Iran. Econ. Rev. Vol. 23, No. 4, 2019. pp. 1041-1055

The Effect of Green Taxes on Labor Productivity in the Iranian Economy

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Received: 2018, November 12 Accepted: 2019, February 10

Abstract

This study attempts to examine the empirical relationship between gasoline taxes (as the most effective energy carrier of emissions) and labor productivities in the case of Iran using the time series data for the period 1990-2015 usingthe autoregressive distributed lag (ARDL) approach. This research tests the interrelationship between the variables using the bounds testing to cointegration procedure. First, we estimated gasoline demand function by ARDL method and thereafter we subordinated the estimated gasoline demand as regressors in the per capita of labor productivity function. According to price variation in the gasoline demand, we calculated the effect of the green tax on labor productivity over three scenarios.

The results imply green tax over three scenarios even though Porter Hypothesis has a negative impact on the labor productivity. Estimating the Error Correction model reveals that the speed of adjustment to restore equilibrium is a stable long-run relationship.

Keywords: Green Tax, Industry, Labor Productivity, Gasoline Demand, Iran, ARDL Method.

JEL Classification: C12, C22, C52, J01, Q52, Q58.

1. Introduction

The environmental crisis is one of the most important challenges that governments in the twenty-first century face. In our country, subsidies have made the energy carriers demand to grow rapidly in the energy sector during recent years. In the Industrial sector, numerous factors such as low fuel prices, high-life of machinery and the mass production of low efficiency machines causedetermined consumption of fuel,

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emitting more emissions and various pollutants into the environment. Economic policies can make changes in the functions of the environmental system and that can be very important especially with regard to the ones that causepollutants. Financial policies such as taxes are one of the main economic policies.

Environmental Regulation (ER) in the form of green tax has been put in place to solve market failure: The negative spillover effect in the form of pollution (water, air, and noise), climatic changes and non-renewable energy depletion is connected to industrial activity.

The Porter Hypothesis (PH) asserts that polluting firms can benefit from environmental policies, arguing that well-designed and stringent environmental regulation can stimulate innovations, which in turn can increase the firm's productivity or product value for end users (Porter 1991; Porter and Van der Linde 1995). According to what Jaffe and Palmer (1997) called as the 'weak' version and the 'strong' version of the PH, referring to the effect of ER on respectively environmental innovations and economic performance, a number of studies have found support for the weaker version of the PH. Little corroboration, however exists for the strong version of the PH (see Wagner (2003); Poop, Newell and Jaffe (2010); Ambec and Barla (2006); and Ambec et al. (2011) for extended reviews). Moreover, Acemoglu, Aghion, Bursztyn, and Hemous (2012), represented that while a large part of the discussion among climate scientists focuses on the effect of various policies on the development of the alternative and more environment friendly energy sources, until recently the response of technological change to environmental policy has received relatively little attention by leading economic analyses of environment policy.

This paper is to shed new light on the PH by using the Iranian time series data. For as much as these types of studies were not implemented in the Iranian economy, we focus on examining the validity of the Poter Hypothesis concerning labor productivity. We choose gasoline in our research as it is one of the most widespread air pollutant, in the country, mainly in the industrial sector. ,.

The plan of paper is as follows. In section 2 an overview of the literature is given. Section 3 discusses the methodology and data sources. Section 4 presents the empirical results andSection 5 concludes.

2. Literature Review

The major body of the literature review is devoted to appraising the seminal contributions of Porter (1991) and Porter and Van del Linde (1995). Originating primarily from empirical regularities found in the analysis of cross-country differences in the stringency of environmental regulation and economic performance.The PH has triggered a lot of research both theoretical and empirical in nature. It has been criticized for being merely based on anecdotal stories and for the lack of a sound theoretical basis.[1] Subsequently, some research attempts to provide a theoretical underpinning of the PH.

A strand of research focuses on the second primitives of the PH, that is, the assertion that ER should be well-designed and stringent enough to be successful also from an economic point of view. An assessment of the instruments of environmental regulation and a judgment of their effectiveness can be found in Wagner (2003). The myriad of environmental instruments can best be understood by distinguishing between command and control and market-based regulations. The instruments that set emission limits and standards fall into the first class and are often labelled as 'end-of-pipe' regulations. Environmental taxes and tradeable emission permits are examples of the second class of instruments. Environmental effectiveness can be defined as the ability to achieve a predefined environmental target. The general view is that this definition is more appropriate for the first class of instruments. By contrast, the second class of instruments has a higher economic profile, because they are aimed at triggering static and dynamic efficiency and internalizing environmental externalities.

Without any doubt, the green tax in the first step implies the Pigouvian tax. Arthur Piguo (1920) suggested that polluters must pay tax based on the amount of damage which pollution emissions cause to the environment hence we named this sort of taxation as Pigouvian taxes.In this paper Grossman (1999) examined the major literature of pollution taxes. His research is according to the Pigouvian point of view and pays attention to Coz rights. In addition, he critiques two approaches and finds new solutions for noticing the pollution issues; such as game theories and public choices. Finally, he sorts different

1. Palmer, Oates and Portney 1995; Cerin 2006

types of taxes that nowadays are very important. Following this matter, Coz (1960), critiques upon the Pigouvian theory, making a lot of discussion between neoclassic economists. Arthur Pigou believed that an efficient tax regulation could refine the negative externalities; however, we should have perfect information that has got a high cost.

The number of papers and articles that have put the PH to the empirical testing is overwhelming but they do not lead to a general consensus. Leeuween and Mohnen (2017), applied reduced-form models in the form of "Green innovations" model to asses the validity of Porter Hypothesis in two versions, which investigates the relationship between environmental regulations and labor productivity in Netherland over the period 2000-2008. The result of this study indicated the weak version of PH. There is a significantly positive effect on labor productivity. Directly and indirectly via their passive effect on eco-investments that in turn boost the propensity of introducing environmental innovations.

In addition, Jaffe and Palmer (1997) examined the validity of the Porter Hypothesis. This study designates productive industries panel data and environmental annual cost survey over period 1974-1999 in the USA. They estimated the environmental cost effect on industry product. Moreover, more stringent countries in Environmental Regulation make more innovation through firms. As a result, we have a positive and significant relationship between ER and the cost of R&D sectors in industries.

Kozluk and Ziperer (2013), with empirical evidence, review the stringency of environmental policies, productivity growth and different sustainable solutions. They spot traditional approaches, which environmental policies introduced as an overload in economic activities, and induces increasing costs with circumstance product technologies. In contrast, with this approach, PH debated that the appropriate environmental policies induce improvement in innovations and productivity. The empirical result revealed that environmental policies do not have efficiency, thus decision makers do not choose this instrument for environmental problems. In this way, accoborate the weak version of PH. Following, mentioned that the competition is the major factor of productivity and we should use it in designing the Environmental policies.

Ambec and the others (2011), in this paper investigated that PH, regarding sustainable theories and unstable evidence figures out the errors of PH: first, in theoretical field, they started their research that recently has stronger efficiency compared with past times. In the empirical field, evidence assures the weak version of PH and mention the complexity into the strong version of PH.

3. Data and Methodology

To allow for causality and dynamics and given that not all of our time-series may be stationary to the same order (some are I(0) while others are I(1)), the cointegration technique suggested by Pesaran et al.(2001), the autoregressive distributed lag model (ARDL) procedure will be used. The approach can be implemented regardless of whether the variables are integrated of order (1) or (0) and can be applied to small finite samples. Based on empirical literature; Adenikinju (1999) and Wang (2011), the long run relationship between Energy (gasoline) demand per labor, Real Price of gasoline, GDP per capita and openness can be specified[1] as:

$$\ln(EL_t) = \beta_0 + \beta_1 \ln RP_{e_t} + \beta_2 \ln GDP_t + \beta_3 \ln OPEN_t + u_t \quad (1)$$

where EL is energy (gasoline) demand per labor, is real price of gasoline as a measure of green taxes, GDP is real GDP per capita and OPEN stands for the ratio of the value of total trade to GDP, is a stationary error term.

In the next step, the long run relationship between labor productivity, stock of capital per labor, wages per labor and energy (gasoline) demand per labor can be defined as:

$$\ln(QL_t) = \alpha_0 + \alpha_1 \ln KL_t + \alpha_2 \ln WL_t + \alpha_3 \ln EL_t + \acute{u}_t \quad (2)$$

where QL is labor productivity, KL is stock of capital per labor, WL is

١. Diagnostic tests

wages per labor and EL is energy (gasoline) demand per labor. With regard to better determination the real variables, all of them have been considered as per capita. The use of per capita measures in aggregates data analysis has been given a good theoretical justification. Due to the role of active labor force productivity in the current work, each of the above mentioned variables has been devided by the number of active labor workers to get the per capita term[1]. Moreover, due to reducing heteroscedasticity and specifying the log linear, which provides an efficient estimate, the variables in this paper have been explicited in natural logarithm[2].

The sources of all data are from Iranian Energy Balance Sheet, Iranian Statistics Center and Central Bank of Iran. The period of the research is over the years 1990 to 2015.

To examine long-run relation between the series, we use the ARDL bounds testing approach to cointegration developed by Pesaran et al., (2001). The bounds testing approach has several advantages: it applies irrespective of the order of integration for independent variables, I(0) or I(1); is better suited to small samples, and a dynamic error correction model (ECM) can be derived from the ARDL model through a simple linear reparametrization. The version of the error correction model of the ARDL approach is given by:

$$\begin{aligned}\Delta \ln(EL_t) = \gamma_0 &+ \sum_{i=1}^{p} \tau_i \Delta \ln RP_{e_{t-i}} + \sum_{i=1}^{p} \theta_i \Delta \ln GDP_{t-i} \\ &+ \sum_{i=1}^{p} \vartheta_i \Delta ln OPEN_{t-i} + \delta_1 \ln EL_{t-1} + \delta_2 \ln RP_{e_{t-1}} \\ &+ \delta_3 \, ln\, GDP_{t-1} + \delta_4 \, ln\, OPEN_{t-1} + \varepsilon_t \end{aligned} \quad (3)$$

$$\begin{aligned}\Delta \ln(QL_t) = \mu_0 &+ \sum_{i=1}^{p} \varphi_i \Delta \ln KL_{t-i} + \sum_{i=1}^{p} \rho_i \Delta \ln WL_{t-i} \\ &+ \sum_{i=1}^{p} \omega_i \Delta ln EL_{t-i} + \acute{\delta}_1 \ln QL_{t-1} + \acute{\delta}_2 \ln KL_{t-1} \\ &+ \acute{\delta}_3 \, ln\, WL_{t-1} + \acute{\delta}_4 \, ln\, EL_{t-1} + \acute{\varepsilon}_t \end{aligned} \quad (4)$$

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١. Active labor force includes both employed and unemployed people in the labor market.

٢. Ln stands for logarithm

where in number 3 equation and in number 4 equation refer to the short run and to in number 3 and to to long-run parameters. The null hypothesis of no cointegration is and against the alternative hypothesis. The rejection of the null rely on the F-statistic suggests a cointegrating relationship. The critical bounds have been expressed by Pesaran et al. (2001). The upper critical bound (UCB) is based on the assumption that all series are I(1). The lower bounds (LCB) applies if the series is I(0). If UCB is lower than the measured F-statistic, the null of cointegration is sustained. If the F-statistic is less than the LCB then there is no cointegration. The decision about cointegration will be inconclusive and if the F-statistic lies between UCB and LCB. In this situation, we will have to rely on the lagged error correction term to investigate the long-run relationship.

The orders of the lags in the specification model (1) and (2) are selected by Schwartz-Bayesian criterion (SBC). For annual data, Pesaran and Shin (1999) recommended choosing a maximum of 2 lags. From this, the lag length that minimizes SBC selected.

If a long run relationship exists, the ARDL representation of the model (1) and (2) are formulated as follow:

$$\ln(EL_t) = \gamma_1 + \sum_{i=1}^{p+1} \tau_{1i}\, \Delta \ln EL_{t-i} + \sum_{i=1}^{p+1} \sigma_{1i}\, \Delta \ln RP_{e_{t-i}} + \sum_{i=1}^{p+1} \theta_{1i} \Delta \ln GDP_{t-i} + \sum_{i=1}^{p+1} \vartheta_{1i}\, \Delta lnOPEN_{t-i} + \varepsilon_t \qquad (5)$$

$$\ln(QL_t) = \mu_1 + \sum_{i=1}^{p+1} \varphi_{1i} \Delta \ln QL_{t-i} + \sum_{i=1}^{p+1} \pi_{1i}\, \Delta \ln KL_{t-i} + \sum_{i=1}^{p+1} \rho_{1i} \Delta \ln WL_{t-i} + \sum_{i=1}^{p+1} \omega_{1i}\, \Delta lnEL_{t-i} + \acute{\varepsilon}_t \qquad (6)$$

The ARDL method estimate, number of regressions in order to obtain the optimal lags for each variable, where the maximum number of lags to be used is and k is the number of variables in the equation (Shrestha and Chowdhury, 2005). The model is selected based on Schwartz-Bayesian Criterion (SBC) that use the smallest possible lag length and is therefore described as the parsimonious model.

The ARDL specification of short-run dynamics is investigated using the ECM version of ARDL model of the following form:

$$\Delta\ln(EL_t) = \gamma_2 + \sum_{i=1}^{p} \tau_{2i}\,\Delta\ln EL_{t-i} + \sum_{i=1}^{p} \sigma_{2i}\,\Delta\ln RP_{e_{t-i}} + \sum_{i=1}^{p} \theta_{2i}\Delta\ln GDP_{t-i} + \sum_{i=1}^{p} \vartheta_{2i}\,\Delta lnOPEN_{t-i} + \psi ECM_{t-1} + \varepsilon_t \quad (7)$$

$$\ln(QL_t) = \mu_2 + \sum_{i=1}^{p} \varphi_{2i}\Delta\ln QL_{t-i} + \sum_{i=1}^{p} \pi_{2i}\,\Delta\ln KL_{t-i} + \sum_{i=1}^{p} \rho_{2i}\Delta\ln WL_{t-i} + \sum_{i=1}^{p} \omega_{2i}\,\Delta lnEL_{t-i} + \xi ECM_{t-1} + \acute{\varepsilon}_t \quad (8)$$

The lagged residual term (ECM) in equation 7 and 8 show the disequilibrium in long run relationship (equation 1 and 2).

Now we want to define green taxes in the Iranian economy through three scenarios regard to 1%, 5% and 10% rise in the real price of gasoline; this is formulated as follows:

$$RP_t = RP_e + x\%RP_e$$

Whereas the real industrial gasoline price after implementing the variation percent is the real price of gasoline and %x is the variation percent of gasoline price.

4. Empirical Results

Pesaran et al. (2001) critical values are based on the assumption that the variables are integrated of order I(0) or I(1). Unit root tests ensure that none of the series is integrated of I(2) or higher. Both the augmented Dickey-Fuller (ADF) (1979) and Philips-Perron (PP) (1988) unit root tests have been employed for that purpose and the results are summarized in Tables 1. Test for stationarity shows that all variables are integrated of order 1 and thus stationary in difference.

Table 1: Unit Root Test

variables	ADF test statistic (with trend and intercept)		PP test statistic (with trend and intercept)	
	Level	first difference	Level	first difference
Log EL	-1.706	-4.339	-1.706	-4.309
Log RP	-3.121	-4.941	-3.083	-10.583
Log GDP	0.966	3.558	-0.744	-5.569
Log OPEN	-1.108	-5.687	-1.112	-5.692
Log QL	-0.791	3.224	-0.881	-5.509
Log KL	-2.755	-4.840	-2.325	-4.007
Log WL	-3.877	-3.421	-6.118	-3.428

To inquire about the presence of long-run relationships between the variables, testing of the bound under Pesaran, et al. (2001) procedure is used. The result of the bound test is given in Table 2. The critical values used in this paper are extracted from Narayan (2004). The calculated F-statistic for equation 1 is 1.288 and for equation 2 is 1.032 while upper critical bound at significance level 1% is 5.966. This implies, there are long-run relationships among EL, RP, GDP and OPEN in model 1 and the same relationship among QL, KL, WL and EL in model 2 over the period of 1990-2015 in Iran.

Table 2: Bounds Test Results

F-statistic	Lag	Significance Level	Bound Critical Values	
			I(0)	I(1)
Model 1 (Energy Demand equation)				
1.288143	1	1%	4.614	5.966
		5%	3.272	4.306
		10%	2.676	3.586
Model 2 (productivity equation)				
1.032960	1	1%	4.614	5.966
		5%	3.272	4.306
		10%	2.676	3.586

The next step of the procedure would be to estimate the coefficients of the long-run relations and the associated error correction model (ECM) using the ARDL approach. The optimal lags on variables selected by Schwartz-Bayesian Criterion (SBC) turned out to be the ARDL (1,0,0,0) for both models. The long-run estimated coefficients are shown in Table 3. As can be seen, all the coefficients are significant. The results in Energy Demand model mentioned that we have a negative and significant relation between gasoline price (RP) and Energy demand (EL) and the coefficient is -1.10. Moreover, the relation among productivity and energy demand is positive, insignificant and equivalent to 1.13, but the relation between the productivity and first lag of energy demand is positive, significant and equivalent to 0.56.

Table 3: Estimated Long-Run Coeffiecents Based on ARDL Approach

Regressors	Energy Demand Equation		Productivity Equation	
	coefficient	significance level	coefficient	significance level
Constant	0.36	0.01	1.45	0.00
Log RP	-1.10	0,02		
Log GDP	0.18	0.03		
Log OPEN	0.16	0,03		
Log EL			1.13	0.65
First lag of Log EL			0.56	0.03
Log KL			1.89	0.00
Log WL			0,94	0.00

The result of the error correction model is reported in Table 4. The ECM represents the speed of the adjustment to restore equilibrium in the dynamic model following the disturbance. The coefficient of the ECM for productivity model is around -0.55 and energy demand model is around -0.56, implying that a deviation from the long-run equilibrium is corrected by 55% and 56% after each year.

Table 4: Error Correction Representation for the Selected ARDL Model

Model name	Coefficient	p-value
Productivity	-0.558	0.00
Energy Demand	-0.526	0.00

The plot of the cumulative sum of recursive residuals (CUSUM) stability test as shown respectively in figures 1 and 2 indicate that all the coefficients of estimated models are stable over the study period as they fall within the critical bounds.

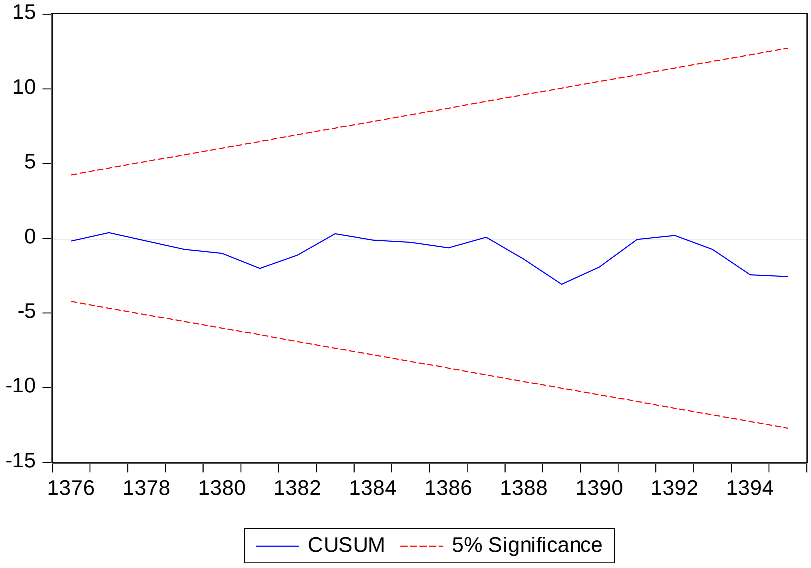

Figure 1: CUSUM for Energy Demand Model

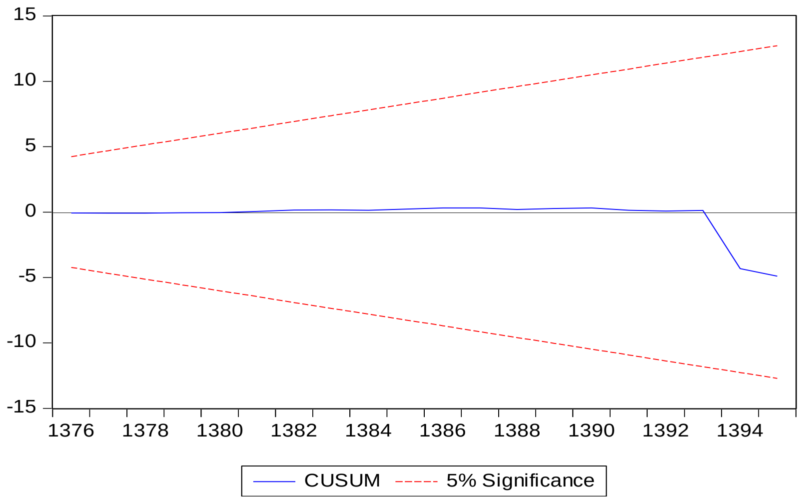

Figure 2: CUSUM for Productivity Model

According to the former estimation process of Energy demand, these three scenarios gauge the green taxes calculations which havethe same results. As the above equations show, all of the price elasticities are repeated, and we just have seen the intercept variation through the equations.

	The Price variation
$\mathrm{LOG(EL)} = 0.477415607067 * \mathrm{LOG(EL(-1))} - 0.0314871143809 * \mathrm{LOG(P1)} - 0.0407515422369 * \mathrm{LOG(GDP)} - 0.0618583501151 * \mathrm{LOG(XG)} - 0.0173757242593 * \mathrm{LOG(XG(-1))} + 0.236542284765 * \mathrm{LOG(XG(-2))} - 0.339909020402$	1%
$\mathrm{LOG(EL)} = 0.477415607066 * \mathrm{LOG(EL(-1))} - 0.031487114381 * \mathrm{LOG(P2)} - 0.0407515422369 * \mathrm{LOG(GDP)} - 0.0618583501151 * \mathrm{LOG(XG)} - 0.0173757242594 * \mathrm{LOG(XG(-1))} + 0.236542284765 * \mathrm{LOG(XG(-2))} - 0.338686066127$	5%
$\mathrm{LOG(EL)} = 0.477415607066 * \mathrm{LOG(EL(-1))} - 0.0314871143811 * \mathrm{LOG(P3)} - 0.0407515422369 * \mathrm{LOG(GDP)} - 0.0618583501151 * \mathrm{LOG(XG)} - 0.0173757242594 * \mathrm{LOG(XG(-1))} + 0.236542284765 * \mathrm{LOG(XG(-2))} - 0.337221285073$	10%

5. Conclusion

This paper has inquired the effect of green taxes with an emphasis on the Porter hypothesis in Iran using annual data for the period 1990-2015 applying autoregressive distributed lag (ARDL) approach. According to the results, we investigated, there are long-run relations among energy demand per labor, real price of gasoline, gross domestic product per capita and openness in energy demand model and likewise, among labor productivity, stock of capital per labor, wages per labor and energy demand per labor in productivity model. Estimating the Error Correction model shows that the speed of adjustment to restore equilibrium are -0.558 and -0.526 which confirms that there is a stable long-run relationship.

As the gasoline short-run price elasticity is – 0.07, therefore it is a type of good, which has perfectly inelastic demand. The consumers regulate their demand in the long period, so the determinant of long-run elasticity is -0.26, which shows the perfect demand elasticity. While the price of gasoline increases (enforcement of green tax), the amount of industrial consumption would change by augmentation of gasoline efficiency. Otherwise, extensibility of the gasoline demand is due to the flexibility in the industrial consumption behaviour and also the existence of sustainable goods. The price elasticity may change through the implementation of the green taxes scenarios, for instance, entry of new technology and existing new products induce the change of elasticity, thus as a result in the short-run, the green taxes efficiency is almost low. However, implementing the green taxes through three scenarios increases the price of gasoline in short-run with circumstances of stability in the other factors, induce the diminution in Energy demand and then decreases the labor productivities. According to the results of the research in the long-run, with the implementation of the green taxes, the energy demand will decrease which in turn will aggravate the labor productivity diminution.

This fact has a lot of consequence, the implementation of the green taxes conduce to motivate towards the economic activities with lower pollution and more innovations in economic sectors. These policies with internalizing the external costs could return the efficiency of the market and in the long-run fulfil the stable development procedure. Therefore, the green taxes in the industrial segment will provide huge revenues for the government to set the macro policies such as improving the social welfare subject to improvement of environmental qualities.

The empirical results strongly corroborate the weak version of the Porter Hypothesis. These results were predictable because ordaining the environmental regulation (in this place green taxes) would lead the industries to the environmental investments and increase the production costs. If not all of the investments will result in reproducing, then there is no reason to invest.

As technological change and innovation have a strong effect on efficiency, an important goal for future research should be to obtain estimates that are more precise by adding the innovation in the current study.

References

Acemoglu, D., Aghion, P., Bursztyn, L., & Hemous, D. (2012). The Environment and Directed Technical Change. *American Economic Review, 102*(1), 131-166.

Adenikinju, A., & Olumuyiawa, A. (1999). Energy Use and Productivity Performance in the Nigerian Manufacturing Sector. *OPEC Review*, Retrieved from https://onlinelibrary.wiley.com/doi/pdf/10.1111/1468-0076.00066.

Ambec, S., & Barla, P. (2006). Can Environmental Regulation be Good for Business? An Assessment of the Porter Hypothesis. *Energy Studies Review*, *14*(2), 42–62.

Ambec, S., Cohen, M. A., Elgie, S., & Lanoie, P. (2011). The Porter Hypothesis at 20. *Discussion Paper, 11-01*, Retrieved from https://academic.oup.com/reep/article-abstract/7/1/2/1578611.

Grossman Britt Pollution TAX. (1999). Environment Economics and Management Faculty of Economics. *Working Paper, 12036-12,* Retrieved from http://murallivre.net/Archives/2500book.pdf.

Jaffe, A., & Palmer, K. (1997). Environmental Regulation and Innovation: A Panel Data Study. *Review of Economics and Statistics, 79*(4), 610-619.

Koźluk, T., & Zipperer, V. (2013). Environmental Policies and Productivity Growth: A Critical Review of Empirical Findings. *OECD Economics Department Working Papers, 1096,* Retrieved from https://search.proquest.com/docview/1465244236?pq-origsite=gscholar.

Leeuwen, G., & Mohnen, P. (2017). Revisiting the Porter hypothesis: an empirical analysis of Green innovation for the Netherlands, *Economics of Innovation and New Technology, 26*(1-2), 63-77.

Narayan, P. K. (2005). The Saving and Investment Nexus for China: Evidence from Cointegration Tests. *Applied Economics, 37*, 1979-1990.

Pesaran, H. M., & Shin, Y. (1999). Autoregressive Distributed Lag Modeling Approach to Cointegration Analysis. In S. Storm (Ed.), *Econometrics and Economic Theory in the 20th Century: The Ragner Frisch Centennial Symposium*. Cambridge: Cambridge University Press.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Economics, 16,* 289-326.

Popp, D., Newell, R. G., & Jaffe, A. B. (2010). *Energy, the Environment, and Technological Change (21), Handbooks of the Economics of Innovation*. Amsterdam: Elsevier Science Publishers.

Porter, M. (1991). America's Green Strategy. *Scientific American, 264*(4), 168-175.

Porter, M., & van der Linde, C. (1995). Toward a New Conception of the Environment-Competitiveness Relationship. *Journal of Economic Perspectives, 9*(4), 97-118.

Wagner, M. (2003). The Porter Hypothesis Revisited: A Literature Review of Theoretical Models and Empirical Tests. *Research Memorandum Center for Sustainability Management (SM)*, Retrieved from https://econwpa.ub.uni-muenchen.de/econ-wp/pe/papers/0407/0407014.pdf.

Wang, C. (2011). Sources of Energy Productivity Growth and its Distrbution Dynamics in China. *Resource and Energy Economics*, *33*, 279-292.