The Role of Fiscal and Monetary Policies in Facing Climate Change Risks (Egypt as a Case Study)

A Research Presented To

The Twenty-Second Annual International Conference

Legal and Economic Aspects of Climate Change

March 19-20, 2023 AD

By

Mayada Ali Hassan Ali El-Morsy (Ph.D.)

Lecturer at the Department Of Political Economy and Economic and Financial Legislation
Faculty of Law-Mansoura University

The Role of Fiscal and Monetary Policies in Facing Climate Change Risks (Egypt as a Case Study)

Abstract

This research aims to analyze the relationship between climate change risks and climate change policies and between macroeconomic variables, especially the monetary policy objectives of central banks and inflation expectations. The physical risks of climate change, as well as the risks of transitioning to a low-carbon economy, pose major challenges to macro-financial stability, as they can harm the financial budgets of governments, households, corporations, and financial institutions, due to negative impacts on investment and economic growth, financial revenues and expenditures, debt sustainability, and the valuation of debt, financial assets. Climate change will have negative effects on the aggregate demand side, as well as the aggregate supply side, during the coming decades. As a result, it may distort the performance of the economic and financial system. Evidence for this is the rising costs resulting from the increased frequency of extreme weather events. Likely, the direct effects of climate change will gradually increase over time as global temperatures rise. An attempt to control the macroeconomic vulnerability to climate change risks can be achieved by climate change

policies that require structural changes in the economy. These policies can have significant financial implications, as climate change is a source of risks to the financial sector. Climate change's physical effects can increase banks' operational, credit, market, and liquidity risks. Climate change affects monetary and fiscal policies in different ways. By setting a carbon price, regulators aim to discourage the production and consumption of high-emitting goods. The carbon price can be set through a tax or a cap-and-trade system. However, these policies can also boost innovation, generate fiscal revenue, and reduce inflationary pressures while increasing energy efficiency and lowering the price of renewable energy.

Keywords: climate change - economics of climate change - central banks - monetary policies - carbon tax - macroeconomic variables.

الملخص

يهدف هذا البحث إلى تحليل العلاقة بين مخاطر تغير المناخ وسياسات تغير المناخ وبين المتغيرات الاقتصادية الكلية، وخصوصًا أهداف السياسة النقدية للبنوك المركزية، وتوقعات التضخم. وتشكل المخاطر المادية لتغير المناخ وكذلك مخاطر التحول إلى اقتصاد منخفض الكربون تحديات كبيرة للاستقرار المالي الكلي، حيث يمكن أن تضر بالميزانيات المالية للحكومات والأسر والشركات والمؤسسات المالية، وذلك بسبب الآثار السلبية على الاستثمار والنمو الاقتصادي، والإيرادات والنفقات المالية، والقدرة على تحمل الديون، وعلى تقييم الأصول المالية. إن تغير المناخ سيكون له آثار سلبية على جانب الطلب الكلي، وأيضا جانب العرض الكلي خلال العقود القادمة، وقد يتسبب في تشويه أداء النظام الاقتصادي والمالي. والدليل على ذلك هو ارتفاع التكاليف الناتج عن زيادة تواتر الظواهر المُناخية المُتطرفة . ومن المُحتمل أن تزداد الآثار المباشرة لتغير المناخ تدريجيًا بمرور الوقت مع ارتفاع درجات الحرارة العالمية. يمكن محاولة التحكم في مدى تأثر الاقتصاد الكلي بمخاطر تغير المناخ عن طريق سياسات التخفيف من التغير المُناخي التي تتطلب تغييرات هيكلية في الاقتصاد. ويمكن أن تنطوي هذه السياسات على آثار مالية كبيرة حيث يُعد تغير المناخ مصدرا للمخاطر التي يتعرض لها القطاع المالي. يمكن أن تؤدي الآثار المادية لتغير المناخ إلى زيادة مخاطر التشغيل والائتمان والسوق والسيولة للبنوك. يؤثر تغير المناخ على السياسة النقدية والمالية بطرق مختلفة؛ فمن خلال تحديد سعر الكربون، تهدف السلطات التنظيمية إلى تثبيط إنتاج واستهلاك السلع عالية الانبعاثات. ويمكن تحديد سعر الكربون من خلال ضريبة الكربون، أو من خلال نظام تداول تصاريح الحد الأقصى لانبعاثات الكربون. ومع ذلك، يمكن لهذه السياسات أيضًا أن تُعزز الابتكار وتولد إيرادات مالية وتقلل من الضغوط التضخمية مع زيادة كفاءة الطاقة وانخفاض سعر الطاقة المتجددة.

الكلمات المفتاحية: تغير المناخ-اقتصاديات التغير المناخي-البنوك المركزية-السياسات النقدية-ضريبة الكربون-المتغيرات الاقتصادية الكلية.

Introduction:

The problem of climate change is global, with many scientific, legal, economic, and ethical aspects. Usually, only some of the adverse effects of climate change appear in the short term but may extend to tens and hundreds of years. This makes it difficult to anticipate or assess the risks of climate change and evaluate the efficacy of climate policy toward the risks of climate change.

Climate change is one of the main challenges facing the world today. It poses a significant threat to livelihoods, ecosystems, water resources, infrastructure, and the global economy. Therefore, governments, businesses, and societies must cooperate to control global greenhouse gas emissions and significantly reduce the impact of climate change in the future to avoid its expected severe effects that would undermine development gains.

The economic aspect of the climate change problem is the most important. Economics is sound in various aspects of the climate change debate. The economy helps to formalize the idea or problem and its possible solutions by looking at climate change as a case of market failure or as one of the adverse external economic effects. Economic ideas can be used to tackle climate change using a cost-benefit analysis approach. In addition, economic insights help to define a range of mitigation and adaptation strategies for climate change.

Economics is critical to the design of climate change mitigation and adaptation policy tools, such as carbon taxes and tradeable carbon emission permits. In addition, economics may contribute to understanding the political economy of domestic and international climate policy negotiations. This means that the science of economics contributes significantly to the knowledge of the causes and possible solutions to confront it.

It has become established that economic activities, in general, and the high rates of economic growth in developed countries and emerging economies are the leading cause of the problem of climate change. This is because economic growth is necessarily accompanied by an increase in energy use and, therefore, an increase in carbon emissions, which are the main cause of global warming. Therefore, regarding possible solutions, economic policies, whether fiscal or monetary, top the list of measures taken in the face of climate change.

The greenhouse gases generated by the combustion of fossil fuels result from economic activity, and the amount of greenhouse gas emissions per capita depends on the level of a country's economic development and government policies to reduce emissions. When greenhouse gases build up in the atmosphere, they tend to cause increased temperatures and other climate changes.

These changes, in turn, can have significant economic impacts. This is similar to the movement in a vicious circle in that economic growth that has been adopted and still depends on carbon-intensive energy causes the problem of global warming and climate change. Moreover, to confront the problem, countries need more financing. The availability of this financing depends on the size of countries' economic growth, and the more it increases; carbon-based economic growth has increased the problem of climate change. (Gaber, 2021, p.366)

Policymakers in central governments need to be aware of the risks to economic growth from climate change and ensure that their policy framework is adequate to address these risks. They also need to consider the potential effects of large-scale, climate-related extremes on public budgets and fiscal policy. The economic impacts of climate policies geared towards implementing global commitments to reduce carbon emissions must also be considered. Climate policy should not be viewed in isolation but as an integral part of the broader policy agenda to promote economic growth.

It has also recently become clear that central banks should pay attention to climate change policies, as these policies can affect their ability to achieve monetary and financial stability goals. Inflationary pressures may arise from a reduced supply of goods or production shocks caused by weather-related events, such as droughts, floods, storms, and sea-level rise. These events can lead to significant financial losses. If it is

insured, it can negatively affect insurance companies, while if it is uninsured, it can affect the value of physical assets. Policies to mitigate climate change and transition to a low-carbon economy may also lead to financial risks if investors do not adapt their investment strategy to the climate (Batten *et al.,* 2016). Several studies, most notably the IPCC Assessment Reports, have identified channels through which climate change can affect economic outcomes. (IPCC, Climate Change 2014: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2014)

The economic impacts of climate change are one of the world's most important challenges today (Tol, 2009, pp.2-7). Mitigating these effects requires major changes in energy production and use because greenhouse gas emissions resulting from turning represent the dominant human factor in the issue of climate change (Cotton & Pielke, 2007, p.75). In the short term, a range of emissions reduction policies is available. For example, there are many opportunities to improve energy efficiency levels and to replace fuels (from high-carbon to low-carbon fuels) in all sectors of the economy.

However, a long-term solution can only be found if the necessary price indicators are in place to make technological development work in a way that is compatible with climate change. These indicators can be reached through economic studies that depend on the cost-benefit approach (Unruh,

2000). The economic analysis of climate change includes knowledge of the effects of climate change on economic variables and production factors, including the human element. In addition to measuring the role of economic policy tools in adaptation and mitigation of the effects of climate change.

In light of this introduction, this research mainly focuses on the impact of climate change risks on the design, objectives, and implementation of monetary policy, the role of central banks in facing climate change, and clarifying the most important monetary policy tools that can be used in facing climate change. The main objective of this research is to reach some results for identifying the most important monetary policy tools, traditional and unconventional, that can be used to deal with the risks of climate change that threaten financial stability and negatively affect the banking sector in general. This requires knowing the extent of the ability to develop the role of central banks to cope with the risks of climate change.

The problem of this research revolves around the fact that monetary policies and central banks only took into account very recently the impact of climate risks on the objectives, design, and implementation of monetary policy. Central banks still use traditional monetary policy tools to achieve monetary goals, targeting inflation and money supply. This means that the powers of the central banks have yet to be expanded and that monetary policy still needs to be more flexible to face the effects of climate change on financial stability, the banking

sector, and the insurance sector. What increases the danger of this is that many studies have proven that the physical climate risks and the risks of transition to a low-carbon economy negatively affect inflation rates, financial stability, and various components of the financial sector.

This research is divided into ten sections: section 1 discuss the nature and definition of the climate change problem, section 2 defines the economic analysis of climate change, section 3: effects of climate change on macroeconomic variables, section 4: macro financial aspects of climate change, section 5: the impact of climate change risks on the design, objectives, and implementation of monetary policy, section 6: the role of central banks in facing climate change, section 7: monetary policy tools in the face of climate change, section 8: the situation of egypt from fiscal and monetary policies applied to confront climate change, section 9: conclusion and finally section 10: recommendations.

1- The Nature and Definition of the Climate Change Problem:

1-1- The Definition of Climate Change:

To begin with, some terms must be clarified, especially defining what is meant by climate change. The climate is usually defined as the statistical average of the change in temperature, wind, humidity, cloudiness, precipitation, and other variables ranging from months to thousands of years. Climate change changes these statistical characteristics when viewed over long periods. Here climate differs from the weather; the weather is a change in the climatic process for a short period. Here you can see the difference between weather and climate because the climate is what you expect, like cold winters, and the weather is what you get, like in an occasional snowstorm. (Romm, 2016, p.32)

A distinction must also be made between climate change and global warming, which follow the other. Global warming refers to an increase in the Earth's average surface temperature. In contrast, climate change refers to the long-term changes in atmospheric conditions that can result from global warming. Warming is the cause, and climate change is the result (Conway, 2008, p.10). The two terms - global warming and climate change - are used, bearing in mind that these words represent a complex set of forces underway because of

the accumulation of carbon dioxide and other greenhouse gases (Bolin *et al.,* 1986, p.541).

1-2- Causes and Consequences of Climate Change:

Scientists have known since the 19th century about the effects that carbon dioxide and other greenhouse gases have on Earth's atmosphere (American Geophysical Union, 2014). However, in recent decades, there has been a growing interest in the issue of climate change resulting from the increased accumulation of these gases. Several studies show that the vast majority of climate scientists agree that global warming trends over the past century have been caused by human activities (Cook *et al.,* 2016). This means that most of the recent global climate change is due to human-caused greenhouse gas emissions. The Intergovernmental Panel on Climate Change expects an increase in temperature by 2100, ranging between 1.5°C and 4.8°C, compared to pre-industrial levels (IPCC, 2014).

Many countries have environmental protection laws that limit the release of local and regional air pollutants. In the language of economics, these laws accommodate, to some extent, the externalities associated with local and regional pollutants. But until relatively recently, there were few controls on carbon dioxide emissions, the main greenhouse gas, and concentrations of carbon dioxide in the atmosphere have risen

steadily, recently exceeding the standard concentration limit, which is 400 parts per million (The Global Monitoring Laboratory, 2022).

After decades of failures at the international level to reach an agreement that includes all countries, significant progress was made in Paris in December 2015. Under the auspices of the United Nations Convention on Climate Change, 195 countries have signed the first global agreement that aims to keep the overall increase in average global temperature to less than two degrees Celsius compared to pre-industrial periods. In addition to actions taken by national governments, hundreds of cities, regions, and businesses have pledged to reduce dioxide emissions over the next 25 years significantly.

It should be noted that carbon emissions are closely related to economic cycles because the recession that occurred in 2008-2009 caused a decrease in emissions. Also of note is the apparent stabilization of carbon dioxide emissions in 2014 and 2015 at an average of 33 billion tons of carbon dioxide. This stability is partly due to slower global economic growth (with a lower rate of economic growth in China). In addition, this stability reflects the increase in energy investment in renewables (solar and wind), which has dominated additional energy production capacity in recent years. This trend significantly influences reducing carbon dioxide emissions from the energy sector (Energy Information Administration, 2016).

In developed countries, there has been a rapid shift from coal power to natural gas and renewable energy, reducing dioxide emissions. In developing countries, coal production continues to expand, but the share of new energy production from renewable energy sources is increasing. However, it is currently unclear whether the stabilization of emissions is a temporary phenomenon or whether it indicates a shift in overall emissions trends.

2-Economic Analysis of Climate Change:

2-1-Climate Change and Negative Externalities:

Almost everything that people and organizations do involves, directly or indirectly, the combustion of fossil fuels, which leads to carbon dioxide emissions into the atmosphere. Carbon dioxide accumulates over many decades, changing the earth's climate and producing many potentially harmful effects. The problem is that the parties that cause these emissions do not pay for the benefits they get, and those affected are not compensated (McKibbin & Wilcoxen, 2002, pp.107-130).

For example, when a person buys an agricultural product, they pay the costs of producing it, so farmers and retailers are compensated for the production costs. However, when agricultural production requires the burning of fossil fuels - to pump water that irrigates the farmland or to fuel the truck that

transports agricultural products - no one covers the cost of damage caused by carbon dioxide emissions. Economists call these costs externalities because they are not reflected in market transactions. In addition, external factors are the accidental consequence of economic activity that causes harm to a third party not related to the economic transaction. These factors are also called public goods in economic jurisprudence, but the term external factors are more intuitive and are used in this context (Burniauxi *et al.,* 2008, pp.1-128). Global warming is no different from other external factors, as it requires positive government action to limit its harmful repercussions.

The release of greenhouse gases into the atmosphere is a clear example of negative externalities that impose high costs at the global level. In economic theory, the current market for carbon-based fuels, such as coal, oil, and natural gas, is characterized by considering only private costs and benefits, resulting in a market equilibrium that does not correspond to an optimal social level. As a result, from a social perspective, fossil fuel prices are low, and the quantity consumed is high.

2-2-Cost-Benefit Analysis of Climate Change:

When economists conduct a cost-benefit analysis, this analysis involves balancing the consequences of an expected increase in carbon emissions with the costs of current policy actions to stabilize or even reduce carbon dioxide emissions. When

climate change policy takes some decisive action to prevent climate change, those actions will yield benefits equal to the value of avoiding harm (Hanley & Spash, 1994, p.65). The benefits of preventing harm can also be referred to as costs avoided. Then the estimated benefits must be compared to the costs of taking action (Tol, 2001, pp.71-85).

To reduce carbon emissions, fossil fuels must be replaced with other potentially more expensive energy sources and investment in new renewable energy. In addition, investment structure, improved energy efficiency, and other carbon-reducing strategies must also be made. In the context of the cost-benefit analysis approach to these actions, economists calculate a measure of the marginal mitigation costs—the cost of reducing one additional unit of carbon—for various climate change mitigation actions, such as improving energy efficiency, switching to solar and wind energy, or avoiding deforestation. Some of these measures are low-cost or even negative (meaning they provide a net economic benefit in addition to contributing to carbon reduction).

When using the results of official economic models, a study (Nicholas, 2007, p.269) estimated that if no intervention were made, the overall costs and risks of climate change would equate to a loss of at least 5% of annual global GDP. If the wide range of climate risks and impacts are considered, damage estimates could rise to more than 20 percent of GDP. In contrast, the costs of actions to reduce greenhouse gas

emissions to avoid the worst effects of climate change could be limited to about 1% of the annual global GDP. When comparing the benefit-cost ratio, which is at least 5:1, it indicates a strong economic case for immediate and significant climate policy action rather than slow intervention.

2-3- Climate Change Policy Actions:

Generally, climate change policy actions can be categorized into two basic categories. The first category includes actions for adaptation and mitigation of the consequences of climate change. The second category includes preventive actions aimed at reducing the magnitude or timing of climate change. For example, adaptation measures include building dams and seawalls to protect against rising seas and extreme weather events like floods and hurricanes. It also includes changing farming patterns to adapt to changing climatic conditions. The urgency and capacity for adaptation vary across the world. The world's poorest countries have the greatest need to adapt, but most also lack the resources to do so. (IPCC, 2014, p.16).

Economists usually prefer methods that work through market mechanisms to achieve their goals. Approaches that use a market mechanism are cost-effective. Instead of trying to control market actors directly, incentives are changed so that individuals and firms change their behavior to take external costs and benefits into account. Examples of market-based policy tools are pollution taxes and tradable permits, which are

helpful tools for reducing greenhouse gases. Other economic policies include the necessary measures to create incentives for adopting renewable energy sources and energy-saving technology (Khan M., 2016, pp.166-178).

Generally, there are different estimates of the costs of appropriate adaptation measures. The United Nations Environment Program estimates that adaptation costs for developing countries could rise to between $140 billion and $300 billion annually by 2030 and between $280 and $500 billion annually by 2050. These amounts significantly exceed the amount pledged by developed countries in the 2015 Paris Agreement, which is $100 billion annually. The UN Environment Program warns that there will be large finance. Adaptation costs are already two to three times higher than the current international public funding for adaptation (United Nations Environmental Programme, 2016).

2-3-1-Climate Change Fiscal Tools:

The importance of fiscal tools in promoting climate change action is becoming more widely acknowledged. The globe has enacted a number of fiscal measures relating to climate change, including taxes or charges on fossil fuel energy, carbon-pricing systems, modifications to fossil fuel subsidy programs, financial incentives, and subsidies for renewable energy. The INDCs of more than 90 nations all incorporate some type of carbon pricing or other fiscal initiatives. The

Paris Agreement serves as a framework for the advancement of these market-based processes and any possible connections between them. To guarantee effective and efficient action on climate change, such activities should be promoted and supported (UNEP, GIZ and IMF, 2016).

- **Carbon Taxes:**

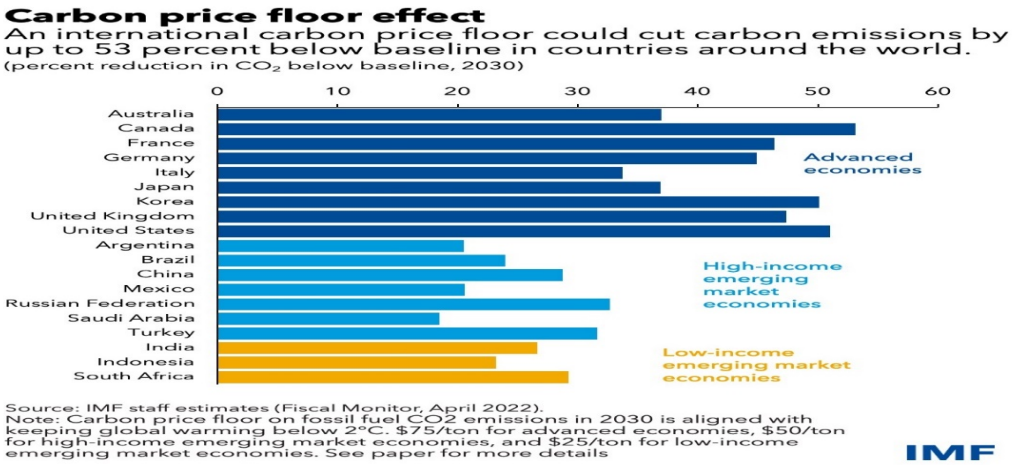
The imposition of a polluter tax per unit of pollution is a standard economic measure to absorb the external costs of that pollution. In this case, what is required is a carbon tax on carbon-based fossil fuels in proportion to the amount of carbon associated with their production and use. Such a tax raises the price of carbon-based energy sources, thus giving consumers an incentive to conserve energy overall (reducing the tax burden), as well as shifting their demand to alternative energy sources that produce lower carbon emissions and thus taxed at lower rates (Ekins & Barker, 2001, pp.325-376).

Nevertheless, two things should be noted about the proposed carbon tax. First, revenue reutilizing can allow revenue from carbon and other environmental taxes to be redirected to reduce other types of taxes. If a carbon tax is offset by a significant reduction in income or social security taxes, it may be more politically acceptable. The idea of increasing taxes on economic externalities, such as pollution, while reducing taxes on other socially desirable activities, such as labor and capital

investment, is entirely consistent with principles of economic efficiency. Instead of increasing net taxes, this would be a neutral tax shift for revenue. That is, the total amount that individuals pay to the government in taxes will not fundamentally change. Some tax revenue can also subsidize low-income people and balance the burden of higher energy costs.

Second, if such a revenue-neutral tax shift occurred, the energy-efficient operations of individuals or businesses would save them a significant amount of cash overall. The rising energy cost would also create a powerful incentive for energy-saving technological innovations and stimulate new markets. Finally, the economic adjustment would be easier if higher carbon taxes (and lower taxes on income and capital) were implemented over time.

Figure 1: Carbon Price Floor Effect



Source: IMF staff estimates (Fiscal Monitor, April 2022).

However, a few significant emitting nations may quicken cooperation and make a significant start in this area. A start like that would reduce emissions and allay worries about competitiveness. In addition, it would allow for alternate strategies while limiting global warming to 2 degrees Celsius or less (such as regulation through the calculation of equivalent prices). Depending on the degree of wealth, a global carbon price can also permit differentiating national obligations.

Governments should help individuals (preferably through-targeted transfers or lump-sum utility bill reductions) rather

than subsidize the usage of fossil fuels as they struggle with an acceleration of energy prices brought on by the conflict in Ukraine. Additionally, short-term solutions should allow initiatives to invest in renewable energy and increase energy efficiency. Countries already establishing a steadily rising route for carbon taxes should stick with it since the anticipated increases will be far lower than previous price swings brought by external shocks. Revenues should be used to ensure that the green transition benefits all employees and communities. It is still vital for nations to get an agreement on a carbon-pricing floor (or similar measures) (Gaspar, V., *et al.,* 2022).

Tradable Carbon Permits:

An alternative to a carbon tax is the Tradable Carbon Permit System, also called cap trading (Gagelman & Hansjuergens, 2002, pp.185-202). According to the national permit trading system, each company contributing carbon emissions is assigned a certain allowable level of carbon emissions. This means that the total number of carbon permits issued equals the national carbon emissions target (Butzengeiger *et al.*, 2001). For example, if a country's carbon emissions are currently 40 million tons, the climate policy goal is to reduce this by 10 percent (4 million tons). Permits will be issued for emissions of only 36 million tons of carbon. Over time, emissions reduction targeting can be increased, resulting in fewer permits being issued in future periods. (Kosobud, 2000)

Permits are assigned to individual carbon-emitting sources. However, an emissions trading program, including all carbon sources, for example, all motor vehicles, could be more practical. In terms of the effectiveness of permitting system implementation, it may be preferable to focus as much as possible on the upstream production process to simplify the management of the permitting program and cover most emissions. The upstream here refers to the early stages of the production process. Permits can be allocated to larger sources of carbon emissions, such as energy companies and factories, or even access to suppliers through which carbon fuels come into production — oil producers and importers, coal mines,

and natural gas drillers. (Mavrakis & Konidari, 2003, pp.48-66)

These permits can be allocated initially for free based on past emissions rates or auctioned off to the highest bidders (Cramton & Kerr, 1998, p.7). The effectiveness of the trading system must be consistent, regardless of how the permits are allocated. However, there is a significant difference in the distribution of costs and benefits, granting permits a windfall for polluters. In contrast, auction permits impose real costs on companies and generate public revenue.

Companies can freely trade permits among themselves. However, companies whose emissions exceed the number of permits they have obtained must purchase additional permits or face some penalties. At the same time, companies that can reduce their emissions below the permissible limit at a low cost will seek to sell their permits for a profit. The price of the permit is determined by supply and demand in the market (Westkog, 1996, pp.85-103). Internationally, countries and companies can also obtain credit to fund carbon reduction efforts in other countries. For example, a German company could get credit to install efficient renewable electricity generation equipment in China to replace heavily polluting coal plants. (Missfeldt & Requate, 2001)

It is noted that the Tradable Permits system encourages the implementation of the lowest-cost carbon reduction options, as

companies will implement emissions reduction measures that are cheaper than the market price of the permits. Tradable permit systems have reduced sulfur and nitrogen oxide emissions at a low cost. While the government limits the number of permits available, market forces determine the permit price. In this case, the supply curve is flat or vertical at the number of agreed passes. The demand curve for permits represents the willingness of companies to pay for these permits. The maximum willingness to pay equals the potential profits these companies could generate from their carbon emissions (Westkog, 1996, pp.85-103).

Assuming that the permits will be auctioned one by one to the highest bidders (a process known as chain auction), the willingness to pay for the first permit will be so high that a particular company will make a relatively large profit by being allowed to issue one unit of carbon. Companies that still need to obtain the second permit are expected to repeat their offers for the second permit. A company that has submitted a successful bid for the first permit can also bid for the second but is expected to bid for a lower amount, assuming its marginal profits will decline. Regardless of whether the same company wins the bid for the second permit, or a new company, the sale price of the second permit will be lower. This process will continue, with all successive permits sold at low prices, until the last permit is auctioned off.

While permits can theoretically be sold at different prices in a sequential auction, tradable permit markets are usually created, with all permits sold at market price. First, all parties interested in purchasing permits submit their bids, indicating the number of permits they wish to purchase and the price they are willing to pay. Whoever bids the highest price will get the number of permits he requested. Then the second highest bidder gets the number of permits they apply for, and so on, until all permits are allocated. The sale price for all permits is the winning bid for the last available permit. No bidders who bid less than this price will receive any permits.

An important point in this context is the opportunity for each company to choose to reduce carbon emissions cost-effectively. Companies have different options to reduce carbon emissions. For example, each company has three basic strategies to reduce carbon emissions. These strategies include replacing old factories and investing in energy efficiency. In each case, there are marginal costs of reducing carbon emissions through that strategy. These marginal costs generally rise with fewer carbon units, but they may be higher and increase more rapidly for some options than others. In this example, replacing plants using existing carbon-emitting technologies that are possible strategy usually has a higher marginal strategy. On the other hand, the option of lowering emissions (through increased energy efficiency) has lower marginal costs.

The permit trading system combines economic efficiency advantages and achieves the goal of reducing total emissions to the required level. However, the main problem is reaching the agreed-upon number of permits and whether permits will be freely allocated or auctioned off. There may also be matters and problems with the issue of measuring emissions, such as whether to count only commercial carbon emissions or to include emissions changes from land-use change, such as changes associated with agriculture and forestry. Here it can be argued that the inclusion of agriculture and forestry would have the advantage of expanding the permit trading program, as it would include many reduction strategies, possibly at a much lower cost. However, obtaining an accurate measure of carbon storage and emissions from land use change may take time and effort.

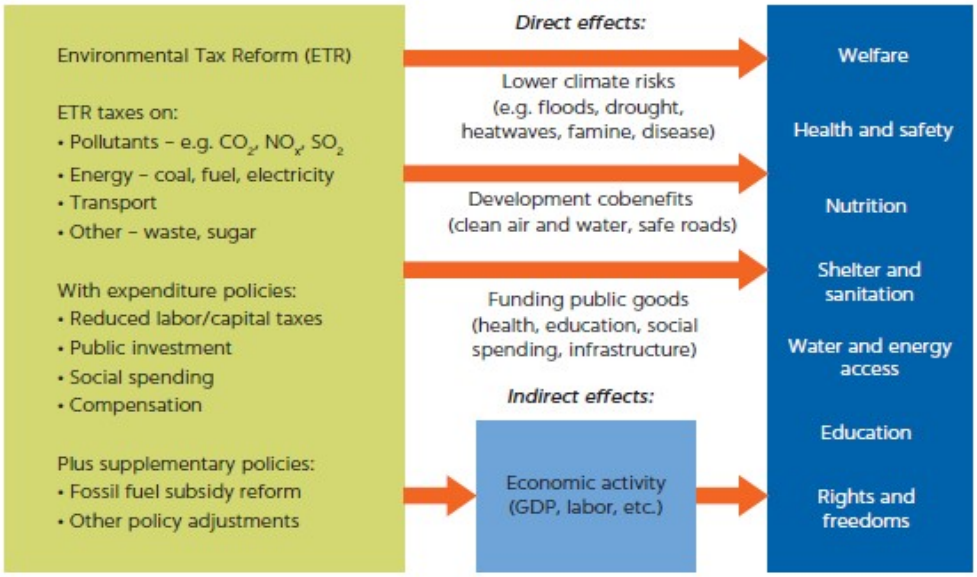
2-3-2-Trade-off between carbon taxes and maximum permit trading:

It is worth noting that there is a debate about what economic climate policy should be used to reduce carbon emissions. There are important similarities between carbon taxes and cap emissions trading policy but also important differences. (Schwarze, 1997)

ETR (Environmental Tax Reform) combines environmental taxes with other tax reductions (tax shifts), spending

programmes, and supplemental policies. ETR can aid poor nations in reducing climate change while improving welfare by increasing upstream taxes on fossil fuels and utilising the proceeds to lower labour taxes, raise public investment, or boost social expenditure (Pigato, 2019).

Figure 2: Environmental Tax Reform Can Help Raise Welfare Directly and Indirectly



Source: (Pigato M., 2019)

Co-benefits include improved roads and cleaner water as well as assisting in funding essential public services like energy access, health care, and education. ETR can also provide positive effects on economic activity, such as increases in

production, employment, or productivity, under situations that are more typical in developing nations. Because of this, ETR can assist nations in achieving the "triple dividend": reducing pollution, producing and supporting public goods and co-benefits of development, and increasing economic activity (Pigato, 2019).

A carbon tax and a cap-permit trading system could achieve a certain pollution reduction level at a lower total cost. Both systems will also lead to the same price increase for the end consumer, creating a strong incentive for technological innovation. Both systems can increase government revenue equally, assuming all licenses are auctioned. Both systems can be implemented in the initial stages of production to cover the same proportion of total emissions.

On the other hand, there are many important differences between both systems. There are some advantages to the carbon tax system. First, a carbon tax is generally easier to understand and more transparent than a cap-trading scheme, as cap-trading can be complex and require new bureaucratic institutions to enforce it. Second, with a technological change that reduces the cost of carbon abatement, a carbon tax will automatically reduce carbon emissions. As for the cap-permit trading program, technological change may reduce the price of permits, which may result in more carbon emissions for some companies. Third, the carbon tax system can be implemented more quickly. Given the need to tackle climate change as soon

as possible, it may not be advisable to spend years working out the details and implementing a cap-permit trading program (Stavins, 1995, pp.133-148).

The most important advantage of the carbon tax system is that it allows for the predictability of changes in price levels. If companies and individuals know the size of future taxes on fossil fuels and other greenhouse gas-emitting products, they can invest accordingly. For example, a company's decision to invest in an energy-efficient heating and cooling system depends on its expectations of future fuel prices. In a cap-permit trading system, permit prices can vary greatly, resulting in price volatility that makes planning and investment decisions difficult. A carbon tax provides price stability, especially if future carbon tax levels are published.

Although a cap trading system may eventually result in the same price increases for consumers and businesses, it avoids the negative effects of a tax. Therefore, political opposition to a cap-trading regime is often less than opposition to a carbon tax regime. In addition, some companies usually prefer a cap trading system because they can pressure governments to obtain free permits rather than buy them at auction. Free permits in the early stages of a cap-trading program can make it more politically acceptable to companies.

The biggest advantage of a cap trading system is that the volume of emissions is known with certainty because the

government limits the number of permits available. Since the goal of climate policy is ultimately to reduce carbon emissions, the cap-trading program achieves this directly, while the carbon tax achieves it indirectly through price increases. With a cap-trading program, a specific emissions path can be achieved simply by setting the number of permits. In the carbon tax system, achieving this goal may require several adjustments to tax rates, which may be politically difficult (Bohm, 1998).

The trade-off between carbon tax regimes and cap-permit trading depends primarily on policymakers' concerns about price stability or emissions stability. If the focus is on price stability because it allows for better planning in the end, then the application of the carbon tax system is preferable. On the other hand, if the primary goal of climate policy is to reduce carbon emissions by a certain amount, then a cap-and-trade program is preferable. However, it may lead to some price fluctuations (Montero, 1997, pp. 27-50).

Another practical difference between these two systems appears to be that carbon tax revenues are often refunded to taxpayers or are used for general government spending, while cap permit trading auction revenues are often used to support green investments, such as renewable energy, energy efficiency, and forest conservation.

2-3-3- Other Policy Tools: Subsidies, Efficiency Standards, Research and Development, Technology Transfer:

Even with a carbon tax or cap-trading system, complementary policies may still be necessary to reduce carbon emissions sufficiently to keep warming within acceptable levels. These policies are generally insufficient but can be important parts of an overall program. These policies are implemented in different countries.

These policies include shifting subsidies from carbon-based fuels to non-carbon fuels. Many countries currently provide direct or indirect subsidies for fossil fuels. However, eliminating such subsidies would shift the competitive balance in favor of alternative fuel sources. In addition, if subsidy expenditures are redirected to renewable sources, they can boost investment in renewable energy sources.

These policies also include using efficiency standards for machinery and equipment and fuel economy standards or requirements for low-carbon fuels. By imposing standards that require greater energy efficiency or less carbon use, technologies and practices can be changed in favor of a low-carbon orientation.

To offer the socially ideal number of modifications with advantageous externalities, subsidies are required. For instance, subsidies are required for spending on research and development of new seeds resistant to drought, novel methods

of controlling sea level rise, and more effective cooling techniques. Public goods, which include the safeguarding of vital resources that guarantee the secure and dependable operation of networks, also require subsidies (Bellon M., & Massetti E., 2022).

Some policies are based on the idea of technology transfer to developing countries. Since the bulk of the projected growth in carbon emissions will occur in developing countries, there is funding for many energy development projects by some agencies, such as the World Bank and regional development banks. To the extent that this money is directed toward carbon-neutral energy systems and alternative energy development, it will be economically feasible for developing countries to move away from fossil fuel-intensive pathways while at the same time achieving significant domestic environmental benefits.

To minimize emissions, policymakers might also use regulatory strategies. These supposedly "command and control" actions take the form of outright bans on particular technologies with detrimental effects on the environment or introducing tight energy requirements for products and operations. A prohibited technology will stop releasing carbon as soon as the ban goes into effect. On the other hand, if time is of the essence, these methods may be more effective because taxing and the ensuing market mechanism may take some time to create a new efficient equilibrium. Another benefit of having well-defined energy standards is that they

may affect the market that extends beyond their initial legal application (Breitenfellner, A., & Pointner, W., 2021).

3-Effects of Climate Change on Macroeconomic Variables:

The resources or operations of state-owned companies may potentially be impacted by natural catastrophes. Disasters may harm or destroy private property, necessitating government assistance for individuals and companies to restore their homes and places of business. Disasters may require governments to bail out struggling financial institutions to the point that they induce financial sector instability. Furthermore, disasters might result in a serious humanitarian crisis, necessitating the implementation of public emergency measures including rescue operations, temporary population displacement, the supply of food and shelter, or medical care. Such crisis management strategies may be quite costly and have a big influence on public spending. (Agarwala M., *et al.,* September 2021)

3-1- Potential Shocks To Supply and Demand:

Climate change risks are often viewed as economic shocks, defined as unpredictable events that cause significant change within the economy. They can affect either the demand or supply side of the economy. Demand-side shocks affect

components of aggregate demand, such as consumption and private (individual) or public (government) investment, business investment, and international trade. Supply-side shocks affect the economy's productive capacity, affecting supply components, such as labor, physical capital, and technology.

On the demand side, losses from weather events, such as floods and storms, can reduce people's wealth and thus reduce private consumption. The level of business investment can also decrease due to damage to physical and financial assets. It has been found that there are significant effects of natural disasters on the volume of bilateral trade. Economies that are less exposed to unusual weather and have extensive relationships with global markets can be negatively affected by climate change shocks to their trading partners, particularly through reduced exports because of the failure of the transmission and distribution network (IMF, 2017).

In addition, on the demand side, anticipating future losses can change current preferences, for example, towards greener consumption and climate change. Business investment can also be reduced due to uncertainty about future demand, growth prospects, and levels. At the same time, climate change may lead to changes in demand conditions. Although damage to infrastructure in the short term may boost investment, expectations of weaker economic growth and income expectations and increased uncertainty may lead companies to

invest less and individuals to save more and consume less in the medium term. Trade may also be affected by transportation disruptions and infrastructure deterioration due to rising global temperatures (Bolton, P., *et al.*, 2020).

On the supply side, the main shocks caused by extreme weather events of climate change are the shortage of imported inputs, especially basic commodities such as food and energy, and the volatility of import prices because of these shortages. Supply shocks also arise from damage to capital stock and infrastructure. In general, gradual global warming can cause economic losses because higher temperatures tend to reduce the productivity of workers and crops (Barrios, S. *et al.,* 2008, pp.287-298).

The risks of switching to a low-carbon economy are the trade-off between the need to reduce current emissions - which comes at a direct mitigation cost and thus reduced growth in the short term - and the need to preserve environmental conditions. Climate policies encouraging investment in low-carbon technologies can cause demand-side shocks if they crowd out private investment and consumption (Melissa, D. *et al.,* 2012, pp. 66-95). A supply-side shock can cause production cuts, higher prices, and less potential future economic growth (Economides & Xepapadeas, 2018).

3-2- Impact of Climate Change on Production:

Climate change can have a negative impact through several channels. High heat and humidity levels can affect productivity by reducing work capacity and production losses. Productivity may be negatively affected due to higher average temperatures and an increase in the frequency of extreme weather events (Deryugina & Hsiang, 2014).

There is also the potential for negative capital and capital formation effects through lower investment. The capital stock can decrease because of damage to physical capital (infrastructure, buildings, and equipment), which may affect the government, corporate, and household sectors. While such damage may stimulate alternative investment in the short term, it will likely reduce net wealth at the macroeconomic level. In addition, if companies become more pessimistic about the future impact of climate change on growth, they may decide to reduce investment, leading to lower capital and expected production growth.

Global warming may also negatively affect the labor market and the household sector. Higher temperatures may influence health and individuals' ability to work, resulting in lower labor inputs (Batten, 2018, p.11). With lower labor inputs and productivity, families may expect diminished future income opportunities, which may lead them to reduce their spending. In addition, the decrease in net wealth resulting from damage

to the capital stock may affect consumer spending. As climate change affects migration patterns, some regions may see a decrease in labor supply, while others may see an increase in the labor component.

Inflation may be affected by climate change in the agriculture and energy sectors. As climate change affects agricultural yields, lasting effects on agricultural commodity prices are likely. However, since yields may rise in some regions of the world (at least initially) and decline in others, the overall impact is likely to depend on the country's location and the sources of its agricultural imports. Commodity prices may also be affected by reduced land availability due to sea level rise and desertification.

Extreme weather events also affect inflation. A recent study found that storms and floods have the potential to cause an increase in inflation in developing countries in the short term, i.e., In the next quarter or two of this century, while droughts can have a more persistent upward effect on inflation that lasts for many years (Parker, 2018, pp.21-48). The results indicate that severe natural disasters can impact inflation in developed countries. It is also likely that there will be indirect effects on inflation due to the wide-ranging effects of climate change on supply and demand. In particular, upward price pressures may arise from a decline in the economy's supply potential.

3-3- The Impact of Climate Change on the Structure of the Economy and Economic Growth:

Climate change will have significant macroeconomic impacts on most economies, whether through physical impacts or the risks of transitioning to a low-carbon economy or shifting to a more climate-responsive economy. These changes will affect the structure of economies and economic growth.

Climate change will bring major structural changes to most economies in the medium to long term. Physical risks, climate adaptation risks, and climate change mitigation risks affect the productivity of existing investments and influence decisions about new investments. It can be said that there are four channels through which climate change can lead to structural changes in the economy, namely, productivity changes due to physical risks, the exclusion of productive investments through investment in adaptation and mitigation measures, the transition to a low carbon economy, and finally, innovation and the emergence of green sectors.

The physical risks of climate change affect the relative productivity of many sectors and regions, which may lead to a shift away from the activities, sectors, and regions most affected by climate change. Agriculture is expected to be among the sectors most affected by climate change, as changes in the frequency and intensity of extreme weather events and changes in temperature and precipitation patterns will

significantly affect the productivity of certain crops and regions. Sea-level rise is also expected to significantly affect the productivity of low-lying coastal areas through flooding and saltwater pollution. Possible reactions to these developments are a preemptive shift to crops that are more resilient to climate change but have lower yields, intensification of agricultural inputs to maintain production, and people moving from farming to other activities.

Sectoral impacts of climate change can be more complex. For example, if climate change reduces the material return of a crop, the price of that crop may rise, perhaps more than the rate of decline in material return. This outcome is indeed likely for food production. At the same time, climate change is expected to reduce physical agricultural productivity; the lower elasticity of food consumption means that prices may rise, making agriculture one of the most economically productive activities, although anticipating the transfer of agricultural activity to areas less affected by climate change. In this case, the impact of climate change on consumers will fall in the form of higher food prices.

Climate change may trigger the emergence of internal and international migration, leading to shifts in the labor supply. Some estimates suggest that climate change will lead to the voluntary and forced displacement of between 100 million and 160 million workers (200 million to 300 million climate migrants of all ages) over the twenty-first century (Carleton &

Hsian, 2016). Moreover, if climate change also gives rise to some conflict, migration rates due to climate erosion could be much higher. (Burzynski, *et al.,* 2019, p.20)

It should be noted that there will be a rising cost of climate adaptation and mitigation measures, which threatens to crowd out other investments and consumption. Adaptation to climate change requires more public and private spending to reduce and prevent physical risks. Such defense spending (public, private, financial, and household sectors) must be borne by all economic actors, which excludes productive investment or consumption, thus directly affecting growth prospects and the well-being of society (Rozenberg & Fay, eds., 2019, p.153)

The transition to a low-carbon economy creates many macro and qualitatively new structural challenges for countries that depend on fossil fuel value chains. The low-carbon transition also has the potential for a structural decline in fossil-fuel-based industries, with associated systemic risks to the countries, businesses, financial institutions, and societies that depend on them. The risks of a low-carbon transition, recognized by financial sector regulators, can be transferred to fossil fuel-dependent countries through many intertwined impacts, such as clean technologies, policies to address environmental problems, and shifts in public opinion (Carney, Breaking the Tragedy of the Horizon- Climate Change and Financial Stability, 2015).

Investing in research and development of low-carbon technologies is an important component of efforts to mitigate the effects of climate change. Indeed, this type of research has led to many innovations in recent decades. Critical components of efforts to achieve economic growth, development, and climate goals include clean energy systems, smarter urban development, sustainable land use, and rational water management. (Jaffe, A. *et al.,* 2001, p.51)

Tropical countries are expected to endure most of the effects of climate change. However, poor people in developing countries tend to be more vulnerable to climate change despite limited means of dealing with climate change risks. Thus, climate change negatively affects poverty reduction policies, but the disproportionate impact on developing countries can also amplify negative effects on economic growth. Moreover, while better-off nations and individuals have the tools to adapt to the effects of climate change, poorer nations do not have this capacity, and the temporary impact can have lasting effects, for example, if these temporary effects lead to children dropping out of school or families being forced to sell income-generating assets.

It is estimated that decisive action on climate change could lead to direct economic gains of up to US$26 trillion through 2030, compared to a business-as-usual scenario. In addition, Office for Economic Cooperation and Development (2017) estimates that a combination of economic reforms and

ambitious climate policies could make offshoot economic growth in G-20 countries by 2.8 percent (and 4.7 percent if avoided climate impacts are taken into account).

4-Macro Financial Aspects of Climate Change:

4-1-The Financial Role of the Public Sector in Addressing Climate Change:

The physical impacts of climate change are causing significant pressures on public revenue and expenditure and adding uncertainty to fiscal management and the public budget. Climate-related risks can affect public sector balance sheets in several ways. For example, physical risks directly impact fiscal revenues by harming the revenue pool, public expenditures destined for disaster relief and reconstruction, or the net income of state-owned enterprises if their activities are affected by natural disasters. In addition, as long as your point forecasts indicate the impact of climate change on the country's growth path, this change can impact the country's debt sustainability, the borrowing space, and the cost of borrowing.

Transition risks are particularly high for countries that derive a large share of their public revenues from carbon-intensive industries. These countries also often need help attracting commercial investors and raising low-cost financing. In

addition, these countries are already burdened by the high cost of debt servicing (cust & Mihalyi, 2017, p.7). Nevertheless, climate policy leaders can help these countries adapt to the low-carbon transition through technology, financial cooperation, and trade agreements that will provide them with the revenues needed to invest in low-carbon growth and diversify investment (Pigato M., 2019, p.115).

Financial instruments are a critical and necessary component of the policy package needed to reduce emissions. The Intergovernmental Panel on Climate Change has found that by 2030, greenhouse gas emissions must be 45 percent lower than 2010 levels to contain a global temperature increase of 1.5°C. However, markets cannot provide relief on their own due to market failures. This is where the need for fiscal instruments, such as price policies (for example, carbon taxes, subsidies for mitigation measures, and low-carbon investment), spending and investment, as well as public guarantees for private sector participation, is necessary.

Carbon pricing aims to ensure that the social cost of greenhouse gas emissions is absorbed into energy prices through carbon taxes and cap-and-trade programs or a combination of the two systems. Carbon taxes are an effective way to reduce carbon emissions, increase revenues, and achieve significant developmental public benefits, such as improving air quality and public health or reducing traffic congestion and road accidents. (Pigato M., 2019, p.25)

Various complementary policies and actions are necessary to achieve global climate goals. Complementary policies being implemented by the world's largest economies to mitigate global environmental challenges include direct regulations, such as standards for fuels and low-carbon products (e.g., In California and the European Union), and also include infrastructure investments, particularly in the energy and transportation sectors, as well as new grids that limited to new clean technologies, soft measures, such as labeling and information campaigns.

All of these actions can accelerate the behavioral response of consumers and investors to the incentives of climate policy. The multitude of policy tools needed to mitigate Climate not only helps address different aspects of climate change mitigation, but these tools are often mutually reinforcing. For example, investments in public transportation can double the price elasticity of carbon emissions for transportation, which means that public investments can make pricing solutions twice as efficient (Paolo A. *et al.,* 2014, p.5).

In addition, countries implementing unilateral climate policies might seriously consider imposing carbon-offsetting measures at borders to protect extensive commercial industries from the unfair competitive effects of uneven climate policies. Trade measures negatively affect the export of manufacturing products and services with a high GHG footprint. It is expected that major countries will consider imposing explicit

trade sanctions to encourage non-cooperating countries to share the burden of international efforts to stabilize the climate. (Nordhaus, 2015)

Higher returns for public (as well as private) spending on climate adaptation is expected to rise. The overall rate of return on adaptation investments is high, with benefit/cost ratios ranging from 2:1 to 10:1 and, in some cases, even higher. Priority investment must be made for the main systems affected by climate change: food, water, natural environment, cities, infrastructure, disaster risk management, and finance (GCA, September 2019).

The fiscal policy measure needed to mitigate climate change is environmental tax reform that adjusts energy prices to reflect climate externalities fully. For such policies to reflect climate externalities fully climate change, it is imperative that more countries implement environmental tax reforms and that environmental taxes must eventually be modified to cover the social cost of greenhouse gas emissions (Wuebbles, D.J. *et al.,* 2017, p. 470).

Moreover, given that, climate change's physical and transitional risks increase countries' financial problems, financial flexibility must be strengthened. Enhancing public sector fiscal resilience requires a combination of insurance purchases, expansion of sovereign borrowing space, and building fiscal buffers. In addition, implementing measures

that enhance the flexibility of revenues and expenditures to adapt to external shocks is also important to reduce financial stability risks.

Various financing instruments must also be used to accommodate financing needs related to climate change. The financing needs for climate adaptation and mitigation are significant and require comprehensive financing strategies. Such strategies would consider public financing priorities and options for private-sector solutions, aim to raise revenues, particularly through environmental taxation, take into account the mainstreaming of climate change considerations in the design, evaluation, and selection of public investment projects, and examine the scope and rationale for the use of debt financing.

4-2-Effects of Climate Change on the Financial Sector:

Climate change is a source of risks for the financial sector. Physical and transitional risks related to climate significant, adverse, direct, and indirect effects on the financial sector may appear suddenly or gradually. More than fifty central banks and supervisory agencies have formed the forming Network to manage climate change risks and support the transition to a low-carbon economy. (NGFS, Network for Greening the Financial System: First Comprehensive Report., 2019)

The physical risks of climate and the risks of transition to the financial sector appear through four channels of financial risks, which affect the physical and financial assets and thus affect the balance sheets of the financial sector (Klomp, 2014, pp.180-192). Firstly, operational risks are represented in damages to financial infrastructure, branches, and office buildings (physical risk) as well as the reputational effects of financial institutions due to their inability to adapt to green investment policies (transition risk). Second, reassessment of financial projections and risk premiums can affect asset valuation. The reassessment process can mirror losses due to economic cycles and tightening funding and liquidity conditions, particularly due to disaster (physical risk), policy technology, or sudden consumer preferences (transition risk). Droughts and disasters (physical risks), as well as necessary shifts in the energy mix (transition risks), may lead to higher commodity and energy prices (Krogstrup, S., & Oman, W., 2019). Third, the borrower's ability to repay may be adversely affected by damage (physical risk), higher energy prices, or lower productivity (physical risk and shift risk). Low collateral prices amplify credit risk, especially when insurance is not available. The quality of credit exposure to carbon-intensive sectors (transition risk) may deteriorate. In carbon-intensive economies prone to natural disasters, sovereign credit risk can interact adversely with financial sector risk (Duan, T. & Weikai, FL., 2019). Fourth, material risks can hinder the accuracy of pricing reinsurance liabilities, causing losses to

insurance companies, raising insurance premiums, or even making certain activities or geographical areas uninsurable, which may lead to increased financial costs, as governments will have to subsidize these losses. The lack of insurance can have important implications for investments and loans.

The financial sector must play a central role in making financial flows more consistent with the transition toward a low-carbon economy or towards a more climate-resilient economy. These flows must also be more consistent with management. These are associated with this transition. The financial sector is the economy's main driver, as it allocates resources for the most productive use and distributes risks efficiently. In light of the large climate finance gap and fiscal constraints, the financial sector must redirect financial flows to better align them with this necessary economic transformation. The ability of the financial system to support this transformation depends on adequate price indicators that reflect risks in financial markets, which are also important for risk management, investment, lending, and insurance decisions.

4-3-The Effects of Climate Change on the Banking Sector and the Role of Banks in Addressing Climate Change:

Banks' association with carbon-intensive sectors and assets creates material transitional risks for these banks. Since there is no historical precedent for how these risks might arise, studies have begun to estimate potential shift effects using stress-testing models. Banks face risks due to their involvement in loans, investments in high carbon-intensive sectors, and unsustainable real estate engagements, including large mortgage portfolios linked to buildings with low energy efficiency scores. If credit supposes, credit portfolio linkages and mostly carbon-intensive sectors are short-term. In that case, it can adapt smoothly to the transition to a low-carbon economy, given the availability of alternative investment opportunities. The provision of financing to carbon-intensive industries and assets exposes banks to reputational risks in the face of changing public opinion. (Regelink, M., *et al.,* 2017)

Not only does climate change affect risks in the banking sector, but it also presents opportunities for banks to contribute to, and thus profit from, the transition to a low-carbon economy. The International Finance Corporation estimates an investment opportunity worth $23 trillion until 2030 for several emerging markets. This is realized by implementing the contribution of these markets to the Paris Agreement (IFC, 2019). Investment opportunities include real estate, transportation, renewable energy, and energy efficiency. To

reach the necessary amount of investment, the International Finance Corporation estimates that banks' balance sheets need to go green from about 7 percent now to 30 percent in 2030 (Stein, 2018). Hence, significant expansion of green loans will be important to achieve this goal. Although total green credit flows are still small and need to be better tracked, they are growing. For example, the 7 percent green credit in the portfolios of members of the Sustainable Banking Network currently represents an estimated $3 trillion. However, the Sustainable Banking Network estimates that with the green asset target of 30 percent and the current growth in membership, the Sustainable Green Banking Network's assets will be valued at $15 trillion by 2030.

Banks need to build capacity, integrating climate factors into their operations. This includes integrating risks and opportunities related to climate change and the energy transition into the Bank's strategy, risk management procedures and pricing models, governance structures, disclosure practices, and loan origination processes. Moreover, the 2019 United Nations General Assembly launched the Principles for Responsible Banking. As part of this initiative, 130 financial institutions, representing $47 trillion in 49 countries, have committed to standards that malign their business activities with sustainability goals. Policymakers and supervisors must be key in better managing climate-related financial risks (Gaber, 2021).

4-4-The Effects of Climate Change on Investment Institutions and Their Role in Addressing Climate Change:

Institutional investors, such as pension funds and life insurance companies, are expected to be affected by climate change because their investment horizons are long-term. In addition to climate risks affecting financial stability, the second-order impacts of climate change (such as food security, social and political unrest, and loss of biodiversity) are likely to be material in the long term. Therefore, the investment strategies of institutional investors must be designed to manage long-term risks.

Evidence of the impact of climate change on various asset classes still needs to be developed, including sovereign bonds, which make up most of the investment portfolios of institutional investors. With clear frameworks by which investors can assess climate risks, assets may be well-priced, hindering these institutions from effectively managing risk.

Although climate change poses risks to institutional investors' portfolios, it also presents investment opportunities, particularly in mitigation and adaptation. There is a $2.5 trillion annual funding gap between the investment flow into sustainable infrastructure and what is needed to achieve the Paris Agreement goal and the Sustainable Development Goals (UNCTAD, 2019). Nevertheless, despite having nearly $100 trillion in assets, institutional investors collectively contributed

only 1% of the $455 billion in global climate finance flows in 2016. (CPI, 2018)

To shift more capital into climate-related investments - particularly in emerging markets and developing economies - there will be a need for better risk management, new investment vehicles, and the important role of both the public and private sectors. Emerging markets and developing economies need more investment due to the high risks in these countries, regulatory uncertainty, weak local capital markets, and the absence of strong local investor bases. In some countries, brown investment continues, such as in coal plants.

Regulations should be amended to encourage or require investors to incorporate climate-related criteria into their risk assessments as part of their fiduciary duty, as documented in the United Nations Principles for Responsible Investment. Some regions and countries have imposed requirements and responsibilities on institutional investors to integrate environmental, social, and governance factors into their investment operations. However, other countries have increased regulatory hurdles, which can discourage or create barriers for institutions adapting their investment operations. (IOSC, 2019)

Policymakers and development financial institutions should work closely with investors to develop more financial mechanisms to bridge the climate-financing gap and meet investment institutions' risk and return needs. Innovative climate finance tools, mechanisms, and approaches must be developed to allow institutional investors to take advantage of climate investment opportunities. The new tools aim to reduce risks, integrate public and private financing, and facilitate investment across the project life cycle. These instruments include concessional financing, loan guarantees, insurance policy, foreign currency liquidity facilities, and huge funds.

5-The Impact of Climate Change Risks on The Design, Objectives, and Implementation of Monetary Policy:

Four main ways in which climate change and policies related to carbon emissions can affect the monetary policy objectives of central banks.

First, weather-related natural disasters can cause a macroeconomic downturn if they cause severe damage to the balance sheets of households, businesses, banks, and insurance companies. The economic impact of natural disasters is likely less severe if the relevant risks are priced into financial

contracts in advance and the financial system distributes them efficiently, for example, by reinsurance. After that, the central bank will need to respond appropriately to the disaster to achieve its monetary stability goals. This requires assessing the impact of the disaster on the output gap and inflationary pressure and adjusting monetary policy if necessary.

Second, gradual warming can also affect the rate of potential economic growth. More accurate quantitative estimates based on a detailed analysis of the impact at the sector level will be needed before central banks can incorporate this impact into their monetary policy analysis.

Third, a sudden and unexpected tightening of carbon emissions policies may create a negative supply shock (transfer risk). While introducing or increasing a carbon price will only temporarily affect inflation, the short- and medium-term macroeconomic consequences are severe if the increase is sharp and sudden. Thus, achieving an orderly transition requires governments to announce in advance a clear and predictable path to tighten carbon emissions policies in the future.

Finally, changes in weather patterns and increased reliance on bioenergy can increase the volatility of food and energy prices and, thus volatility of headline inflation rates. This may make it more difficult for central banks to gauge underlying inflationary pressures and to keep inflation close to the target

level. As a result, central banks will increasingly need to incorporate climate variables into their macroeconomic models (Debelle, 2019). Specifically, to assess the impact of short-term extreme weather on economic variables, such as GDP and inflation, existing forecast models can be extended to include weather effects.

The long-term effects of gradual global warming on the growth rate of potential output may also need to be included in the monetary policy-modeling toolkit. Finally, the interactions between financial and macroeconomic weather shocks could become an important source of risk for future monetary policy implementation.

6-The Role of Central Banks In Facing Climate Change:

Achieving the goals of the Paris Agreement requires a major shift towards low-carbon technologies. However, socio-technological transformations often involve harmful structural modifications, even when they are ultimately beneficial to the well-being of society (Perez, 1983). Moreover, the disruption will likely occur during the transition to a low-carbon economy, with potentially significant implications for economic dynamics and financial stability (Battiston *et al.,* 2017). Thus, there is challenging for societies to achieve a

rapid structural transition to a low-carbon economy while avoiding excessive economic losses while maintaining the financial system's stability.

There can be a direct correlation between the role of central banks in protecting financial stability and the state of response to environmental and sustainability challenges. Even when environmental and sustainability goals are not part of the central bank's explicit remit, the effective achievement of sustainability elements may be relevant to the central bank's goals to achieve price stability or protect financial stability (Bernal, J & Ocampo, J.,, 2021).

In climate change, the primary responsibility for strategic planning rests with governments because they have various policy options. For example, governments can impose environmental regulations (such as standards on fuel efficiency), implement investment programs in the infrastructure needed to adapt to climate change (such as smart grids), and design market-driven policies to shift the preferences of individuals and firms towards low-carbon activities. The main proposed policy tool has been carbon pricing, which could be implemented either through a tax on the carbon content of goods and services or the creation of a carbon cap-and-trade system (Edenhofer, 2017). Other market-based instruments include clean technology subsidies and phase-out fossil fuel subsidies.

In this context, the question is raised about the adequacy of the well-designed set of fiscal and environmental policies designed by the government to achieve the goals of the Paris Climate Agreement. Carbon pricing mechanisms may not be suitable for addressing specific cases of market failure in some financial systems and therefore do not provide sufficient incentives to mobilize low-carbon investments at the required level and speed (Campiglio, Beyond carbon pricing: The role of banking and monetary policy in financing the transition to a low-carbon economy, 2016). More importantly, government climate policies may not prevent financial instability during the transition period. Moreover, these policies may exacerbate transformation risks if implemented suddenly and without the necessary precautions. Finally, because carbon pricing can harm businesses and consumers, this option is often politically unpalatable for governments locked into the electoral cycle and therefore forced not to act with force required to ensure a smooth transition to a low-carbon economy.

The extension of credit by banks for activities that are not socially desired, such as carbon-intensive or polluting activities, can be described as a credit market failure. This type of credit market failure lies in the mismatch between the legitimate goals of commercial banks - which create the majority of the money supply - in achieving their interests and the development goals that society sets for itself, whose achievement is conditional on the availability of financial

resources and a certain degree of monetary stability. In the presence of externalities, credit allocation by commercial banks may be suboptimal from a societal perspective, as a significant portion of the credit is allocated to carbon-intensive activities (Campiglio, Beyond carbon pricing: The role of banking and monetary policy in financing the transition to a low-carbon economy, 2016).

Thus, environmental regulation and carbon pricing should be the policy tools to correct this type of market failure and prevent or discourage such investments. However, if carbon-pricing markets do not function and the environment is not applied effectively, a central bank may be justified in using its powers to influence credit creation and allocation. In this sense, the credit market failure argument for green financial regulation is an application of the second-best option theory. In other words, if the first best policies cannot be implemented to fix the failure of the credit market, the government may turn to the second best policy, which is to authorize the central bank or the financial supervisor to address the negative environmental externalities using the tools available to these institutions (Lipsey & Lancaster, 1956).

Central banks may have an important role in developing stock markets, for example, by establishing procedures to enhance the disclosure of information or developing a secondary market. In this context, the argument can be made in favor of central banks to support the accumulation of market segments

that do not exist to promote green finance, such as the green bond market. In addition, if new green markets are created, this will ensure that the traditional tools of monetary policy are compatible with environmental policy (Heller, 1999).

Central banks worldwide are paying increasing attention to climate change, and they must recognize that climate change could affect their ability to achieve monetary and financial stability goals. Climate change also poses economic and societal challenges, which inevitably require the financial system to play a central role in managing climate risks and financing the transition to a low-carbon economy. The Bank of England has been the leader among central banks in assessing climate risks for central banks, and this has involved trying to understand the impact of climate change on the insurance industry (Bank of England, 2015), on the banking sector (Bank of England, 2018), and on central bank objectives (Batten *et al.,* 2018), as well as developing a response to these challenges. (Scott *et al.,* 2017)

Currently, many central banks and other financial supervisors are involved in initiatives to deal with climate change. For example, central banks, regulators, and financial supervisors have supported the Financial Stability Board's initiative to create a Climate Financial Disclosure Task Force to help improve corporate disclosure of climate-related risks (TCFD, Status report, 2018). In 2017, central banks and financial supervisors also established the Financial System Greening

Network to help strengthen the global response required to achieve the goals of the Paris Agreement and to strengthen the role of the financial system in managing risk and mobilizing capital for green or low-carbon investments. As of March 2020, this network has 42 members and eight observers across five continents. (NGFS, 2019)

A transition to a carbon-neutral economy is ultimately necessary to avoid the physical damage and associated financial instability. However, the shift itself may increase the risk of economic dislocation and stranded assets (transformation risk). For example, lowering the temperature level would likely require a significant portion of the existing oil, gas, and coal reserves to remain in the ground and thus be written off from the balance sheets of the companies that own them (McGlade & Ekins, 2015). Other physical assets that could lose some of their value include real estate, transportation infrastructure, and carbon-intensive industrial technology (Campiglio *et al.,* 2017). Not only could this diversion of assets lead to economic losses and unemployment, but it could also affect the market valuation of the companies that own these assets, negatively affecting their investors and potentially triggering cascading effects throughout the interconnected financial system. (ESRP, 2016)

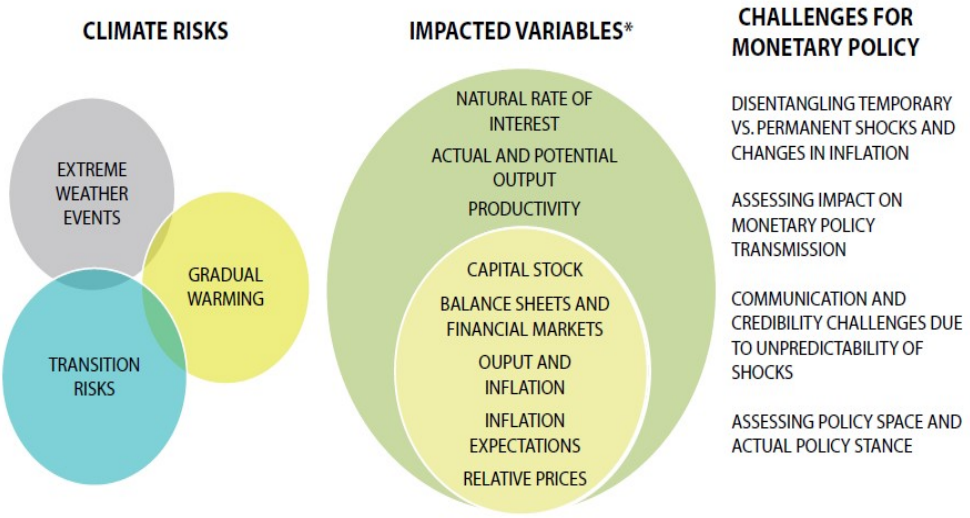
While some disruption across sectors of the economy is inevitable, the transition as a whole can represent an opportunity to achieve sustainable and inclusive economic

prosperity (OECD, 2017). However, this is likely only possible with comprehensive and coherent policies to support the low-carbon transition and its complex management. (Tooze, 2019)

7-Monetary Policy Tools in the Face of Climate Change:

The complexity of the transition to a low-carbon economy has led researchers to begin analyzing what central banks and financial regulators can do to support rapid and orderly structural change. In this context, the debate about the appropriate scope of interventions by central banks and financial regulators can be viewed. Some types of interventions to deal with climate-related risks, whether by financial regulators or central banks. First, these institutions can develop approaches and tools to promote a better understanding of these risks and their economic and financial impacts. Second, investors could be encouraged or required to disclose their exposure to climate-related risks. Third, these risks can be explicitly considered when setting up financial regulations. Fourth, central banks can factor climate-related risks into their policy toolkit (for example, through monetary policy).

Figure 3: Climate Risks, Macroeconomic Variables, and Challenges for Monetary Policy



Source: (NGFS, Climate Change and Monetary Policy: Initial Takeaways, June 2020)**.**

Central banks can use several policy tools to influence investment decisions, create and allocate credit in green investments and away from environmentally harmful activities. Some of these are variations of traditional monetary policy tools that can promote green investments, including different rediscount rates and capital or reserve requirements, stimulating green lending. In addition, some tools can be classified as unconventional monetary policy tools, such as green quantitative easing. Central banks can also use their

collective strength to encourage financial institutions to consider climate and environmental risks in their operations and develop capabilities to address them. Furthermore, central banks – or other financial authorities if the responsibility for financial regulation lies outside the central bank – can require financial institutions to disclose climate-related risks and conduct climate-related impact tests.

7-1-Evaluating climate-related financial risks:

Some central banks have begun to assess the exposure of their domestic financial systems to climate-related risks. For example, the Dutch Bank recently conducted two studies of the Dutch financial system that show that while the link to fossil fuel producers is relatively small, the link to carbon-intensive sectors is large enough to pose potential systemic risks and that some of these risks are already materializing (Schotten, G. *et al.,* 2016). Insurance companies and banks can also incur significant losses because of extreme weather-related events. The Bank of England attributed the UK's insurance sector's exposure to climate-related financial risks and is conducting a similar review of the banking sector (Scott M. *et al*., 2017, pp.98-109). Other institutions that have examined the potential impact of climate change or a low-carbon transition on financial stability include the European Systemic Risk Board and the Bank of France (Assessing

Climate Change-Related Risks in the Banking Sector, 2017). Researchers have also begun to develop climate stress-testing methods, demonstrating that the association of investors can exacerbate the risks of a low-carbon transition to the financial system. (Battiston, S., *et al.,* , 2017)

However, there are some challenges to assessing climate-related financial risks (Turell, 2016). First, the data required for a comprehensive climate impact test is often nonexistent or inaccurate and difficult for researchers outside financial regulators to access. Second, the integrated assessment of climate-related financial risks cannot rely on static snapshots alone; it requires modeling the dynamic interactions between the macroeconomics, financial system, climate change, and environmental policies. This is challenging. Integrated valuation models, traditionally used to study economic and climate interactions, often need a representation of the financial system. Third, despite some exceptions, the stochastic dynamic general equilibrium models, which central banks often use in macroeconomic and monetary policy analysis, do not include variables specific to climate change and environmental policies (Annicchiarico, B. & Di Dio, F.,, 2016).

7-2-Detecting Climate-Related Risks:

One of the main obstacles to achieving a smooth transition to a low-carbon economy is the low level of awareness among companies and investors about their exposure to climate-related financial risks. Most companies are not accustomed to assessing the impact of these risks on their business models. In contrast, most investors need to be aware of the extent to which their investment portfolios are exposed to these risks. Thus, recent international efforts have focused primarily on improving the flow of information by supporting the disclosure of climate-related risks by private actors. For example, the Financial Stability Board established a Task Force on Climate-Related Financial Disclosures, whose final report makes sector-specific recommendations on how companies should voluntarily disclose climate-related financial risks to inform best investors, lenders, and underwriters (TCFD, Recommendations of the Task Force on Climate-Related Financial Disclosures., 2017).

The French Energy Transition Law further requires companies to disclose information about their exposure to climate-related risks and the measures adopted to reduce them. It also requires banks to test climate-related impacts on their loan portfolio and disclose the results (Mason *et al.,* 2016). In addition, several initiatives led by industry or academia aim to improve the flow of climate-related information available to financial investors (Dietz *et al.,* 2018). However, while central

banks have been supportive of private companies' disclosure of climate-related risks, they have yet to disclose the exposure of their asset portfolios to climate risks.

Supporting the development of voluntary disclosure standards is consistent with encouraging the financial industry to price climate-related risks appropriately and concerning institutional freedom and market mechanisms. However, the expected effects of voluntary disclosure remain uncertain. Many large investors seem reluctant to require companies to assess and disclose how they will be affected by climate change in the event of a 2°C rise. Despite recent progress, corporate climate risk disclosures may not be comprehensive enough or meaningful and comparable in the near term. Investors may also ignore disclosed information if it is unavailable in formats that are easy to understand and comparable across companies. (Coalition of Finance Ministers for Climate Action, 2022)

Thus, more research is needed to improve assessment and disclosure approaches for climate-related financial risks facing individual firms. Over time, this could lead to standardized and comparable disclosures, which allow investors to consider these risks when allocating their capital. Such research will also likely inform the best green asset grading schemes (Ehlers., T. & Packer, F., 2017). At the same time, developing spatially detailed integrated databases of physical assets can improve risk assessment, even in the absence of disclosure (Caldecott B. *et al.*, 2018).

7-3-Climate-Compatible Financial Regulation:

It is possible to adjust financial regulations to accommodate climate-related risks. Macroprudential policies include regulatory tools to reduce systemic financial-specific risks facing individual financial institutions. The tools at the disposal of these institutions vary across different countries. They may include bank reserves, liquidity and capital requirements, and maximum credit growth, and in some cases, these policies target specific sectors (Cerutti, 2017). Institutions holding riskier assets are also required to meet more stringent regulatory requirements. Recent research indicates that this may harm banks' willingness to lend to low-carbon projects due to its higher risk, lower liquidity, and longer repayment period (Arestis, P. & Sawyer, M., 2017).

However, current prudential regulation needs to take into account climate-related risks explicitly. A more comprehensive risk assessment could increase capital requirements on carbon-intensive assets, given the higher transition risk (Schoenmaker, D. & Tilburg, R. V., 2016). If this, in turn, increases the cost of financing high-carbon activities, it may also have the effect of reorienting lending towards low-carbon activities.

Some central banks in emerging markets have used prudential policies to mitigate environmental risks or encourage lending

for low-carbon activities (Dikau, S. & Collins, J., 2017). For example, the BDL differentiates reserve requirement ratios—that is, the required ratio of central bank reserves held by private banks to the deposit stock—according to the amount of bank lending flowing into renewable energy and energy efficiency projects (Intermediate Circular 236, 2010). The Central Bank of Brazil requires commercial banks to incorporate environmental risk factors into their governance framework and to show how these risks are assessed when calculating capital needs (ICAAP, 2011). The People's Bank of China is integrating green finance into the macroprudential assessment framework. (China Monetary Policy Report-Quarter Four 2017, 2018)

The idea of including climate-related risks in financial regulations more explicitly is gaining political traction in high-income countries. Recently, the EU High-Level Expert Group on Sustainable Finance suggested introducing green support factors into capital requirements, depending on the sustainability risks borne by the borrowing sectors (Thom, J. & Hilke, A., 2018). The European Commission has proposed that European supervisory agencies integrate environmental, social, and governance standards into their work to enable them to monitor how financial institutions identify, report, and address risks that these factors may pose to financial stability. (EC, 2017)

However, many problematic aspects still need to be addressed regarding the effectiveness of these measures. First, there is a risk that lowering capital requirements on bank loans for low-carbon investments could jeopardize prudential policy objectives. More generally, as long as the role of capital requirements is to mitigate risk, its design must remain risk-based. Second, a climate-compliant prudential policy could be an arbitrator if applied to banks' relationship to entire productive sectors or firms, as they would not be able to discriminate within carbon-intensive sectors (such as utilities) those firms that engage in carbon investments. However, estimating the capital requirements of banks based on the greenness of specific investment projects may burden banks with valuation practices they need to familiarize themselves with. Third, high-carbon companies can avoid tightening prudential policy in a given geographic area by raising funds from international financial markets unless such policies are implemented in all major countries.

7-4-Green Quantitative Easing (Green QE):

Green QE is a tool central banks can use to adapt their monetary policy tools to environmental sustainability goals. Before the 2008 global financial crisis, central banks conducted monetary policy primarily by adjusting the benchmark interest rate (Call for a European Finance-Climate

Pact, 2017). In the aftermath of the crisis, many central banks began to take unconventional quantitative easing measures by purchasing financial assets, such as government and corporate bonds, to stimulate the economy. It should be noted that quantitative easing is a form of monetary policy in which the central bank buys long-term securities from the open market to increase the money supply and encourage lending and investment. Asset purchases mainly include government bonds, although some central banks have also bought corporate bonds and equities. Although there is a conflict of opinion about the effectiveness of QE in general, what supports this tool is the possibility of directing it toward purchasing green financial assets, such as green bonds. Buying these securities adds new money to the economy, lowers interest rates by bidding for fixed-income securities, and expands the central bank's balance sheet. (Volz, On the Role of Central Banks in Enhancing Green Finance, 2017)

Central banks' quantitative easing programs are intended to be temporary cyclical tools. Thus, they are designed to avoid market distortion while ensuring that the purchased assets comply with credit standards. As a result, central banks could reassess their QE purchases to exclude carbon-intensive financial assets and favor bonds issued to finance low-carbon projects (Ryan-Collins, J. *et al.,* 2013). Alternatively, central banks could keep existing QE programs unchanged and run a parallel standalone program focused on purchasing additional

low-carbon financial assets. This green QE will benefit from providing significant amounts of additional liquidity to companies interested in switching to clean forms of production.

For example, the European Central Bank's total purchases in 2017 were around €730 billion, while the additional annual investment required to meet the EU's energy and climate goals is estimated at €170 billion (ECB, 2018). Central banks could expand their purchases of green bonds, representing a rapidly expanding niche market, estimated at €221 billion globally as of June 2017 (Bonds and Climate Change: The State of the Market in 2017, 2017). Corporations, development banks, local authorities, or governments can issue these bonds.

Although central banks view QE as a cyclical policy tool intended to provide a temporary stimulus to the economy, using it to bring about low-carbon structural change may burden central banks with additional responsibilities and potentially harm their effectiveness in maintaining price stability. In addition, the current financial risk criteria may not apply to low-carbon assets for inclusion in the list of assets eligible for purchase from the central bank, which mainly consists of investment-grade bonds - that is, bonds with a low level of default risk. As a result, buying riskier green assets may raise concerns about central bank portfolio quality, particularly when central banks need to assess the relative

merits of new technologies in times of change. (Honohan P., 2019)

It should be noted that there is an indirect form of green quantitative easing, which is, in fact, the purchase of bonds issued by public sector entities that finance low-carbon activities. For example, the European Central Bank allocates about 10% of its public sector purchase program to bonds issued by international institutions, which include several regional and national development banks. Development banks have taken the lead in financing climate change mitigation in recent years (Mazzucato, M. & Semieniuk, G., 2018). For example, the European Investment Bank allocates at least 25% of its loans to climate action projects (EIB, 2016). Thus, the ECB may indirectly support low-carbon investments, albeit to a limited extent, by including EIB-issued bonds in its quantitative easing program. (Schoenmaker, 2019)

In the UK, the Bank of England started QE in January 2009, and the green QE debate has been on since that time (Lucas, 2011). QE could provide a significant incentive to green the UK's infrastructure, not only for renewable and nuclear energy but also for more efficient use of all resources, reducing the environmental impact of the economy.

Central banks can generally manage their assets according to social impact investment criteria. However, as some have pointed out if central banks join the UN Principles on

Responsible Investment, another $24 trillion in funds will be added to the $45 trillion already pledged, equivalent to a quarter of global financial assets (Sheng, 2014). In addition, 4% of the Central Bank's assets allocated to this financing will amount to only one trillion US dollars.

7-5-The Powers of the Central Bank:

Ultimately, what central banks and financial regulators do to support a smooth transition to a low-carbon economy will depend on what central bank powers allow, how they interpret it, and their willingness to act. The powers and policy tools at the disposal of central banks vary greatly between countries. In particular, a distinction can be made between central banks of high-income regions and central banks of developing economies. Most central banks in high-income countries have relatively narrow powers focused primarily on price stability and, in some cases, financial stability and regulation of individual financial institutions (Tucker, 2018).

These banks are usually granted operational independence to achieve specific objectives within their mandate. Thus, these banks usually only interfere with market mechanisms or government policies if necessary to achieve their objectives. Thus, central banks have mainly sought to enhance the financial system's resilience to climate-related risks by developing and promoting best-in-class portfolio assessment

tools and information. Other measures include international cooperation to foster green financial markets, including the G20 Green Finance Study Group, the Sustainable Insurance Forum, and the Financial System Greening Network (McDaniels, J., *et al.,* 2017).

On the other hand, central banks in emerging and developing countries used a broader set of tools to target sectors related to environmental sustainability, which indicates that the powers of these banks are broader and more closely related to the government's development goals. For example, the Reserve Bank of India requires commercial banks to allocate a certain percentage of their lending to a list of priority sectors, which includes renewable energy (Priority Sector Lending-Targets and Classification, 2015). The Bank of Bangladesh has also introduced a minimum credit quota that financial institutions must allocate to green sectors, currently set at 5%. It offers refinancing lines to commercial banks on preferential terms for their green loans (Barkawi, A. & Monnin, P., 2015). Although Japan is not an emerging economy, the Bank of Japan has a loan support program to provide below-market loans to financial institutions to support several priority lending sectors, including environmental businesses (Bank of Japan, 2010).

7-6-Green Reserve Requirements and Capital Requirements:

Another way for the central bank to influence the allocation of credit is to use reserve requirements, for example, reserve requirements linked to the composition of commercial banks' portfolios or the geographical location of credit. Historically, asset-based reserve requirements were widely used to encourage lending to desirable sectors (Mesonnier, J. *et al.,* 2017). The reserve requirement ratio is the share of deposits that banks and other depository institutions, such as savings and credit unions, must hold as a reserve and not for lending. Reserve requirements greatly affect the ability of banks to create credit and, thus, the economy's money stock. If the central bank lowers reserve requirements, banks can increase their lending. Allowing a reduction in the required reserve ratios on green assets would be an effective way to favor green investments over conventional investments. (Rozenberg, J., *et al.,* 2013)

Lebanon's central bank, introduced such a policy, in which banks with the largest share of green lending are subject to lower reserve requirements, in 2010. The stated goal of the Lebanon Bank was to facilitate the financing of investments in specific economic sectors by exempting banks from part of the reserves required to finance these projects at a low cost. In cooperation with the Central Bank, the Lebanese Center for Energy Conservation, an agency of the Lebanese Ministry of

Energy and Water, implemented a National Action Plan for Energy Efficiency and Renewable Energy aimed at providing cheap credit to the private sector operating in areas related to renewable energy and energy efficiency in buildings. Lebanon Bank supports green credits by reducing reserve requirements for commercial banks by 100 to 150% of the loan value if the bank's customer can present a certificate from the Lebanese Center for Energy Conservation confirming the potential of the financed project to save energy (Campiglio, 2016).

It is also proposed to boost the carbon certificate market by accepting carbon certificates as part of the legal reserves of commercial banks. The first idea here is to distribute carbon certificates to low-carbon projects and make them exchangeable for soft loans. This would reduce the capital costs of low-carbon projects. Hence, low-carbon projects will become relatively more attractive than normal investments. (Rozenberg, J., *et al.,* 2013)

7-7-Green Finance and Green Credit Guidelines:

Another option is to issue green credit guidelines to guide banks toward greener lending. In fact, as of January 2017, 37 countries are represented in the Sustainable Banking Network, a network that aims to enhance knowledge sharing between banking regulators and banking associations established in 2012 to support the development of environmental and social

risk management by financial institutions and to promote green and inclusive lending. Thirteen member countries of the Sustainable Banking Network have already introduced green finance guidelines, while others are working on such guidelines.

China was at the forefront of countries that developed green banking policies, as attempts to address environmental risks through financial regulation date back to 1995. In 2012, the China Banking Regulatory Commission issued green credit guidelines to encourage banking services by focusing on green credit, effectively adjusting the credit structure, effectively warding off environmental and social risks, better serving the real economy, and promoting the transformation of the economic growth pattern, adjustment of the economic structure (CBRC, 2012). Although the China Banking Regulatory Commission's green credit guidelines have received much support, China's experience has shown that such non-binding guidelines are not sufficient to influence banks' lending practices, suggesting that it may be necessary to move forward further and introducing mandatory elements into a more comprehensive green finance framework (Volz, 2015). In 2014, the China Banking Regulatory Commission supplemented the Green Credit Guidelines by introducing the Green Credit Monitoring and Evaluation Mechanism and the KPI Checklist. Therefore, China's green credit policies have evolved from an initial principles-based approach in 2007 to a

standardized, metric-based performance appraisal of all licensed banks. In addition, in 2015, the People's Bank of China introduced green bond rules.

Other countries that have adopted comprehensive green banking frameworks include Bangladesh and Indonesia. In 2011, the Bank of Bangladesh, the central bank, published Policy Guidelines for Green Banking and Environmental Risk Management Guidelines to encourage banks to conduct a systematic analysis of environmental risks as part of their credit assessment process. The Bangladesh Bank has implemented two other green finance development policies: the Green Refinancing Scheme and the Compulsory Credit Quota for Loans. A green banking framework roadmap has recently been developed to develop capacities for environmental risk assessment and green lending with mandatory elements for Indonesia.

By including climate and other environmental challenges on the agenda, the central bank can signal the importance of this issue to market players and encourage them to take it seriously. To achieve this goal, central banks can also rely on their international networks and joint international action, whether on standards, methods, or political participation, such as the G20.

7-8-The Role of Monetary Policy in Dealing with Climate Change:

Monetary policy must consider climate-related risks, as the implications for achieving monetary policy objectives are significant. Most monetary authorities are mandated to pursue one or more policy goals (macroeconomic stability, economic growth, inflation, or employment goals) using monetary policy tools. Thus, many central banks have invested significant resources in understanding the economic impact of climate change on these goals.

Some highlight the importance of jointly choosing climate and monetary policies, given the important interactions between each of these policies. This indicates that climate change's effects affect inflation and production adversely. There are also some important interactions between the design of climate policy and monetary policy; in particular, the cap-and-trade program is associated with greater price volatility, which makes forecasting inflation more difficult. Thus, a carbon tax or a combination of a cap-trading program and a carbon tax may be preferable. (McKibbin, W.J. *et al.,* 2017)

The monetary policy base may also be more appropriate in conditions of increased uncertainty, where output and inflation gaps are difficult to predict. Losses from climate shocks are lower under a flexible exchange rate regime than under a fixed exchange rate regime. In addition, a flexible exchange rate

regime provides central banks with greater leeway to deal with increased volatility due to weather shocks (Economides, G., A Xepapadeas., 2019).

Since central banks typically have large asset portfolios, appropriately assessing and incorporating climate risks into their portfolios is important to reduce their exposure to climate risks. An improved assessment of climate risks by central bank governors could influence prices for carbon-intensive assets and provide incentives for investors to increase the allocation of their portfolios to low-carbon assets (Krogstrup, S., Oman, W.,, 2019).

A more direct intervention to reinforce climate change mitigation efforts would include explicitly targeting low-carbon assets in central bank asset sales and purchases. However, such interventions are often constrained by the limited powers of central banks and can risk politicizing these institutions. (Van Lerven, F., & J. Ryan-Collins,, 2017)

8-The Situation of Egypt From Fiscal and Monetary Policies Applied to Confront Climate Change:

Egypt is extremely sensitive to the effects of climate change and is at high risk for natural disasters. One of the three "severe" vulnerability hotspots in the globe is the Nile Delta in Egypt. According to future forecasts, Egypt will see a rise in sea level, water shortages, and scarcities, as well as an increase in the frequency and severity of extreme weather events such as heat waves, sand and dust storms, flash floods, rockslides, and heavy rains. According to forecasted future climate, the nation is anticipated to get usually hotter and drier. Droughts are already anticipated to become more frequent and severe, and Egypt is already quite vulnerable to them (UNDP, 2018).

Moreover, it is anticipated that sea level rise would cause a significant chunk of the northern Nile Delta to disappear owing to erosion and flooding, with a corresponding loss of agricultural land, infrastructure, and urban centers. Water resources, agriculture, fishing, health, housing, biodiversity, telecommunications, energy, tourism, and coastal zones are some of the major industries affected (UNDP, 2018).

Water, agriculture, forestry, human health, and livestock are the main industries impacted. Moreover, a greater danger of

flooding, riverbank overflow, and flash floods will result from a rise in the frequency of strong precipitation events. Additionally, this could lead to crop waterlogging and soil erosion, which would reduce yields and raise the risk of food insecurity, especially for small-scale farmers who rely on their land for subsistence. Increased aridity and rising temperatures may also cause stress in livestock and lower agricultural production. Economic losses, harm to agricultural areas and infrastructure, as well as human casualties, are all possible outcomes of this (FAO, 2018).

Additionally, the lives of the rural poor are further impacted by land degradation and soil erosion, which are made worse by frequent floods and droughts. Small-scale farmers in rural areas are more vulnerable to the effects of catastrophes (floods, dry spells) because they have fewer resources available to them to influence and boost their capacity for adaptation (WB, 2021).

Food security, agricultural issues, and loss of livelihoods are all predicted to get worse in the country because of climatic stresses. Furthermore, the country's efforts to continue developing and reducing poverty are seriously hampered by environmental degradation, impacted water resources, and biodiversity loss. These factors also make the nation more vulnerable to risks and hazards, which emphasizes the need for sustainable adaptation and resilience measures (WB, 2021).

The Egyptian government is committed to strengthening its expertise and efforts in disaster risk management (DRM). The Information and Decision Support Center of the Egyptian Cabinet of Ministers created a specialized crisis and catastrophe management section in 2000. It is the responsibility of this agency to establish national DRM rules and regulations. The National Strategy for Adaptation to Climate Change and Disaster Risk Reduction for the nation is the result of this. Plans for risk mitigation, adaptation, and reduction across several sectors are included in the strategy.

The agency needs more institutional capability and financial resources to enhance DRM across the nation. The improvement of regional coordination and financial support for technological advancements to address water scarcity are among these priorities, as is the investigation of financing and insurance options for disaster risks, the improvement of early warning systems, and the expansion of the Information and Decision Support Center's capabilities and financial resources. In addition, the nation's early warning system has to be improved, catastrophe risk finance methods need to be developed, and investments in resilient urban infrastructure need to be made. (GFDRR, 2019)

As part of its ongoing comprehensive development goals, Egypt has started to put a lot of emphasis on the green economy. The sustainable development plan "Egypt's Vision 2030" aims the environmental factor as a fundamental priority

in all development and economic sectors, and the execution of several projects in line with the State's economic and environmental goals may accomplish this.

Several worldwide green economy ideas and their ultimate aims are at the heart of Egypt's plan for making the transition to a green economy. The Ministry of Environment, which has given careful attention to protecting the environment and natural resources and relieving strain on them, is leading this plan, which intends to broaden the scope of goals set forth by sectors. To fulfill Egypt's national goal of sustainable development, which the green economy is seen as one of the methods for attaining, it is important to guarantee future generations' access to such resources in order for them to benefit from progress and maintain public health. A chance to grow beyond advanced development is the green economy.

The purpose of the worldwide movement for "sustainable development," which includes sustainable finance as a component, is to make financial institutions significant players in accomplishing the goals of sustainable development. Thus, sustainable finance can be defined as “any type of financial services and financial management that integrates environmental, social and governance (ESG) criteria when taking investment related decisions”. Activities within the framework of sustainable finance include green finance companies, green bonds, green microfinance, and other activities. (Ahmed, August 2021)

Green Finance: Mobilizing national and international green finance through multiple mechanisms and initiatives. The launch of the first Sovereign Green Bonds (September 2020) in the Middle East and North Africa region by Egypt's Ministry of Finance at a value of 750 million listed on the London Stock Exchange to attract foreign investors. Egypt's portfolio of eligible green projects is worth $1.9 billion, 16% in renewable energy, 19% in clean transportation, 26% in sustainable water and wastewater management, and 39% in pollution reduction and control (SIS, 2020). The Environmental Sustainability Criteria Guideline has enabled the increase of green investments from 15% in FY2019/20 to 30% in FY 2020/21, with projections to reach 50% in FY2024/25. This is complemented by Financial Regulatory Authority Decree 107 and 108 in 2021 that mandates companies listed in the Egyptian Stock Exchange and companies operating in the non-banking sector to submit environmental, social and governance disclosure reports related to sustainability (ESG standards) and to the financial impacts of climate change. Furthermore, availing attractive green finance through public and private financial institutions, notably the Green Economy Financing Facility (GEFF). (Egypt's First Updated Nationally Determined Contributions, 8 June 2022)

An overview of the climate finance landscape in Egypt is necessary, as it will provide information on the challenges and

opportunities for climate finance in general and for private sector involvement in particular. In Egypt, bilateral and multilateral funds are major sources of climate finance. These funds are provided by various donors in the form of grants, concessional loans, technical assistance and debt-swap programs. Key donors in Egypt include The World bank, African Development Bank (AFDB), various European Institutions, United States, Germany, France, Japan, Saudi Arabia, Kuwait, Arab Fund (AFESD), United Arab Emirates and South Korea. (Fobissie, K., & Shalaby, H.,, March 2021)

From a multilateral perspective, especially in the context of ongoing NDC initiatives, Egypt is yet to join or benefit from the NDC Partnership and the World Bank NDC Support Facility (NDC-SF). These NDC initiatives facilitate the implementation of NDCs through the mobilization of financial and technical support for countries. However, Egypt has been able to attract a good amount of climate finance (396.8 USD million as of 2019) compared to many African countries. Most of the funding comes from multilateral funds dedicated to fight climate change such as the Clean Technology Fund (CTF), Green Climate Fund (GCF), Global Environmental Facility (GEF), Adaptation fund (AF), Special Climate Change Fund (SCCF), Adaptation for Smallholder Agriculture Program (ASAP), Global Energy Efficiency and Renewable Energy Fund (GEEREF), and Global Climate Change Alliance (GCCA). More than 66% of all climate finance has been so far

spent on mitigation actions. (Fobissie, K., & Shalaby, H.,, March 2021)

The following parties are active in attempts to put into practice the green economy development policies, which are required to carry out the sustainable development goals: (Ahmed, August 2021)

• In regards to energy: The Ministry of Electricity has established renewable energy objectives of 20% of the power mix by 2022 and 42% by 2035, as stated in the Integrated Sustainable Energy Strategy (ISES) through 2035. In order to generate the electricity Egypt needs and that can be exported to North Africa and Central Europe, the Ministry of Investment is interested in economically exploiting the Egyptian desert and stepping up investment there. This could be done by investing in biofuels or by carrying out solar energy projects. By doing so, it will be possible to achieve great development for this region while adjusting the price structure of petroleum products.

• With regards to transportation, the Ministry of Environment has executed a project to replace the cab in Greater Cairo with the goal of reducing CO2 emissions as well as the economic and social benefits of this initiative, in collaboration with the Ministry of Finance and Nasser Bank. In order to lessen the pollution they emit, the Ministry of Environment is also putting into place a programme to convert government

vehicles to run on natural gas rather than gasoline. Additionally, in coordination with the Ministry of Trade and Industry, two-stroke motorcycle production and importation will be outlawed in favor of four-wheelers. The third metro line was constructed with full support of the public and private sectors in infrastructure projects, demonstrating the state's commitment for mass transportation networks. In order to attract additional investments in the energy industry and enable adaptation to the consequences of climate change, the state also promotes mass transport networks, as evidenced by the establishment of the third metro line with the cooperation of the public and private sectors.

• With regard to industry: For both the public and private industrial sectors, the Ministry of Environment implements industrial pollution control and environmental protection initiatives. Additionally, it promotes the relocation of industries to new cities, changes to Egypt's industrial structure, and increased support for small and medium-sized businesses engaged in environmental protection, water recycling, and industrial wastewater management. These initiatives are carried out in collaboration with the Ministry of Industry.

• With regard to agriculture, the Ministries of Environment and Agriculture are working together to achieve the sustainable use of natural agricultural resources. They are concentrating on integrated agricultural management techniques to increase the efficiency of water uses in agriculture, improving irrigation

and sanitary systems, changing crop composition for less water-intensive agricultures, and reusing agricultural water and sanitary systems.

• In terms of institutional actions, environmental law has been changed, environmental management systems have been created, and attention has been given to the creation of green, less carbon-dependent economic sectors. The environmental aspect has been incorporated into all development programmes, with the implementation of finance policies, completing the institutional framework for managing national efforts to adapt to the consequences of climate change.

All development projects now include the completion of the institutional framework for managing national efforts to adapt to the effects of climate change and the environmental dimension, as well as the adoption of internal financial policies that encourage, support eco-friendly facilities, and toughen penalties for environmental wrongdoing. In order to push the 100 corporations listed on the stock market to lower their thermal emissions in order to comply with environmental regulations and norms, the Ministry of Investment created the Egyptian Index of Social Responsibility. This index considers both environmental and social factors.

9-Conclusion:

-This research reached several results, which we summarize as follows:

•Weather-related natural disasters can cause a macroeconomic downturn if they cause severe damage to the balance sheets of households, businesses, banks, and insurance companies (physical risks). However, the economic impact of natural disasters is likely less severe if the risks are priced at the link in financial contracts in advance, and the financial system efficiently distributes it through insurance and reinsurance. After that, central banks will need to respond appropriately to the disaster to achieve the goals of monetary stability.

•Gradual warming can also affect the rate of potential economic growth. More accurate quantitative estimates based on a detailed analysis of these effects at the sector level will be needed before central banks can incorporate this effect into their monetary policy analysis.

•Sudden and unexpected tightening of carbon emissions policies may lead to a negative supply shock (transfer risk). While introducing or increasing the price of carbon will only temporarily affect inflation, the short and medium-term macroeconomic consequences are severe if the increase is sharp. Thus, achieving an orderly transition requires governments to announce in advance a clear and predictable path to tighten carbon emissions policies in the future.

•Changes in weather patterns and increased reliance on bioenergy can increase the volatility of food and energy prices and, thus, the volatility of headline inflation rates. This may make it more difficult for central banks to gauge underlying inflationary pressures and to keep inflation close to the target level.

•Central banks need to incorporate climate variables into their macroeconomic models to assess the impact of short-term extreme weather on economic variables, such as GDP and inflation. Existing forecast models can be extended to include the effects of weather. The long-term effects of gradual global warming on the growth rate of potential output may also need to be included in the monetary policy-modeling toolkit.

•More effectively and efficiently than monetary policy, carbon taxes, emissions trading systems, direct regulations, or green industrial policies can aid in the transition to a carbon-neutral economy. In turn, a well-managed transition would lessen the

risks to the stability of the financial markets and assist central banks to accomplish their goals by their mandate.

•Egypt has not yet implemented fiscal policies to confront the risks of climate change, such as imposing a carbon tax or a carbon tradable permit policy as a means to reduce carbon-dependent industries. In addition, it has not appeared to us in any of the means that Egypt used as monetary policies, perhaps only some green quantitative easing means represented by green financing for green projects and green bonds to support green investment in Egypt.

10-Recommendations:

• Regulations should be amended to encourage or require investors to incorporate climate-related criteria into their risk assessments as part of their fiduciary duty.

•Institutional investors must act proactively to shift capital to the degree necessary to avoid the worst effects of climate change.

•Policymakers and development financial institutions should work closely with investors to develop more financial mechanisms to bridge the climate-financing gap and meet institutional investors' risk and return needs. Innovative climate finance tools, mechanisms, and approaches must be developed to allow institutional investors to take advantage of climate investment opportunities. These instruments include concessional financing, loan guarantees, insurance policy, foreign currency liquidity facilities, pledge funds, and secondary equity.

•Banks must incorporate climate factors into all aspects of their operations. This includes integrating the risks and opportunities associated with climate change and the energy transition into the Bank's strategy, risk management procedures, pricing models, governance structures, disclosure practices, and loan origination processes.

•More progress is needed to develop robust methodologies and collect comprehensive data to assess climate-related risks to businesses and investors. The disclosure of risks and the development of databases at the asset level will contribute to accurately assessing climate risks.

• Support the achievement of climate objectives through the most cost-effective means by assessing the effects of climate policies, costing the policies, incorporating the cost of carbon, and factoring these analyses into government budgetary decisions to drive climate action.

• Transform economies by investing in climate mitigation and adaptation measures and the decarbonization of public infrastructure.

• Maximize green job opportunities by assessing the likely impacts of global policy and technological changes on business opportunities and the labor market and using regulation and public investment to drive climate action in both the public and private sectors.

• Mobilize finance, including through green bonds, concessional climate financing, and private investment, by implementing a regulatory environment, budget practices, and public investments that support capital for new green industries and resilience.

List of Figures

List of Abbreviations	
IPCC	Intergovernmental Panel on Climate Change
INDCs	Intended Nationally Determined Contributions
IMF	International Monetary Fund
UNEP	United Nation Environment Programme
ETR	Environmental Tax Reform
GHG	Greenhouse Gas emissions
GCA	Global Center on Adaptation
NGFS	Network for Greening the Financial System
IFC	International Finance Corporation
UNCTAD	United Nations Conference on Trade and Development
IOSC	International Oil Spill Conference
BDL	Banque Du Liban
ICCAP	Internal Capital Adequacy Assessment Process

ECB	European Central Bank
FAO	Food and Agriculture Organization
WB	World Bank
UNDP	United Nations Development Programme
GFDRR	Global Facility for Disaster Reduction and Recovery

References

Agarwala M., Burke M., Klusak P., Mohaddes K., Volz U., Zenghelis D.,. (September 2021). *Climate Change and Fiscal Sustainability: Risks and Opportunities.* UK Economic and Social Research Council, The Productivity Institute, Working Paper No. 008. UK: University of Cambridge.

Ahmed, I. (August 2021). *Green Economy Policies and Sustainable Development in Egypt.* Egypt: The Egyptian Cabinet Information and Decision Support Center.

American Geophysical Union.(2014). *Human-Induced Climate Change Requires Urgent Actions.* American Geophysical Union.

Annicchiarico, B. & Di Dio, F.,. (2016). GHC emissions control and monetary policy. *Environ. Resour. Econ. 67*, 823-851.

Arestis, P. & Sawyer, M. (2017). *Economic Policies Since the Global Financial Crisis.* London: (Palgrave Macmillan.

Banque du France. (2017). *Assessing Climate Change-Related Risks in the Banking Sector.* France: Direction Générale du Trésor, Banque du France and ACPR.

Banque du Liban. (2010). *Intermediate Circular 236.* Banque du Liban.

Bank of China. (2018). *China Monetary Policy Report-Quarter Four 2017.* People's Bank of China.

Bank of Japan. (2010). *Principal Terms and Conditions for the Fund-Provisoning Measure to Support Strengthening the Foundations for Economic Growth Conducted Through the Loan Support Program.* Bank of Japan.

Barkawi, A. & Monnin, P.,. (2015). *Monetary Policy and Sustainability Barkawi, A. & Monnin, P., (2015). The Case of Bangladesh (UNEP Inquiry into the Design of a Sustainable Financial System), P.14.*

Barrios, S., Bazoumana, O., and Strobl, E.,. (2008). The Agricultural Production: Is It Different for Impact of Climatic Change on Africa? *Food Policy*(33), 287-298.

Batten, S. (2018). *Climate Change and the Macro-economy: A critical Review.* England: Staff Working Paper, No 706, Bank of England.

Batten, S., Sowerbutts, R. and Tanaka, M., (2016). *let's talk about the weather: the impact of climate change on central banks.* London: Bank of England Staff Working Paper no. 603.

Batten, S., Sowerbutts, R., & Tanaka, M.,. (2018). Climate change: What implications for central banks and

financial regulators? In B. Caldecott, *Stranded assets and the environment.* London: Routledge.

Battiston, S., Mandel, A., Monasterolo, I., Schütze, F. & Visentin, G., . (2017). A climate stress-test of the financial system. *Nature Clim. Change 7*, 283-288.

Bellon M., & Massetti E.,. (2022). *Economic Principles for Integrating Adaptation to Climate Change into Fiscal Policy.* International Monetary Fund, Washington, DC.: IMF Staff Climate Note 2022/001.

Bernal, J & Ocampo, J.,. (2021). *Climate Change: Policies to Manage Its Macroeconomic and Financial Effects.* New York, USA: the United Nations Development Programme.

Bohm, P. (1998). Benefits of international emissions trading: theory and expremintal evidence. *the International Emission Trading Conference.* Sydney.

Bolin, B., Doos, B.R., Jager, J. and Warwick, R.A.,. (1986). *The Greenhouse Effect, Climate Change and Ecosystems* (Vol. Scope 29). Chichester: Wiley.

Bolton, P., Despres, M., Awazu, L., Samama, F., and Svartzman, R.,. (2020). *The green swan: Central banking and financial stability in the age of climate change.* France: Bank for International Settlements.

Breitenfellner, A., & Pointner, W.,. (2021). The impact of climate change on monetary Policy. *MONETARY POLICY & THE ECONOMY*, 59-80.

Burniauxi, J., Châteaui, J., Duvali, R., and Jameti, S.,. (2008). *The Economics of Climate Change Mitigation: Policies and Options for the Future.* Paris: OECD Economics Department Working Papers No.658.

Burzynski, M., Deuster, F., and Docquier, J.,. (September 2019). *Climate Change, Inequality, and Human Migration.* IZA Discussion Paper Series No. 12623.

Butzengeiger, S., Betz, R., and Bode, S.,. (2001). Making GHG Emissions Trading Work – Crucial Issues in Designing National and International Emissions Trading Systems. *HWWA Hamburg, Discussion Paper 154*.

Caldecott, B., Dericks, G., Bouveret., G., Schumacher, K., Pfeiffer, A., Tulloch, D., Kruitwagen, L., and McCarten, M.,. (2018). *Asset-level data and the Energy Transition.* Oxford Sustainable Finance Programme.

Campiglio, E. (2016). Beyond Carbon Pricing. The Role of Banking and Monetary Policy in Financing the Transition to a Low-carbon Economy. *Ecological Economics 121*, 220-230.

Campiglio, E., Godin, A. & Kempt-Benedict, E. (2017). *Networks of Stranded Assets: A Case for a Balance Sheet Approach.* Agence Française de Développement.

Carney, M. (2015). *Breaking the Tragedy of the Horizon-Climate Change and Financial Stability.* London: Speech by the Governor of the Bank of England.

Carleton, T.A. and Hsian., S.M. (2016). Social and Economic Impacts of Climate. *Science*.

CBRC. (2012). *Notice of the CBRC on Issuing the Green Credit Guidelines.* China: The China Banking Regulatory Commission.

Cerutti, E. C. (2017). The use and effectivness of macro-prudential policies: New evidence. *J. Financ. Stab. 28*, 203-224.

Chandavarkar, A. (1987). *Promotional Role of Central Banks in Developing Countries,.* Washington, DC: International Monetary Fund: IMF Working Paper No. 87/20.

Climate Bonds Initiative. (2017). *Bonds and Climate Change: The State of the Market in 2017.* Climate Bonds Initiative.

Coalition of Finance Ministers for Climate Action. (April 2022). *Driving Climate Action through Economic and Fiscal Policy and Practice.* Washington, D.C.: Coalition of Finance Ministers for Climate Action.

Conway E. (2008). *What's in a name? Global warming vs. climate change.* NASA.

Cook, J., Naomi, O., Peter T. D., William R. L., Bart., V., Maibach, W. ; Carlton, Stuart J.,, Stephan S., Andrew G. ; Sarah A., Dana N., Peter, J.,Mark., R., Winkler B.,. (2016, April 13). Consensus on consensus: a synthesis of consensus estimates on human-caused global warming. *Environmental Research Letters, 11*(4), article id. 048002.

Collectif Climate. (2017). *Call for a European Finance-Climate Pact.* Collectif Climate 2020.

Cotton, W.R., & Pielke R.A.,. (2007). Human Impacts on Weather and Climate. *Cambridge University Press*, p. 75.

CPI. (2018). *Global Climate Finance: An Updated View 2018.* Climate Policy Initiative.

Cramton P. and Kerr, S.,. (March 1998). *Tradable carbon allowance auctions: how and why to auction.* Center for Clean Air Policy.

cust, J., and Mihalyi, D.,. (2017). Evidence for a presource curse? Oil Discoveries, Elevated Expectations, and Growth Disappointments. *Policy Research Working Paper 8140, World Bank, Washington, DC,*, p. 7.

Debelle, G. (2019). *Climate Change and The Economy.* Sydney: Speech given at the Public Forum hosted by the Centre for Policy Development.

Deryugina, T. and Hsiang, S.M.,. (2014). *Daily Temperature and Income in the United States, Does the Environment Still Matter?* . NBER Working Paper, No 20750.

Dietz, S., Gardiner D., Gostlow, G., Grabert, M., Nachmany, M., Sullivan, R., van der Merwe, E.,. (2018). *Management Quality and Carbon Performance of cement producers: update.* Transition Pathway Initiative.

Dikau, S. & Collins, J.,. (2017). *Green Central Banking in Emerging Market and Developing Countries.* New Economics Foundation.

Duan, T. and Weikai FL.,. (2019). Worrying About Climate Change: Evidence from Mortgage Lending. *SSRN mimeo*.

EC. (2017). *Reinforcing Integrated Supervision to Strengthen Capital Markets Union and Financial Integration in a Changing Environment.* European Commission.

ECB. (2018). *Asset Purchase Programmes.* European Central Bank.

Economides, G. and Xepapadeas, A.,. (2018). *Monetary Policy Under Climate Change.* Bank of Greece Working Paper, No. 247.

Economides, G., A Xepapadeas. (2019). *The effects of climate change on a small open economy.* CESifo Working Paper 7582.

Edenhofer, O., Knopf, B., Bak, C. & Bhattacharya, A.,. (2017). Aligning climate policy with finance ministers. *G20 agenda. Nat. Clim. Change*(7), 463–465.

EEAA. (2016). *Egypt Third National Communication under the United Nations Framework Convention on Climate Change*. Retrieved March 4, 2023, from Egyptian Environmental Affairs Agency: https://unfccc.int/sites/default/files/resource/TNC%20report.pdf

(8 June 2022). *Egypt's First Updated Nationally Determined Contributions.* Egypt.

Ehlers, T., Gardes-Landolfini, C., Natalucci, F., Ananthakrishnan, P.,. (2022, October 7). *How to Scale Up Private Climate Finance in Emerging Economies*. Retrieved January 14, 2023, from IMF: https://www.imf.org/en/Blogs/Articles/2022/10/07/how-to-scale-up-private-climate-finance-in-emerging-economies

Ehlers., T. & Packer, F.,. (2017). *Green Bond Finance and Certification.* Bank for International Settlements.

EIB. (2016). *EIB Climate Strategy.* European Investment Bank.

Ekins, P. and Barker, T.,. (2001). Carbon Taxes and Carbon Emissions Trading. *Journal of Economic Surveys*(15), 325-376.

(2016). *Energy Information Administration.* International Energy Agency.

England), U. B. (2018). *The impact of adverse weather: Inflation Report.* London: Bank of England.

ESRP. (2016). *Too Late, Too Sudden- Transition to a Low Carbon Economy and Systemic Risk* . European Systemic Risk Board.

FAO. (2018). *Drought Characteristics and management in North African and the Near East*. Retrieved March 4, 2023, from FAO: http://www.fao.org/3/CA0034EN/ca0034en.pdf

Fobissie, K., & Shalaby, H.,. (March 2021). *NDC implementation in Egypt through green investments by the private Sector: A Scoping Study.* The African Development Bank.

Gaber, A. (2021). Economics of Climate Change. *Spirit of Laws Magazine, 93*(93), 359-642.

Gagelman, F. and Hansjuergens, B.,. (2002). Climate Protection through the EU Proposal for a CO2 emissions trading system in tradeable permits: Europe. *European Environment*(12), 185-202.

Gaspar, V., Hebous, S., Mauro, P.,. (2022, April 12). *Tax Coordination Can Lead to a Fairer, Greener Global Economy*. Retrieved January 14, 2023, from IMF:

https://www.imf.org/en/Blogs/Articles/2022/04/12/blog041222-sm2022-fm-ch2

GCA. (September 2019). *Adapt Now: A Global Call for Leadership on Climate Resilience.* GCA (Global Commission on Adaptation).

GFDRR. (2019). *Egypt*. Retrieved March 4, 2023, from Global Facility for Disaster Reduction and Recovery: World Bank: https://www.gfdrr.org/en/egypt

Global Monitoring Laboratory. (2022). Retrieved from Earth System Research Laboratories: https://gml.noaa.gov/

Hanley N., and Spash C.,. (1994). *Cost-Benefit Analysis and The Environment.* Cheltenham: Edward Elgar.

Heller, W. (1999). Equilibrium Market Formation Causes Missing Markets, Markets, Information, and Uncertainty. In G. Chichilnisky, *Essays in Economic Theory in Honor of Kenneth J. Arrow* (pp. 235–252). Cambridge: Cambridge University Press.

Honohan P. (2019). *Should Monetary Policy Take Inequality and Climate Change into Account?* Washington, DC: Peterson Institute for International Economics.

ICAAP. (2011). *Circular 3, 547 of July 7, 2011: Establishes Procedures and Parameters Related to the Internal Capital Adequacy Assessment Process.* Banco Central do Brasil.

IFC. (2019). Sustainable Banking Network: Global Progress Report.

IMF. (2017). *The Effects of Weather Shocks on Economic Activity.* International Monetary Fund.

IOSC. (2019). *Sustainable finance in emerging markets and the role of securities regulators.* International Organization of Securities Commissions.

IPCC, (2014a). *Climate Change 2013: Phsical Science Basis.* IPCC.

IPCC. (2014b). *Climate Change 2014.* Synthesis Report: Intergovernmental Panel on Climate Change(IPCC).

IPCC. (2014c). *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Geneva, Switzerland: IPCC.

Jaffe, A., Newell, R., and Stavins, R.,. (2001). *Technological Change and the Environment.* Discussion Paper 00–47REV, Resources for the Future,.

Khan M. (2016). The Climate Change Adaptation Literature. *Review of Environmental Economics and Policy, 1*(10), 166-178.

Klomp, J. (2014). Financial fragility and natural disasters: an emprical analysis. *Journal of Financial Stability,, 13*, 180-192.

Kosobud, R. (2000). *Emissions Trading: Environmental Policy's New Approach.* New York: Wiley.

Krogstrup, S., Oman, W.,. (2019). *Macroeconomic and Financial Policies for Climate Change Mitigation: A Review of the Literature.* IMF Working Paper WP/19/185.

Lipsey, R. and Lancaster, K.,. (1956). The General Theory of Second Best. *Review of Economic Studies, 24*(1), 11–32.

Lucas, C. (2011). *Caroline Calls for Green Quantitative Easing as Bank of England Announces £75bn Injection",.* England.

Mason, A., Martindale, W., Heath, A. & Chatterjee, S.,. (2016). *French Energy Transition Law: Global Investor Briefing.* Principles for Responsible Investments.

Mavrakis, D. and Konidari, P.,. (2003). Classification of Emissions trading scheme design characteristics. *European Environment*(13), 48-66.

Mazzucato, M. & Semieniuk, G.,. (2018). Financing renewable energy: Who is financing what and why it matters. *Technol. Forecast. Soc. Change 127*, 8-22.

McDaniels, J., Robins, N. & Bacani, B.,. (2017). *Sustainable Insurance: The Emerging Agenda for Supervisors and Regulators.* UN Environment Inquiry.

McGlade, C. & Ekins, P.,. (2015). The geographical distribution of fossil fuels unused when limiting global warming to 2 °C. *Nature 517*, 187–190.

McKibbin, W.J., A.C. Morris, P.J. Wilcoxen, A.J. Panton. (2017). Climate Change and Monetary Policy: Dealing with Disruption. *Climate and Energy Economics Project. Brookings*, 6.

McKibbin, W.J., and Wilcoxen, P.J.,. (2002). The Role of Economics in climate change policy. *Journal of Economic Perspectives*(16), 107-130.

Melissa, D., Jones, B., and Olken, B.,. (2012). Temperature Shocks and Economic Growth: Evidence from the Last Half Century. *American Economic Journal: Macroeconomics, 3*(4), 66-95.

Mesonnier, J., O'Donnell, C. & Toutain, O.,. (2017). *The interest of Being Eligible.* Banque de France.

Missfeldt, F. and Requate, T.,. (2001). From National Emissions Taxes to international emissions trading: the cases of Scandinavia and the UK. *Department of Economics, University of Heidelberg, Discussion Paper No. 342*.

Montero, J. (1997). Marketable Pollution Permits with Uncertainty and transaction Cost. *Resource and Energy Economics*(20), 27-50.

NGFS. (2019a). *Climate change as a source of financial action: A call for risk.* Network for Greening the Financial System.

NGFS. (2019b). *Network for Greening the Financial System: First Comprehensive Report.* Network for Greening the Financial System.

NGFS. (June 2020). *Climate Change and Monetary Policy: Initial Takeaways.* France: Network for Greening the Financial System Technical document.

Nicholas, S. (2007). The Economics of Climate Change: The Stern Review. *Campridge: Campridge University Press*, 269.

Nordhaus, W. (2015). Climate Clubs: Overcoming Free-Riding in International Climate Policy. *American Economic Review, 105*(4), 1339-70.

OECD. (2017). *Investing in Climate, Investing in Growth.* Organisation for Economic Co-operation and Development.

ozenberg, J., and M. Fay, eds. (2019). *Beyond The Gap: How Countries Can Afford the Infrastructure They Need while Protecting the Planet.* Washington, DC: Sustainable Infrastructure Series: World Bank.

Paolo, A., Jun, E., and Stephane, H.,. (2014). *Carbon Price Efficiency: Lock-In and Path Dependence in Urban*

Forms and Transport Infrastructure. Washington DC.: World Bank Policy Research Working Paper No. 6941.

Parker, M. (2018). The Impact of Disasters on Inflation. *Economics of Disasters and Climate Change, 2*(1), 21-48.

Perez, C. (1983). Structural change and assimilation of new technologies in the economic and social systems. *Futures*(15), 357-375.

Pigato, M. A. (2019). *Fiscal Policies for Development and Climate Action.* Washington, DC: International Bank for Reconstruction and Development / The World Bank.

UNEP. (2016). *The Adaptation Gap Report.* Nairobi, Kenya: UNEP.

Regelink, M., Reinders, H., Vleeschhouwer, M., and I. van de Wiel, . (2017). *Waterproof? An Exploration of Climate-Related Risks for the Dutch Financial Sector.* Amsterdam: De Nederlandsche Bank.

Reserve Bank of India. (2015). *Priority Sector Lending-Targets and Classification.* Reserve Bank of India.

Romm, J. (2016). Climate Change: What Everyone Needs To know. *Oxford: Oxford University Press*, p. 32.

Rozenberg, J., Hallegatte, S., Perrissin-Fabert,B. and Hourcade, J.,. (2013). "Funding Low-carbon Investments in the Absence of a Carbon Tax. *Climate Policy, 13*(1), 134-141.

Ryan-Collins, J., Werner, R., Greenham, T. & Bernardo, G.,. (2013). *Strategic Quantitative Easing: Stimulating Investment to Rebalance the Economy.* New Economics Foundation.

Schoenmaker, D. & Tilburg, R. V.,. (2016). What Role for Financial supervisors in addressing environmental risks? *Comp. Econ. Stud. 58,*, 317-334.

Schoenmaker, D. (2019). *Greening Monetary Policy.* Bruegel Working Paper issue 2.

Schotten, G., van Ewijk, S., Regelink, M., Dicou, D.& Kakes, J.,. (2016). *Transition—an Exploratory Study of the Transition to a Carbon-Neutral Economy.* Netherlands: Central Bank.

Schwarze, R. (1997). Taxes versus tradeable permits for climate change policy: the case for new policy principles and criteria for a new field of policy: the case of environmental policy. *Technical University Berlin, Discussion paper No.22*.

Scott, M., van Huizen, J., & Jung, C.,. (2017). *The Bank of England's response to climate change.* London: Bank of England Quarterly Bulletin.

Sheng, A. (2014). *Should Central Banks Engage in Social Impact Investing?* Mimeo, Hong Kong: Fung Global Institute.

SIS. (2020, September 27). *Egypt getting ready for issuing its first sovereign green bonds - minister*. Retrieved March 4, 2023, from State Information Service: https://sis.gov.eg/Story/152324/Egypt-getting-ready-for-issuing-its-first-sovereign-green-bonds---minister?lang=en-us

Stavins, R. N. (1995). Transaction cost and tradable permits. *Journal of Environmental Economics and Managment*(29), 133-148.

Stavins, R. (n.d.). Transaction cost and tradable permits. *Journal of Transaction cost and tradable permits'Stavins, R.N., (1995). ' Environmental Economics and Management 29, PP.133–148.*

Stein, P. (2018). *Scale up Climate Finance through the Financial Sector: 30 by 30 zero.* International Finance Corporation.

TCFD. (2017). *Recommendations of the Task Force on Climate-Related Financial Disclosures.* Task Force on Climate-Related Financial Disclosures.

TCFD. (2018). *Status report.* Task Force for Climate-Related Financial Disclosure.

Thom, J. & Hilke, A.,. (2018). *The Green Supporting Factor: Quantifying the Impact on European Banks and Green Finance.* 2 Degrees Investing Initiative.

Tol, R. (2001). Equitable Cost-Benefit Analysis of Climate Change Policies. *Ecological Economics*(36), 71-85.

Tol, R. S. (2005). Emission Abatment versus Development as Strategies to Reduce Vulnerability to Climate Change: An Application of FUND. *Environment and Development Economics*(10), 615-629.

Tol, R. (2009). why worry about climate change? *Research Bulletin, 9*(1), 2-7.

Tooze, A. (2019). Why Central Banks Need to Step Up on Global Warming. *Foreign Policy*, 5.

Tucker, P. (2018). Unselected Power: The Quest for Legitimacy in Central Banking and the Regulatory State. *Princeton University Press*, 405.

Turell, A. (2016). Agent- Based Models: Understanding the Economy from the Bottom up. *Quarterly Bulletin, Q4*, 174.

UK Bank, (2015). *The impact of climate change on the UK insurance sector: A climate change adaptation report by the Prudential Regulation Authority.* London: Bank of England.

UNCTAD. (2019). *Developing countries face a $2.5 trillion annual investment gap in key sustainable development sectors,.* UNCTAD report estimates.

UNDP. (2018). *National Adaptation Plans in Focus: Lessons from Egypt*. Retrieved March 4, 2023, from United

Nations Development Programme: https://www.adaptationundp.org/sites/default/files/resources/naps_in_focus_lessons_from_egypt.pdf

UNEP, GIZ and IMF. (2016). *Green Economy- Fiscal Policy Reforms for Climate Change.* German: Green Fiscal Policy Network.

Unruh G. (2000). Undrstanding Carbon Lock-In. *Energy Policy 28*, 817-30.

Van Lerven, F., & J. Ryan-Collins,. (2017). *Central banks, Climate Change and the Transition to a Low Carbon Economy: A Policy Briefing.* New Economics Foundation.

Volz, U. (2015). *Towards Sustainable Finance in Indonesia.* Geneva: UN Environment Inquiry into the Design of a Sustainable Financial System.

Volz, U. (2017). *On the Role of Central Banks in Enhancing Green Finance.* Inquiry Working Paper, United Nations Environment Programme,.

WB. (2021). *Climate Risk Profile: Egypt.* Washington, DC: The World Bank Group.

Westkog, H. (1996). market power in a system of tradable CO2 quotas. *The Energy Journal*(17), 85-103.

Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. (2017). *Climate Science Special Report: Fourth National Climate*

Assessment,. Washington, DC, USA: U.S. Global Change Research Program.

Table of Contents