rebound Strikes Back?. *Advanced Sustainability Analysis; Series Discussion and Working Papers; Turku School of Economics and Business Administration: Turku, Finland.*

Wang, Q., Hang, Y., Zhou, P. & Wang, Y (2016). Decoupling and attribution analysis of industrial carbon emissions in Taiwan. *Energy, 113, 728–738.*

Wang, Y., Zhou, Y., Zhu, L., Zhang, F. & Zhang, Y.C (2018). Influencing factors and decoupling elasticity of China's transportation carbon emissions. *Energies, 11, 1157.*

Wu, Y., Zhu, Q.W. & Zhu, B.Z (2018). Comparisons of decoupling trends of global economic growth and energy consumption between developed and developing countries. *Energy Policy, 116, 30–38.*

Xu, S., He, Z., Long, R., Chen, H. & Zhang,W. (2016). Comparative analysis of the regional contributions to carbon emissions in China. *J. Clean. Prod, 127, 406–417.*

Yandle, B., Vijayaraghavan, M. & Bhattarai, M. (2002). The environmental Kuznets curve: a primer. *PERC research study 1e02. Available from: <http:// www.perc.org/pdf/rs02_1.pdf>.*

Yang, H. & Ma, X. (2019). Uncovering CO2 Emissions Patterns from China-Oriented International Maritime Transport: Decomposition and

Decoupling Analysis. *Sustainability, 11, 2826; doi:10.3390/su11102826.*

Yavari, K., Khodabakhsh, M. & Najarzadeh, R. (2021). Estimation of Resource Allocation Inefficiency in the Iranian Manufacturing Sector. *Quarterly Journal of Quantitative Economics (JQE), 18(4),* 71-84. 10.22055/JQE.2021.27519.1964 [In Persian]

Zhang, k., Liu, X. & Yao, J. (2019). Identifying the driving forces of CO2 emissions of China's transport sector from temporal and spatial decomposition perspectives. *Environmental Science and Pollution Research https://doi.org/10.1007/s11356-019-05076-3.*

Zhang, Z.L., Xue, B., Pang, J.X. & Chen, X.P (2018). The decoupling of resource consumption and environmental impact from economic growth in China: Spatial pattern and temporal trend. *Sustainability, 8, 2-22.*

Zhao, X., Zhang, X., Li, N., Shao, S. & Geng, Y (2017). Decoupling economic growth from carbon dioxide emissions in China: A sectoral factor decomposition analysis. *J. Clean. Prod, 142, 3500–3516.*

Zheng, J., Hu, Y., Dong, S. & Li, Y (2019). The Spatiotemporal Pattern of Decoupling Transport CO2 Emissions from Economic Growth across 30 Provinces in China. *Sustainability 2019, 11, 2564; doi:10.3390/su11092564.*