ECONOMIC IMPACT OF CLIMATE CHANGE ACROSS THE SECTORS AND REGIONS

R. GOPALAKRISHNAN
Assistant professor of Economics, Government Arts College, C.Mutlur, Chidambaram

Abstract-This paper deals with impact of climate change on economy. It outlines the economic impact of climate change with reference to raising inflation, higher energy cost and cost of infrastructural damage. This paper makes a special note on estimation of climate change damage, effects of climate change on economic growth and regional economic effects of climate change and policy responses to climate change impact on economy. This paper concludes with some interesting findings.

Introduction

The overall aggregate effect of climate change on economic growth will most likely be negative in the long run. Although there will be winners and losers from climate change at varying levels of warming, the impact of rising temperatures will be widespread, in part due to the financial, political and economic integration of the world's economies. Global warming will primarily influence economic growth through damage to property and infrastructure, lost productivity, mass migration and security threats. The balance between winners and losers turns increasingly negative as temperatures rise. Global warming is expected to increase the frequency and severity of extreme weather events, bringing with it property and infrastructure loss.

Economic Response of Climate Change

While the initial economic response to recover this damage may be positive for GDP once it is recognized that such events are a permanent feature of the environment, the world economy faces an extreme challenge. Many will find that it is not worth replacing capital stock unless measures can be taken to prevent future damage, or there is an opportunity to move the business to safer ground. At best, this could involve a short period of disruption as businesses relocate; at worst, a permanent loss of capital stock and output. As the temperatures continue to climb, the damage will become increasingly permanent.

Using a production function one can demonstrate the likely effect climate change will have on output. If one assumes less capital stock is available due to the damage inflicted from climate change, one would see a fall in the productive capacity of the world economy. This would translate into a downward shift in the world production function as each unit of labor produces less output. Lower labor productivity may not just occur due to a lower level of capital stock, however. Higher global temperatures may affect food security, promote the spread of infectious diseases and impair those working outdoors. Such factors are likely to cause greater incapacity and social unrest and as a result will reduce both the effectiveness and the amount of labor available to produce output.

According to Mendelsohn (2013), the biggest threat climate change poses to economic growth is from immediate, aggressive and inefficient mitigation policies. The process of adaptation and mitigation will require a temporary economic transition from consumption to investment, with the argument being that the transitional costs are small relative to the cost of inaction. Stern (2006) estimates the costs of mitigation to be in the region of 1% of global GDP per annum by 2050. However, one would argue that as the costs of mitigation rise, budget constraints are likely to become increasingly important. Governments may be unable to raise the capital necessary to build adequate defenses, for example. Inflation is likely to rise as shortages emerge, particularly in agriculture.

Climate Change, Agriculture Productivity, Inflation and Energy Cost

Agricultural yields are sensitive to weather conditions and as our climate becomes ever more extreme, more frequent droughts may reduce crop yields in areas where food production is vital. Higher global food prices will likely thus squeeze consumers' income in the process. One must acknowledge that these effects will be partially offset as other regions becoming more suitable for crop production and new drought resistant crops are developed. However, in aggregate, and as the level of warming becomes even greater, food price inflation should rise. Rising inflation may also materialize through reduced land availability. The surge in global temperatures may eventually cause some areas of the world to become uninhabitable and with this will come mass migration. Alongside the political and socioeconomic implications of these moves will be higher demand for an ever decreasing amount of land. In essence, the world's population will be forced to live in an increasingly concentrated space. In similar fashion to food inflation however, this effect will also be moderated by some areas of land becoming more habitable. Energy costs to increase in the transition to renewables

Higher energy costs are also likely to boost inflation. As our climate becomes more extreme we are likely to demand greater energy to both cool our working and living environments during the summer, and heat them when people experience harsher winters. Not only will energy demand change, but supply may shrink as the efficiency of existing power stations is compromised due to higher temperatures. Policy actions by governments to encourage a transition to green energy may further contribute to energy inflation in the short- to medium-term whereby taxes are placed on fossil fuel-derived electricity. Given that energy forms the basis of most of the world's production, the secondary effects of higher energy prices on inflation will be felt throughout the global economy. Conversely, depending on the pace of change, the greater prominence of renewable energy could limit the cost of energy increases going forward. Climate change risks are already pushing insurance costs higher The insurance

industry recognizes that it is likely to bear much of the risk of global warming. Companies have already felt the force of extreme weather events on profits; from unseasonal floods in the UK to Hurricane Katrina in the US, extreme weather-related damage to properties has seen insurance companies pay out to cover these costs.

Climate Change Damage effects on Economy

Estimates of climate change damage vary according to whether there is a tipping point at which damage accelerates The "N-damages" climate damage function, named after its originator Nordhaus (2013), is widely used by economists and is the least concerning of the three climate damage functions. Climate damage under this function would be progressive whereby no tipping point is reached and the world's population has the greatest amount of time to offset any negative effects of global warming. It can be seen that by the year in which the world is 4°C warmer, annual economic output will be just 4% lower than a base case with no warming. The baseline case in Nordhaus's study is for warming of around 3.8% by 2100.

Nordhaus believes the economic impact of climate change is likely to be small over the next couple of decades and that agriculture is the most exposed sector to global warming. Although the cumulative effects are reasonable at the point at which 4°C is reached, the loss in terms of average annual growth would be extremely small and difficult to distinguish given that it will take many decades to reach 4°C of warming based on current estimates. The "W-damages" function was produced by Weitzman (2012) and estimates that by the time 4°C of warming are reached, 9% of annual economic output will be lost relative to the base with no warming effect. Under this scenario, those industries that are largely predisposed to climate change risk globally are likely to be affected, for example insurance, agriculture and forestry. However, Pearce et al (1996) believe that only a fraction of the market economy is vulnerable to global warming, namely agriculture, coastal resources, energy, forestry, tourism, and water. According to Mendelsohn (2013) these sectors contribute just 5% of global GDP to which their share is expected to shrink overtime.

This can be seen when we translate the damage function into the effect on economic growth. If we assume a base case of 3% annual economic growth and that 4°C warming is reached by 2080, one find that annual growth will be pared back to 2.85%. This is based on an economy that is 9% smaller due to climate damage in 2080 relative to an economy with no warming. An effective loss of 0.15% per annum could be seen to warrant some attention from policymakers and the government alike, but is unlikely to be sufficiently powerful to prompt a significant response to climate change. In the most severe case, global GDP growth would be some 1% lower per annum.

The final climate damage function, "DS-damages", named after Dietz and Stern (2014) is the most extreme scenario in which the global economy would suffer considerable loss as a result of climate change. Under this scenario, as and when warming extends to 4°C, annual economic output will be 50% lower compared to a scenario where no warming occurs. To put this into perspective, Dietz and Stern estimate warming of approximately 3.5°C by 2100. If we take a stricter approach however, using the same assumptions as the W-damages function above but assuming 4°C is reached in 2080, the base case 3% annual economic growth rate falls to just 1.9% a year. At this rate, climate change is set to have a noticeable impact on future growth and living standards. Reaching a tipping point at 2-3°C, as Dietz and Stern predict, could therefore be seen as a crucial stage of warming for the global economy whereby the costs of insufficient action significantly weigh on growth. Christine Lagarde, head of the International Monetary Fund (IMF), believes the planet is "perilously close" to a climate change tipping point to the extent that climate change poses the greatest economic challenge of the 21st century. In table 2 we summarize some additional benchmark studies in the literature aiming to address the economic impacts of climate change.

This analysis indicates that output losses accelerate once warming exceeds 2°C, but that these effects are not likely to be felt for another 30 years. It is this threshold which is apparent in investment studies such as that recently published by Mercer which finds negative returns to diversified portfolios once warming breaches 2°C. However, let us not forget that warming unfolds over time and that actions today have implications for the future. Since the process is largely irreversible over the medium term, the global economy can be seen to have committed to a certain degree of future warming already. A 2014 World Bank study titled "Turn Down the Heat. Confronting the New Climate Normal" estimates that warming of close to 1.5°C above pre-industrial times is locked into the earth's atmospheric system and is thus unavoidable. According to the same study, without reasonable action to reduce emissions, the earth is on track for 2°C warming by mid-century and 4°C or more by the end of the century. Stern (2006) also estimates that without action to reduce emissions, the concentration of greenhouse gases could double their pre-industrial levels as early as 2035, almost committing the world to temperature increases of over 2°C.

Regional Effects of Climate Change

The burden of climate change will be felt most by the developing world. The effects of climate change will not be uniformly distributed across the globe and there are likely to be winners and losers as the planet warms. Applying a broad brush to climate effects, developing countries are more likely to disproportionately experience the negative effects of global warming. Not only do many developing countries have naturally warmer climates than those in the developed world, they also rely more heavily on climate sensitive sectors such as agriculture, forestry and tourism. As temperatures rise further, regions such as Africa will face declining crop yields and will struggle to produce sufficient food for domestic consumption, while their major exports will likely fall in volume. This effect will be made worse for these regions if developed countries are able to offset the fall in agricultural output with new sources, potentially from their own domestic economies as their land becomes more suitable for growing crops.

Developing countries may also be less likely to create drought resistant harvests given the lack of research funding. The increased frequency and severity of extreme weather will weigh on government budgets. The aftermath of natural disasters often falls on authorities who are forced to spend vast amounts on clear-up operations and healthcare costs that come with experiencing extreme weather. Revenue reductions may also be experienced by countries heavily dependent on tourism or on selling fishing

rights, for example (IMF, 2008). The effects on the developing world are two-fold. Firstly, as developed countries face an increasing strain on domestic budgets, fewer resources in the form of aid and economic development funds will flow to developing countries. Secondly, the governments of these nations will be forced to channel resources away from productive and growth-enhancing projects towards countering the costs of extreme weather. Such effects will damage near-term growth prospects. According to Hallegatte, Dumas, and Hourcade (2010) developing countries are likely to have less capacity to rebuild. The time required to recover from natural disasters will be prolonged and if longer than the frequency with which such disasters occur, many developing economies could remain in a constant state of reconstruction.

Climate Change Impact on Africa and Asia

Highly vulnerable regions in the emerging world include Sub-Saharan Africa and South and South East Asia, according to the World Bank. In South Asia, cities such as Kolkata and Mumbai will face increased flooding, warming temperatures and intense cyclones. Loss of snow melt from the Himalayas will also reduce the flow of water into the Indus Ganges and Brahmaputra basins. Meanwhile in South East Asia, Vietnam's Mekong Delta, which produces most of the country's rice, is especially vulnerable to rising sea levels. Mendelsohn et al (2006), note that for Sub-Saharan Africa, food security will be a major challenge due to droughts and shifts in rainfall. Many developing nations are situated in low latitude countries and it is estimated that 80% of the damages from climate change may be concentrated in these areas. It is evident from the work of Stern (2006) in contrast, northerly regions such as Canada, Russia and Scandinavia, may enjoy a net benefit from modest levels of warming. Higher agricultural yields, lower heating requirements and lower winter mortality rates are a handful of economic benefits climate change may bring, although these benefits may diminish as warming continues.

The prediction that developing countries will be disproportionately affected is reinforced by Standard and Poor's research on the influence climate change will have on sovereign risk. Recognizing that climate change is a global mega-trend impacting sovereign risk through economic, fiscal and external performance, they find that lower-rated sovereigns appear most exposed. They assess sovereign vulnerability on three measures: share of the population living in coastal areas below five meters of altitude, the share of agriculture in national GDP and a country score from the "vulnerability index" compiled by the Notre Dame University Global Adaption Index. Such an index measures the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change. Based on these measures we can interpret the results in part as the susceptibility of an economy to climate change. Figure 4 below summarizes the results on a world map. In line with much of the economic literature, many developing nations appear most vulnerable to climate change during the remainder of the current century.

Government Policy Responses to Mitigate Climate Change Impact

Climate change calls for a collective effort from governments, firms, shareholders and individuals to both adapt and implement measures to mitigate its effects. As carbon dioxide emissions are the main culprit for global warming, any policy response must effectively target reduced emissions. Since free markets fail to incorporate and price the negative externality2 of global warming, government intervention is required to realign resource allocation. Without public policy looking to change private sector behavior, economies run the risk of continuing to pollute to a point where it is too late and the economic costs are catastrophic.

Intergovernmental agreements that encompass all major economies will be the most effective in tackling climate change. Without a collective policy response, the efforts of only a handful of countries looking to reduce carbon dioxide emissions will fall short of what is needed to make a material impact on a global level. We touch upon some popular policy responses below. Decarbonizing the world's energy supply through a rapid energy transition will reduce the risks of climate change. The use of biofuels, hydrogen and clean energy can speed up decarbonization alongside reducing demand through energy efficiency measures. Governments may offer subsidies to green energy providers to promote innovation and reduce the cost of energy from these sectors. The Bank of England has recently committed to researching the risks to the financial system if climate regulation were to limit global temperature increases.

Finally, let us briefly consider the monetary policy implications of climate change. Climate change will reduce economic growth and create higher inflation. From a monetary policy standpoint, such a stagflationary environment will place the world's central banks in a dilemma: weaker growth will bring calls to stimulate the economy, but such efforts are only likely to aggravate inflation. Monetary policy is not able to offset the shift in the supply curve and policy action will have to focus on the measures described above. The long-time horizon means that we are unlikely to see much in the way of a visible effect until much later in the century.

Conclusion

It could be seen clearly from the above discussion that climate change has major impact on the economy by the way of cost of damaging the economic infrastructural faculties. It could be noted that climate change enhances the inflation rate, raising the energy cost and cost of climate change adaptation. The countries should understand the economic impact of climate change, and try to overcome the negative impact of climate change in production of goods and services. Hence, the government should make use of international funding, private funding and multilateral funding institutions towards mitigating the economic impact of climate change.

References

- Carney.M (2014) "World Bank Seminar Speech on Integrated Reporting", October 10th, 2014
- Carney.M (2015) "House of Lords Economic Affairs Committee Speech", March 10th, 2015

- Covington. H and Thamotheram. R (2015), "The Case for Forceful Stewardship (Part 1): The Financial Risk from Global Warming", Available at SSRN: http://ssrn.com/abstract=2551478orhttp://dx.doi.org/10.2139/ssrn2551478
- Covington.H and Thamotheram.R (2015), "The Case for Forceful Stewardship (Part 2): Managing Climate Risk (January 19, 2015), Available at SSRN: http://ssrn.com/abstract=2551485andhttp://dx.doi.org/10.2139/ssrn.2551485
- Dietz.S & Stern.N (2014), "Endogenous growth, convexity of damages and climate risk: how Nordhaus' framework supports deep cuts in carbon emissions", Centre for Climate Change Economics and Policy, Working Paper No.180
- International Monetary Fund, Fiscal Affairs Department (2008), "The Fiscal Implications of Climate Change", Available at SSRN: http://www.imf.org/ external/np/pp/eng/2008/022208.pdf
- Hallegatte.S, Dumas.P and Hourcade.J.C (2010), "A Note on the Economic Cost of Climate Change and the Rationale to Limit it Below 2°C", World Bank Policy Research Working Paper 5179
- Hope.C (2006), "The Marginal Impact of CO2 from PAGE2002: An Integrated Assessment Model Incorporating the IPCC's Five Reasons for Concern",Integrated Assessment Journal, 6(1): 19–56
- IPCC (2014), "Summary for Policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects.
- Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change" [Field, C.B., V.R. Barros, D.J. Dokken,
- K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R.
- Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.
- Lagarde.C. (2013) "A New Global Economy for a New Generation." Speech given at the World Economic Forum Annual Meeting, Davos, January23rd, 2013
- Lagarde C (2014), "A New Multilateralism for the 21st Century: the Richard Dimbleby Lecture", Speech given in London, February 3rd, 2014
- Mercer LLC, International Finance Corporation and The UK Department for International Development (2015), "Investing in a Time of Climate Change",
- Available at SSRN: http://www.mercer.com/services/investments/investment-opportunities/responsible-investment/investing-in-a-time-of-climate-changereport-2015.html
- Mendelsohn.R (2013), "Climate Change and Economic Growth, Commission on Growth and Development", Working paper no.60
- Mendelsohn.R, Dinar.A and Williams.L (2006), "The Distributional Impact of Climate Change on Rich and Poor Countries", Environment and Development Economics 11: 1–20
- Mendelsohn.R, Schlesinger.M and Williams.L (2000) "Comparing Impacts Across Climate Models" Integrated Assessment 1, pp. 37-48.
- Mendelsohn.R, Morrison.W, Schlesinger.M and Andronova.N (2000), "Country-specifi c Market Impacts of Climate Change", Climatic Change, 45(3– 4):553–69
- Nordhaus.W (2013), "The Climate Casino", Yale University Press
- Pearce.D.W, Cline.W.R, Achanta.A.N, Fankhauser.S, Pachauri.R.K, Tol.R.S.J. and Vellinga.P (1996), "The Social Costs of Climate Change: Greenhouse
- Damage and the Benefi ts of Control", In Bruce, J.P., Lee, H. and Haites, E.F., (Eds.) (eds.) Climate Change 1995: Economic and Social Dimensions, Cambridge University Press, Cambridge.
- Rose.A (2004), "Defi ning and Measuring Economic Resilience to Disasters," Disaster Prevention and Management, Vol. 13, No. 4, 2004, pp. 307-314.
- Ruth.M, Coelho.D and Karetnikov.D (2007), "The US economic impacts of climate change and the costs of inaction", Center for Integrative Environmental Research
- Stern.N (2006), "Stern Review on The Economics of Climate Change (pre-publication edition). Executive Summary", HM Treasury, London. Archived from the original on 31 January 2010
- Stern.N (2006), "Stern Review on The Economics of Climate Change, PART II: The Impacts of Climate Change on Growth and Development". HM Treasury, London. Archived from the original on 31 January 2010
- Tol.R S.J. (2002), "Estimates of the Damage Costs of Climate Change. Part 1: Benchmark Estimates," Environmental and Resource Economics, Vol. 21 (January), pp. 47–73
- Weitzman.M (2012), "GHG Targets as Insurance against Catastrophic Climate Damages", Journal of Public Economic Theory, 14 (2), 2012, pp.221-244
- World Bank (2014), "Turn Down the Heat: Confronting the New Climate Normal", Washington, DC: World Bank, License: Creative Commons Attribution—NonCommercial—No Derivatives 3.0 IGO (CC BY-NC-ND 3.0 IGO)