The Implications of Climate Change on the Insurance Industry and the Israeli Economy

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Abstract

The insurance industry has a major role in the efficient and sustainable development of modern economies. Climate change is considered one of the most severe risks which could affect the whole socio-economic structure with emphasis on the insurance industry. During the 21st century, substantial changes in climate around the world are expected. Moreover, the changes in the Mediterranean basin are expected to be extremely significant, which could have adverse consequences for the insurance market and the Israeli economy at large (Baror and Golan, 2008). An incomplete list of potential impacts includes (Axelrod, 2010):

a) Sea level rise and more frequent extreme weather events which will cause coastal land loss leading to capital loss and increase in insurance costs.
b) Extreme precipitation events - increased water demand, increased frequency of extreme events.
c) Sharpen water shortage.
d) Changes of pattern of tourism.
e) Decline in energy demand for heating and increase in energy demand for cooling.
f) Effects on agriculture cultivation - Increase in agricultural pests, plant diseases and weeds, changes in crop yields.
g) Changes in biodiversity, especially in the Mediterranean Sea.
h) Effects on human health: Spread of illnesses by vectors and increased illnesses caused by heat.

These effects will cause changes in consumption patterns and even in the means of production which may lead to structural changes in the economy, in the terms of foreign trade and eventually decline of the GDP. One of the most vulnerable industries to climate change is the insurance business.

Significant damages to public and private property can affect its profitability and its redemption abilities - the ability to pay installments on losses as a result of disasters (Axelrod, 2010).

The research is based on the methodology developed by Bosello and Roson (2007) with modifications to employ the Israeli General Equilibrium Model (IGEM), developed specifically for the Israeli economy-wide analysis.

1. Literature Review

1.1. Climate Change

A leading organization in climate change area, called IPCC, Intergovernmental Panel on Climate Change, claims that the global climate change is expected to increase the frequency and severity of extreme weather conditions (IPCC, 2007). These changes might affect the economy in general and the insurance industry in particular. Global warming will cause global temperature increase of 1.8°c -4°c by the end of the 21st century depending on the different greenhouse gas emission scenarios (IPCC, 2007).

Standard climate change scenarios, i.e. an average warming of 3.9°c by 2100, were examined in terms of global market for wide and unpredictable climate change (Stern, 2007a). The results indicate the following changes to the gross world product: a decrease of 0.2% by 2060, a decrease of 0.9% on 2100, and a decrease of 5.3% on 2200. Global warming could lead to sea level rise, which is expected to hit coastal areas that could significantly affect the state of Israel because most residents live on the coastal plain. The Stern report (Stern, 2007a) indicates that a rise of 20-80 cm of sea level caused by a 3-4 °C change may cause exposure of about 7-300 million more people to floods each year. A basic conclusion of the Stern Review is that the costs of strong and urgent action on climate change will be less than the costs thereby avoided of the impacts of climate change under "Business as Usual". A number of commentaries on the Review have challenged elements of the analysis that lead to this conclusion. However, Stern et al. (2007b) sets the response to these commentaries. Stern et al. (2007b) demonstrates that the conclusions of the Review are robust— in particular that the costs of action are much less than the costs of inaction— and do not rest on any one particular modeling approach or assumption.

Figure 1 illustrates the possible impact of global warming on different sectors in various years of impact (IPCC, 2007).

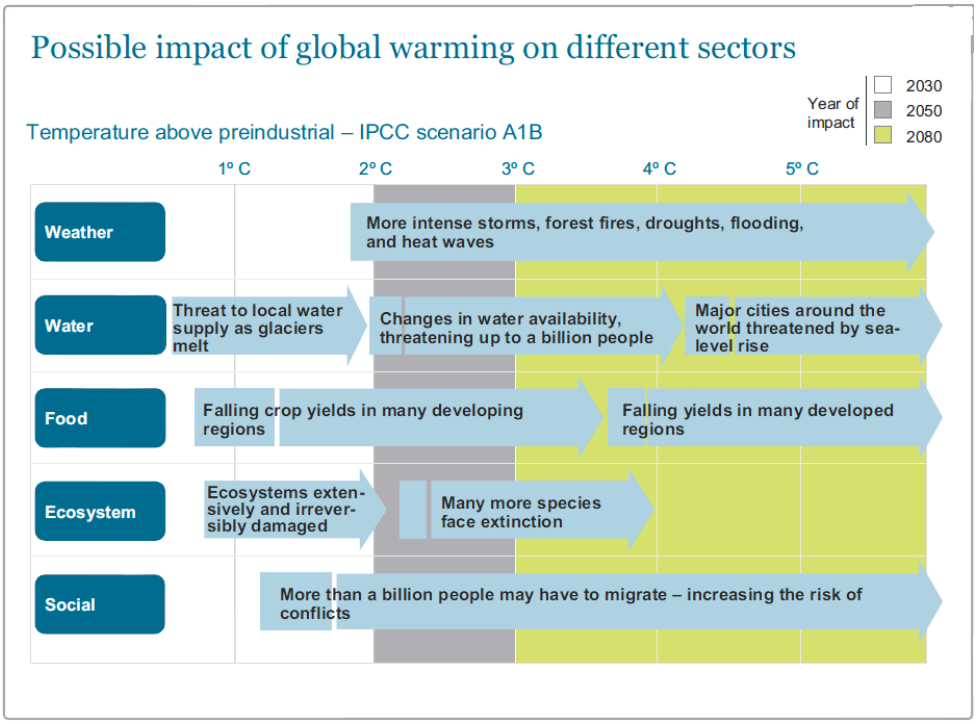

Figure 1: Possible impact of global warming on different sectors

1.2. The Effects of Global Warming on Israel

In comparison to the years 1961-1990, the A1B scenario of the IPCC, predicts a rise of 1.5° C in Israel's average temperature by 2020. According to IPCC scenarios A2 and B2, average temperature in the years 2071-2100 is expected to increase further by 5° C and 3.5° C respectively. Rainfall amounts are expected to decrease by 10% by 2020 and 20% by 2050.

Another expected impact is an increase in the number of extreme weather events in Israel, along with a decrease in the amounts of seasonal rain. The differences in average precipitation from year to year are expected to increase compared to today. Furthermore, the intervals between dry spells and wet spells are also expected to increase. This indicates a tendency towards a more arid climate in Israel which confirms the IPCC forecasts for 2100. There is an expected increase in the number and frequency of extreme weather events, severe droughts, floods and heat wave events. These changes may have far reaching implications on the insurance industry, the electricity sector, energy sector, agriculture, water management and the national product of social welfare in Israel.

In Israel, the economic studies in recent years have examined the impact of climate change on Israel, focusing on a single industry such as agriculture (Yehoshua and Shechter, 2003; Kan et al., 2007; Haim et al., 2008) or electricity (Gressel et al., 2000). Other studies have estimated the costs due to Israel joining to the post-Kyoto statement (Palatnik, 2009).

Most of the related literature deals with evaluation of "market damages", i.e. industry based cost/benefit assessment (Palatnik and Shechter, 2008).

A small selection of studies attempted to evaluate the economy wide costs and benefits of greenhouse gases mitigation.

Avnimelech et al. (2000) scanned GHG polluting sectors of the Israeli economy and provided sector based policy guidelines for GHG emission reduction in the form of technical and economic measures. Gressel et al. (2000) assessed the demand functions for fossil fuels and electricity and analyzed welfare losses caused by carbon taxes on these goods. However, this approach evaluated costs for 'energy addicted' sectors without incorporating substitutes. Tiraspolsky (2003) examined the effectiveness of a national carbon tax scheme applied to different emitting sectors and inspected some distributive and competitiveness effects arising from this application. The argument for modest-level regressively of tax in the residential sector was confirmed by partial analysis of distributional incidence of a modeled carbon tax of NIS 70 per ton of CO2.

Yehoshua and Shechter (2003) employed a simple production function model approach to assess the economic impact of climate change on the agricultural sector in Israel. A more elaborated study, using the same production function approach was presented by Kadishi, et al. (2003). Kan et al. (2007) developed a model based on these two previous studies. The model enables assessment of climate-change impacts on optimal agricultural management, where adaptation to water quality and quantity changes is considered endogenously with respect to both the extensive and intensive margins.

Yehoshua et al. (2007) analyzed the major impact of sea level rise – manifested principally in land loss due to inundation and erosion - on Israel's Mediterranean coast. Given the specific and rather unique nature of the Israeli coastline, this study has employed specific tools to assess the 8 damages. The economic assessment focused mainly on valuing the beaches as a public resource for recreation, using methods such as CVM and TCM.

Haim et al. (2008) explored economic aspects of agricultural production under projected climate-change scenarios by the “production function” approach, as applied to two representative crops: wheat and cotton. Results for wheat varied among climate scenarios; net revenues became negative under the severe scenario, but may increase under the moderate one. By contrast, under both scenarios cotton was found to experience a considerable decrease in yield with significant economic losses.

Nevertheless, the estimated impact of climate change on the industry market and Israeli economy has not been studied yet.

1.3. The Insurance Industry

1.3.1. The global insurance industry

The insurance industry is a one of biggest industry markets in the world with an annual yield of 3.5 trillion dollars in 2009. Insurance is 8.6% of GNP in developed countries (3405 dollars per capita and 2.9% of GNP in developing countries (Swiss Re, 2010). Figure 2 illustrates these data for developing countries.

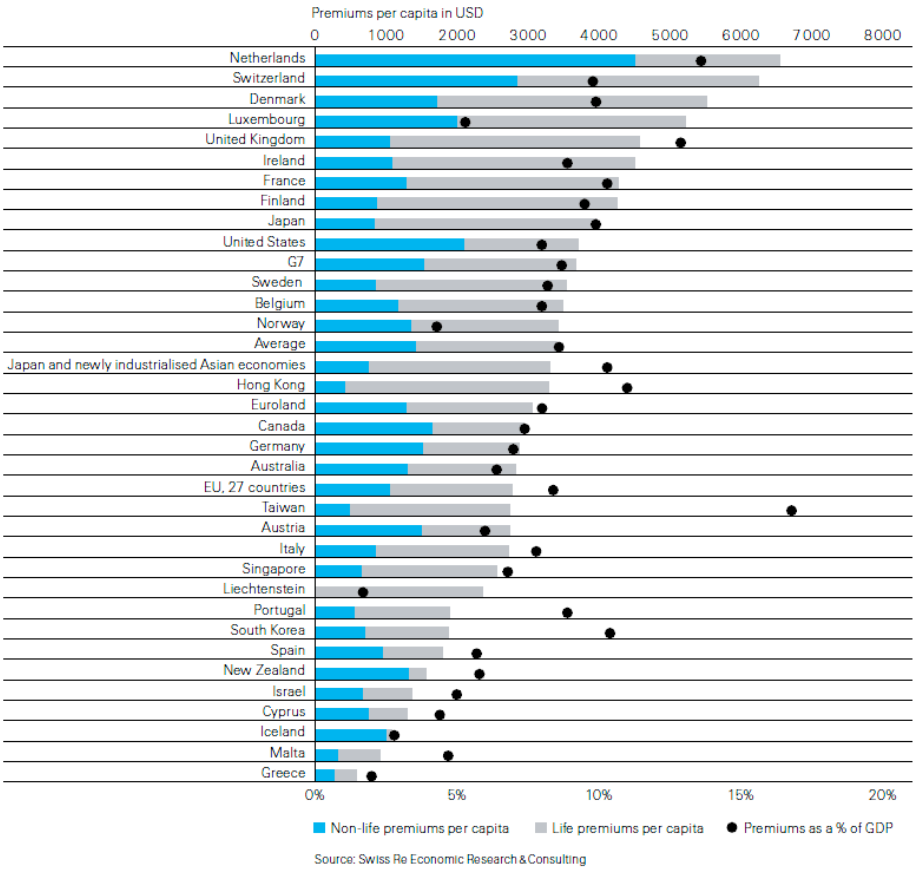

Figure 2: Premium per Capita in USD in developing countries

Climate change may cause an increase in frequency and intensity of extreme weather events, which may cause negative impacts on the insurance industry in particular and the economy in general (Botzen et al., 2010).

Changes in the amount of precipitation and their frequency as well as average temperature are expected to increase uncertainty in various industries, thus increasing the demand for new insurance products and markets to protect against these risks. For example, increase in requirement for insurance against climate change effects and later on increase in insurance claims as a result of sea level rise and the frequency of extreme weather events. Accordingly,

the insurance premium will increase and with it most of the economic expenditure on insurance industries.

The overall picture of natural catastrophes in 2010 indicates on very severe earthquakes and many severe weather events (Munich Re, 2011). Several major catastrophes in 2010 resulted in substantial losses and an exceptionally high number of fatalities. The overall picture on 2010 was dominated by an accumulation of severe earthquakes to an extent seldom experienced in recent decades. The high number of weather-related natural catastrophes and record temperatures both globally and in different regions of the world provide further indications of advancing climate change. A comparison of the natural disasters in the last decade is presented (table 1). In addition tables 2 and 3 include the five largest natural catastrophes of 2010, ranking by overall losses and by insured losses respectively.

	The figures of the year 2010	The figures of the year 2009	Average of the last 10 years 2000-2009	Average of the last 30 years 1980-2009
Number of events	950	900	785	615
Overall losses (US$m)	130,000	60,000	110,000	95,000
Insured losses (US$m)	37,000	22,000	35,000	23,000
Fatalities	295,000	11,000	77,000	66,000

Table 1: Natural catastrophes in 2010

Date	Country/Region	Event	Fatalities	Overall losses US$m	Insured losses US$m
27.2.2010	Chile	Earthquake, tsunami	520	30,000	8,000
July – Sept. 2010	Pakistan	Floods	1,760	9,500	25
12.1.2010	Haiti	Earthquake	222,570	8,000	200
26-28.2.2010	Europe	Winter Storm Xynthia	65	6,100	3,100
June 2010	China	Floods	260	6,100	

Table 2: The five largest natural catastrophes in 2010 ranking by overall losses

Date	Country/Region	Event	Fatalities	Overall losses US$m	Insured losses US$m
27.2.2010	Chile	Earthquake, tsunami	520	30,000	8,000
3.9.2010	New Zealand	Earthquake (Preliminary estimation October 2010)		3,700*	3,300*
26-28.2.2010	Europe	Winter Storm Xynthia	65	6,100	3,100
12-16.5.2010	USA	Severe storm, hail	3	2,700	2,000
4-6.10.2010	USA	Severe storm, tornadoes		2,000	1,450

Table 3: The five largest natural catastrophes in 2010 ranking by insured losses

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Sea level rise may also cause loss of physical capital located close to the beach and subsequently a decline in fertility and increased expenses to restore those loses. In addition, these changes may lead to changes in other areas:

- Further deterioration of Israel's water shortage - an increase in demand for water in parallel to decline in supply will increase the need for desalinated water. As a result, water prices will rise to the end users.
- Drop in energy demand in the short winter and increased demand in the long summer - as a result of the increase in average temperature, the installed capacity of power stations in Israel will have to grow as well as annual spending on energy production.
- Changes in temperature and precipitation will affect agriculture in Israel. Some agriculture sectors will benefit from these changes, but, eventually, the costs will rise for most of the crops.

These changes will cause changes in consumption patterns and even in the means of production which may lead to structural changes in the economy, the terms of foreign trade and eventually decrease in GDP. This list of potential effects of climate change on the Israeli economy illustrates the need to use a model that includes inter-connections between the various economic markets. The General Equilibrium Model (GEM) is the appropriate analytic tool for analyzing those implications.

One of the classic definitions of insurance describes it as social or commercial component that provides financial compensation for effect of a disaster (or misfortune) when returns are made from all payments partners of the insurance premium payment. Insurance Fund is based on premium value (dependent on the insured risk profile of the insured) that provides the insurance budget when the event happens. A key component of insurance is the need of optimal assessment of risk and ability to manage it, in accordance with the ability to decide on the acceptance/rejection of an insured candidate. Unexpected changes for which risk assessment is of high uncertainty are a significant problem. An example of change with high uncertainty is the risk resulting from climate change (Liedtke, 2009). The insurance industry has a major role in the efficient and sustainable development of modern economies. Availability of insurance has beneficial effects and side effects well beyond the financial aspect. In the context of climate change, the insurance is not only a tool for risk assessment and management, but is a valuable mechanism for determining the desired behavior. The insurance industry is expected to slowdown in growth following the increase in frequency and

intensity of extreme weather events and disasters and to even bring down these damage economic burdens on governments and individuals. Most types of insurance are vulnerable to anticipated climate change, including property insurance, health insurance, life insurance, crop insurance and livestock insurance and loss of public services (Mills, 2005)

However, not all natural disasters are insured. In some cases, such as: floods and destroyed crops, insurance companies and the public together are impacted by the economic burden. Unexpected changes in the natural disasters location, scope and their nature are the biggest threat for the insurance companies. For the throughout history, the public and insurance companies were not prepared to most unpredictable natural disasters (Baror and Golan, 2008).

There is a need to define effective ways of dealing with risks related to extreme weather conditions and their implications on the overall damage costs. Private-public partnerships are expected to be developed for financing risks, ranging from weather insurance funds to designated funds against disasters. The governments are required to recognize the need of subsidies or other legal solutions. The focus should be on financing options (e.g. insurance) and suggested ways to improve the role of the public sector (Aakre et al., 2010).

1.3.2. The insurance industry in Israel

The activity of most insurance firms in Israel is in both life and general insurance. Non-life penetration in Israel in 2009 was 2.6%, life density was US$672 per capita and the GDP per capita is over US$26,000. Israel is a rich country in which the wealth is evenly spread and the percentage of people using insurance is high. Compared to rich countries, non-life penetration in Israel is higher than it is in Japan or Hong Kong, where car ownership is far from universal but about two-thirds of what it is in Western Europe or North America. Israel's insurance sector is mature. Premiums have grown at single digit rates in both major segments since 2006 and are estimated to continue to do so over the forecast period. The global 2008 financial crisis appears not to have had an impact on premiums. It is testament to the general resilience of the Israeli economy in 2009.

Israel's economy stability may also be a reflection of the nature of the non-life and the life segments. In the non-life segment, the companies in the Harel Group, the Clal Group and the Menora Mivtachim Group accounted for 19.3%, 18.8% and 13.0% of premiums respectively in 2009, according to data from the Israel Insurance Association (IIA). The Phoenix Insurance Company, the fourth substantial local group, accounted for another 12.3% of premiums. Migdal, the local subsidiary of Italian-based multinational Generali, made up another 8.7%. Aside from Phoenix, all these companies gained market share in 2009 compared to 2008. The

life segment is dominated by Migdal, whose market share increased marginally to 30.3% in 2009. Clal accounts for another 21%, while Harel and Phoenix have about 15% of the market each.

The insurance has another key advantage in a joint effort of the overall agriculture industry (Kahane, 2010). This common interest of farmers and the government had lead 40 years ago to the establishments of the Israeli agricultural natural disasters insurance fund. The fund, called Kanat, is a government insurance company that is shared with the leading agricultural organizations, in order to insure the farmers against natural disasters and to help them continue to function following severe natural disasters. The fund enables the government and the agricultural organizations to develop an organized and supervised mechanism that enables high-quality insurance results and efficiency benefit of all parties. Because of the special nature of agricultural insurance, as some risks are catastrophic in nature, there is a particular problem related to insurance rates. Therefore, there is a need to find a way to allow the insurer, which handling catastrophic industries, to hold appropriate reserves and maintain the surplus from year to year (Kahane, 2010).

Agriculture in Israel has been changed in the last decade significantly as a result of technological progress. However, the nature of the agricultural risks has also been changed from exposure to new risks: increase in plots that were once considered apprentices, a large investment concentration, increased exposure to market risks and increasing the global competition, etc. One of the main risk management tools is natural disasters insurance. Using this insurance, the farmers can plan their level of exposed risk. Natural risk insurance for the agriculture industry is an important tool for the government. The insurance framework enables the payment of compensation in an informed and orderly way, according to professional criteria, rather than an additional government budget in the expense of breaking the current budget.

The Mount Caramel fire disaster (Munich Re, 2011) that occurred at the end of 2010 is an example of event that becomes much severe due to climate change much after a long period of drought and dryness. The overall damages from the forest fire are evaluated at about 1 Billion USD (Munich Re, 2011). Unfortunately, the damages are partially covered by private insurance made by the citizens affected. In addition, some parts are covered by the Government through Kanat Foundation.

1.3.3. Climate Change adaptation and insurance

Over the past 50 years, severe weather disasters have caused some 800,000 deaths and over a trillion dollars in economic loss – and in the present decade the damage wrought by such

disasters has reached record levels. Economies in many parts of the world are already susceptible to significant disruption from today's climate – and continued economic growth could put even more value at risk. Climate change could cause significant incremental loss, even within the next 20 years. However, knowledge about future climate – particularly the local impacts of global climate change trends – is incomplete. Decision-makers will have no option but to make policy and investment choices under uncertainty (ECA, 2009)

Adaptation has become a strategic negotiation issue only recently, although UNFCCC (1992) already referred to it in Art. 2 and Art. 4. Among other things, the difficulty of implementing national and international mitigation policies and the increasing awareness of climate inertia eventually put adaptation under the spotlight of science and policy (Bosello et al., 2010). According to IPCC(2007) Mitigation and Adaptation to climate change can be defined as follows:

Climate change Mitigation:

- A human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHG), either by reducing their sources or by increasing their sinks.

Adaptation to climate change:

- Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Mitigation and Adaptation:

- Mitigation aims at avoiding the unmanageable impacts, while adaptation aims at managing the unavoidable impacts.
- Adaptation and mitigation are two types of policy response to climate change, which can be complementary, substitutable or independent of each other.
- Irrespective of the scale of mitigation measures, adaptation measures will be required anyway, due to the inertia in the climate system.

The insurance industry can have an important role to play in both of these responses (Herweijer et al., 2009). Adaptation can be identified along three dimensions (Smit et al., 2000):

- The subject of adaptation (who or what adapts)
- The object of adaptation (what they adapt to)
- The way in which adaptation takes place (how they adapt).

Insurance has a dual role with respect to adaptation. Access to insurance payouts can lessen the net adverse impact of climatic events on policy holders. At the same time, insurance is also an instrument for incentivizing adaptations aimed at reducing climate risks. Properly set insurance premiums can, in principle, send appropriate signals to policy holders to undertake adaptation measures to reduce exposure to various risks, including those posed by climate change. On the other hand, poorly designed premiums that do not adequately reflect the underlying risk can actually impede adaptation or even promote maladaptation. As climate changes and historical weather records become less useful, the insurance sector will have to develop new ways of assessing risk and spreading it away from those affected, while encouraging those at risk to adapt to the new environment (Agrawala and Fankhauser, 2008).

Insurance can play a prominent role in any adaptation strategy, covering risks, such as crop failure, snow coverage and the impact of freak weather events (e.g. floods, storms, hurricanes and heat waves). However, there are a number of reasons why its impact on adapting to climate change may be limited. First, as long as climate impacts are uncertain, insurance companies will overcharge for climate risk or refuse coverage of risks that might otherwise be insurable. Second, budget constraints, inertia and cultural factors will prevent people from adapting fully in the short term. Third, insurance cover is by no means universal. It is especially patchy among poor households and in poor countries. Public policy measures will likely be needed to overcome these market imperfections. The immediate effect of climate change will be to raise the demand for insurance products. Increased weather variability will make risk reduction a more attractive proposition. However, climate change will also increase the cost of insurance and this may curb some or all of the extra demand.

From a public policy point of view, the main issue is whether the adaptation action taken by the insurance industry results in the “right outcome“ in terms of the availability and level of cover and the distribution of risks. In an ideal scenario, competitively priced insurance products would send an accurate signal to the market about the economic cost of climate risks. Firms and households would respond to the price signal by climate proofing their businesses and homes (to reduce premiums) or, if the premium is considered too high, by relocating to a less risky area. The result would be an efficient level of insurance cover and residual adaptation (Agrawala and Fankhauser, 2008).

2. Research Question and Research Goals

The purpose of the study is to examine the implications and impacts of climate change in 2030 on the insurance market and the Israeli economy.

The study will carry out an assessment of the predicted consequences of climate change on the Israeli economy in the medium-long term by 2030. The research is based on unique insurance market model in light of anticipated climate changes over the medium-long term by 2030. The study is focused on consequences of climate changes according to "Business as Usual" scenarios by year 2030 on insurance, energy, water and agriculture markets, other industries, and the relationship among them and private and public consumption, employment, investments and foreign trade.

The proposed model is the General Equilibrium Model (GEM) which is the appropriate analytical tool most commonly used for such analysis. The study proposed model uses a dynamic general equilibrium computer (Israeli General Equilibrium Model - IGEM) adapted to describe the Israeli economy. The model yields a quantitative assessment of changes in prices, quantities, and costs for the economy in a situation of non-reduction of greenhouse gas emissions to 20 years to come.

The study focused on a main research question: What are the expected climate change costs caused by the overall economy as a result of the insurance costs (direct costs and indirect costs) and how to minimize. Insurance costs are expected to arise due to several sources:

1. Designated taxes dedicated to insurance in the annual government budget
2. Direct insurance premium for Israeli private insurance companies and foreign international reinsurance companies. (Note: The insurance premium will be determined individually depending on the insured's risk assessment).
3. Governmental-Private insurance fund for emergency response in the case of current annual budget breakthrough.

The objective of this study is to examine the overall market-costs as a result of adopting a common government-private policy in establishing an insurance response to natural disasters resulting from climate change.

3. Methodology

The research is based on the methodology developed by Bosello and Roson (2007) with modifications to employ the Israeli General Equilibrium Model (IGEM), developed specifically for the Israeli economy-wide analysis, called: the dynamic CGE model for the Israeli economy.

This methodology is superior to conventional estimation techniques, in terms of consistency, reliability and theoretical foundations. The study is focused on consequences of climate changes according to "Business as Usual" scenarios by year 2030 on insurance, energy, water and agriculture markets, other industries, and the relationship among them and private and public consumption, employment, investments and foreign trade.

As opposite to other researches that focus on one sector solely and ignore the macro-economic relationships, this study evaluates the economy-wide costs of the Israeli economy as a result of climate change. All impacts are considered simultaneously and consistently, analyzing transformations in relative competitiveness, trade and capital flows, and consumption patterns. The study forecasts the changes in consumer behavior, industrial production, employment, social welfare and gross domestic product.

A general equilibrium model is an economic model, based on the underlying economic theory of general equilibrium. A state of general equilibrium is a state in which the following conditions hold (Mansfield, 1991):

1. Every consumer chooses a consumer basket subject to a budget constraint, which is determined by the prices of inputs and the prices of products.
2. Every consumer supplies whatever amount of inputs he or she chooses, given the inputs of product prices that prevail.
3. Every firm maximizes profits subject to a budget constraint imposed by the available technology, the demand for its products, and the supply of inputs in the long run. How ever economic profits are zero.
4. The quantity demands equals the quantity supplied at the prevailing prices in all product and input markets.

The fundamental conceptual starting point for a CGE model is the circular flow of commodities in a closed economy, shown in figure 3 (Wing, 2004). The main actors in the diagram are households, who own the factors of production and are the final consumers of produced commodities, and firms, who rent the factors of production from the households for the purpose of producing goods and services that the households then consume. Many CGE

models also explicitly represent the government, but its role in the circular flow is often passive.

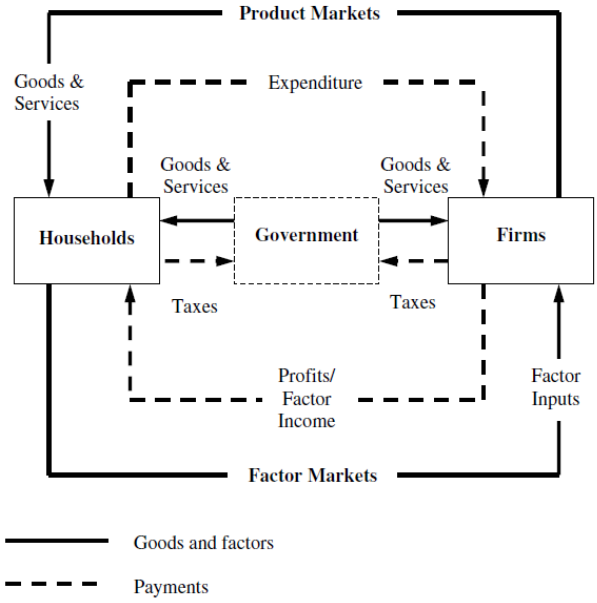

Figure 3: The Circular Flow of Economy

Our research is based on the first energy-environment-CGE model for Israel with specific detail in the area of taxation (Palatnik and Shechter, 2008). It is a structural, real, static model of a small open economy with four energy commodities, 14 other commodities, a government, an investment agent, a foreign agent and a single representative household. It incorporates energy flows among producers and between producers and consumers. CGE models are simulations that combine the abstract general equilibrium structure formalized by Arrow and Debreu with realistic economic data to solve numerically the levels of supply, demand and price that support equilibrium across a specified set of markets. CGE models are a standard tool of empirical analysis, and are widely used to analyze the aggregate welfare and distributional impacts of policies whose effects may be transmitted through multiple markets, or contain menus of different tax, subsidy, quota or transfer instruments. Examples of their use may be found in areas as diverse as fiscal reform and development planning (Perry et al., 2001), international trade and environmental regulation (Weyant 1999, Goulder 2002). Kremers et al. (2002) provide a survey of CGE models for climate change policy analysis.

The general structure of this computable general equilibrium model is a familiar one which has been used frequently in a number of applications, including the analysis of the effects of greenhouse gas emissions restrictions, as noted above. The standard assumptions of market

clearing, zero excess profits and balanced budget for each agent apply. Commodity markets merge primary endowments of households with producer outputs. In equilibrium the aggregate supply of 10 each good must be at least as great as the total intermediate and final demand. Producer supplies and demands are defined by producer activity levels and relative prices. Final demands are determined by market prices. The model is calibrated to the benchmark data. A less common feature is the separation of activities from commodities which permits activities to produce multiple commodities, while any commodity may be produced by multiple activities. In addition the model allows to export the imported commodities adopting the Armington assumption. It is assumed that the economy is in equilibrium in the benchmark. A policy simulation is implemented as a 'counter-factual' scenario, which consists of an exogenous set of shocks to the system. The model output shows the state of the economy after all markets have reached a new equilibrium, i.e., we conduct a comparative-static analysis.

A firm can choose the quantity of each of the commodities it can produce. The output is divided among the produced commodities with a CET (Constant Elasticity of Transformation) function, where the elasticity of transformation is equal to zero for all industries. This perfectly inelastic function ensures that the shares of commodities produced, in terms of quantity, remain the same during all simulations.

The static CGE model was upgraded to dynamic CGE model with matching to the Israeli economy. This dynamic model, called: ICES, derived from research work of Eboli, Parrado and Roson (2009) based on the extension of a static CGE model presented to the Israeli economy by Palatnik and Shechter (2008). There are references in the literature of dynamic economic models. For example: Dellink et al. (2004) and Bovenberg & Heijdra (1998) describing a dynamic model to reduce environmental pollution.

ICES (Inter-temporal Computable Equilibrium System) is a recursive dynamic general equilibrium model developed with the purpose to assess the final welfare implication of climate change affects regional and world economies (FEEM ICES Website). As in every computable general equilibrium (CGE) model, its general equilibrium structure - in which all markets are interlinked - is tailored to capture and highlight the production and consumption substitution processes at play in the social-economic system as a response to climate shocks. In doing so, the final economic equilibrium determined, takes into account explicitly the autonomous adaptation of economic systems. The idea behind ICES is to provide a climate change impact assessment tool that can go beyond the simple quantification of direct costs, thus offering an economic evaluation summarizing second and higher-order effects. In addition to climate-change impact assessment, the model can be used to study mitigation and

adaptation policies as well as different trade and public-policy reforms in the vein of conventional CGE.

On the economic context, the model accounts for intersectional factor mobility, international trade and also international investment flows allocated by a global financing entity. By taking advantage of the database from the Global Trade Analysis Project (GTAP) the model offers a flexible regional and sectorial disaggregation, which allows the analysis of climate effects at a global and regional scale. The model's dynamic is driven both by exogenous and endogenous sources. The first source stems from exogenously imposed growth paths for some key variables – population, labor stock, labor productivity, land productivity. The values for these variables are taken from available statistics and projections from other modeling exercises. The second source concerns the process of capital accumulation. Capital stock is updated over time in order to take into account endogenous investment decisions: capital goods are allocated among different regions in such a way that the current rate of return to capital grows at the same pace with the global rate of return.

In accordance with the extension of the static model to the dynamic model, the household's problem representation, to maximize the benefits is:

$$max \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho}\right)^{t} \mathrm{U}(c_t)$$

When:

t - a period of time

$\mathrm{U}(c_t)$ - utility function in t

c_t - consumption in t

ρ - parameter of personal preference

There are two constraints to consider them while finding a maximum of benefits:

1. Total output of firms in each period is divided into consumption of households or investment.

$$c_t = F(K_t, L_t) - I_t$$

When:

$F(K_t, L_t)$ - The firm's production function

K_t - Shareholders in period t

L_t - Work in period t

I_t - investment in period t

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2. There is a decline in the capital value between periods at a constant rate of δ (depreciation).

$$K_{t+1} = K_t(1-\delta) + I_t$$

As a result from these changes, all three conditions of general equilibrium - discounting all markets, normal profit, and balanced budget now begin to be dependent on time. Static model can be solved for each period based on Paltsev (2004). In that way the future general equilibrium can be forecasted.

4. Discussion and Summary

The research is based on the Palatnik and Shechter (2009), the first static general equilibrium model (CGE) for the Israeli economy, called: IGEM (Israeli General Equilibrium Model). In that study, the effects of economic incentives to reduce emissions of carbon dioxide (CO_2) were analyzed. The modified model is based on a dynamic model used to assess policy instruments to reduce greenhouse gas emissions in Israel. In our research, the model is upgraded to a dynamic model for evaluation of the effects of climate change on the insurance industry and the Israeli economy and in order to define the scope of route discovery of medium-long term of economic effects (2030).

The structure of the model emphasizes the insurance industry, water management, agriculture and useful energy as factors affecting and affected by climate change. This is a realistic structural model of a small open economy, which includes insurance industry, energy, agriculture and water, and other markets of the economy, as well as the government, the investment sector, foreign trade and private consumers. The model combines energy flows between producers themselves and between producers and consumers. The model is based on the economy is in equilibrium in all markets. The various scenarios are examined external shock as a result of predicted climate change. The model results will gauge the impact of changes expected by 2030 (according to existing models and forecasts on the basis of existing information) under a scenario of "Business as Usual" on the insurance market, GDP, employment and other economic performance measures of the economy by the year 2030. This assessment is carried out under a scenario of "Business as Usual".

The research is a comprehensive study and multidisciplinary. The study includes thorough analysis of all relevant economy costs, especially the insurance industry, to be implemented in case of climate change projections until 2030. The study reviews existing information about

the effects of climate change in Israel, which is being translated to economic influence parameters that are the parameters affecting the IGEM. In addition, the Israeli economy development is built without climate change expected to serve as a benchmark. With relation to this benchmark, a climate change parameter (for one or more economy key variables) is updated for testing how to the main economic indicators were changed according to the methodology developed by Bosello and Roson (2007).

The innovation of the research is the ability to assess the overall Israel economy costs as a result of expected climate change, compared with other studies performed that allow assessment of changes in one specific link, ignoring macroeconomic connections. The research allows quantitatively assessment of the economic damage expected climate change, and through the results determine the volume of changes in consumers behavior in insurance industry, water, energy, agriculture and other industries, employment, social welfare and GDP.

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Acronyms

CET - Constant Elasticity of Transformation

CO_2 – chemical formula of Carbon dioxide

CVM - Contingent Valuation Method

FEEM - Fondazione Eni Enrico Mattei

GEM - General Equilibrium Model

GDP – Gross Domestic Product

GHG – Greenhouse Gas

GNP – Gross National Product

GTAP - Global Trade Analysis Project

ICES - Inter-temporal Computable Equilibrium System

IGEM - Israeli General Equilibrium Model

IPCC - Intergovernmental Panel on Climate Change

NIS – New Israeli Shekel

TCM – Travel Cost Method

USD – US Dollar