Macroeconomic and Distributional Implications of Shocks and Policies Affecting the Provision of Environmental Goods and Services: A Modeling Approach.

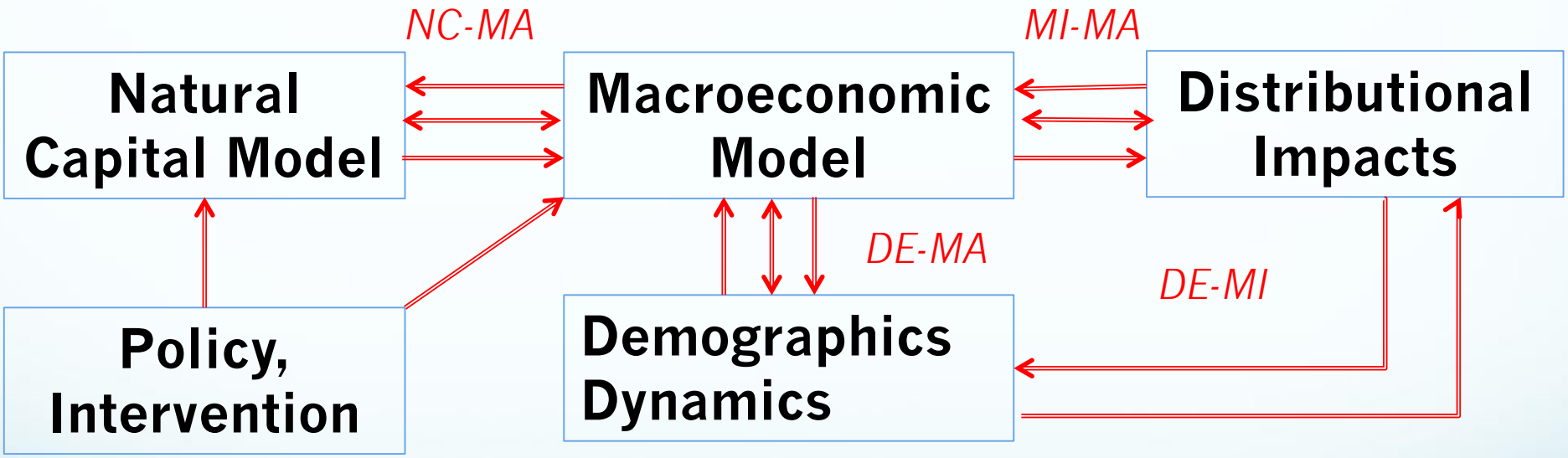
Leonardo Garrido
Senior Research Consultant for the World Bank Group

Prepared for Workshop on Green Growth Modeling.
Advanced Systems Analysis (ASA) and Risk and Resilience (RISK),
International Institute for Applied System Analysis (IIASA).
Schloss Laxemburg, Austria. July 18th, 2017

Agenda

- Conceptualization
- Ecological Models
- Macroeconomic Models
- Micro, Distributional Impacts Models
- Demographics
- Model Examples

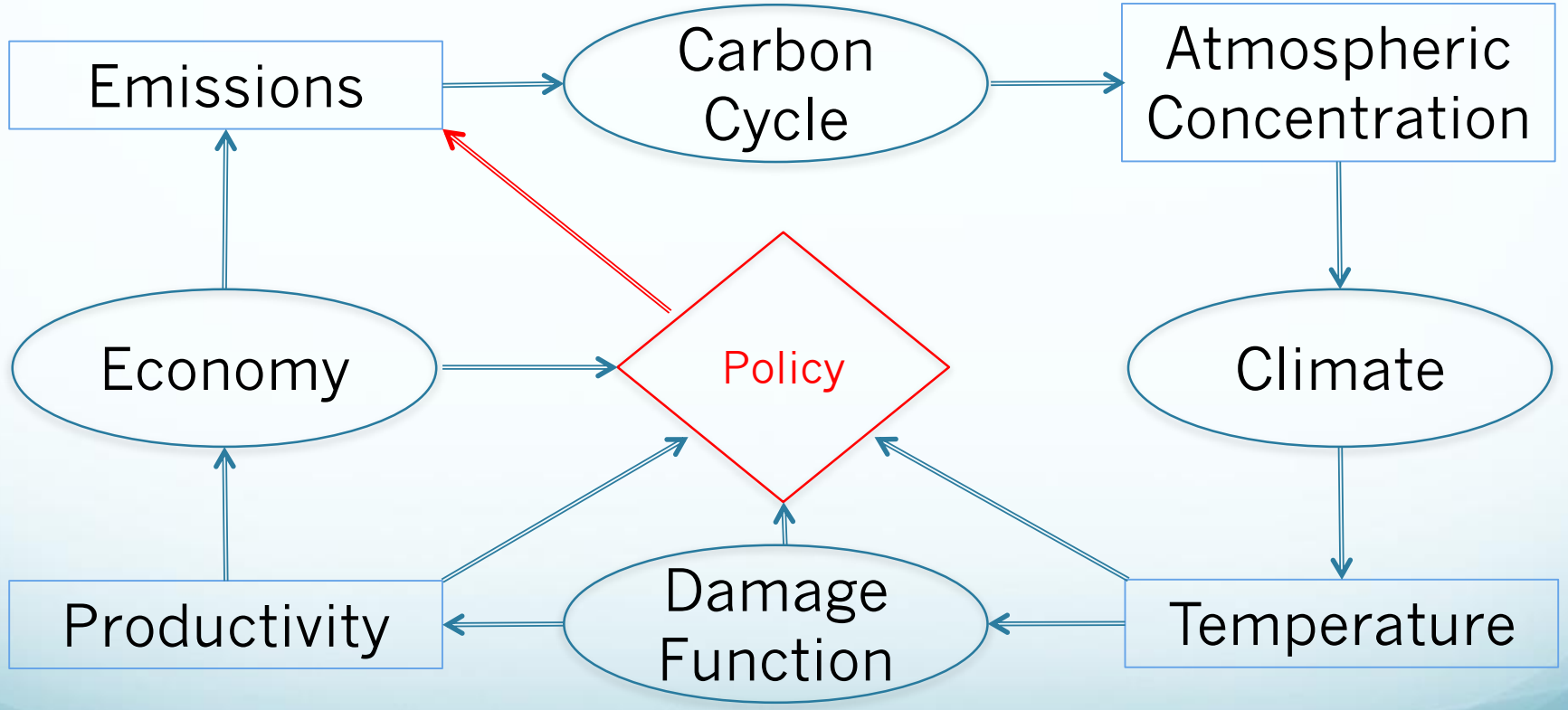
Thinking About Models for Linking Natural Capital and the Socio-Economic



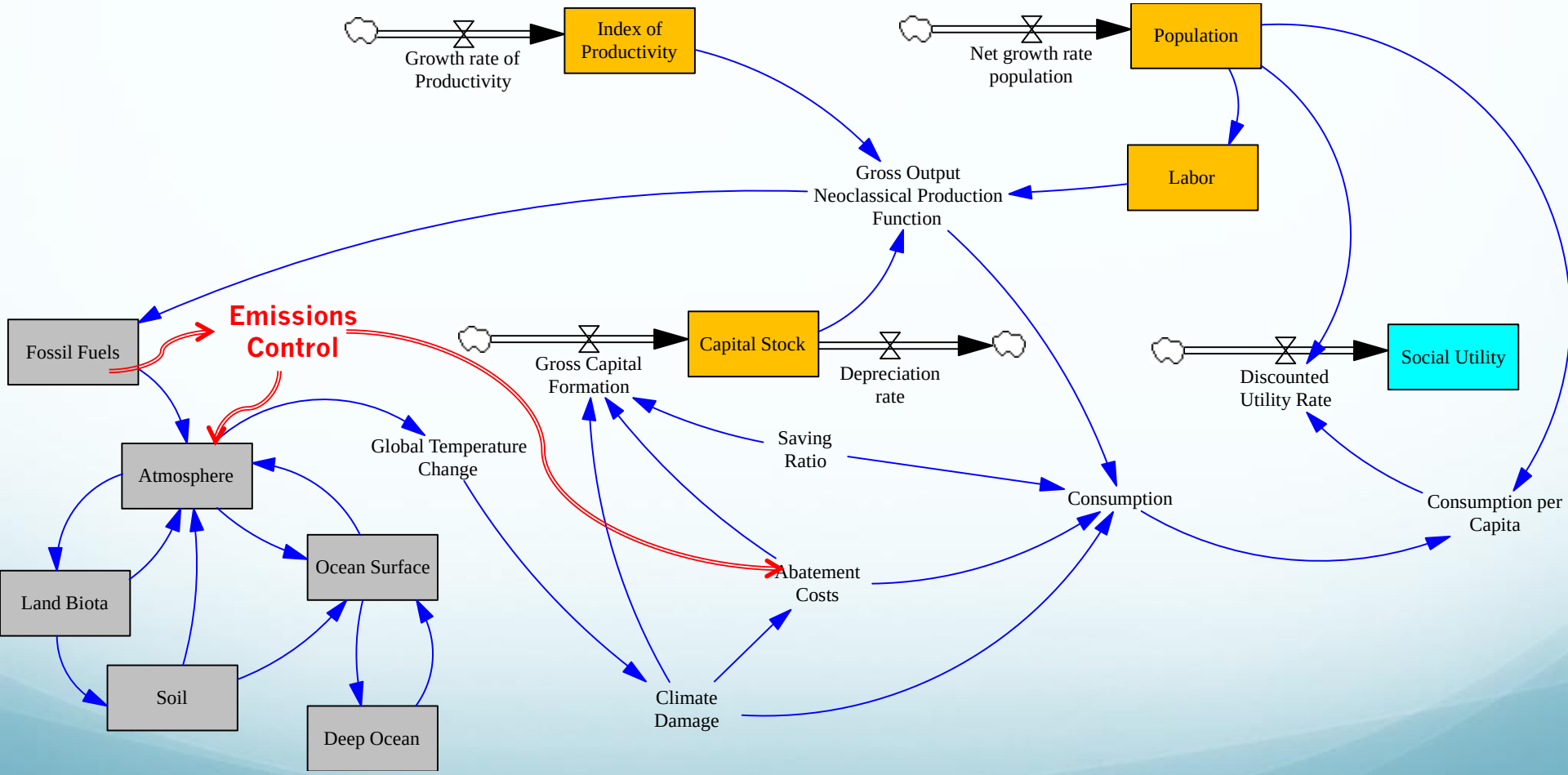
Linking Natural Capital and the Macro Economy

- **NatCap → Macro** : Impacts of Natural Capital Depletion, Pollution, Emissions on Factor Productivity, Input and factor supply (e.g. Jorgeson IGEM)
- **Macro → NatCap** : Impacts of Economic Activity on Pollution, Emissions, Natural Capital Depletion
- **NatCap → Macro**: Integrated Assessment Methods (e.g. Nordhaus DICE, RICE Models; World Bank's ENVISAGE)

Feed Backs: Economy and Climate

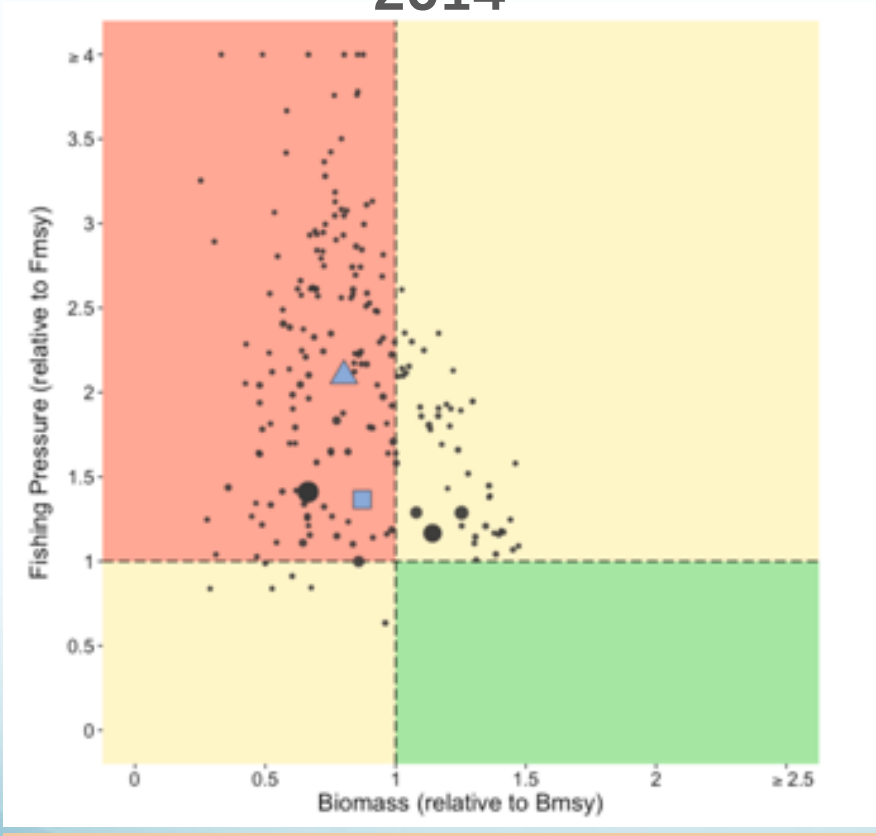


High Schematic Diagram for DICE Model



Ecological Model

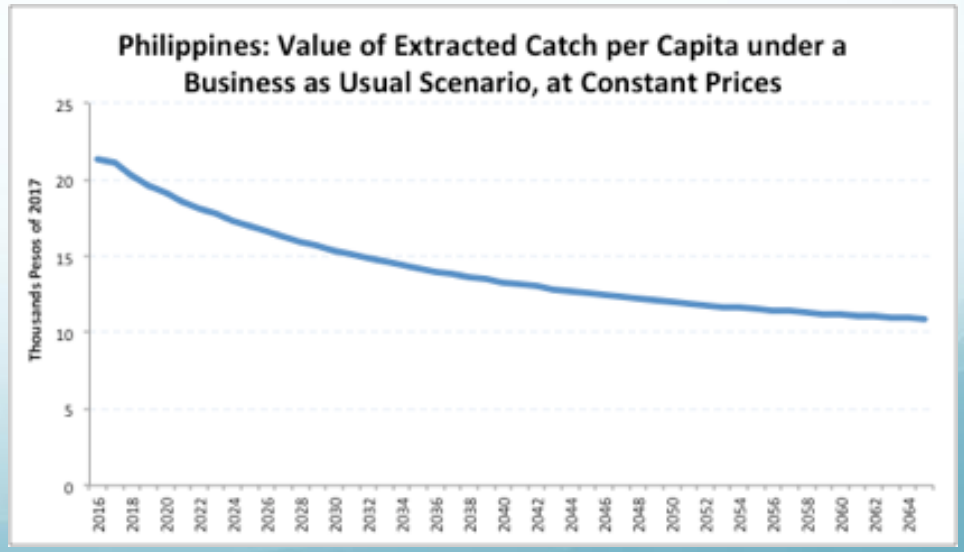
Kobe Process. Philippines, 2014



https://www.bloomberg.org/program/environment/vibrant-oceans/
https://www.rare.org/our-work#.WWnv-0u5uUc

SUSTAINABLE FISHERIES GROUP
UC SANTA BARBARA
rare

- Bio-economic modeling framework
- Vibrant Oceans Initiative



Ecological Model

InVEST

integrated valuation of ecosystem services and tradeoffs

- Carbon
- Coastal Vulnerability
- Crop Pollination
- Fisheries
- Habitat Quality
- Habitat Risk Assessment
- Malaria
- Marine Fish Aquaculture
- Marine water quality
- Offshore wind energy
- Water purification

https://www.naturalcapitalproject.org/invest/

Macro Model

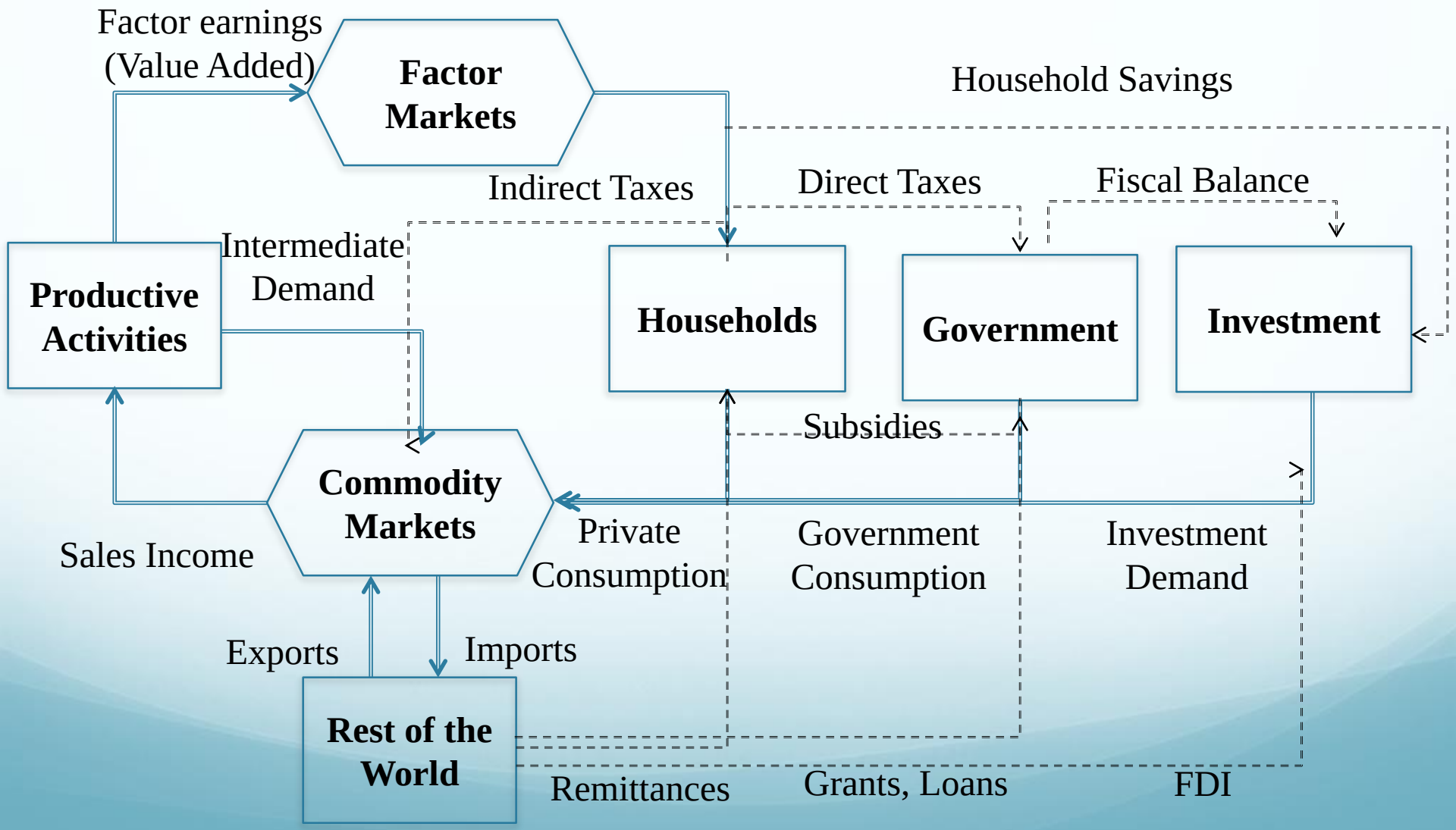
	Simple	Complex
Orthodox	• SAM, I-O Multiplier • Neoclassical Growth Model	• CGE Model (Static, Dynamic) • Large-scale macro-econometric model
Heterodox	• Simple SysDyn • Simple ABM	• System Dynamics • Agent-based, computational models

Continued Reliance on Social Accounting Matrices for Registering Economic Transactions Across Sectors, Institutions and Factors of Production

	ACTIVITIES	COMMODITIES	FACTORS	INSTITUTIONS
ACTIVITIES		DOM SUPPLY		
COMMODITIES	I-O			DEMAND
FACTORS	VALUE ADDED			
INSTITUTIONS	SUBSIDIES	INDIRECT TAX, IMPORTS	FACTOR PAYMENT TO HH	DIRECT TAX, TRANSFERS, SAVINGS, CAB

- At one point in time (Does not pick up changing technologies, supply / demand relationships)
- Not all factors of production included (Labor, Capital, Sometimes Land)
- Retains all faults and weaknesses attributed to national accounts to deal with natural phenomena

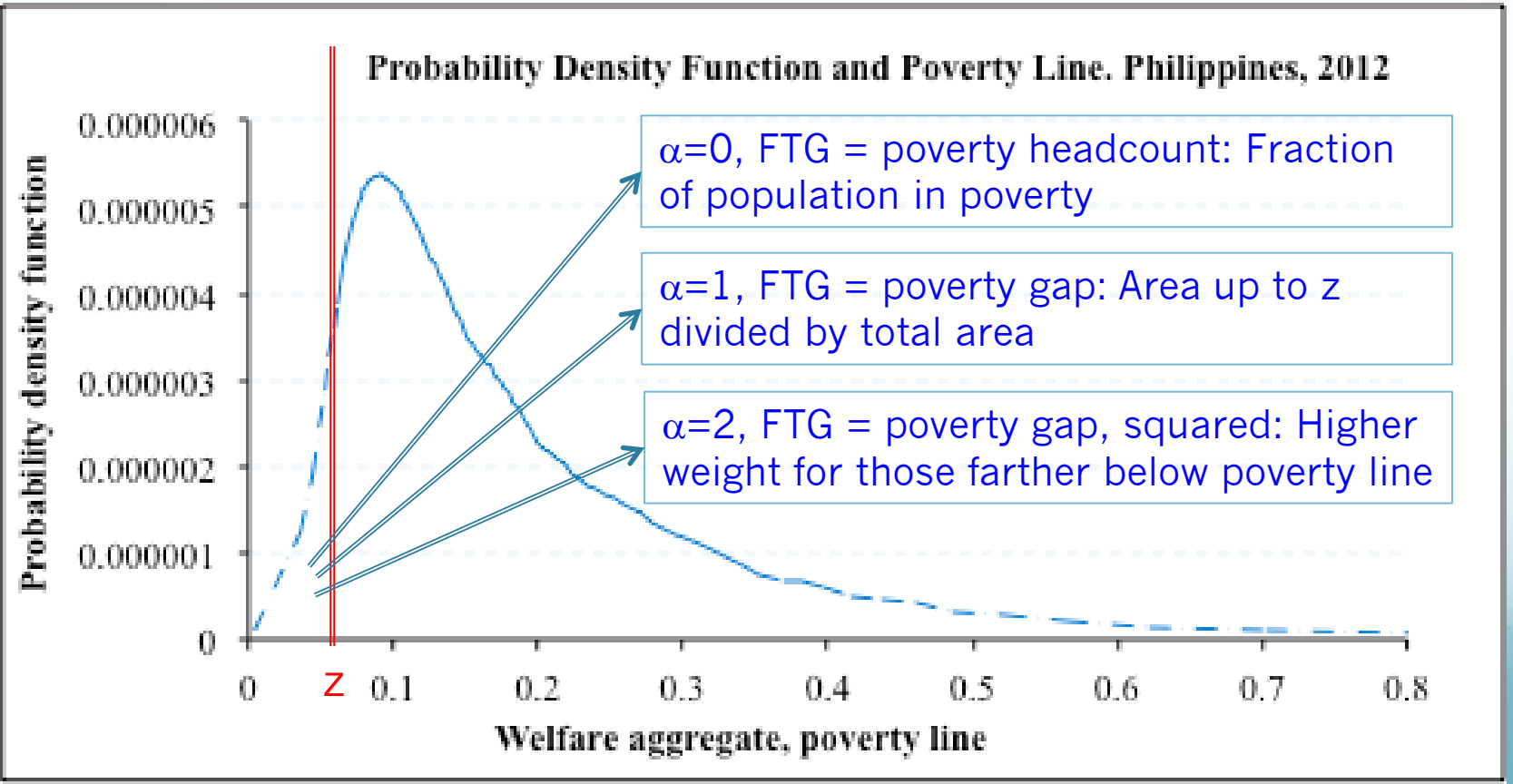
Circular Flow Diagram



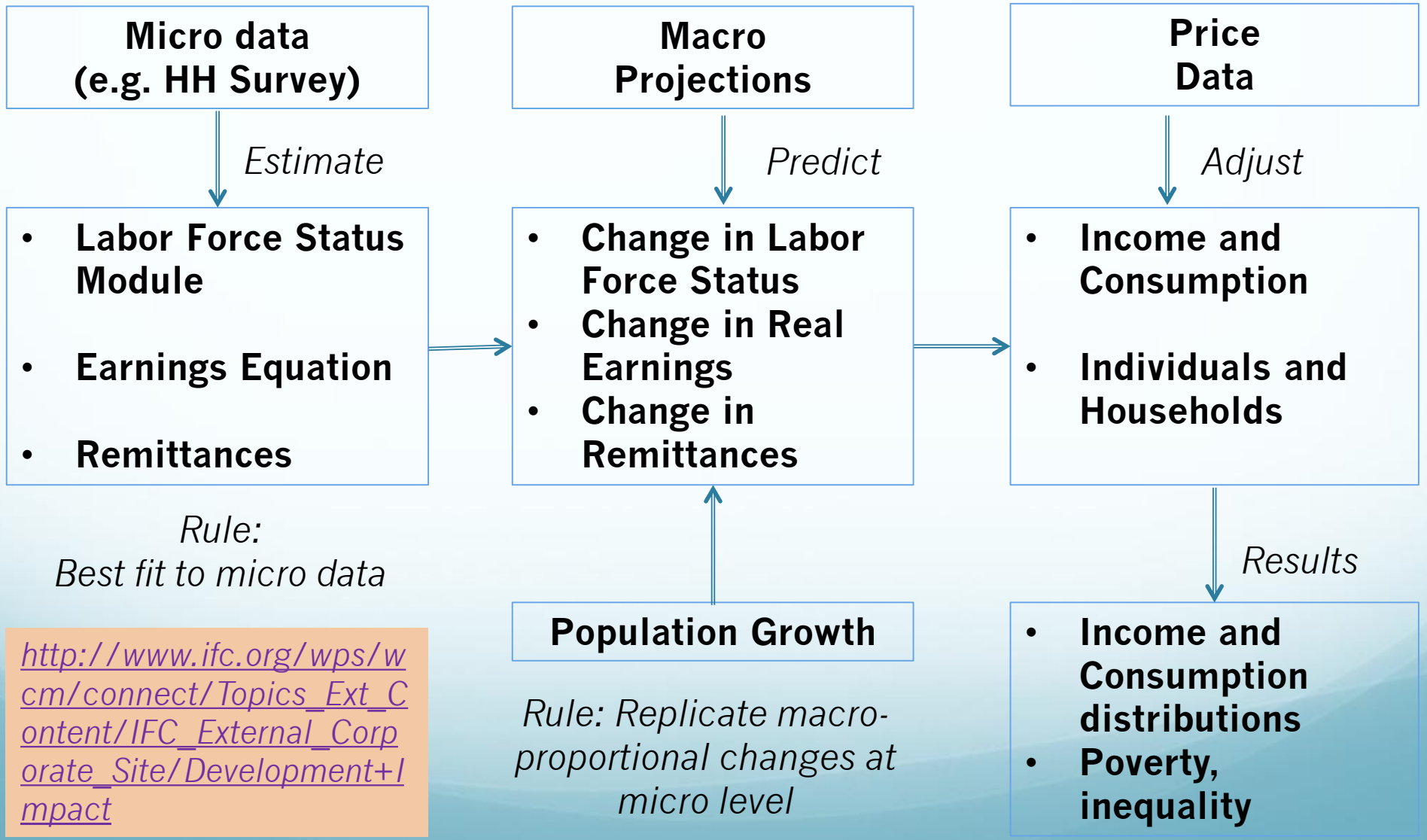
Welfare Considerations as Ultimate Goals for Modeling Process

$$FTG_\alpha = \frac{1}{N}\sum_{i=1}^{H}\left(\frac{z - y_i}{z}\right)^\alpha$$

N = Total population
z = Poverty line ($$)
y_i = Income of HH or individual
H = Number of poor (number of people with y_i<z)

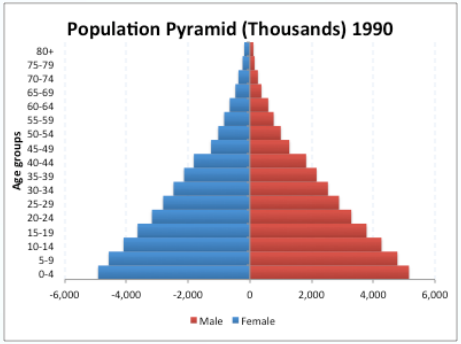


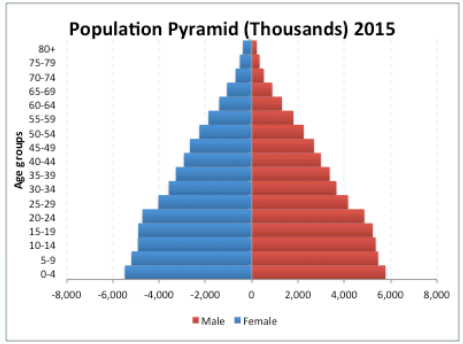
Poverty and Distributional Impacts. Top-Down Approach: ADePT Simulation

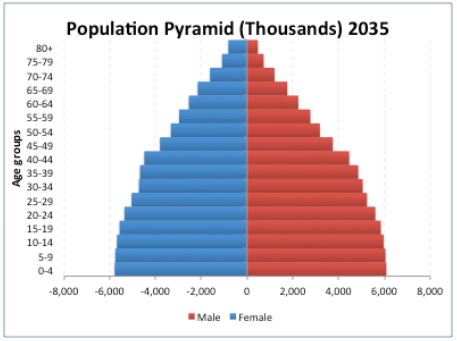


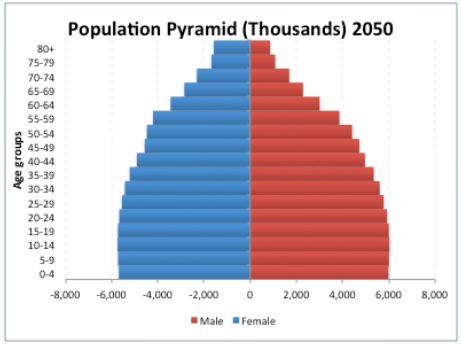
Demographics

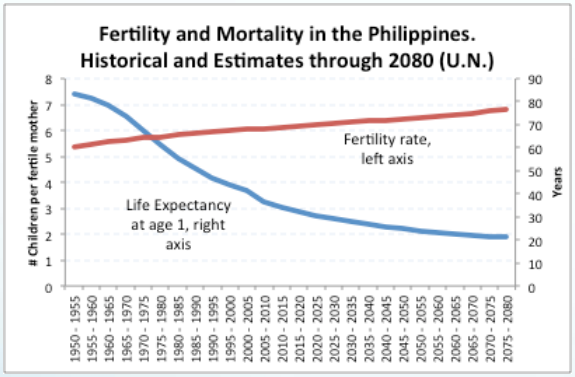
(Example from the Philippines, based on UN Estimates)

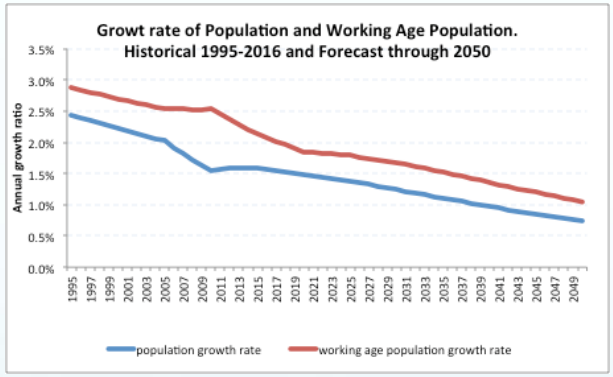


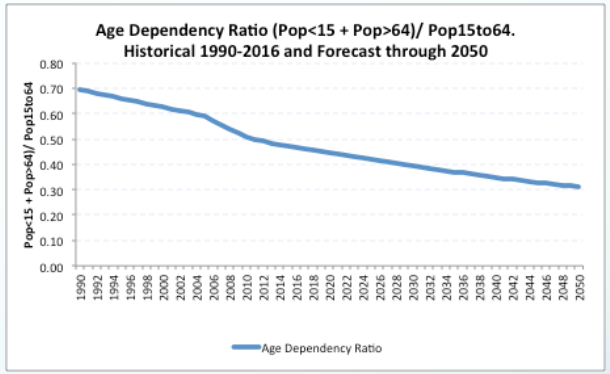








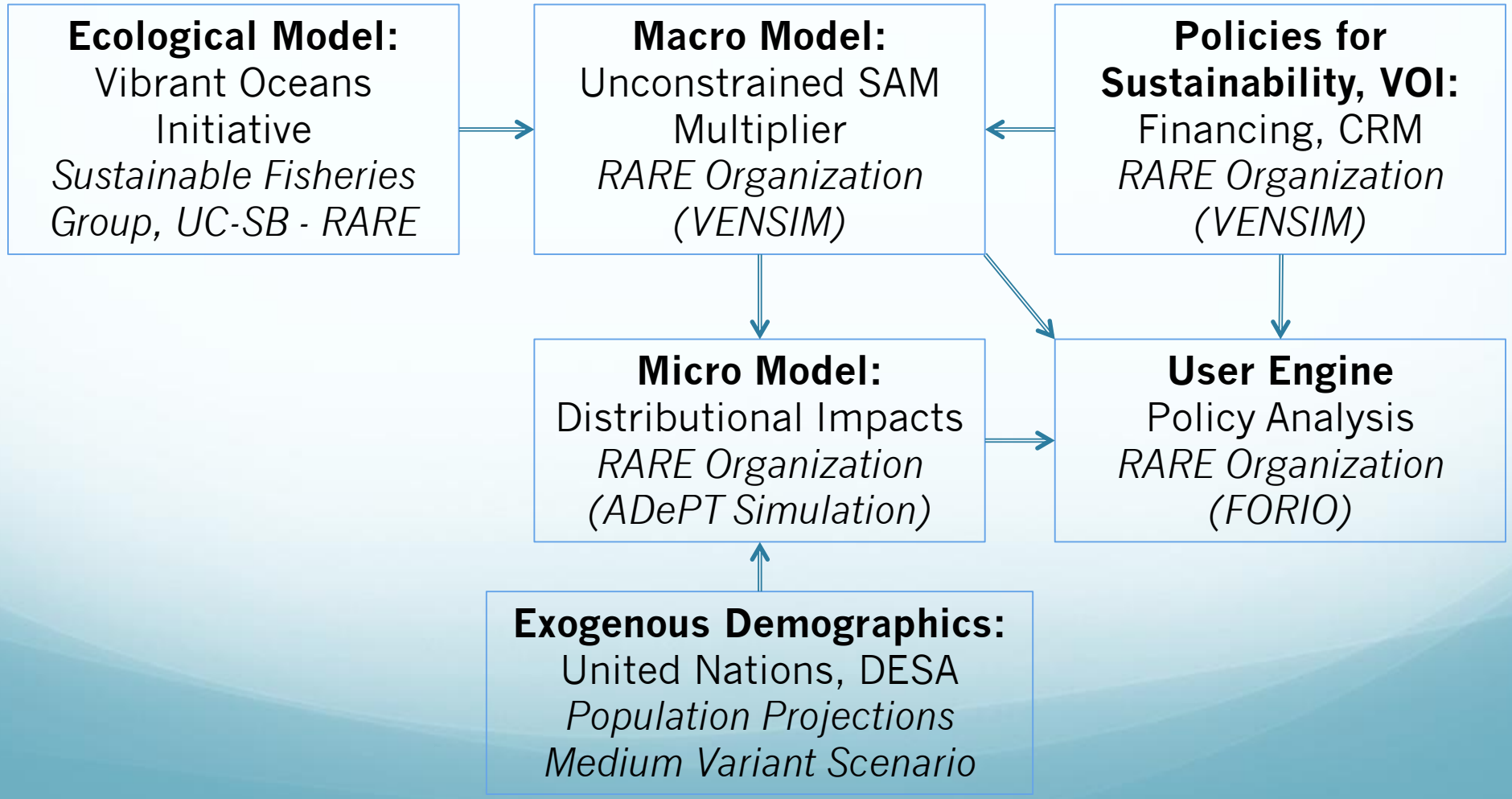




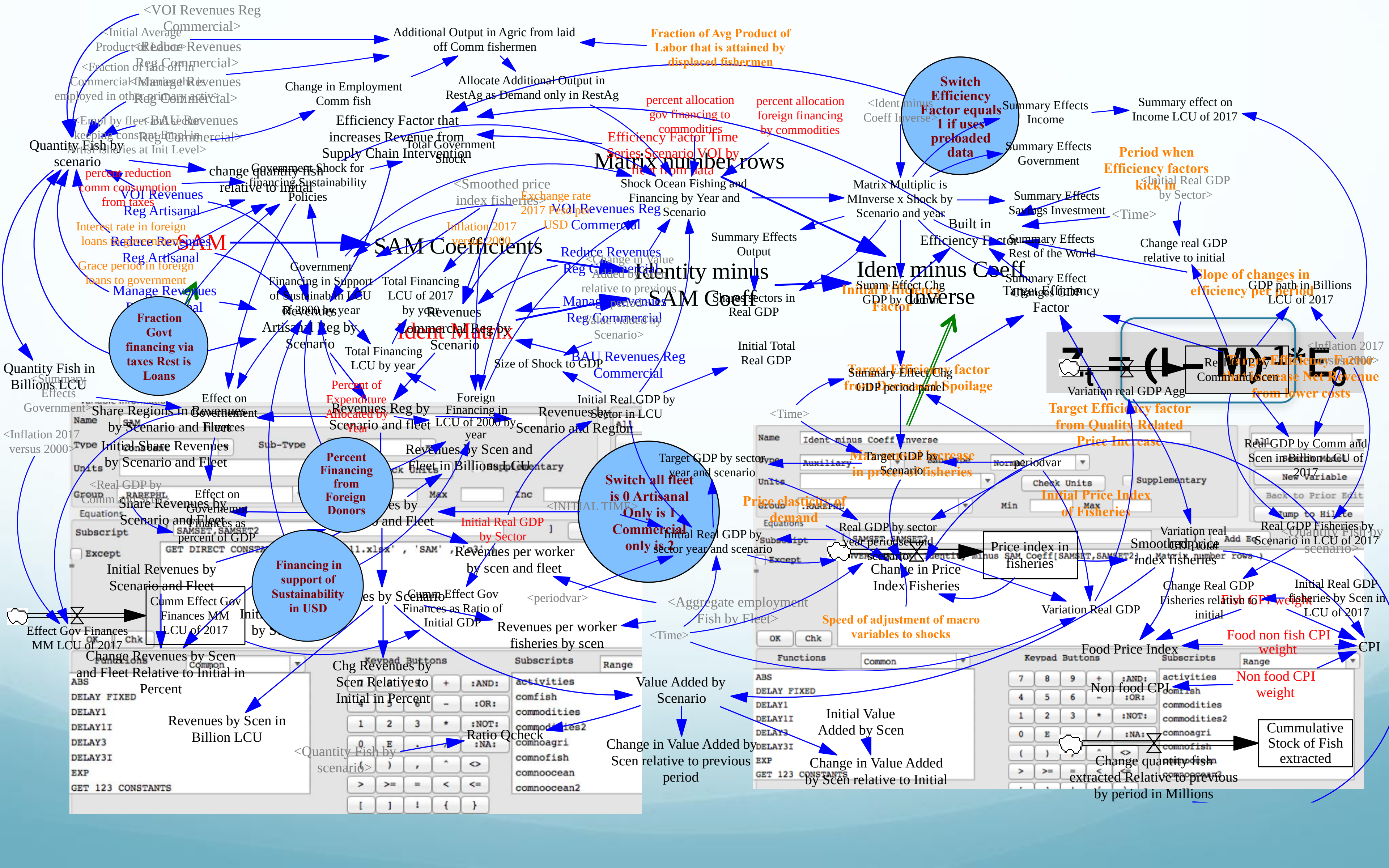
An ongoing Demographic, affects the age structure of population and dependency ratios has important implications about the supply of labor and employment dynamics:

- Demographic Dividend in Developing Countries
- Post Transition - Aging in Advanced Economies

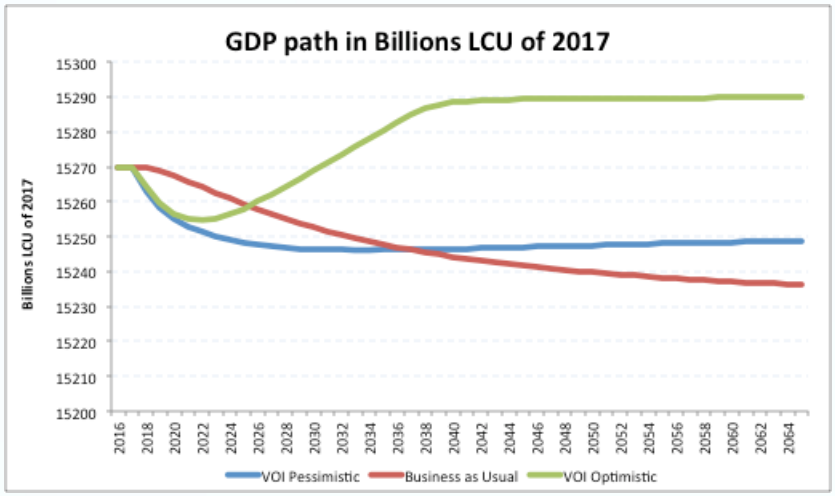
A Model for Socio-Economic Analysis of Policies for Sustainability of Fisheries in the Philippines

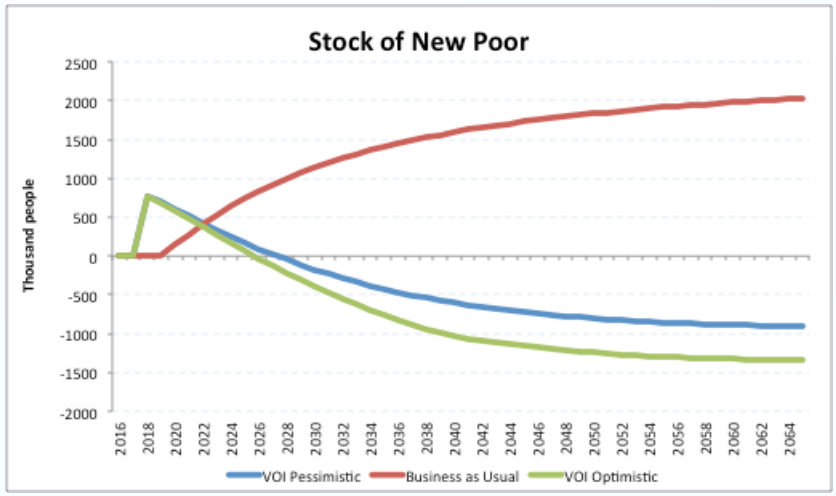


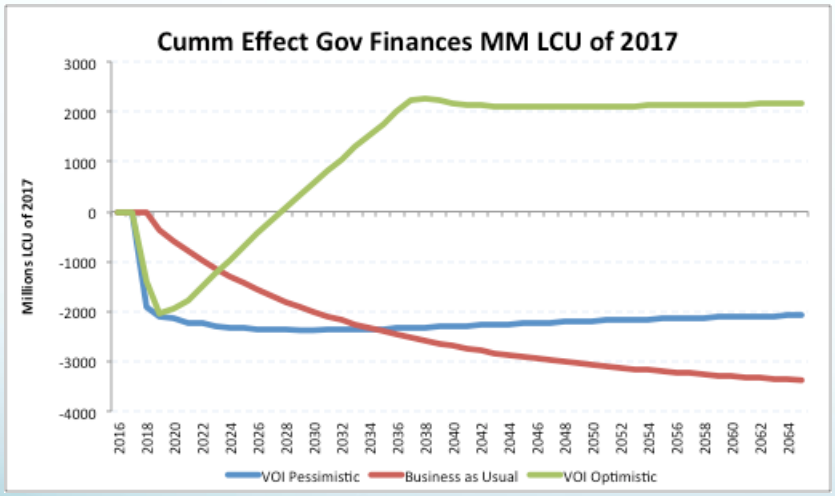
The Model in VENSIM

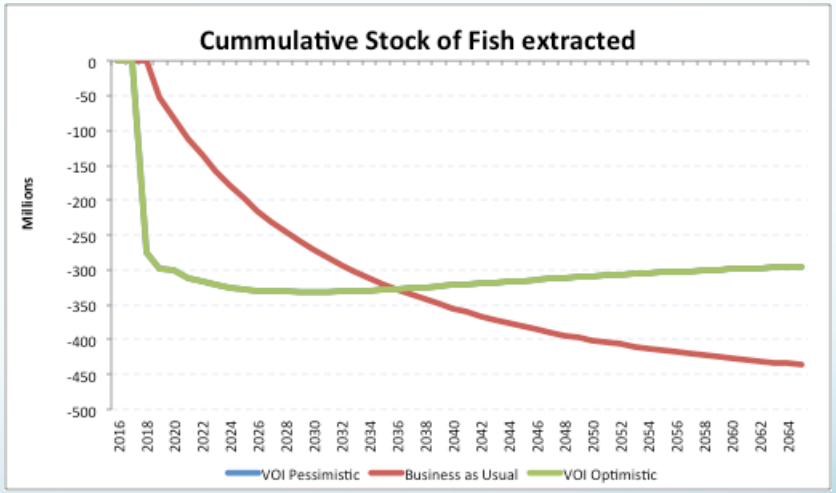


Outputs from Socio Economic Model



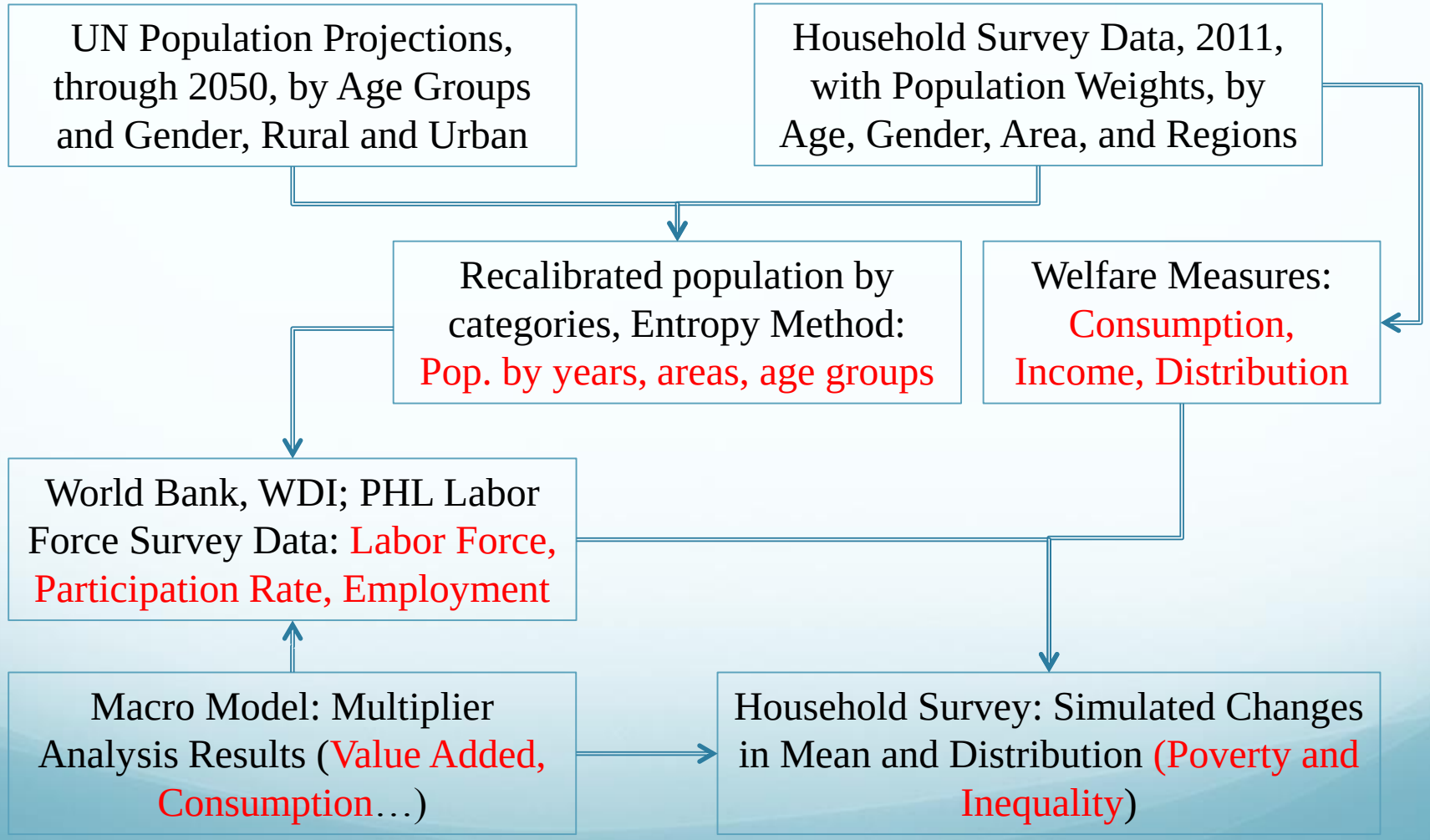




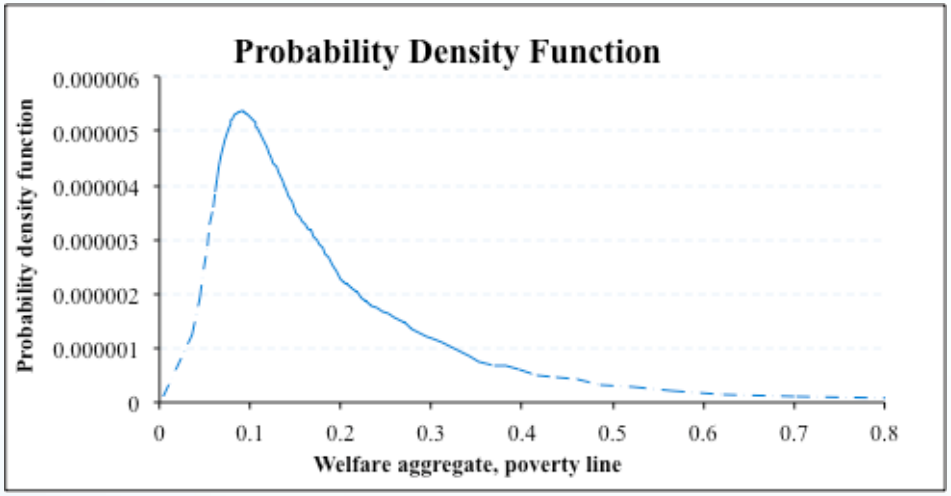


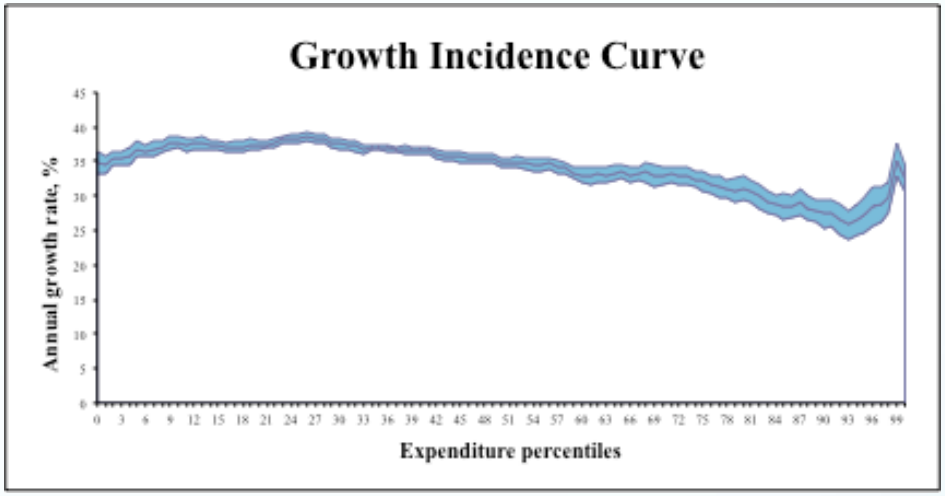
- BaU: Do Nothing, Over-fishing
- VOI Pessimistic: Sustainable fishing, no VOI Financing, no Efficiencies
- VOI Optimistic, Sustainable fishing, VOI financing, Efficiencies

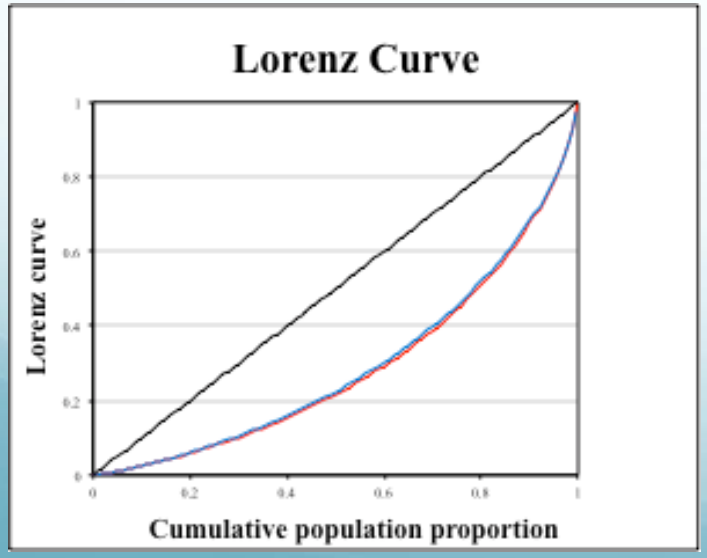
Distributional Impacts Model



Some Outputs from ADePT Simulation

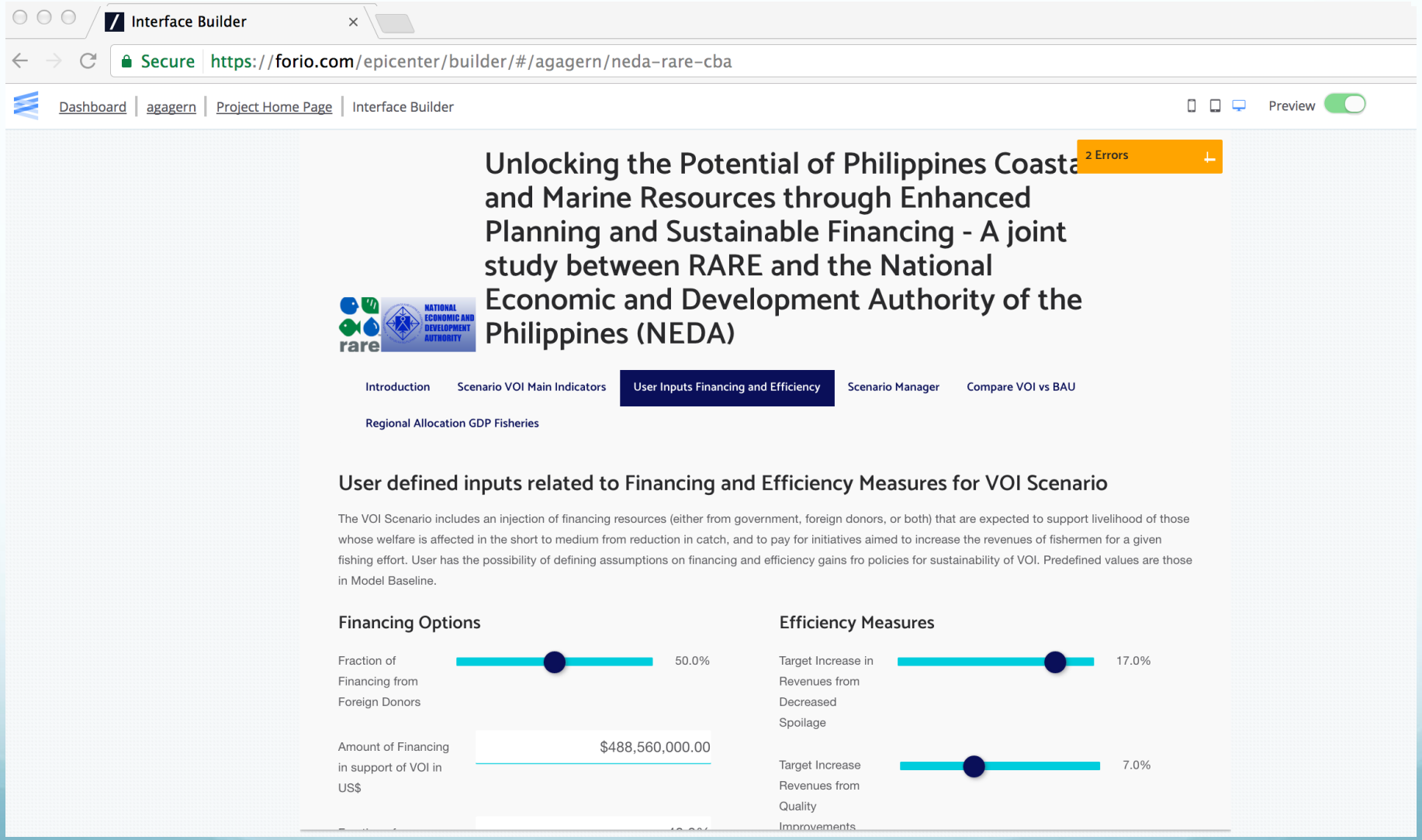






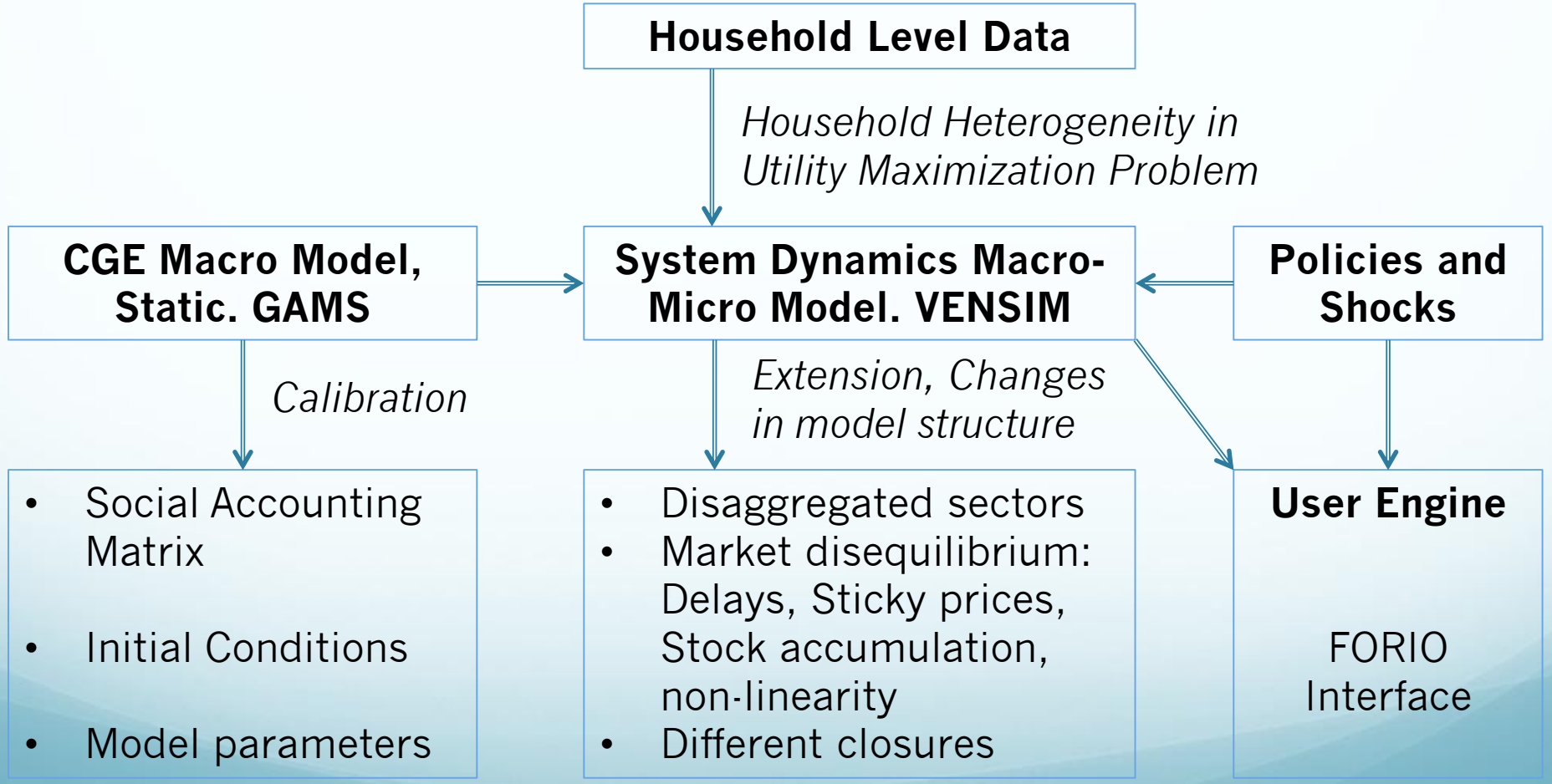
	Poverty Headcount Rate			Poverty Gap		
	PHL2006	PHL2012	Change	PHL2006	PHL2012	Change
Poverty line = poverty line in local currency per month. Equivalent to 1.9*365/12 = 57.7917 $/m						
Urban	5.4	4.8	-0.6	1.2	1.0	-0.1
Rural	26.9	20.1	-6.9	6.4	4.6	-1.8
Total	16.3	13.2	-3.1	3.8	3.0	-0.8

User Friendly Interface for Policy Analysis



https://forio.com/epicenter/builder/#/agagern/neda-rare-cba

A Model for Ex-Ante Analysis of Shocks and Development Policies in Ethiopia



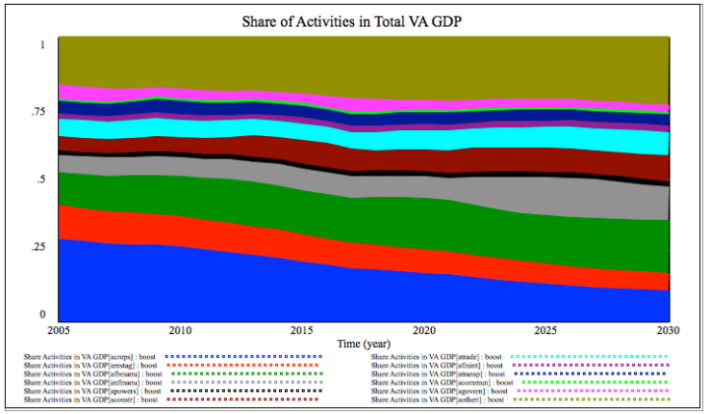
Main Features of Model

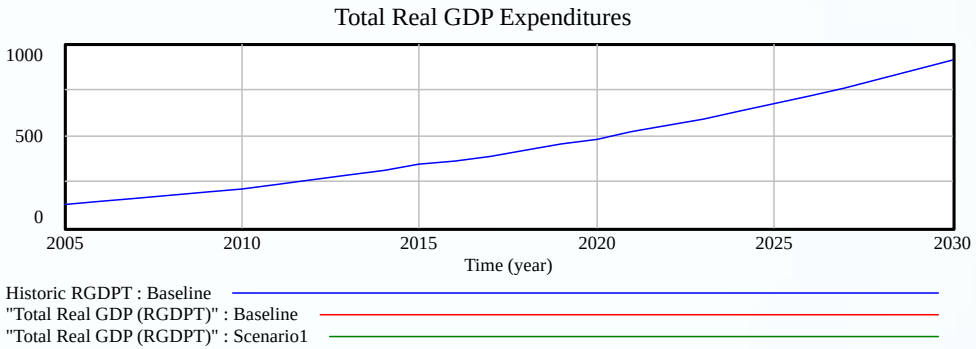
Static CGE Model	System Dynamics Model (Changes CGE)
HH Utility Maximization (Stone Geary)	Sticky Prices, elasticities
Firms take demand as given, Maximize Profit	Stock accumulation (inventories by tradable commodities)
12 activities, commodities	Full developed sectors
Open Economy, Armington, CET	(Exogenous) Changes in Price of X, M
Government collects taxes, spends	Debt accumulation
Different closures: Savings – Investment; RER – Foreign Savings	Additional closure to Model: Restricted vs unrestricted Government Expenditure
Model calibrated to SAM values	Dynamic calibration to historical period
Micro-Macro linkages from SAM, HH data (Replicate Consumption by Commodity, Income)	Top-Down, Bottom-Up model results emerge from feed-back structures, calibration rules, closures and scenarios

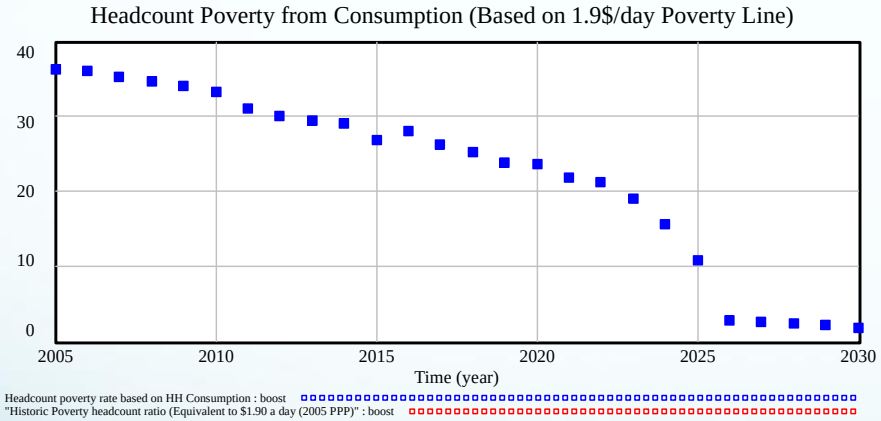
Using Ethiopia Model for ex-ante assessment of policies as shocks

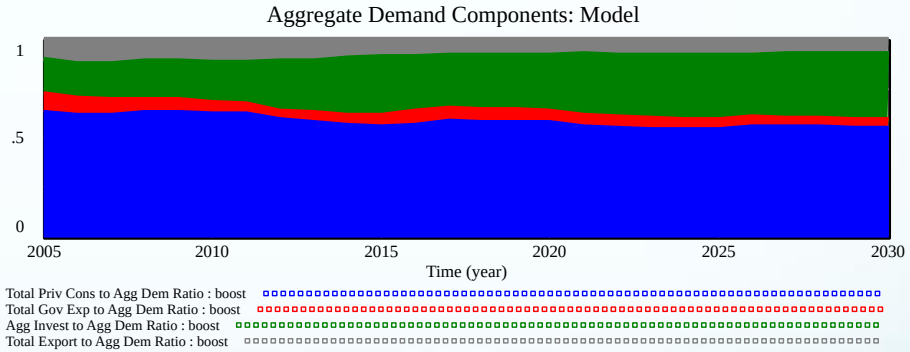
- For assessing expected impacts of policies included in Ethiopia Long Term Development Plan
- Model versatile to “connect” to fully fledged sectors (Including agriculture), modules linked to provision of environmental goods and services
- Convenience of carrying on policy, shock analysis with Tod-Down, Bottom-Up structures, under a consistent Macro-Micro framework and given “rules” or “closures”
- Model amenable to compute several indicators included among Sustainable Development Goals

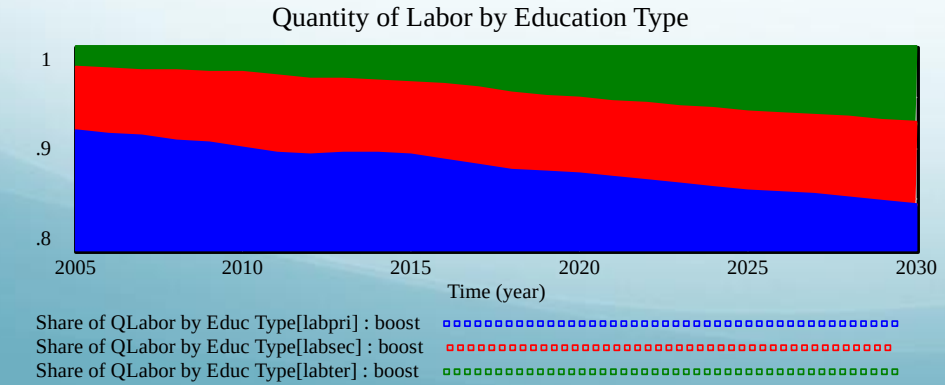
Some Preliminary Charts

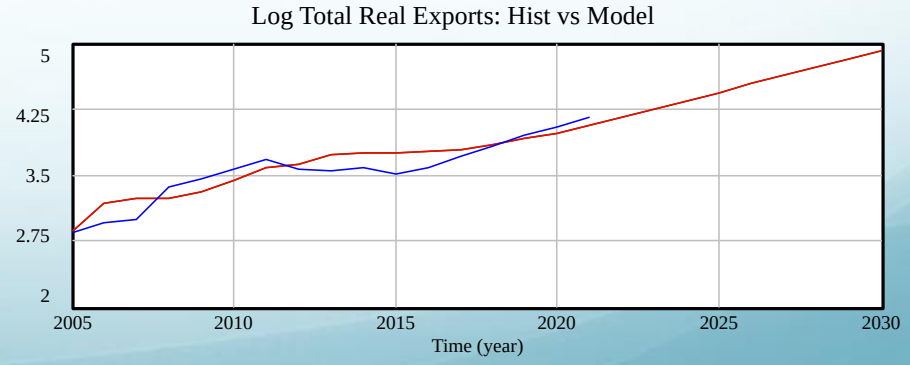












Thank You!