Nobel Prize In Economics: A Report On Nordhaus And Romer

William D. Nordhaus and Paul M. Romer were the 2018 Nobel laureates who have been jointly awarded the 2018 Sveriges Riksbank Prize in Economic Sciences, in which their constructing models have significantly broadened the scope of long-run macroeconomic analysis, explaining how the market economy interacts with climate change and innovation. In which follows, not only does the contribution of both researchers to economics would be briefly explained, but also the reasons of the committee for awarding both researchers together would be justified.

To begin with, Dr. Romer developed a pioneering “post-neoclassical endogenous growth theory” in which he modeled how the creation of technological progress is determined by the economic decisions and market conditions, demonstrating that technological change is endogenous as a driver of long-term economic growth, contrary to the exogenous assumption suggested in Solow Model (Waaghals, K., 2018). In Romer’s endogenous growth theory, he emphasized that knowledge is produced by undertaking R&D by private agents and its non-rivalry in nature, where knowledge is an essential input in the production process.

From the proposal of non-rivalry nature of knowledge, reinvestment on ideas are not necessary to be taken place every time since the “learning-by-doing” principle (i.e. productivity is correlated with knowledge which are gained from experience) and concept of “knowledge spillover” (where knowledge generates positive externalities for the whole economy as knowledge cannot be kept undisclosed) are recognized.

Non-rivalry furthers suggests that each unit of knowledge is associated with positive externalities on the aggregate economy as numerous firms could use the same idea and people could become more productive simultaneously. In other words, if we double the objects and knowledge, we will more than double total production. Since the spillover effect becomes stronger as more knowledge is created, it would further generates increasing returns to knowledge accumulation at the aggregate level.

In Solow model, as there are constant returns to scale in the rival inputs, sustainable per capita growth could not be obtained if there is population growth without an increase in output. However, in Romer’s model, with increasing returns, growth would follow naturally as everyone would be better-off from non-rival ideas produced by researchers, which could be further characterized by substantial growth in living standards. Hence, government institutions could incentivize private entrepreneurs to innovate new ideas as to obtain sustained exponential

growth.

Since a constant exponential growth rate of knowledge is proportional to the amount of research effort (i.e. one of Romer's main assumptions for the intuition behind the model), the importance of entrepreneurships and researchers have been emphasized; and implementation of policies that affects their efforts such as taxation, research funding and education would be potentially influential towards the long-run prospects of the economy.

He has demonstrated a deep insight into regulations and policies that encourage new ideas and long-term prosperity in which a well-regulated market and policy interventions (such as R&D subsidies and patent regulation) are crucial to R&D and technological creation, as well as long-run growth not just within a country but globally.

For example, poor countries might improve their underlying performance if they concentrate on supply-side measures such as R&D, innovation and skills.

Since low stock of knowledge could be identified in poor countries, low marginal return to new knowledge creation would not incentivize private agents to participate in R&D investment, in which the country might be trapped in stagnation and poverty. Meanwhile for those relatively advanced economies with considerable pre-existing knowledge capital, a persistent increasing growth rate could be observed. The theory proposed by Romer disproved the convergence hypothesis in the Solow growth model where poorer countries are predicted to experience a faster growth rate and able to catch up with the richer economies.

Although Romer's proposed theory imposed several challenging views on the understanding of the neoclassical growth theory, it could be explained by different assumption taken for the role of government in two models. In Neoclassical growth model, presumptions of perfect market and rational agents are grounded in which the role of the government intervenes on long-run growth is not taken into account. Meanwhile for Romer's, government intervention is necessitated to create incentives for private agents to engage in R&D under the presence of positive externalities from knowledge creation, which establish the importance of effective government policies.

Under the increasing returns with non-rivalry nature in Romer's model, a perfectly competitive equilibrium with no externalities could not be obtained since private initiatives in knowledge creation could not be fully rewarded and monopoly profits from costly knowledge creation could not be sustained under perfect competition. Whereas in Romer's model, he emphasized the importance of imperfect competition and externalities towards the knowledge (Jones, C.I., 2019). In particular, excludability of knowledge create could be assured by patenting and establish long-run monopoly profit, which might incentivize private firms to involve in costly R&D

activities. With non-rivalry nature of knowledge and spillover effects, knowledge creation would benefit all producers in long-run in terms of stock of knowledge and reduced marginal costs of new innovation.

Although questions about whether countries with higher population growth rate is necessarily to have better economic performance have been raised and some declines in countries' growth rates could be observed in recent years, Romer's model helps us to better understand how discovery of new ideas are essential to boost growth in a cumulative fashion, as well as helps explaining the discrepancy between the Solow model and reality (i.e. convergence controversy).

For Nordhaus, he has created an Integrated Assessment Model (IAM) by integrating theories and empirical results from physics, chemistry and economics, where the interactions between the global climate and the social economy are being explored, and estimate the possible consequences of climate policy interventions such as carbon taxes.

Not only does he associate climate change into economic analysis by assessing the costs and benefits of CO2 reduction, but he also develops a modeling tool that can quantify carbon prices for a widely applied policy framework, which he helps the global economy converging towards a more sustainable long-term growth.

As shown in Equation 5, Nordhaus managed to illustrate the cost-benefit approach to climate policy and defined the optimal carbon pollution price which is denoted as q(t), in which the optimal carbon tax should be implemented at q(t) dollars per ton where the marginal abatement cost is equal to the present value of marginal damage from another ton of CO2 emission. In other words, it could be expressed as the social cost of carbon emission.

Furthermore, Nordhaus kept refining his model and introduced Dynamic Integrated model of Climate and the Economy (DICE) as a maximizing social welfare function, where ? captures the degree of curvature in the utility function, and ? defines the pure rate of social time preference. As both parameters are highly accountable to determine the rate of willingness of trading-off their present consumptions against future with different income levels in economy, social preferences and opportunity costs of investment on alternative aspects (e.g. health or technological research) versus climate abatement could be reflected after parameters calibration with empirical savings and interest rates observations.

Although there were obstacles in measuring the environmental damage since it is thought as a "stock" while GDP is a "flow", Nordhaus is still able to study the concepts of "green accounting" and outline the unintended side effect of environmental degradation against economic growth (Cowen, T., 2018). Meanwhile, Nordhaus has argued that environmental issues should be considered as "global public good" such as national defense and international

trade, and be well-regulated under either quantity oriented market approaches and tax or price-based regimes, but not through a command-and-control regulation.

Indeed, a global carbon tax on the use of burning fossil fuels is thought to be the best remedy for such negative externalities, where the fundamental cause of rising temperature could be traded and taxed. By doing so, not only could the greenhouse gas emission be reduced, but also the free-rider phenomenon could be avoided (JewishWebSight. 2018). Besides, since higher prices will motivate firms and consumers to substitutes from carbon-based products, investment on renewables technologies would be incentivized in the economy as to make their alternative products competitive in the market, in which further results in a lower emission and new low-carbon technologies developed in global (Gleckman, H., 2018). Besides, if equalization of carbon prices is implemented across participating countries, then it is easy for enforcement since tariffs or border tax adjustments are not necessary among participants. Despite of opportunities exist for any countries to increase its coal subsidies or reduce diesel fuel taxes in order to try offsetting their carbon tax, poor incentive to reduce carbon emission would just put everyone risking in suffer the consequences.

Moreover, a carbon tax might be preferable for those countries that suffer from budget deficit such as United States. The additional tax revenue from CO2 tax might be able to replace some existed policies that pursue the reduced-usage of fossil fuel as well (Gleckman, H., 2018). Meanwhile, a bundle of financial and technological supports in helping low-carbon technology adoption and a substitution of carbon tax for other taxes are essential to induce low-income countries to participate the emissions reductions scheme and allow them to grow.

In order to meet the target (i.e. the world must reduce half of the net CO2 by 2030 and eliminate them by 2050) set by the UN'S Intergovernmental Panel on Climate Change, Nordhaus is relatively uncertain about whether a direct carbon tax or a cap-and-trade system would deliver the most efficient outcome, Besides, a Coaliton-DICE (C-DICE) model is developed by Nordaus in which a global climate club is also suggested as an alternative approach in order to protect the climate and maintain the planet's livability. Members in the coalition could participate the agreement conference about the international target carbon price, while the countries that denied joining the club would be penalized through harsh tariffs on all imported goods imposed by club members, and if the opportunity cost of rejection of becoming a member were high enough, then most countries would join the club and incorporate to reduce greenhouse gas emissions and maintain a sustainable long-term growth.

In terms of the reasons why they are jointly awarded together, due to DICE model is developed based on Solow exogenous growth model (i.e. treats technological change as exogenous), which might allow Romer to interpret endogenous technological change (i.e. R&D investments and learning?by?doing principle) and reveal altogether different climate policy approach from

Nordaus's model. Furthermore, Nordhaus discovered some alike results with introducing the R&DICE model, it enables firms to reduce the carbon concentration of production ?(t) through R&D. When endogenous technological change is taken into account, the effects on reducing emission are quantitatively moderate. Therefore, they might able to overlap their research findings and design a more integrated model as to address both climate issues and economic growth

Moreover, both researchers both started with neoclassical growth model and modified it while they have made huge strides towards long-term sustainability (e.g. tackling market failures; lack of innovation; increased pollution levels) in which endogenous growth theory and climate-economic relationships have not been deeply studied by previous researchers. Both of their scientific research had hugely contributed to the community in terms of maximizing social welfare.

There is no doubt that their rich-expanding literatures have greatly designed to address our current basic and pressing questions about how we create long-term sustainable economic growth. Since both researchers have demonstrated the critical role of government in boosting innovation and addressing environmental damages while the markets are imperfect, they drive other economists or policy makers estimating the costs of inaction in the case of climate change and the benefits of action in the case of innovation, improving public policy interventions for the future generations.

By way of conclusion, both Nobel Laureates Romer and Nordhaus have shown their significant contributions towards different aspects to influence economic growth. Although some challenges or criticisms may be raised against their models, both winners have made huge strides towards tackling climate change and sustainable development.