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Evaluation of decoupling of GDP and energy in Central Asia

A Junissov[1], A Bekaliyev[1], A Adamov[1] and S G Poulopoulos[1,2]

1 Department of Chemical and Materials Engineering, School of Engineering and Digital Sciences, Nazarbayev University, 010000, Nur-Sultan, Kazakhstan

[2] stavros.poulopoulos@nu.edu.kz

Abstract. Currently, economic growth remains the main criterion of development. However, it does come along with threats to the environment, due to its link to the increased energy consumption and carbon dioxide emissions. Decoupling can be used to break this link and stop jeopardizing the environment in the favor of economic progress. This paper focuses on the decoupling between economic growth and energy consumption in each of five Central Asian countries – Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan – from 1990 to 2014. The Tapio decoupling model was implemented in order to determine the decoupling states for each country. Gross domestic product (GDP) was used to represent the economic growth, and the total primary energy supply (TPES) described the environmental pressure. These data were obtained from the IKE World Energy Balances. Both the GDP and the TPES of most of the Central Asian countries had a parabolic trend of initial drop and further increase during the timespan analyzed. This observation can be explained by the collapse of USSR and the transition to market economy. The results of the decoupling analysis can be divided into two stages for Kazakhstan, Turkmenistan, and Uzbekistan, and into three stages for Kyrgyzstan and Tajikistan, with several different decoupling states observed during each stage. According to the results, the main decoupling states in Central Asia were expansive negative decoupling, expansive coupling, weak decoupling, and strong decoupling. The analysis showed that there is a serious environmental pressure on the economic development in Central Asia.

1. Introduction

Economic growth was and remains the vector of the development of the world [1]. It is usually linked to the consumption of energy, which is normally obtained from natural resources, such as fossil fuels [2]. An increase in energy demand due to the continuous economic progress leads to a conflict with the environment, reflected in enormous greenhouse gas emissions, water problems, and loss of biodiversity [3]. Therefore, it is necessary to disconnect the economic growth and the environmental issues.

Decoupling is a concept used to describe this process. Despite being a popular topic among scientists, a very limited research has been done on decoupling between economic development and environmental pressure in Central Asia. To our knowledge, there are only two articles discussing this topic. Although they do result in important conclusions such as the possibility of using decoupling method in the Central Asian region, their timespans are somewhat outdated, specifically ending in 2010 and 2004, respectively [4-5]. A more updated research is, therefore, needed to understand the current decoupling trends, and another method of analysis can be used for broader understanding of the current situation.

Central Asia will be the main and only subject of this study. Five countries are usually included in the Central Asian region: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. This region is crucial in the scope of the studied topic because it is rich in natural resources, has carbon-intensive fossils as the main energy sources, and as stated previously, has not been paid enough attention [6]. The region is diverse in terms of the economic development level, population, energy consumption, carbon emissions, and carbon and energy intensities. For example, Kazakhstan and Uzbekistan have the greatest populations and contribute to more than 80% of the total energy consumption in the region, which might be connected to the fact that they produce most of the carbon dioxide emissions per capita [6]. Nonetheless, the carbon intensity of energy is not significantly different in all five countries in the region, namely within the range of 1.18-3.09, meaning that the region as a whole is dependent on carbon-intensive energy sources like coal and gas [7].

With that being said, the main objective of this work is to analyze the type of connection between the economic growth rate and the rate of environmental pressure rise in Central Asia using the Tapio decoupling model for the timespan from 1990 to 2014.

2. Methodology

2.1. Variables
The decoupling was done year-by-year for each country between two variables, gross domestic product (GDP), representing the economic growth, and total primary energy supply (TPES), meaning the environmental pressure. The GDP was normalized to the price levels of 2010 and then converted to USD based on the 2010 average purchasing power parties (PPPs). The data were received from IKE World Energy Balances.

2.2. Tapio decoupling elasticity method
The Tapio decoupling model was developed by Tapio in his research about European transportation [8]. This method has an advantage over some other methods because it is not dependent on the variables' dimensions. The result of this method is the flexibility index, or elasticity, in this particular case, between TPES and GDP, indicating how TPES affects economic growth.

$$\mu = \frac{\Delta TPES/TPES}{\Delta GDP/GDP} \tag{1}$$

In this equation, Δ is a change of the variable between two chosen years, and μ is the elasticity between decoupling factors. Tapio developed eight possible outcomes of his decoupling elasticity model represented in Table 1 [9]. To clarify how the notation works, expansive negative decoupling means that there is an increase in energy consumption and economic growth, but the rate of growth of environmental pressure is higher than that of the economic variable. Similarly, strong decoupling represents the situation when the energy consumption is decreased, and economic growth is increased. Other states can be explained in the similar manner based on the Table 1.

Table 1. Eight possible decoupling outcomes by Tapio [9].

Decoupling states	ΔTPES/TPES	ΔGDP/GDP	Decoupling elasticity (μ)
Expansive negative decoupling (END)	0<	0<	$\mu > 1.2$
Strong negative decoupling (SND)	0<	<0	$\mu < 0$
Weak negative decoupling (WND)	<0	<0	$0 < \mu < 0.8$
Weak decoupling (WD)	0<	0<	$0 < \mu < 0.8$
Strong decoupling (SD)	<0	0<	$\mu < 0$
Recessive decoupling (RD)	<0	<0	$\mu > 1.2$
Expansive coupling (EC)	0<	0<	$0.8 < \mu < 1.2$
Recessive coupling (RC)	<0	<0	$0.8 < \mu < 1.2$

3. Results and Discussions

The results of the Tapio decoupling analysis are represented in Table 2. The elasticity of decoupling indicators was calculated for each pair of years in each Central Asian country. The main decoupling states observed are EC, END, WD, and SD, or expansive coupling, expansive negative decoupling, weak decoupling, and strong decoupling, respectively. However, it is necessary to discuss each country separately because the decoupling states differ greatly between them.

Table 2. Decoupling states by Tapio model for Central Asia.

Time	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
1990-1991	SND	RC	WND	RD	SND
1991-1992	SND	RD	WND	RD	WND
1992-1993	RD	RD	RD	WD	SND
1993-1994	RC	RD	RC	SND	WND
1994-1995	RD	RD	RC	SND	RD
1995-1996	SD	END	WND	SD	END
1996-1997	SD	SD	SD	SND	WD
1997-1998	WND	END	EC	WD	END
1998-1999	SD	SD	SD	EC	WD
1999-2000	SD	SD	SD	WD	SD
2000-2001	SD	SD	SD	WD	WD
2001-2002	END	SND	WD	END	EC
2002-2003	EC	EC	WD	END	SD
2003-2004	END	SD	WD	EC	SD
2004-2005	WD	SND	0	WD	SD
2005-2006	END	SD	WD	WD	WD
2006-2007	EC	END	EC	END	SD
2007-2008	END	EC	SD	WD	WD
2008-2009	SD	SD	SD	SD	SD
2009-2010	END	RD	WD	END	SD
2010-2011	END	END	0	WD	EC
2011-2012	SD	SND	EC	WD	WD
2012-2013	END	SD	END	WD	SD
2013-2014	SD	SD	EC	WD	WD

The results for Kazakhstan can be divided into two parts according to the specific time periods. While transiting to an independent country and experiencing the collapse of USSR, Kazakhstan's decoupling states were strong negative decoupling at the beginning, and moderate decoupling afterwards until 2001. This period can be described as a transformation period for Kazakhstan. Economic changes that took place during that time were significant, but generally there was a decline with further growth of GDP and decrease in TPES [10]. The second part covers the period from 2001 to 2014. During that time, Kazakhstan's economy completely recovered and started to experience an expansive negative decoupling. There were periods when the states showed strong decoupling, but this is mainly due to the increased export of energy and lack of cooperation, and not the decreased energy consumption [9].

Kyrgyzstan's decoupling states can be generally divided between three periods. First, from 1990 to 1995 Kyrgyzstan was experiencing de-industrialization due to the collapse of the USSR, and a dramatic decline in GDP [11]. This is why the state during that period is recessive decoupling. After that, from 1995 to 2001, SD and END were constantly replacing each other. The difference is in the sign of the change of energy consumption, and due to such a constant fluctuation between two states, it seems that there was a disruption in fossil fuels, and that the energy sector had not recovered yet

[12]. Lastly, there is a third period, when END, SND, and SD were the dominant states. Expansive negative decoupling means that the economy was growing faster than the environmental pressure, which is explained by the migrant remittances that contributed to one third of the country's GDP in the corresponding years [12]. SND implies that there was a decline in economic growth, which could be caused by the corruption and instability in the region in 2001, 2004, and 2011. Finally, the strong decoupling state was observed for 2003, 2005, 2008, 2012, and 2013, which is in match with the available information about coal production decline during that time [13].

Similar to Kyrgyzstan, Tajikistan showed three stages that the results could be divided into, with two instability periods and one decoupling phase. From 1990 to 1996, Tajikistan had experienced a dramatic decline in economic growth. For example, in 1995 the GDP was equal to 41% of that in 1991 [9]. Therefore, during this period weak negative decoupling was the primary state, with some instability in the states shown in Table 2. After that, from 1997 to 2006, strong decoupling and then weak decoupling were the major states. The difference is in the sign of TPES change, and due to the increased energy demand and the further growth of the TPES by 10%, the decoupling type changed [14]. Finally, the period from 2006 to 2014 shows instability in decoupling states, with the reasons behind that being not totally clear. It is also worth noticing that Tajikistan's TPES did not change two times within the timespan, thus resulting in zero values of the elasticity.

The results of decoupling states in Turkmenistan can also be divided into two phases. First, from 1990 to 2001, similar to all other Central Asian countries, it had experienced inflation and de-industrialization due to the collapse of the USSR [15]. Therefore, the period starts with the recessive decoupling with both economic and energy consumption decline. After that, SND takes place, meaning the increased energy consumption and negative economic growth rate. However, closer to 2001, Turkmenistan's economy had experienced the weak decoupling with the energy consumption growth rate being smaller than that of the economic growth. The second phase covers the period from 2001 to 2014, when the expansive negative decoupling and then weak decoupling were the main states. This observation can be explained by the development of the commodity-based strategies in the beginning of the 21st century [15].

Last but not least, Uzbekistan's decoupling states can be divided into two stages as well. From 1990 to 1998, it had experienced all three negative decoupling states due to the fall of economy and energy consumption, lack of reforms, unemployment, and undeveloped business platforms, etc. [16]. After that and until 2014, Uzbekistan had experienced weak and strong decoupling, meaning the development of the economy and the decrease in energy consumption.

4. Conclusion

The results of the Tapio decoupling analysis show that there is a critical environmental pressure on the economic growth in Central Asia. Although the strong decoupling was observed in some countries during certain time periods, the reasons behind that were not related to the advancement of the energy consumption methods. Most of the countries experienced relative decoupling, but this is not enough for the adequate results in mitigating environmental stress on the economy in the region. In most of the countries, a significant impact of the USSR collapse with its further consequences was observed, but to guarantee further sustainable development, countries have to focus on decreasing energy consumption without sacrificing the economic development through the implementation of advanced technologies and mitigation strategies.

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