

-RESEARCH ARTICLE-

## THE ROLE OF CARBON EMISSIONS TAXES AND CARBON GREENHOUSE GAS EMISSIONS ON THE RENEWABLE ENERGY OUTPUT: EVIDENCE FROM SOUTH AFRICA

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### —Abstract—

In reference of the need to accomplish continuous economic growth globally, it is difficult to achieve carbon reduction targets that are set by solitary command-and-control measures. Carbon tax is seen as an effective measure to reduce carbon intensive development in different countries. The paper aims at forecasting the impact of carbon tax in South Africa and how different carbon tax blends assist in reduction of carbon footprints. The authors conducted a literature review of different developing countries' carbon tax strategies, which inter alia considered various equilibrium models to appreciate the economic effect of carbon tax implemented in various economies. Suggested hereto, the appropriateness of the proposed equilibrium models will depend on the ability of the carbon tax employed in the different equilibrium models to both reduce CO<sub>2</sub> and concurrently not adversely affect the national Gross Domestic Product.

**Keywords:** CO<sub>2</sub> emissions taxes, CO<sub>2</sub> emissions, GHG emissions, industrialization, urbanization, renewable energy output

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## 1. INTRODUCTION

The reduction in greenhouse gas emissions that are generated by burning fossil fuels to produce energy and, thereby, drive national economies is generally believed to be necessary to avoid the undesirable effects of global climate change. One way to achieve this reduction is by the imposition of a carbon tax. South Africa seeks to use carbon tax as a policy initiative to reduce the carbon emissions generated by its economy. This will be facilitated by means of a singular carbon tax instrument, which will be introduced in a staggered way, starting from the date of promulgation of the Carbon Tax Act 15 of 2019 (Carbon Tax Act). To reduce the initial burden of the carbon tax over a prolonged period, the tax will be phased in, providing rebates of up to 60 per cent of the tax rate to companies conducting certain activities (World Bank, 2016:1). However, there is uncertainty about how this tax could be implemented without harming economic growth. There is also uncertainty whether this carbon tax, if implemented, in isolation, will serve as a constraining measure to reduce the use of fossil fuels in order to adhere to international emission reduction targets. South Africa use the Sectoral Emission Targets (SETs) as an instrument that will place quantitative limits of all future greenhouse gas emissions. These SETs will promote the mitigation of climate change and are divided into reduction goals for the short term (2016-2020), medium term (2020-2030) and long term (2030-2050) (Department of Environmental Affairs 2019:x). Taking into consideration the SETs set by South Africa, uncertainty still prevails as to how the phasing in of the carbon tax will affect the speed at which emissions are reduced as well as the affect that it will have on economic growth.

Energy generation in South Africa as well as globally is a necessary constituent of economic growth. This generation has been based mainly on the burning of fossil fuels, has prevailed since the start of the industrial revolution in the mid- 19th century in Europe. The growth of economies in the industrial sector is inseparable from the increase in energy needs to turn the heavy wheels of national industries and business wealth creation. The accelerating pace of energy demands globally has also contributed to the rising levels of atmospheric emissions, which, in turn, has caused the upsurge of greenhouse gases (GHGs), nitrogen oxides (NO<sub>x</sub>) and sulphur oxides (SO<sub>x</sub>). The consequence of the increase in the carbon dioxide will radically change climate patterns that will disrupt the global environment and create other environmental problems (Draper and Weissburg 2019:1). In 2010, energy-related carbon dioxide emissions reached an all-time high of 30.6 GtCO<sub>2</sub>e, notwithstanding the global economic crises that temporally led to a sustained worldwide economic downturn (Marchal, Dellink, Van Vuuren, Clapp, Chateau, Lanzi, Magne and Van Vliet, 2011:72). Hereto the emissions in the next decade further increased exponentially with about 1.5 per cent annually to reach 51.8 GtCO<sub>2</sub>e in 2018. (Emissions Gap Report 2019:3)

One proposal to reduce GHG emissions, is the implementation of a carbon tax while interpreting its corresponding effect and impact on national economies. The consequences of implementing carbon tax are to be considered with reference to economies like India and China, which like the economy of South Africa, are important examples of emerging economies. China and India in the context of this study be considered as important reference since both countries have previously implemented carbon taxes policies. Hereto both nations are also part of the G20 Member Nations which account for 78 per cent of global GHG emissions and largely determine global emission trends and performance in terms mitigating global emissions. (United Nations Emissions Gap Report 2019: xvi) It follows that the emerging economies have an important role to play in relation to mitigating increased emissions associated with the highest economic growth, in particular India and China.

This study therefore considers the effectiveness of taxation of carbon emissions as a deterrent, and moreover, the possible mitigation of the economic effect of such a tax on a market activity that generates negative economic externalities by supplementing the carbon emission strategy with supplementary renewable energy solutions. This article reports on carbon emission mitigation actions in India, China and South Africa, with the focus on the use of carbon tax as part of carbon pricing instruments to emphasise their potential contribution to addressing climate change.

This research considers the application of general equilibrium models (GEMs) to derive the possible effect that imposing different levels of carbon tax will have on economic growth. The South African University of Pretoria General Equilibrium Model (UPGEM) model is used to optimise the combined effect of a carbon tax and the installation/utilisation of renewable energy technologies. The UPGEM model allows the authors to investigate whether the current South Africa carbon emissions tax, as a solitary deterrent, is sufficient to reduce carbon emissions without affecting economic growth in developing economies. Moreover, based on insufficient empirical research available to specifically demonstrate that carbon tax can act as a deterrent, the levying of such a tax and other possible mitigation strategies will be researched by means of computable GEMs until actual data can determine the viability of carbon tax as a Pigouvian tax to support carbon reduction strategies.

Finally, the authors investigate the effect of carbon emission changes using different carbon taxes and other strategies on the South African economy as an example of a smaller emerging economy. In the cases of India and China, the GEMs will demonstrate that with carbon tax as a solitary instrument to reduce GHG emissions could impede economic activity. This study would, therefore, show that the notion that carbon tax cannot be considered as the only instrument for reducing harmful emissions and why developing countries do not necessarily have to compromise economic growth effectively to reduce emissions.

It will be demonstrated that combined strategies to reduce GHGs, that have a negligible impact on economies, are supported by results of the UPGEM model, which illustrates how to impose a sustainable carbon tax. It follows that a sustainable carbon tax combined with renewable energy policies that meets GHG emission targets are economically responsive and have sustainable outcomes, without affecting national growth targets, that previously seemed not to be feasible. The first part of this article provides the background of mitigation strategies of carbon emissions in India. The discussion will be followed by the introduction of the mitigation strategies of carbon emissions and carbon tax in China. An analysis will be drawn in terms of the application of the General Equilibrium Model (GEM). After the analysis, the discussion will be followed by the introduction of the South African energy mix and the UPGEM model. After the analysis, a conclusion will be drawn. This paper comprises of a literature review of the relevant textbooks, articles, and legislation. Primary and secondary source material will be subjected to an analysis, which will give rise to the conclusion of the paper.

## **2. CARBON EMISSIONS MITIGATION MIX: INDIA**

Further to the outlook of the presented data and the Fisher-Vanden model it is suggested that carbon tax as a solitary instrument is not sufficient to reduce GHGs in accordance to the global climate objectives. The Pradhan-Gosh CGE Model also finds that the rapid transition to a green economy is dependent on the mix associated with the mitigation strategy. (Pradhan and Ghosh 2012:20) Climate initiatives and transition from dirty energy should therefore not depend on carbon tax to achieve climate objectives and economic outcomes, but should rather be focussed on the design of a suite of appropriate carbon mitigation policies. (Pradhan and Ghosh 2012:20) It follows that the required carbon mitigation mix must include clean energy sources like renewable energy.

Kumar and Agarwala (2013:154) reflect on the dual application of both a carbon emissions tax combined with a method of renewable energy (this is energy that is produced from sources that do not deplete or can be replenished within a life-time of humans) and energy recycling (this is considered to be energy that would normally be wasted, now recovering the energy and converting it into electricity or energy). If the dual application is used in tandem, it would stimulate both the reduction of emissions and the realistic economic growth of a developing country.

Although initially limited, in 2014, investments in renewable energy in India grew by 14 per cent by US\$7.4 billion (Renewable Energy Policy Network for the 21st Century, 2015:82), with wind power (wind power or also known as wind energy is the process whereby the wind is used to generate mechanical power or electricity. The wind turbines then convert the kinetic energy in the wind to mechanical power) accounting for almost 84 per cent of the total energy produced (Renewable Energy Policy Network for the 21st Century, 2015:82).

This indicates a sluggish shift from fossil fuel processes to renewable energy and the influence of energy-efficient technology. India now represents one of the top 10 national investors in renewable energy and indicates the country's potential to generate energy from fossil fuel to renewables (Renewable Energy Policy Network for the 21st Century, 2015:81)

Another method of mitigation has been implemented as part of the Indian national programme to reduce emissions, known as the perform, achieve and trade (PAT) scheme. This system seeks to address both the rapid growth of developing countries and the minimisation of carbon emissions in growing economies (Singh, 2013:1). The PAT scheme seeks to reduce CO<sub>2</sub> emissions by 26 million tons of carbon dioxide by 2015, thus reflecting a 20-25 per cent reduction of the 2005 levels by 2020. By evolving the concept of sectoral emission reduction, the PAT scheme seeks to set targets for individual plants and reduce emissions. The scheme, applied in the context of individual plants, merits an annual reduction target of 4-5 per cent, which is easier to achieve and measure than the overall sectoral target in terms of carbon emissions (Singh, 2013:1).

The origin of the scheme is to be found in the 2001 Indian Energy Conservation Act (the act has been amended to the Energy Conservation Act, 28 of 2010), which allows the government to identify high energy consumers as designated consumers (DCs) and led to the application of emission standards to them. The Bureau of Energy Efficiency identified DCs from 15 economic sectors, which cover 478 facilities (Singh, 2013:2). These energy consumers are consistent with facilities from aluminium, steel, textile, fertiliser, pulp, cement and power generation plants and represent roughly 60 per cent of India's total primary energy consumption (Singh, 2013:2)

Kumar and Agarwala (2013:161) believe that the PAT scheme, with the necessary networking between state and industry, will revolutionise the industrial sector in relation to energy-efficient technology and processes. The relevant targets applied to the individual plants are projected based on historic data, which allows for past performance and comparative benchmarking to set appropriate targets (Kumar et al., 2013:161).

### **3. GENERAL EQUILIBRIUM MODEL (GEM)**

Glomsrod and Wei (2002) in Lu et al. (2010:7278) confirmed the use of the GEM to determine the effect of carbon emissions tax on the Chinese emissions and economy. This computed model applied energy consumption levels in the production sector and residential sectors, which considered 19 commercial energy products, including coal, oil and natural gas (Lu et al., 2010:7278).

Lu, in conclusion, determined that carbon emissions tax would decrease carbon emissions but that the tax would correspondingly negate economic growth (Lu et al., 2010:7278). The outcome of the GEM subsequently concluded that with a tax rate of US\$5 per ton of carbon, the country's GDP would shrink with 0.4 per cent and the carbon emissions would reduce by 8 per cent. The long-term effects on the GDP indicated a 0.1 per cent decrease and a carbon reduction of 0.4 per cent over extended timeframes.

At an increased rate of US\$10 per ton of carbon, short-term effects indicate a decrease in the GDP by 0.85 per cent, whereas expected reduction in emissions will decrease by 14 per cent. The application of this rate over longer periods of time shows a decrease of 0.07 per cent in the GDP and a reduction of carbon emissions by 4 per cent (Lu et al., 2010:7279).

Other studies, such as Gao and Chen (2002), according to Lu et al. (2010:7279), further researched the implication of carbon taxes and suggest that, should an effective rate of US\$50 per ton be implemented between 2030 to 2050, the projected emissions would decrease by 30 per cent. Also, should the rate be increased to US\$100 per ton of carbon, the emissions reduction is only further affected by a 3,4 per cent improvement on the US\$ 50 per ton application (Lu et al., 2010:7279).

The effect on the GDP, however, is considerable, based on the US\$50 per ton carbon implication, taking into consideration the size of the Chinese economy, with GDP losses estimated at US\$18.8 billion in 2030 and US\$40 billion in 2040. The alternative rate of US\$100 per ton carbon indicates a loss in the GDP of 0.6 per cent and an annual decrease of the GDP of about 0.75 per cent each year (Lu et al., 2010:7279). Like the projections in the Indian Model of carbon tax levied at different rates, the Chinese GEM models serve to provide evidence of the unsuitability of carbon as solitary emission mitigatory instrument and the nett effect on the economy.

#### **4. CARBON EMISSIONS MITIGATION MIX: CHINA**

Other strategies followed by the Chinese jurisdiction allow for cap-and-trade systems, which entail the enforcement of carbon targets through the capping of maximum emissions within the industries, therefore, placing a mandatory reduction of annual emissions, effectively forcing compliance through statutory targets.

Munnings et al. (2014:2) confirm the use of seven current cap and trade pilot projects, which are used to develop the future China National Cap and Trade Programme. Three of these pilot programmes based in Guangdong, Shanghai and Shenzhen are used as a model in the implementation of the national structure. Chinese President, Xi Jinping, further announced the implementation of the National Cap and Trade Scheme to commence in 2017 (Dong et al., 2017:596).

Based on the high levels of energy consumption, stimulated by rapid industrialisation and urbanisation and the application of these cap-and-trade programmes to curb emissions cannot be considered in isolation from market-based emission reduction strategies (Dong et al., 2017:596).

As with other jurisdictions with high export outputs, China produces more steel, aluminium and cement than any other jurisdiction in the world, which further forms a large part of the total energy consumption in China (Munnings et al., 2014:9). A cap-and-trade initiative in these industries, therefore, would contribute immensely should China be able to limit these industries in relation to energy consumption, which in turn would curtail carbon emissions.

Like India, the initiatives followed by China are not limited to one reduction strategy and a compilation of mitigation strategies are suggested. Consequently, the implementation of an untainted carbon tax would be unwise, noting the discourse in both under- and overtaxing carbon emitters, which can, however, be corrected by applying an assemblage of methods of mitigating carbon emissions (Stram, 2014:519). Carbon tax can, however, stimulate demand migration from dirty energy towards clean energy (Dong et al., 2017:597).

Stram confirms the need for both carbon tax and research and development (R & D) for alternative energy sources (Stram 2014:519). A clear shift from solely carbon tax scenarios to simultaneous supplementation of use of renewable energy solutions can also be seen in the Chinese market, with China rated as the top investor in renewable energy investments during 2015. China accounted for almost a third of the total global investment into renewable energy initiatives in 2015, with investment of US\$ 83.3 billion into renewable energy, almost double the investment of second-placed United States of America (Renewable Energy Policy Network for the 21st Century, 2015:81). Consequently, like India's scenario, the computable GEMs indicate that lower carbon taxes would not redress carbon emissions, whereas higher carbon taxes would stunt economic growth, which indicates a need to balance carbon tax with other recycling strategies. It follows that in the context of both the Indian and Chinese scenario, said computable GEMs definitively pronounce on the negative consequences of the opposite extremities of carbon tax, yet said modelling does not conclusively pronounce on the correct carbon tax blends to assist in reduction of carbon footprints without harshly stemming economic growth in the specific jurisdictions.

## **5. SOUTH AFRICA AND CARBON EMISSIONS TAX**

Globally, in 2020, experienced its warmest year on record which is a tie with the year 2016 (NASA 2021:1) and 2019 was the second-warmest recorded (Climate Central 2020:1).

The Organisation for Economic Co-operation and Development (OECD) (South Africa, China and India are listed as “Key Partners”) in the Joint Programmes of Work, enhanced to encourage co-operation of countries and to progressively bring the Key Partners closer to the standards set by OECD. The OECD issued its Environmental Outlook to 2050 in which it warns of the imminent risk that GHGs bring with continued economic development without any effective mitigation strategy. It affirms that climate change is a global systemic risk that threatens all life and the global economy (Marchal et al., 2011:75; Flato et al., 2013:741). The point of no return, according to the OECD, is the 685 parts per million (ppm) mark to be reached by 2050, with CO<sub>2</sub> contributing 530 ppm to these emissions (Marchal et al., 2011:83). The atmospheric burden of GHGs is further projected to increase to over 1000 ppm by the end of the 21st century and beyond. The projection not only reflects mathematical equations, or the outcome of a scientific exercise, but it is anticipated to create an increase in global temperatures by 2–2.8°C by 2050 and approximately 3.7–5.6°C by the year 2100 (Marchal et al., 2011:84). This would contribute to the risk of overshooting the “climate change tipping point”, resulting in global environmental catastrophes, which once reached cannot be undone (Marchal et al., 2011:87; IPCC, 2013:1463).

The estimated tipping point, according to these sources, avers that catastrophic events would occur should temperatures rise between 2 and 5–6°C. These include the melting of the West Antarctic Ice Sheet and the Greenland Ice Sheet, leading to reduced functioning of the Atlantic (including water temperature warming, seasonal shift in different biodiversity, coral bleaching, the rise in sea levels, coastal inundation, erosion of the coast, harmful algal blooms, new marine diseases, the loss of marine mammals, changes in the levels of precipitation as well as fishery declines), overturning circulation (Marchal et al., 2011:87). The OECD outlook document proposes the mitigation of emissions by observing two primary strategies: first, to stabilise the emissions by 2050 and, second, to maintain the reduction of emissions once stabilised.

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 to influence international negotiations on climate change. The IPCC included scenarios of future GHG emission that extend well beyond into 2100 (IPCC, 2014:6). In order to reaffirm the IPCC, a United Nations Framework Convention on Climate Change (UNFCCC) was ratified by South Africa in 1997 (Schmalensee, Stoker and Judson 1998:15). The IPCC, as part of the Working Group III Contribution to its Fifth Assessment Report, affirms that the generation of GHG presents an imminent but uncertain risk to society, despite growing mitigation policies. Annual GHG emissions increased on average by 1.0 Gt of carbon dioxide equivalent (GtCO<sub>2</sub>eq) (2.2 per cent) from 2000 to 2010, up from 0.4 GtCO<sub>2</sub>eq (1.3 per cent) per year from 1970 to 2000 (IPCC, 2014:6). GHG emissions have increased the last decade by an average of 1.1 per cent annually per year from 2012 to 2019 (PBL Netherlands Environmental Assessment Agency 2020:1).

GHG could have a significant effect on the future sustainability of our planet, as these gases progressively cause climate change, which leads us inevitably down the road of global environmental changes and eventually to further risk of environmental disasters such as droughts and declining agricultural outputs. Climate change is described by Fenichel, Levin, McCay, Abbott and Pinsky (2016:237) as the greatest environmental challenge of the world and would have a great impact on the sustainability of the environment. It is estimated that without intervention, emissions will rise by 50 per cent by 2050, 70 per cent of which can be directly associated with growing energy needs. This is projected on an estimated 80 per cent increase in global energy demand (Marchal et al., 2011:72). This increase in the demand for energy will have a negative impact on sustainability if energy is not used more efficiently.

In “Our Common Future, 1987” Report, the United Nations World Commission on Environment and Development developed the definition of sustainable development. The definition of sustainable development “meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, Our Common Future, 1987). The Brundtland Report addresses the economic development in global terms because the economic, environmental, and ethical challenges were global in scope. Although this Brundtland Report, in its original application, had a significant impact on a macro-economic level, it will also have an implication for businesses at the micro level (Des Jardins 2015:117). Therefore, in the mitigation policies applied, it will not only have an impact on the environment, but also on economic factors.

The ensuing part of the paper focuses on investigating carbon strategies from the perspective of South Africa, the second-largest emitter of GHGs on the African continent (U.S. Energy Information Administration (EIA), 2015:3). Hereto South Africa further generates about 40 per cent of Africa’s electricity. (Department of Energy 2019:15) Electricity generation facilities include: coal-fired power generation capacity, hydro powered facilities, pumped storage power and nuclear power generation facilities, of which distribution of electricity is done to about 2 703 industrial customers, 51 848 commercial customers, 81 638 agricultural customers and approximately 6 million residential customers (Department of Energy 2019:15). The International Energy Agency in 2015 affirmed that South Africa’s energy consumption per unit of GDP in 2012 was double the global average and electricity consumption per capita was 40 per cent higher than the world average (U.S. Energy Information Administration (EIA), 2015:3). From 1990 to 2012, South Africa accounted for an increase in GHG emissions by 44 per cent. Possessing 95 per cent of the continent’s coal reserves, South Africa uses mainly coal to meet its energy needs, of which electricity generation accounted for half the country’s coal consumption (USAID From the American People, 2016:1).

Suggested as one of the top 20 global emitters, South Africa based on its dependency of dirty energy requires emission reduction. (South Africa's Low Emission Development Strategy 2050 2020: viii) Similar to the concern raised in relation to other developing economies, South Africa also "rapid transition" could negatively affect both economic growth and sustainable development. (South Africa's Low Emission Development Strategy 2050 2020: viii)

South Africa remains responsible to address the emission of GHG by virtue of being a signatory to the UNFCCC that consented to the Kyoto Protocol and consequently adopted the Paris Agreement. Consequently, although not lawfully mandated to specific emission targets as recognised under the UNFCCC, South Africa has assumed developmental targets to realise climate change measures within its regional economy. The measures would serve to reduce the destructive effect of climate change, of which it is anticipated that South Africa would endeavour over an extended period to diminish the use of dirty energy with the use of clean energy, thus continuously improving the country's energy mix (Department of Environmental Affairs, 2010:26).

The Climate Change Bill, 2018 (CCB) has subsequently been circulated by the Department of Environmental Affairs for public comments on 8 June 2018. Up to date (March 2021), the Climate Change Bill, 2018 has not been finalised and passed. Its proposed objects and principles are to create legislation, which primarily addresses specific processes pertaining climate change; nonetheless, proposing the balancing of both the reduction of emissions and regulating the effect of probable GDP losses within the national economy.

## **6. EMISSION REDUCTION AND ENERGY REQUIREMENTS**

With coal and gas being the primary fuels used in the national energy mix (Department of Mineral Resources and Energy 2021:1) supplementary energy sources need be considered to achieve the necessary reduction of GHGs without causing harm to the economic growth of the country. The National Development Plan (NDP) states that "South Africa should initially focus on pursuing those mitigation options that are likely to have the least remorseful options, particularly around energy efficiency, that improve the competitiveness of the local industry, create jobs and represent a net saving rather than cost to the economy and gross domestic product" (The Davis Tax Committee, 2015:19). It is, consequently, common cause that the NDP supports a solution that is both emission and economically responsive. Further support for the authors position is found in the Davis Tax Reform Committee's First Interim Report on Carbon Tax, finding that a carbon tax should not be used as a solitary policy instrument to regulate carbon emissions but rather be aligned with further policies to minimise effects on the economy (The Davis Tax Committee, 2015:19).

## 7. CARBON TAX ACT 15 OF 2019

Based on the above comments of the Davis Committee, it is of concern that the proposed Carbon Tax Act is currently considered the core carbon emission instrument to mitigate emissions and minimise effects on the economy. The administration of the carbon tax is facilitated under section 54A of the Customs and Excise Act, read in conjunction with the interrelated penalties for non-compliance. The Carbon Tax Act suggests, however, a three-phase implementation programme with the first phase from 2017 to 2020, the second phase from 2021 to 2025 and a third phase from 2030 onwards (Carbon Tax Act). The emissions covered in the Act comprise all the known greenhouse gases, which include fossil fuel combustion products, fugitive emissions, as well as the effects of industrial processes and product use. Rebates allowed on the emissions deal with fossil fuel combustion, industrial process emissions, fugitive emissions and trade exposure with a proposed limitation of rebates capped at 95 per cent (Carbon Tax Act: section 14).

The implementation of a staggered approach in the determination of the rate with further carbon tax rate increases during the onset of the second and third phases of implementation is envisaged. The types of emissions included are direct emissions, as well as indirect emissions from electricity generation and from the supply chain; although, sectors like agriculture, forestry and land use, waste disposal and residential areas are exempted from the emission sources addressed (Carbon Tax Act).

Carbon tax is regarded as a Pigouvian tax, which focusses on addressing negative externalities such as carbon emissions and it is therefore critical to apply a carbon emissions tax at the correct rate to achieve the mitigating objectives associated with a justifiable deterrent (Stern, 2006:35). Applying the emissions tax at the correct rate would deter the negative anomaly of GHGs associated with the phenomenon of climate change. The same concern needs to be raised in relation to the pricing of the proposed rate of R120 (equivalent US\$8, if US\$1 is equivalent to R14,50) per ton of CO<sub>2</sub> emissions, which, based on the Stern Review would not be sufficient to stabilise the emissions. Citing the importance of stabilising the global emissions in relation to the 2055 scenario, hence not exceeding the 550 parts per million (ppm) CO<sub>2</sub> threshold, the Stern Review states that “[t]he economics of climate change (2006) confirms that the rate for global CO<sub>2</sub> should not envisage prices lower than US\$8 per ton CO<sub>2</sub>e.” (Department of National Treasury, 2013:31). This rate, therefore, would not be sustainable in isolation in a South African context and does not have the potential to curb the current emissions’ growth rate.

Context provided hereto indicates that in 2019 only about 20 per cent of the total GHG emissions were managed under carbon pricing instruments, of which only 5 per cent are correctly priced to attain the emission mitigation objectives anticipated by the Paris Agreement. (“State and Trends of Carbon Pricing 2019” State and Trends of Carbon Pricing (June), World Bank, Washington, DC:3)

In view of the uneconomical proposed rate to mitigate emissions and the effect that the US\$8/tCO<sub>2</sub>e would have on the national economy, it is contended that a carbon tax as a solitary ameliorating instrument could adversely affect the South African economy. Consequently, the principle of carbon pricing as a necessary constituent of a mixed emission strategy whereby the pricing of carbon plays an important role in mitigating fossil fuel usage with an incentivising advancement using renewable energy. (Department of National Treasury, 2013:32)

## **8. RENEWABLE ENERGY AND REVENUE RECYCLING**

In consideration of the above, it demonstrates that a solitary emission reduction mechanism would be ineffective to mitigate emissions and simultaneously minimise the negative anomaly associated with excessive carbon tax, which could adversely influence the economy. The authors suggest that the aspect of renewable and recyclable energy (the recovery of energy that is normally wasted in an industrial process by flaring, exhausting to the atmosphere or to operate at low efficiency equipment and to convert it to electricity of thermal energy) be formally adopted as part of the emissions reduction mix, thus supplementing the solitary deterrent from a Pigouvian tax perspective.

The benefit of renewable energy incentives envisages solutions that stimulate the economy rather than reduce the energy potential of the industry with constituted statutory deterrents resembling constraining carbon taxes. Fossil fuel (dirty) energy is thereby replaced with clean energy consisting of renewable energy sources. Moreover, it is well established that South Africa has extensive potential for revenue recycling opportunities, given the current initiatives employed by the South African Revenue Services (SARS). Several tax instruments are currently available to supplement carbon tax instruments, as a result establishing a mixed carbon tax and renewable energy policy, which meets carbon emission goals without adversely affecting the economy.

An optimum policy mix needs to include energy-efficient policies, technology policies, but also, importantly, a carbon pricing mechanism (Department of National Treasury, 2013:31). South Africa currently have the Renewable Energy Policy of South Africa White Paper, White Paper on Energy Policy and Integrated Resource Plan 2010-2030 which was revised in 2019 that includes the efficient policies in the energy mix. An effective policy mix would further stimulate appropriate research and development, allowing the development of low-carbon societies using low-carbon technologies. The effective pricing of more conventional carbon-intensive technologies would increase and

eventually lead to the phasing out of such technology with newer technologies eventually being more competitive than older technologies.

Among the recycling scenarios, specific reference is given in terms of recycling of tax revenue through an output-based rebate on production as well as subsidies on the production of renewable electricity generators (World Bank, 2016:8). Current South African renewable energy incentives include income tax deductions on machinery and implements used to produce bio-diesel or bio-ethanol and the production of energy using wind, sunlight or hydroelectric power (SAICA, 2011). Some of these revenue recycling opportunities could likely include some of the following instruments. Sections 12B (1) and (2) of the Income Tax Act (ITA) allows for clean development mechanisms (CDM), which permits the participation of developing countries in the reduction of emissions (SAICA, 2011). This, for example, makes provision for capital allowance for movable assets that are used in the production of renewable energy. This incentive makes allowance for 100 per cent asset accelerated depreciation in the first financial year where the asset was brought online. This further equated to a 28 per cent deduction on the income tax of the business. Further disposals of CDM projects would also allow for tax incentives under section 12K of the Act, with the disposal of CDM projects being exempt from income tax and capital gains tax. However, noting that the disposal is exempt from income tax, the expenditure in relation to the CDM would not allow for a deduction in relation to section 11(a) of the ITA.

Other incentives under section 12L of the ITA permit for the claim of a notional allowance for income tax purposes should energy consumers indicate an energy savings initiative in the year of assessment. This, however, coincides with the necessary proof of an energy savings certificate from regulated measurement and verification professionals (SAICA, 2011).

Possible further incentives for revenue recycling through subsidies could also include the Industrial Policy Projects (IPPs) and government grants, such as through the Manufacturing Competitive Enhancement Programme (MCEP) and the Manufacturing Investment Programme (MIP) (DTI: MCEP Guidelines, 2012:17). The MCEP specifically allows for green technology and resource management improvements leading to incentives pertaining to renewable energy and the utilisation of clean energy in terms of ISO50010 standards (Department of Trade and Industry (DTI), 2012:17). The Department of Trade and Industry confirmed the initiation of 50 projects with an estimated total investment of R46 billion up to 28 February 2015 (DTI: MCEP Guidelines, 2012:17). The IPP programme includes both Greenfield and Brownfield manufacturing projects that necessitate the use of cleaner production technology and improved energy efficiency (SAICA, 2014). Section 12I of the Income Tax Act 58 of 1962 (hence ITA) allows for the approval of related projects by the Minister of Trade and Industry, although only projects valued at more than R50 million qualify for the

specific allowance (Income Tax Act 58 of 1962 (ITA), Section 12I (7)). The specific allowance entails 75 per cent of the cost of new and unused manufacturing assets in an IPP within an industrial development zone (IDZ) or 35 per cent of the cost pertaining to a new and unused asset in an IPP (ITA, Section 12I (2)(b)). Should the project constitute a preferred project, however, the allowance would cater for 100 per cent cost of new or unused equipment of an IPP within an IDZ or 55 per cent of the cost of a new and unused asset of an IPP (ITA, Section 12I (2)(a)).

Based on findings in the Renewables 2015 Global Status Report of the Renewable Energy Policy Network for the 21<sup>st</sup> Century (REN21), South Africa is the leading African country amongst the top 10 international investors in renewable energy in the world (Renewable Energy Policy Network for the 21<sup>st</sup> Century, 2015: 81). According to the report, South Africa has seen a renewable energy investment increase of 5 per cent in 2014, amounting to US\$5.5 billion (Renewable Energy Policy Network for the 21<sup>st</sup> Century, 2015:82). Noting that South Africa has only recently seen the development of carbon tax strategies, this growth in the renewable energy market cannot be attributed to mitigation strategies through carbon tax but should partly be attributed to other financial instruments used by SARS. It follows that based on the availability of revenue recycling instruments and renewable energy policies as part of national decarbonising policies, the medley of instruments has the potential to reduce the hindering effect of high valued taxes and allow for monetary incentives to inspire climate reform. The aforementioned therefore confirm the viability of formally including renewable energy and revenue recycling as part of the emissions reduction mix, thereby supplementing the solitary deterrent from a Pigouvian tax perspective.

## **9. UNIVERSITY OF PRETORIA GENERAL EQUILIBRIUM MODEL**

### **(UPGEM)**

The University of Pretoria General Equilibrium Model (UPGEM), a 53-sector model of the University's Department of Economics, demonstrates how South Africa can implement a carbon tax regime supported by a renewable energy policy that allows the country to meet its emission obligations without affecting the national economy. Its application considers the current instruments used by South Africa to achieve the reduction of current emissions by 34 per cent in 2020 and 42 per cent in 2025, as accepted in terms of the UNFCCC in 2009 (World Bank, 2016:1). It will also focus on how a combination of instruments could be used. Reduction of emissions as an objective in terms of the National Development Plan (National Planning Commission, 2011:180) encompasses both the future implementation of a carbon tax and current renewable energy incentives.

Henceforth, based on the considerations of both emission reduction and the least negative effects on the economy, it is contended that UPGEM can be used to project the

best-practice scenario. Based on the model indications, it is projected that emissions can be reduced from 1900 Mtco<sup>2</sup>-equiv to 2300 Mtco<sup>2</sup>-equiv from 2016 to 2035 (Van Heerden, Blignaut, Bohlmann, Cartwright, Diederichs & Mander, 2016:714).

The CGE model used the variables as confirmed in the Carbon Tax Act to project the necessary emission objectives and applied different rates to understand both implications relating to the reduction of emissions and the effect on the economy. The Carbon Tax Act anticipates a tax rate at R120 per ton of CO<sub>2</sub> emission with the estimated date of enactment originally scheduled for 2017 (World Bank, 2016:1). This is confirmed in the Carbon Tax Act.

According to the UPGEM model, the importance of a core policy mix would anticipate the use of recycling schemes in the form of various revenue and energy recycling practices (World Bank, 2016:7). Included in the UPGEM model, therefore, are both policy and recycling scenarios to establish the best practice to obtain an optimum policy mix (World Bank, 2016:7). This includes policy considerations allowing only for the introduction of a carbon tax based on the implementation strategy as envisaged under the Carbon Tax Act. Moreover, the introduction of both a carbon tax and additional recycling schemes represents additional reduction instruments.

The study demonstrates that much potential exists to mitigate the negative effect of carbon emissions with the proper adoption of a carbon tax strategy in accordance with the Carbon Tax Act. Further, according to the UPGEM model, emissions would be 33 per cent lower than the baseline should both carbon taxes be applied according to the proposed design, which anticipates the allowances (World Bank, 2016:10). This broad scheme includes allowances to be gradually removed at a rate of 10 per cent from 2021 onwards and the recycling of revenue through output-based rebates. This scenario would only marginally affect the annual growth of the economy by 0.15 percentage points lower than the baseline (World Bank, 2016:10).

By contrast with the above recycling scheme, the narrower recycling scheme, which focuses on renewable energy emissions reductions in 2035, could be 46 per cent lower than the baseline compared to the 33 per cent lower of the broader recycling revenue scheme (World Bank, 2016:18). Although comprehensive in terms of emissions reduction, the narrower recycling scheme could, however, have a slightly increased adverse effect on GDP, causing it to decline by 0.8 per cent annually, reducing the annual growth rate to 2.7 per cent (World Bank, 2016:18). Other positive attributes associated with a carbon tax supplemented by recycling schemes foresee output associated with clean energy sources, such as wind, hydropower, gas and solar photovoltaic generation sectors increasing by 200 percent more than without a carbon tax by 2035 (World Bank, 2016:21). Similarly, dirty energy output generated by coal, according to the UPGEM model, is likely to be 46 per cent lower by the year 2035 due to the increased use of clean energy (World Bank, 2016:21).

## 10. CONCLUSION

Based on the research conducted, the necessity of correctly priced carbon tax rates is vital and inapt rates would not reform a highly intensive carbon industry. As suggested by the Stern Review, the correct CO<sub>2</sub> rate of implementation is critical to stabilise emissions to a maximum of 550 parts per million (ppm), therefore, the envisaged price, as reflected in 2006, would already require a carbon tax rate of US\$30 per ton CO<sub>2</sub>e.

Further, in return, caution needs be heeded that the effect of an excessive carbon tax rate could stunt economic growth. Confirmed by the Fisher-Vanden model, an adequate equilibrium between the need for economic growth and the need for carbon reform needs to be generated. Notwithstanding the importance of carbon tax, Lu et al. confirm the negative outcomes should carbon tax be implemented as a solitary mitigation instrument. Further supported by the 30-Chinese-province CGE model, Dong et al. suggest that carbon tax needs be applied as an auxiliary measure, of which various carbon projects, which include cap and trade projects, emission reduction strategies and sectoral carbon tax initiatives can be utilised to complement a combined mitigation strategy (Dong et al., 2017:596).

Therefore, based on the submitted examination of carbon mitigation methods in specific jurisdictions, the research results validate the importance of carbon tax accompanied other mitigation strategies. The 53-sector model of the University of Pretoria's Department of Economics provides critical insight into projected solutions of additional carbon reduction strategies. The UPGEM model projections, considered from a South African perspective, support the position of combining the positive attributes derived from complementing carbon taxes with revenue and energy recycling.

Based on the findings generated, valuable insight is gained into supplementing the suggested carbon tax model, together with additional revenue and energy recycling. The findings indicate probable reduction of emissions between 33 percent and 48 percent and further limited losses generated on the national GDP.

Furthermore, based on the current carbon emission strategies in India, China and South Africa, the investigation confirms the need to balance the correct mitigation of carbon-intensive practices and achieve sustainable carbon reduction levels, which also allows the prospect of continuous growth in developing countries. Developing countries can reduce emissions through the creation of a balanced inter-relationship between policy and revenue recycling, more specifically, carbon emissions tax and renewable energy initiatives.

Therefore, in the light of the research into future implementation of carbon tax in South Africa and carbon tax research in the Indian and Chinese jurisdictions, it is evident the decarbonising policies and related policy mix is interrelated. Hence in anticipation of attaining sustainable national growth trajectories and address decarbonisation, in the

context of developing countries, carbon tax must be applied together with other climate strategies to allow for an sustainable mix of climate strategies.

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