

The Environmental Policy Stringency in Taiwan and Its Challenges on Green Economy Transition*

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With the aim of promoting green economic transition on a national level, this study applies the environmental policy stringency index, developed by OECD, to analyse Taiwan's energy policies between 1990 and 2015, and compare results with those of other OECD countries. After examining the institutional foundation and regulatory tools in Taiwan's green economy transition, we found that green transition in Taiwan currently faces eight major challenges in common with other OECD member states. We argue that the government of Taiwan needs to make adjustments to its environmental policy or follow OECD trends and strengthen environmental regulations. However, we also argue that the goal of green economic transition will never be easy to reach as long as a nation remains heavily dependent on "non-market mechanisms." The establishment of the OECD environmental policy stringency provides an international standard by which individual countries can compare themselves to measure their development.

Keywords: environmental regulation, regulation-driven innovation, market-based policy, green economic transition, OECD

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Introduction

Green Economy Initiative

In the aftermath of the 2008 global financial crisis, the UN began to pay attention to the concept of a Green Economy. The sudden and global nature of the financial crisis led to the stagnation or decline of economies worldwide as well as an upsurge in energy prices, leaving developed countries trying everything they could to find a new momentum for growth, and it was within this context that the concept of green economies started to receive greater attention. The United Nations Environmental Programme (UNEP 2008) launched the 'Green Economy Initiative', proposing a green economy model to be a way to improve human welfare, ensure social equity, avoid the continued exhaustion of natural resources, and control environmental risks (UNEP 2011). The United Nation hoped that as dealing with economic difficulties, it could also help to deal with issues related to climate change, limited water resources, food deficiency as well as other challenges caused by environmental issues and finally bring about a policy call for the "Global Green New Deal, GGND" (UNEP 2009). The reality is that the financial crisis and environmental crisis coexist, and through the GGND environmental regulations are brought together with green investments. It could be that the end result of the financial crisis turns out to be the beginning of the alleviation of the environmental crisis (Tienhaara 2010).

Green Economy along with Environmental Regulations

The development of a Green economy along with environmental regulations has the greatest potential to ensure nations a sustainable development model. The GGND report defined green economy as "able to facilitate the improvement of human welfare and social equity, while at the same time decreasing the type of economy which causes environmental risks and ecological scarcity." Therefore, green economy can be seen as a low carbon, highly resource efficient and socially inclusive form of economy. With a green economy, increases in income and employment are a result of both public and private investment aiming to reduce carbon emissions and pollution and increase energy and resource efficiency while also preventing the loss of multiple species and damage to ecological systems. That is to say that, the practical evidence of developing a green economy should be sufficient to

justify the Porter Hypothesis, that is, when the overall environmental policy trend is increasingly environmentally friendly, it will not mean economic growth being strangled but rather that such a move would bring about renewal, offset with the cost of green transition (Porter 1991). Besides this, a green economy to a certain extent is the product of social demand, as only this sort of sustainable development model enables a reduction of the effects of climate change and global warming on the environment, economy, society and our very existence. So many countries hope to see such a move from a traditional industrial society to a low carbon society or a green economy society, in order to escape from the current development dilemma with its high pollution, high carbon emissions and high energy consumption (Chou 2016).

Most of the Interviewed Pro Green Economy

In 2012 on the eve of Environmental Day, the UNEP publicly released a report on the topic of green economy, showing that in many countries both the public and researchers of sustainable development were in support of green economy. This poll was carried out by “The Regeneration Project,” which conducted interviews with 16,000 members of the public in 17 different countries, while also conducting questionnaires in 117 countries. The poll points out that green economy is much more equipped to deal with the economic, social and environmental problems currently facing. More than 70% of those interviewed said that they believed green economy would be better equipped to protect the environment, and give the next generation a better future (68%), while 61% of interviewees believed that green economy could improve quality of life and deal with the challenges of climate change (UNEP 2012).

Taiwan Itself to be Delayed and Backwards

However, in comparison to many other countries, on the subject of green economy, Taiwan has shown itself to be delayed and backwards, even becoming the object of unwanted attention from the international community, as an example of a country with a weak undeveloped green economy (Hsu 2013; Lee et al. 2013; Yang 2014; Yang 2016). Energy Report published by the European Chamber of Commerce (2015) and the White Paper published by the American Chamber of Commerce (2015) both mentioned Taiwan’s renewable energy development as being weak as well as

pointing out that the Taiwanese governments lowering of energy prices, has enabled Taiwan enterprises to tenaciously defend their own self-interests, while neglecting long term development opportunities. While Taiwan, ranking at number 17th in 2018, may come in relatively high on the Swiss International Institute for Management Development, Lausanne's IMD list of Global competitiveness (IMD 2018), however in the 'Health and Environment' index of green competitiveness, Taiwan is found amongst the less developed countries. One of the indicators used to sort the index was the average CO₂ emissions per person. The International Energy Agency (IEA) report also sees the same problem (IEA 2015). In 2014, Taiwan's CO₂ emissions amounted to 2.5 million tons, making it the 21st largest CO₂ emitter worldwide. Moreover, the average carbon emissions per person were as high as 10.63 tons. Amongst countries with total population over ten million, Taiwan came in 7th highest worldwide for carbon emissions per person in 2013 (IEA 2015). Such findings show that Taiwan still has a long way to go in green economy transition.

Literature Review and Research Scope

Literature Review

Beginning in 1960, researchers of Global public health gradually began exploring the source of innovation for resolving countries' environmental health problems. They found that any environmentally friendly innovation began mainly with regulations made by government and from there the 'Regulation-driven innovation' would become the major way of resolving advanced countries' environmental issues (Rennings et al. 2011; Johnstone et al. 2012; Rubashkina et al. 2015), or have the impact on relocation (Milani 2017). Furthermore, as for a specific country or most advanced countries, environmental policy stringency is connected with a short-term growth in industrial or thermal power plants' productivity (Antonietti et al. 2017; Johnstone 2017; Alorizio et al. 2017). Moreover, in order to implement climate change policy and move towards a green economy society, besides policy led elements such as options of social value and agendas, regulations were also a vital element (Chou 2013a; Chou 2016). While at the same time for the innovation of governance, there would be a need to concentrate on the structures of decision-making and regulations within the context of local society (Chou 2013b). In order for a country to develop a green economy,

they must first explore the economic regulation model and legal mechanisms in place for ensuring environmental protection (Smoilov et al. 2015), and the rule-of-law structure can assist countries substantially to pursue economic growth and overcome environmental challenges in the long term (Chen 2017). For example, we can find that the EU makes a political promise to implement its vision for ensuring sustainable development, as a result of which we can see green growth and capacity building within economic context nowadays (Ivanescu et al. 2016).

Based on these findings, this research studies the Organization for Economic Co-operation and Development (OECD) “Environmental policy stringency, EPS,” from a historical perspective to analyse the institutional foundation of green economy transition in Taiwan, to locate Taiwan within the larger context of the global green economy transition. We believe only by understanding Taiwan’s position in the greater context of the global green economy transition can we identify the loopholes and limitations of the regulations currently in place. Only by improving norms related to environmental regulations, is there a chance for Taiwan to bring about fresh innovation in its own economy transition. What is more, differences between countries in terms of social culture, historical events and individual traditions, have led to the formation of various models of politics and governance which in turn lead to differences in regulatory configuration and operation logic of nations (Chou 2004). Green economic society should develop with different regulatory or capitalized models (Tienhaara 2013). Therefore, countries should make adjustments to environmental policies in order to move towards a green economic society in accordance with the assessments and analysis of EPS. The relationships between environmental policy and competitiveness maybe change based on characteristics of the industry or sectors concerned (Iralso et al. 2011). Although OECD Green Growth Indicators could be adopted to evaluate for green economy as well, it is broader to be connected with environmental regulation or authorities’ interference (OECD 2018). Taiwan, as like the other countries in the world, faces a challenge of climate change via energy transition. Besides, Environmental Policy Stringency Index is more suitable to be adopted than Green Growth Indicators, because Environmental Policy Stringency Index includes more prioritized indicators of renewable energy development and energy saving, which are mainly crucial elements of energy transition.

OECD's Eight Major Challenges

As an OECD participant country, Taiwan must face the challenges that OECD members have experienced in their transition to a green economy. After an assessment of member states' progress and analysis of green growth, the OECD (2015) pointed to 8 major challenges that they could expect to face. Challenge (1): establish and clarify the cost of greenhouse gas emission, whether it be through the implementation of tax revenues or a tradable permit scheme; Challenge (2): through a pricing scheme to change the consumption behaviour of water, wastes and transportation; Challenge (3): transit to an environment friendly tax revenue; Challenge (4): Eradicate tax revenue schemes which damage the environment; Challenge (5): in order to promote green technology, gradually eliminate subsidies which have a negative effect on the environment; Challenge (6): develop the basic infrastructure needed to support green growth; Challenge (7): designate innovation institutions which prioritize green growth; Challenge (8): improve energy efficiency. How Taiwan faces these challenges is the focus of this paper.

Research Scope

This study is divided into the sections below. First, we will give an overview of the methods adopted by various countries in the assessment of EPS and adopt the OECD assessment method to analyse the development of Taiwan's EPS between 1990 and 2016 in order to understand where Taiwan has improved or where there is still need for further improvement. Even though Taiwan is only a participant state and not an OECD member state, we will apply the OECD's actual methods and analyse their pros and cons, and then on the foundation built by the OECD, examine Taiwan's own newly added EPS index to periodically track policy effectiveness and review what is in need of improvement, in order to promote the transition in Taiwan towards a green economy.

Procedure and Measure

With the purpose of comparing Taiwan's EPS performance with other OECD member states, we adopted the OECD index building method (refer to 3.1.),

looking at Taiwan's related laws and finding corresponding index which could be used as a basis for scoring EPS for Taiwan. When constructing the EPS index, OECD used the data provided by individual countries. In order to ensure Taiwan's index possessed historically comparative implication, we looked to use similar and related data for calculation. Below is the explanation of the research method adopted and data source.

Method of OECD Studies

Generally speaking, methods for examining a countries' EPS are highly diverse; we can observe the extent to which a countries' environmental laws are put into practice, or how much budget is set aside for preventing pollution or developing renewable energy. Another way would be through a survey of professionals in the field providing their perception of the EPS of countries around the world to determine a country's relative environmental policies in comparison to other countries. Previous literatures show different means of measuring EPS, such as the cost spent by the private sector in slowing down environmental pollution, and measurement on the basis of administrative regulations, pollution emissions, energy consumption or public expenditure (Brunelet et al. 2013). While at a practical implementation and comparison level, you could separate into comparisons of a single policy, composite index, the perception survey of stringency, company survey, environmental 'shadow price' or practical environmental results (Botta et al. 2014).

In order to overcome the methodology difficulties as well as the diversity of indicators, the OECD's Economics Department researchers established an assessment of environmental policy's composite index, with the aim of simplifying and scoring EPS, while also revealing the connection between EPS and economic development. As part of this, the structure of the economy-wide indicator was separated into Market-based Policies and Non-market policies, which is the same as Testa et al. (2011) in distinguishing environmental regulations as direct regulations and economic instruments. The former includes Energy Tax, Emission Trading Schemes, Renewable Energy Power, Energy Saving, Feed-in Tariffs, Deposit and Refund Scheme along with other indicators. The latter includes Air Pollution Emission Standards, the Content of Sulphur allowed in Diesel, Renewable Energy R&D subsidies and other indicators. This composite index attempts to cover all possible perspectives with greater simplicity while possessing characteristics of profiled transnational comparison and longitudinal time-average

TABLE 1
OECD ENVIRONMENTAL POLICY STRINGENCY INDICATORS

NO.	Instrument(Indicator)	Information for Scoring
1	Carbon Dioxide Tax(CO ₂ _Tax)	Tax rate in EUR/ tonne
2	Nitrogen Oxides Tax(NO _x _Tax)	Tax rate in EUR/ tonne
3	Sulfur Oxides Tax(SO _x _Tax)	Tax rate in EUR/ tonne
4	Emission Trading Scheme(CO ₂ _TS)	Price of one CO ₂ allowance
5	Renewable Energy Certificates Trading Scheme(Green_TS)	% of renewable electricity that has to be procured annually
6	Energy Certificate Emission Trading Scheme(White_TS)	% of electricity saving that has to be delivered annually
7	Feed In Tariff for wind(FIT_Wind)	EUR/kWh
8	Feed In Tariff for solar(FIT_Solar)	EUR/kWh
9	Maximum Content of Sulphur Allowed in Diesel(S_content)	Value dictated by the standard
10	Government R&D Expenditures for Renewable Energy Technologies(R&D)	Expressed as % of GDP
11	Tax on Diesel for Industry(Diesel_Tax)	Total tax for a liter of diesel used in transport for industry
12	Deposit and Refund Scheme (DRS)	Deposit Refund Scheme for Beverages
13	Nitrogen Oxides Emission Limit Value for Newly Built Coal-fired Plant(ELV_NO _x)	Value of Emission Limit in mg/m ³
14	Sulfur Oxides Emission Limit Value for Newly Built Coal-fired Plant(ELV_SO _x)	Value of Emission Limit in mg/m ³
15	Particulate Matter Emission Limit Value for Newly Built Coal-fired Plant(ELV_PM)	Value of Emission Limit in mg/m ³

Source: Botta and Koźluk (2014)

comparison and it has been used to track the changes of OECD member states' EPS between 1990 and 2012.

The OECD EPS composite index is 'policy based', observing the changes in the energy and economic standings of member states, marking levels between 1 and 6, giving different weight to different indicators, and finally the levels would be counted cumulatively to provide a final score which could

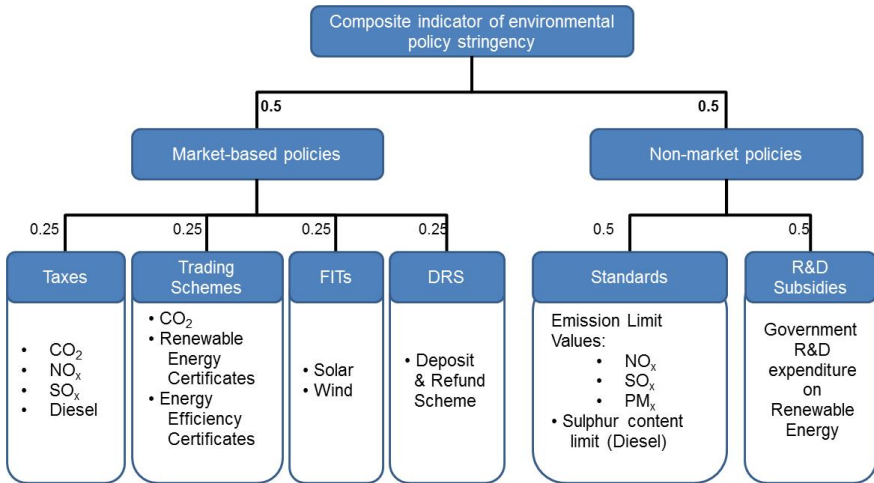


FIG. 1.—OECD Environmental Policy Stringency pointing structure (Botta and Koźluk 2014)

be used for comparison. The OECD EPS scoring system includes 15 indicators as seen in the Table 1. Once the standards of scoring are finalized and in accordance to the real situation each indicator reveals, then OECD sets levels or thresholds between 1 and 6, 1 representing the lowest and 6 the highest, if they are no laws or the member state fails to provide information on any one indicator the score will be 0. As to pointing or weighting, please refer to the link to the data set https://www.oecd.org/eco/growth/EPS%20Indicator_Data.xlsx

Finally, as the explanation and table above show, the OECD separated all its indicators into Market-based Policies and Non-market policies, each representing 50% of the total, and then beginning with each indicator, gradually working out layer by layer. Finally, the OECD reaches an ESP’s composite scores for comparisons.

Method Adopting and Data Processing

This study will follow the OECD’s methodology, which is so say we will adopt the OECD’s method for calculating a countries’ EPS. OECD has developed composite indexes to measure the stringency of individual countries’ policy, as well as attempting to set up indicators which directly make connections between the environment and energy resources, and this study will adopt the same composite indicators and sub ones as the same as OECD ones,

preliminarily constructing Taiwan EPS, with the aim of adopting international standards and seeking out a standard for making comparisons with other OECD member states. Furthermore, the methodology for scoring provides the basis on international comparative analysis and reproducibility of environmental policy stringency, and nations could compare itself during a long period of regulatory history and revise the indicators to fit in their specific development status. Besides, the diverse indicators could be selected for comprehensive analysis, such as FIT Prices and Procured Renewable Energy, to strengthen the objectivity of the indicators and scoring.

With the major source of data being from regulations or official documents, not only can the source be recognized as stable, but also possess greater credibility and reliability. Regulations relating to this issue are as follows: Air Pollution Control Act, Rates for Stationary Air Pollution Source Control, Fee Collection and Allocation Act of Automobile Fuel Consumption, Greenhouse Gas Reduction and Management Act, Renewable Energy Development Act, Waste Disposal Act, Air Pollution Emissions Standard for Power Facility, Standards for the Composition of Automobile Gasoline and Diesel Fuels, Investment Offsetting Act for Companies Purchasing Equipment or Technology of Energy Saving or Usage of New and Cleaner forms of Energy. On the other hand, the source of official documents comes from Bureau of Energy, Ministry of Economics and the Directorate General of Budget, Accounting and Statistics, both belonging to Executive Yuan.

Analysis of Results

International Status and historical Profile

This study carried out an assessment of Taiwan's EPS to find where Taiwan was positioned amongst all of the OECD countries. In 2012 Taiwan's EPS level in terms of Market-based Policies was 1.46. While for the Non-market policies it was around 3.25, and its overall average was around 2.36. In comparison, the 24 OECD member states' Market-based EPS was on average around 2.35 while their stringency for Non-market policies was around 3.70, with a final average of around 3.00. Comparatively speaking, Taiwan's policies are not stringent but rather comparatively relaxed, closer to the stringency levels of countries such as Australia, Italy, or France.

Major Trends in Changes of Taiwan EPS:

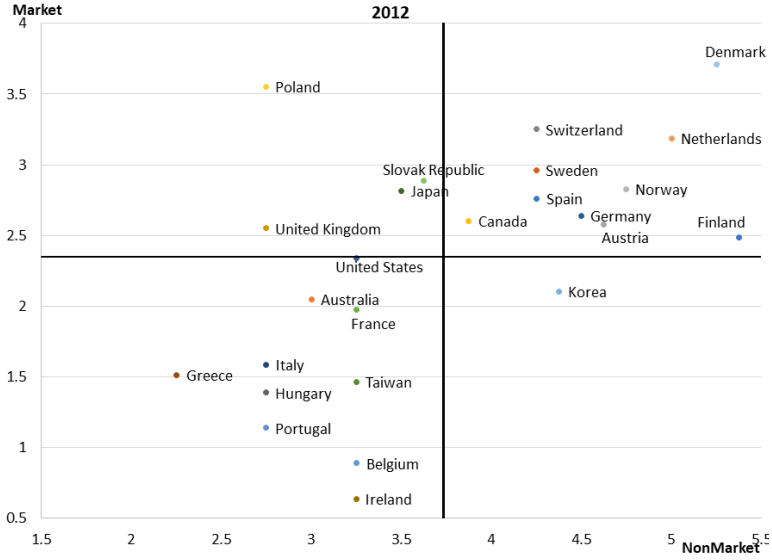


FIG. 2.—Comparison of the EPS among Taiwan and other OECD member states

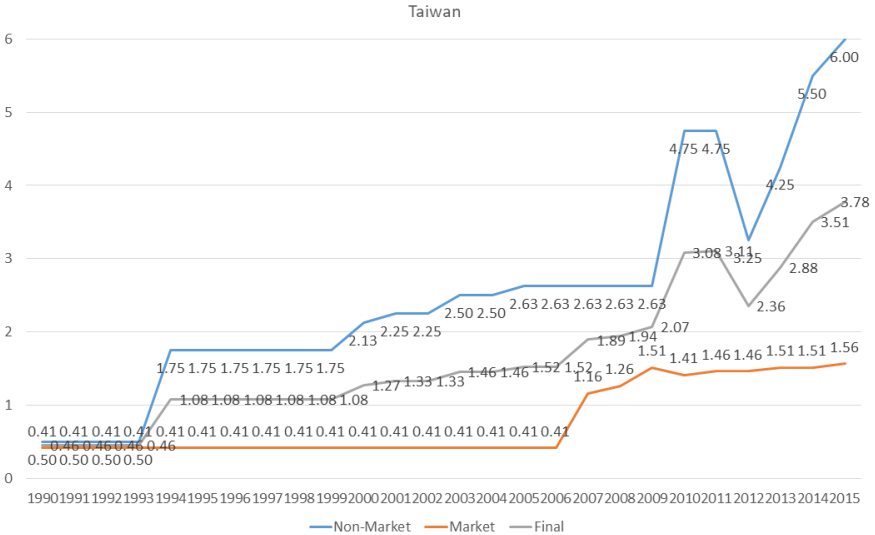


FIG. 3.—Changing trends in Taiwan Environmental Policy Stringency (X Axis: Year; Y Axis: Environmental Policy Stringency)

- (1) Total stringency reveals an upwards trend, with two major turning points occurring in 1993 and 2009 respectively.
- (2) Between 1990 and 2015, Non-market policies' stringency was found to be greater than those of Market Policies.
- (3) The turning point for increased stringency in Non-market policies occurred in 1993 with an upward trend beginning in that year. Then after 2008 there was another turning point with a major change in financial support for R&D into renewable energy, while a more fundamental reason can be found in the formulation and implementation of the 2009 Renewable Energy Development Act, along with the affect the Financial Crisis on fluctuations in energy consumption.
- (4) In terms of Market Policies, the greatest influence on stringency occurred with a turning point and upward trend in 2006.
- (5) Overall Non-Market Policy has had a greater impact on stringency.

Evolution of Indicators

In the following section we consider the meaning and related institutional development of individual indicators within context of various composite indicators to explain the changes of Taiwan EPS. Firstly, The Energy Tax that this indicator focuses on is related to various forms of pollution or energy, including Carbon Dioxide, Nitrogen Oxides, Sulfur Oxides and Diesel. Below we will discuss each form separately in accordance with the OECD's original figure:

- (1) Energy Tax of Carbon Dioxide Emissions Levy:

Taiwan doesn't currently levy a Carbon tax, placing this individual indicator lowest with a level 0 of 6.

- (2) Energy Tax of Nitrogen Oxides Emissions Levy:

According to the Air Pollution Act Article 17(2), the Executive Yuan's Environmental Protection Agency announced 'Rates for Stationary Air Pollution Source Control', which came into effect in 2007. Although these rates haven't been revised, in comparison to other OECD member states they are relatively high, placing Taiwan at the level 6 for this indicator, the highest of all levels.

- (3) Energy Tax of Sulfur Oxides Emissions Levy:

According to the Air Pollution Act Article 17(2), the Executive Yuan's Environmental Protection Agency announced 'Rates for Stationary Air

Pollution Source Control', which came into effect in 2007. Although these rates haven't been revised, in comparison to other OECD member states they are relatively high, placing Taiwan at the level 6 for this indicator, the highest of all levels.

(4) Energy Tax of Diesel User Levy:

According to Highway Traffic Act Article 27(2), Ministry of Transportation and Communications announced 'Fee Collection and Allocation Act of Automobile Fuel Consumption', prior to 1990 with the introduction of an Automobile Fuel Consumption Fee there was a distinguishing between different types of automobiles, petrol or diesel and for 26 years there haven't been any revisions. Despite Taiwan already implementing tax on automobile Fuel, in comparison to other OECD countries the rates are low, and as a result this indicator is only level 1 of 6.

(5) CO₂ Emissions Trading Scheme:

Taiwan passed the Greenhouse Gas Reduction Act on the 15th June 2015, Article 8 within this Act stipulates that the government should establish total amount control, trade-off, auction, distribution and trading of greenhouse gas. This research analyses data until 2015, which means that prior to 2015 this individual indicator would have been measured at level 0.

(6) Renewable Energy Development as a Percentage of all Power Generation:

In terms of all power generation, in 1992 renewable energy power (not including 'Hydroelectric power') accounted for 0.52% of all generated electricity, a figure which gradually increased over the following 9 years to account for 1.25% of overall power by 2001. And 12 years later in 2013 this figure had risen again to 2.13%, only reaching levels 1, 1, and 2 of 6 for the indicator, rather low in comparison with other OECD member states. By 2015 when including hydroelectric power, renewable energy in Taiwan accounted for 4.06% of all power generated (Taiwan Power Company 2016).

(7) Proportion of Annual Energy Saving:

Between 1990 and 2007 energy consumption increased annually at a rate of anything between 2% and 7%. However, between 2008-2009, and 2011-2012 and then in 2015 we start to find the occurrence of energy saving, with 2008-2009 being the most obvious, with savings of between 2% and 3%. Within a period of 25 years Taiwan has only seen energy saving taking place in 5 years of these years; a figure placing Taiwan on the level 1 or 2. Again this figure is low if compared with other OECD member states. This shows that for Taiwan there is yet to be a decoupling of the relationship between economic growth and energy consumption and that green growth or

transition still has a lot of room for development or improvement.

(8) Wholesale for Solar Power Generation:

In 2009 Taiwan passed and began implementing its 'Renewable Energy Development Act', and one aspect of this Act was the introduction of Feed-in Tariffs, subsidies for electricity prices and a rewarding system for the modeled facilities. While Taiwan already has a feed-in tariff system, the fees are low. As a result, this indicator is only rated level 1 of 6.

(9) Wholesale for Wind Power:

While Taiwan already has a feed-in tariff system for wind power, similarly to that of solar power, the fees are low. As a result, this indicator is only rated level 1 of 6.

(10) Waste Deposit Refund System:

While Taiwan began implementing its "Waste Disposal Act" in 1974, it wasn't until 1988 that the Act was amended to legalize the responsibility of industry to ensure the recycling and disposal of waste, and demand that industry pay fees for the handling of waste recycling and disposal. Even before 1990 Taiwan had already implemented a Deposit Refund System and over a period of 26 years this indicator has always measured at the highest level 6 of 6.

(11) Emission Standards for Nitrogen Oxides:

In 1994 and in accordance with the Air Pollution Control Act's sub-law 'Air Pollution Emissions Standard for Power Facility', Environmental Protection Agency in Taiwan formulated stringent standards aimed at individual industry in order to control air pollution including Nitrogen Oxides, Sulfur Oxides, and particulate pollutants. As part of this there was a limitation set on the permissible emissions of Nitrogen Oxides for newly built power plants of 250ppm. This law wasn't amended during the 20 years between 1994 and 2013, until 2014 when amendments were made to the law as a result of power facilities operations and its unique emission properties, with Nitrogen Oxides emissions being limited to 30ppm. From this we can find that in 2014 Taiwan clearly strengthened existing regulations on air pollution. In light of this, the measurements for this indicator placed it at level 4 before 2014 and level 6 after showing that it has already reached the highest level.

(12) Emission Standards for Sulfur Oxides:

In 1994 and in accordance with the Air Pollution Control Act's sub-law 'Air Pollution Emissions Standard for Power Facility', limitations on emissions of Sulfur Oxides in newly built power plants have been adjusted twice from 300ppm to 250ppm in 1999 and then again to 30ppm in 2014 and 2015. As

for this indicator, the scale has increased over time from level 3 to 5 and then finally 6, placing it at the top currently.

(13) Emission Standards for Particulate Pollutant:

In 1994 and in accordance with the Air Pollution Control Act's sub-law 'Air Pollution Emissions Standard for Power Facility', limitations on emissions of particulate pollutants in newly built power plants were set at 25ppm. While between 1994 and 2013 there were no amendments made to this figure but in 2014 this figure was reduced to 10ppm. Again we can find a progression from level 3 to 6 and again in this respect Taiwan has reached the highest level.

(14) Content of Sulfur Allowed in Diesel:

According to the Air Pollution Control Act Article 35 in 1999, Taiwan authorized the revision of the Act to be made to establish 'Standards for the Composition of Automobile Gasoline and Diesel Fuels', having first been implemented in 2000. Revisions of this Act have been made five times. Focusing on regulatory standards for Sulfur in Diesel, in 2000 Sulfur content was the highest at 0.05wt% (weight in percentage of 500ppmw), and then in 2001 this was revised to 0.035 wt%(350ppmw), again in 2005 to 50ppmw and 2010 in 10mg/kg, which shows that there has been a gradual improvement in the stringency for regulatory standards. As a result, the level for this indicator has gone from 3 in 1999 to a level 6 by 2010, reaching the highest level on the scale.

(15) Funding for Renewable Energy R&D:

This individual indicator refers to renewable energy as a ratio of nominal GDP (multiplied by 1000). Since the Taiwan government has yet to provide detailed figures on its funding for renewable energy R&D, we must first look back on related policies, and then from the perspective of renewable energy funding, estimate a rational percentage as a standard for assessment. Since 1995 and in accordance with the 'Investment Offsetting Act for Companies Purchasing Equipment or Technology of Energy Saving or Usage of New and Cleaner Energy', the Ministry of Finance has already put into effect taxation measures for various forms of renewable energy power generating facilities, to ensure the relief of income tax in order to produce incentives for investment. Moreover, in 1999 the Ministry of Economic Affairs used concessional loans to establish a system of incentives for investment. However, related research wasn't developed into legislation until 2009 when the Renewable Energy Development Act came into force, the Act obligates electricity enterprises and anyone equipped with self-use power generating facilities exceeding a certain installed capacity to pay a certain amount to a fund calculated by the total power generated of its non-renewable energy for

the development of renewable energy. Besides this, the Taiwan National Energy Program- Phase I, implemented from 2009 to 2013, is a forward-looking Program on the Strategy of energy science and technology. Taiwan's Renewable Energy Fund's budget in 2010 was about \$15.6 million NT, a ratio of 0.00011 compared to Taiwan's nominal GDP of about \$14.1 trillion NT. While in terms of levels on the scale for this indicator and assumed that the stringency of Taiwan's expenditure on renewable energy from 1999 to 2010 on level 1 of 6, this indicator was on level 5 in 2010, decreasing to level 2 in 2012 and increasing to the highest level 6 on the scale in 2015, which is the main reason why there is a significant drop for the market and final Environmental Policy Stringency in 2012.

Conclusion and Policy Implications

Conclusion

History and Status of Taiwan's Transition towards Green Economy

This study attempts to recap history in the light of the basic institutions driving Taiwan's transition towards green economy, indicating the extent of Taiwan's EPS in contrast to others within the international community. We made use of the OECD's latest EPS to calculate Taiwan's EPS, to measure changes occurring over a 26 years period between 1990 and 2015, and to identify the areas where in comparison to other OECD member states Taiwan was either ahead of or lagging behind OECD member states. As to the updated OECD's EPS, please link to the dataset, <https://stats.oecd.org/Index.aspx?DataSetCode=EPS> (Data Visited: July 20, 2018). Furthermore, we also calculated Taiwan's EPS over a decade in order to identify overall average scores, highest peak score as well as lowest scores, this content can be found in the Table 2, and from this we can see changes in the indicators as high and low levels of performance.

Furthermore, the stringency of Taiwan's Market Policies reached their highest level, including standards for the air pollution levels adoptable for newly built coal-fired power plants and renewable energy R&D subsidies at the same year 2015, representing two comprehensive indicators and five individual indicators. Meanwhile, in terms of non-market based EPS, three individual indicators attained the highest level while the other seven individual indicators all scored less than 2. Moreover, by taking the individual indicator measurements from 2012 as a base line and then comparing with

TABLE 2
DURING THE PERIOD OF 1990-2015, TAIWAN'S AVERAGE AND EXTREME VALUE OF ENVIRONMENTAL POLICY STRINGENCY

Indicator	CO ₂ - tax	NO _x - tax	SO _x - tax	CO ₂ - TS	green_ TS	white_ TS	FIT_ Wind	FIT_ Solar	S_ content	RD	Diesel_ tax	DRS	ELV_ NO _x	ELV_ SO _x	ELV_ PM
Average	0.00	2.08	2.08	0.00	1.12	0.27	0.27	0.27	3.08	1.81	1.00	1.00	3.54	3.62	2.77
Highest	0	6	6	0	2	2	1	1	6	6	1	1	6	6	6
Lowest	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0
Y2012	0	6	6	0	1	1	1	1	6	2	1	1	4	5	3

2015, we can see that renewable energy R&D financing has significantly increased with this indicator already having reached the highest level. However, while the majority of this financing has been used in developing feed-in tariffs for renewable energy power generation, the development of renewable energy remains slow. Therefore, we can see that the development of renewable energy can't depend on subsidies for energy pricing alone neither can it only focus on non-market environmental policies. While newly built fossil fuel power plants have to adhere to relatively stringent air pollution emission standards there are still many fossil fuel power plants which have yet to be decommissioned due to technical limitations that adhere to much more relaxed standards of air pollution emissions, added to this the fact that current policy controls only air pollution emissions but not total amount of pollutants. Controlling emission standards alone is not enough to resolve the seriousness of the air pollution problem in Taiwan.

Taiwan's Non-market Policy

In terms of its non-market policy, the early introduction and implementation of a national waste deposit system enabled the establishment of a strong foundation, along with the increasingly stringent emission standards in place for newly established fossil fuel power plants, Taiwan's EPS has already caught up with the standards of advanced countries, even reaching the highest level in individual indicators by 2015. However, new regulations take time to come into effect, usually experiencing a period of vacuum or gap for the implementation of such new regulations. Since it is difficult to demand old power plants to abide by new and stringent standards to get rid of outdated equipment, this makes it difficult to improve on the current problems of CO₂ and suspended particles emissions in the short term. This is the main reason that Taiwan's fossil fuel power generation has been held back and unable to improve on the big problem of Taiwan's overall air quality. Another aspect of this issue is renewable energy R&D, while by 2010 investment into renewable energy R&D had already reached level 5 of the individual indicator, until now this increase in R&D funding has yet to directly promote an increase in power produced by renewable energy. Probably the greatest impact on the low level of power generated from renewable energy is the low feed-in tariffs paid for solar and wind power. However, comparing this with the environmental policies for the market, Taiwan's Electricity Act remained unrevised in 50 years until 2017. The electricity market remains monopolized by state-owned enterprise, therefore there is not a fair market provided to renewable energy power plants for competing with thermal or nuclear power

plants. On the other hand, the general public has the other and limited option for purchasing electricity from Renewable Energy industry, if other than from Taiwan Power Company. As a result, electricity enterprises have experienced little liberalization, lacking market-based electricity reforms or environmental regulations.

Taiwan's Market-based Policy

We can see that while Taiwan's non-market based environmental policy has seen vast and clear improvements, market-based policy on the other hand has sadly been neglected, lacking the market mechanisms for guiding state, society or enterprise to enable the transition to a green economy. We can also see that in terms of Taiwan's market based policy indicators they fall well behind those of OECD member states, one of the main reasons for this is the lack of a clear and coherent carbon trading market, including the lack of a carbon tax or energy tax mechanism. The long time failure to implement controls on carbon, carbon trading and energy taxation has meant a long term failure in improving the stringency of indicators for Taiwan's market based environmental policy. From 1990 to 2006, the stringency of various indicators for Taiwan's market based environmental policy experienced 15 years with no change, and it has only been in the past ten years that these levels have improved ever so slightly. Such a delay in the transition reveals the fact that market-based environmental policies are neglected by the government, industry and Taiwan society as a whole in their decision-making process; the result of which is that while the rest of the world is already moving towards a new way of thinking which pushes for a transition to green economy, we remain in the old glory of traditional industries and are unwilling to consider the new challenges that such a transition will have.

Policy Implications

Taiwan Experiencing the Eight major challenges as well

Taiwan is experiencing the same eight major challenges as OECD member states, and is in desperate need of greater regulations to be enforced in the area of environmental policy. Taiwan faces the following challenges in transition: (1) It is slow for Taiwan Government to enforce Greenhouse Gas Reduction and Management Act. Taiwan has yet set up a clear pricing scheme of greenhouse gas emissions or adept measures to enable an emissions trading scheme, only encouraging greenhouse gas emitters to take part in a voluntary report. (2) The pricing for Taiwan's water, oil, natural gas,

electricity is currently relatively low as a result of government subsidies, which is not to the advantage of plans for water and energy saving or industrial transition. (3) Taiwan needs to transit from water and petrol subsidies to provide incentives for the development of renewable energy. And while in 2015 indicators measuring the development of Taiwan's renewable energy R&D funding reached the highest level on the stringency, yet currently resources are being invested more into the feed-in tariff of renewable energy, rather than the building of an electricity trading market or the fostering of future renewable energy R&D talent. (4) According to the IMF published Energy Subsidies Reformation Report (Clements et al., 2013), in 2011 the subsidies for electricity, natural gas, coal accounted for 0.3%, 0.2% and 1.7% of the national GDP respectively, while according to this research as a result of subsidies for industrial electricity in Taiwan accounted for 0.2 and 0.1% of the GDP, therefore we can see that Taiwan is dependent on thermal power generation, and the traditional subsidization of high carbon fossil fuels have far from disappeared. (5) Besides eradicating subsidies supporting the continued consumption of fossil fuel, Taiwan is also yet to establish a scheme which clearly sets out energy taxes and the foundation for such tax, remaining messy and lacking unity. (6) Such a slow development of Taiwan's renewable energy means that the building of a smart electric meter and smart grid remain from off. (7) Although at the beginning of 2017 the Legislative Yuan passed the review of revisions made to Taiwan's Electricity Act, the reforms of the electricity enterprises or liberalization of the market is too conservative to bring about any significant developments in renewable energy. (8) There has yet been a decoupling of Taiwan's GDP growth and electricity growth (Chou 2015), while Taiwan's energy efficiency has been improved, with the 2008 Financial Crisis bringing about a recession in industry which also reduced energy use. From the challenges cited above which Taiwan faces on its path towards a transition to green economy, we can see that if Taiwan wants to face these challenges, it must reduce subsidies for fossil fuel, establish an electricity trading market, construct the basic infrastructure of a smart grid, and enable advanced revisions to the Electricity Act. Moreover, the Taiwan government has neglected the market-based EPS, such as carbon or energy taxes, carbon trading scheme, energy-saving annually and so on.

Taiwan's Room for Establishment of a Green Economy System

While Taiwan's EPS has gradually improved, there is still a lot of room for improvement when compared to OECD member states, and there should be

the establishment of a green economy system in accordance with the laws. In particular, while we can see that emission levels for thermal power plants have greatly improved in terms of the non-market based policies, from the perspective of the overall energy transition, non-market indicators such as investment in renewable energy R&D, or tariff feed-in pricing for wind and solar power, as well as ratio of renewable energy, promotion of energy efficiency, Taiwan clearly lacks motivation and delays to action compared with OECD member states. This will be the greatest challenge to Taiwan's transition to a green economy in the coming days. In terms of reforms to the market-based policy, this paper recommends the following reforms: setting out legislature on energy tax to force high pollution and high energy consumption industries to bring about energy transition, actively promoting renewable energy diversity and energy democratization to improve the overall percentage of electricity generation that renewable energy accounts for, the stipulation of auxiliary regulations of the Greenhouse Gas Reduction and Management Act to implement a carbon trading scheme. Furthermore, particularly in need of explanation is that revisions of Greenhouse Gas Reduction and Management Act made in 2015 state for response to climate change, it would regulate government to plan and manage related laws and policies, including the establishment of a green economy system (Office of the President 2015).

Taiwan Should Strengthen Market-based Environmental Policy

Through the changes made to the stringency of Taiwan's environmental policy and the challenges Taiwan faces in its transition to green economy, we can see that changes to non-market policy are not able to achieve the goal of economy transition without simultaneously strengthening market-based environmental policy. If we take a closer look at the hidden meaning behind the indicators, we can also see that the adoption of certain indicators to assess Taiwan government faces challenges in adapting to the situation in Taiwan. While stringency for non-market related environmental policies is stricter than that for market related policies, with standards for air pollutants emission being significantly stricter in non-market related policy, it shows that only focusing on non-market environmental regulations is not enough to protect life, environment or human health, even when these policies are high on the stringency levels. Therefore, environmental regulations for non-market and market must work together in a two-pronged approach. In terms of non-market environmental regulations, there should be a greater reduction of fossil fuel subsidies, internalizing environmental costs for water

and energy, while for the market-based environmental regulations, the establishment of a greenhouse gas emissions trading scheme, the liberalization of the electricity market, and the establishment of market mechanisms and economic incentives, could bring about industrial competitiveness.

OECD's EPS for Comparative Benchmark and National Revision

The OECD establishment of EPS provides countries with an international comparative standard, while through the long-term profile of indicators and implementation of the policy evaluation and revisions to current legislation, individual countries can also develop an EPS which suits their current level of development. Taiwan and OECD member states adopt standardized EPS and this can be used to carry out international comparisons with countries in a similar development stage. Moreover, observing long term changes to these indicators can become the foundation for future revisions or amendments to environmental policies, and enable environmental protection, improvement in quality of life and reduction of climate change. Besides, when using the EPS provided by the OECD, we have considered the development of a version which is suitable for Taiwan or other countries at the same stage of sustainable development and this version of indicators is referred to as Taiwan EPS, TEPs. For example, TESP has added even more detailed aspects, such as air pollution control standards for finer particulate matter (PM_{2.5}), the extent of total amount control, indicators for trading electricity, or the extent of liberalization of electricity industry. In accordance to industry patterns, the path to economic development and the vision of a transition to a green economy, countries are able to develop a set of comparatively subjective, friendly, and tailored EPS, through the construction of indicators and time set for assessment. On the one hand, the tailored EPS for a specific nation enables individual countries to identify their progress on the path to green economy transition, and reveals that the efforts and contribution individual countries make to global green economy transition. Although this article updated the EPS till 2015, the evaluation method of EPS could be adopted to measure or observe the major changes after 2015 as well.

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