Modeling Global Futures: Frameworks and Tools

Dr. Jay Gary & Dr. Thomas Ferleman

July 16, 2009, WorldFuture 2009, Chicago, IL

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Slides: http://www.jaygary.com/model.pdf

Presenters

Dr. Jay Gary

Assistant Professor,
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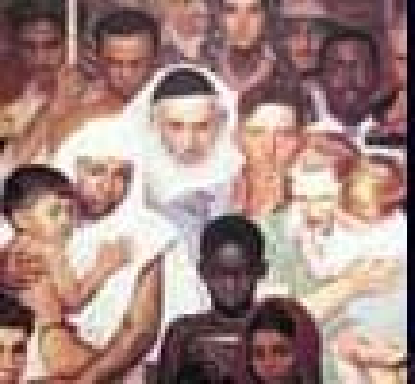
Dr. Tom Ferleman

Principle, Global Futures: Forecasting Patterns, Alternatives & Risk, Gaithersburg, MD

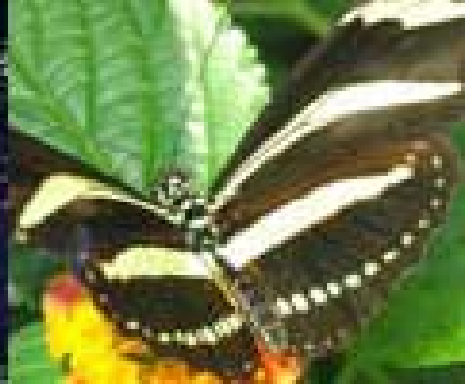
School of Global Leadership & Entrepreneurship
REGENT UNIVERSITY

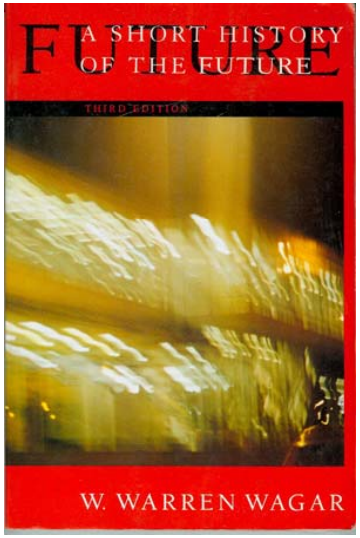
- M.B.A.
- M.A. in Organizational Leadership GLE
- M.A. in Strategic Foresight
- Doctor in Strategic Leadership
- PhD in Organizational Leadership

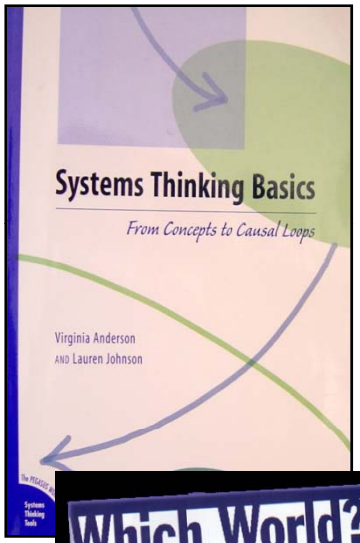


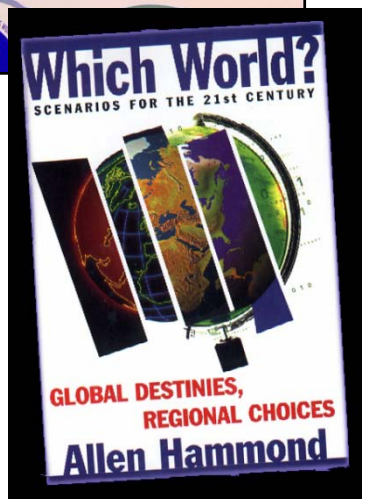
LDSL 718

Global Futures and System Dynamics









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http://www.regent.edu/acad/global/syllabi/ldsl718.shtml

Schedule

9:00	**Introduction & Framework: Dr. Gary**
9:45	**Overview of IF Model: Dr. Ferleman**
10:30	**Break**
10:50	**Capabilities of IF Model: Dr. Ferleman**
12:00	**Lunch**
1:00	**Live Case Study of IF Model: Dr. Ferleman**
2:30	**Break**
2:50	**Application of Global Modeling: Dr. Gary**
4:45	**End**

Attendees

- Policy planners, risk consultants, academics, professional futurists, and global advisors who recognize the need for data-driven tools to measure alternative futures; anyone seeking to learn practical modeling and simulation capabilities of a large-scale integrated global simulation modeling tool for long-term policy analysis.

Rationale

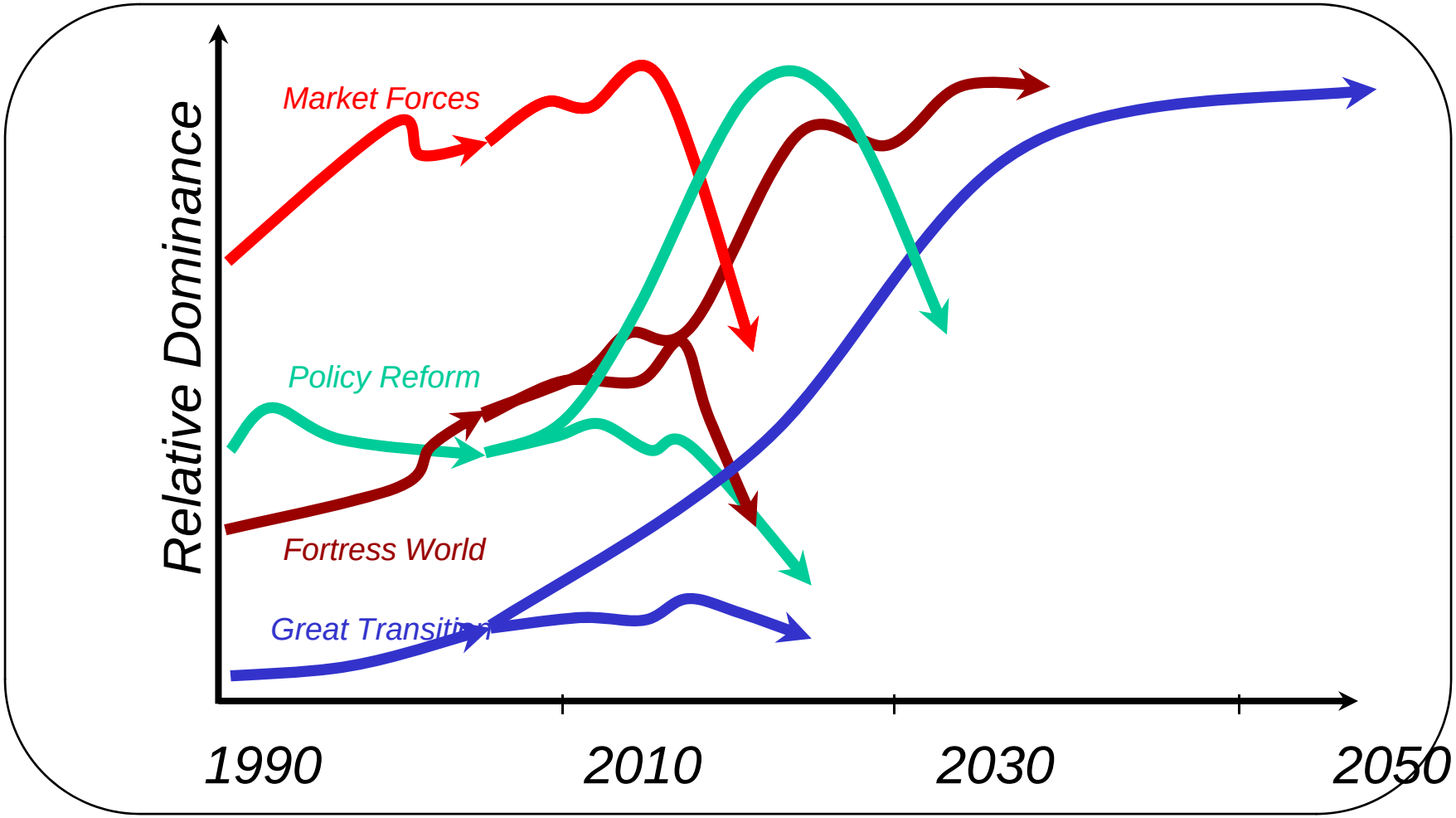
- Futurists are good at gathering information to track trends, but they also must use quantitative models to frame baseline forecasts and alternative scenarios.
- What will be the long-term impact of concentration of global oil production in the Middle East? Or continuing poverty in Africa? How will a resurgent Russia impact European stability in a global recession? How will new activist social policies in the U.S. impact global change?

Rationale

Without the ability to model patterns, forecast alternatives and develop risk mitigation strategies, futurists cannot help business executives or government officials weigh long-term dynamics against measurable investment choices.

- Create long-term global outlooks;
- Provide clients with credible forecasts;
- Offer data-driven scenarios to top management teams;
- Relate your industry-based research to other sectors to inform global decisions.

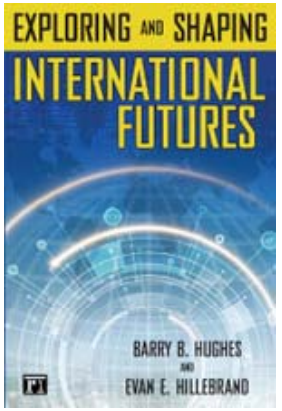
Beyond Qualitative Scenarios



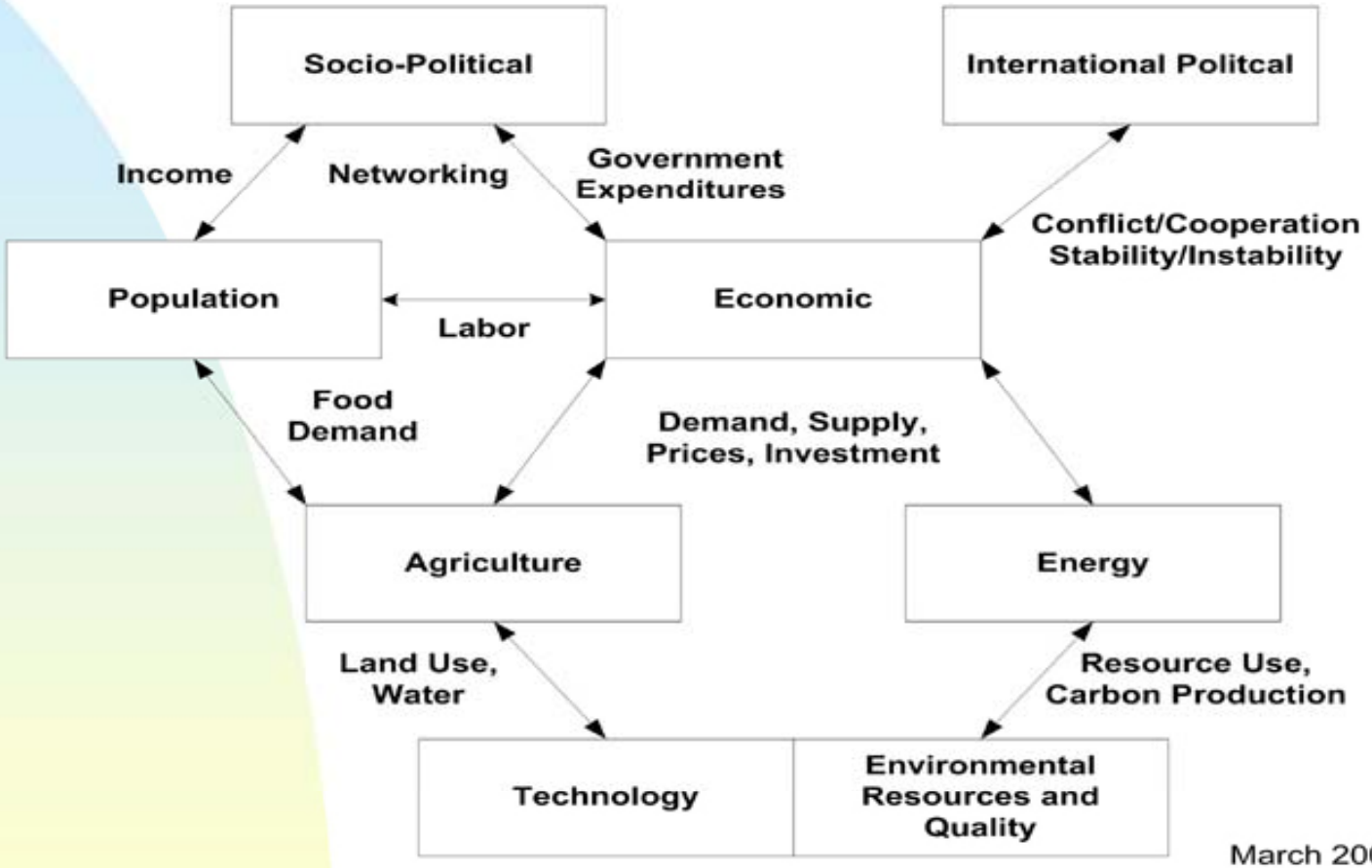
Source: The Great Transitions, John Stutz, Tellus Institute, http://www.tellus.org

Course Tool

- This course demonstrates how to use a public access forecasting tool to map global trends, determine key forces, and develop analytical rigor behind alternative scenarios.
- Using the International Futures (IFs) computer simulation, participants will gain insight into how the European Commission, the U.S. National Intelligence Council, and the United Nations use this global simulation to evaluate public policy choices.



International Futures Model



March 2004

http://www.ifs.du.edu/

What you'll learn

- **How to:**

(1) construct strategic frameworks for forecasts,

(2) choose the most critical variables in a domain to represent client interests,

(3) create a baseline from the historic data set that comes with IFs,

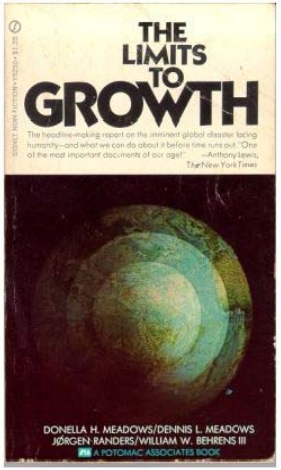
(4) generate an alternative scenario with IFs by changing one or more assumptions, run the model, and display impacts of change.

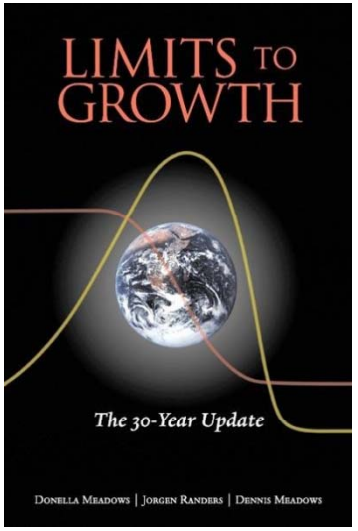
Dana Meadows on models…

1. Everything we think we know about the world is a model. Every world and every language is a model. … So are the ways I picture the world in my head - my mental models. None of these is or ever will be the real world.

2. Our models usually have a strong congruence with the world. That is why we are such a successful species …

3. [But] our models fall far short of representing the world fully…





http://thenextwavefutures.wordpress.com/2009/04/06/thinking-in-systems/

Dana Meadows on models…

3. [But] our models fall far short of representing the world fully... That is why we make mistakes … We often draw illogical conclusions from accurate assumptions, or logical conclusions from inaccurate assumptions. …

And to give two examples of the last type, we aren't very good, for example, at thinking about non-linear systems - 'trends that bend' - or at understanding exponential growth. We're also poor at estimating the effects of delays within a system, or how the relationship between stocks and flows affects overall outcomes.

→ Our models are not <u>pictures</u>,
but <u>maps</u> of reality

http://thenextwavefutures.wordpress.com/2009/04/06/thinking-in-systems/

Corporate Foresight
Dominant Logics / Paradigms

Assumption:
The future can be foreseen by collecting and comparing the opinions of (numerous) experts.

Expert-based Foresight

Assumption:
The future can be calculated by appropriate computer models based on huge amounts of data and mathematical finesse.

Model-based Foresight

Assumption:
Businesses can understand the future by anticipating the impact of trends on customers and markets.

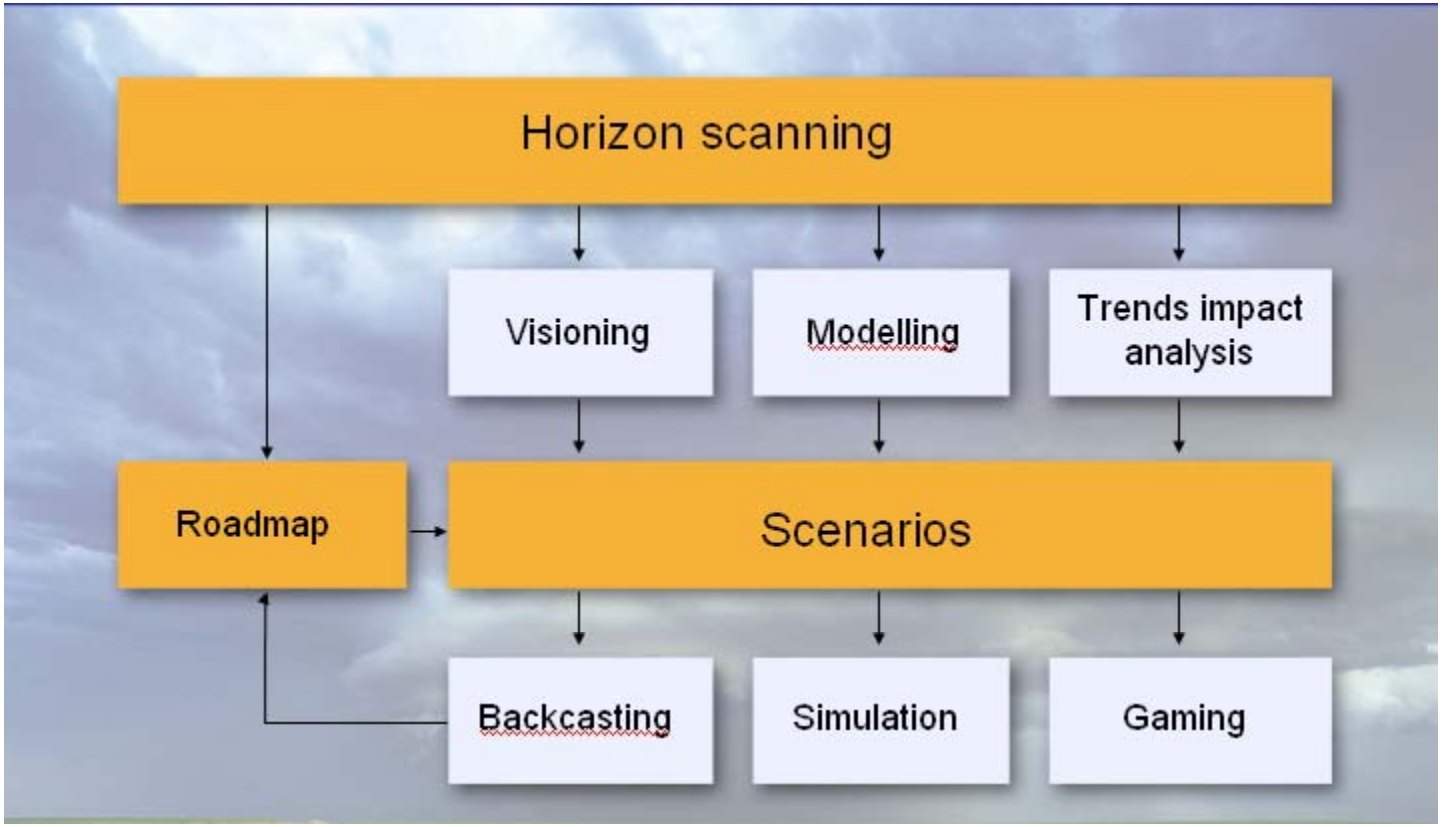
Trend-based Foresight

Assumption:
Businesses can shape future contexts and markets by anticipating the dynamic interaction between social, techn. & economic forces.

Context-based („Open“) Foresight

punkt

Future Methods

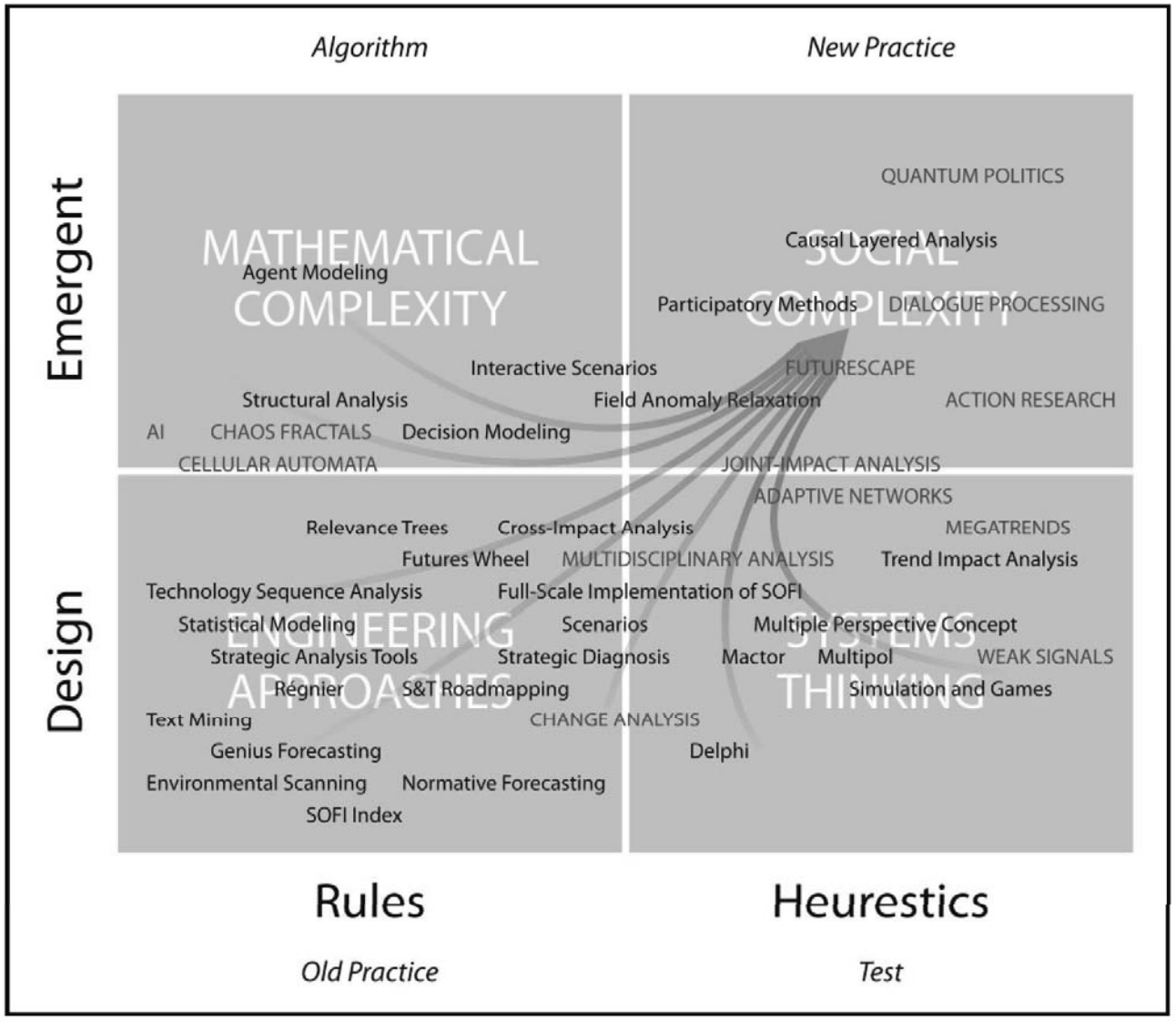


Source: Shaping Tomorrow.com http://practicalforesight.wetpaint.com/

Futures Research Methodology

millennium-project.org/millennium/FRM-V3.html

Figure 2 *Futures Research Methodology – V2.0* with complex systems concept – tools map



http://www.complexsys.org/pdf/identifying_system.pdf

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Group Introductions

- **Who is here?**
- **What ‘take aways’ are you looking for?**

Network Exchange

Card 1:

Is anyone else thinking about….

Name, email

Card 2:

One thing I have learned that might help others is…

Name, email

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Agenda

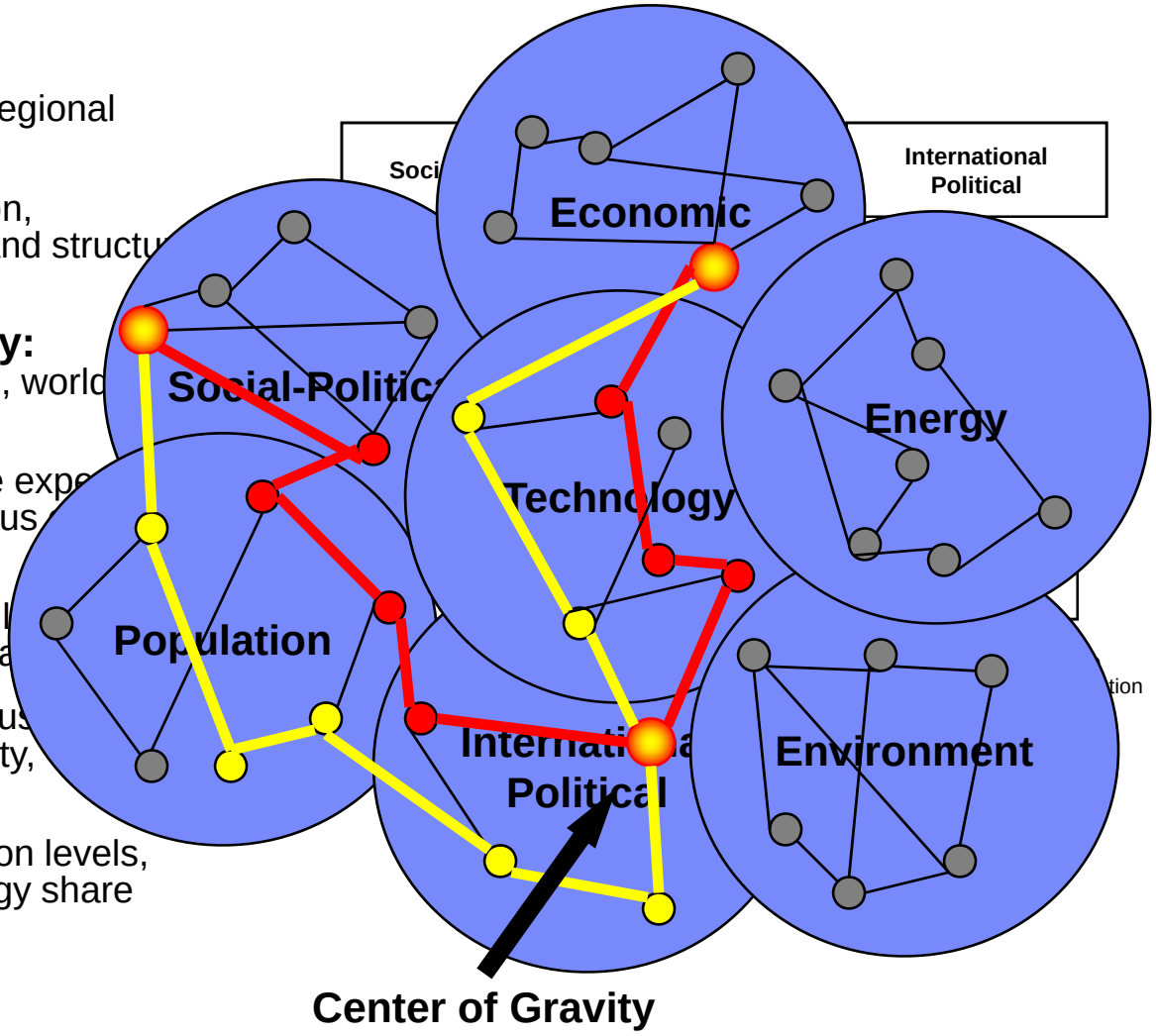
- Background and History
- Architecture: Power, Threat, Stability
- Verification & Validation
- Data Analysis
- Simulation and Scenario Analysis
- Conflict, Threat, Globalization, & Power
  - Example: State Failure through Internal War in Africa
  - Example: Globalization in Africa
  - Example: Power & Stability of 1% Countries

Background and History

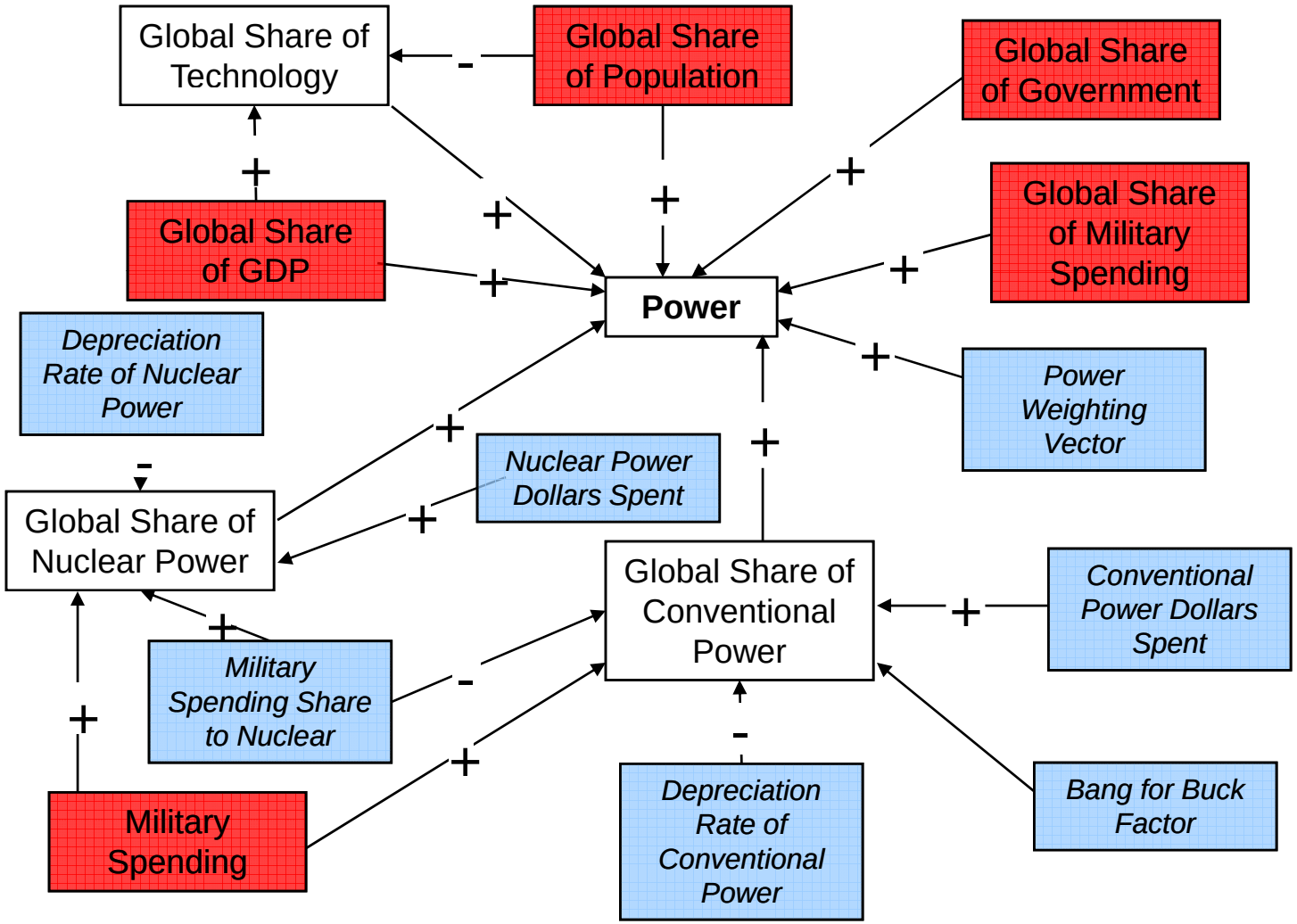
- Deep roots in the world models of 1970s and the work of Barry Hughes from the University of Denver
- Inspired by the World Integrated Model (Mesarovic and Pastel 1974) in which International Futures (IFs) founder Barry Hughes was involved
- Also draws on Leontif World Model (1977), the Bariloche Foundation World Model (1976) and Systems Analysis Research Unit Model (SARU 1977)
- First Generation released in Fortran in 1980 and used by the US Foreign Service Institute for mid-career training
- 2nd Generation on microcomputer platform released in 1985 and is now in 5th generation and used by CIA, UN, and others

Architecture

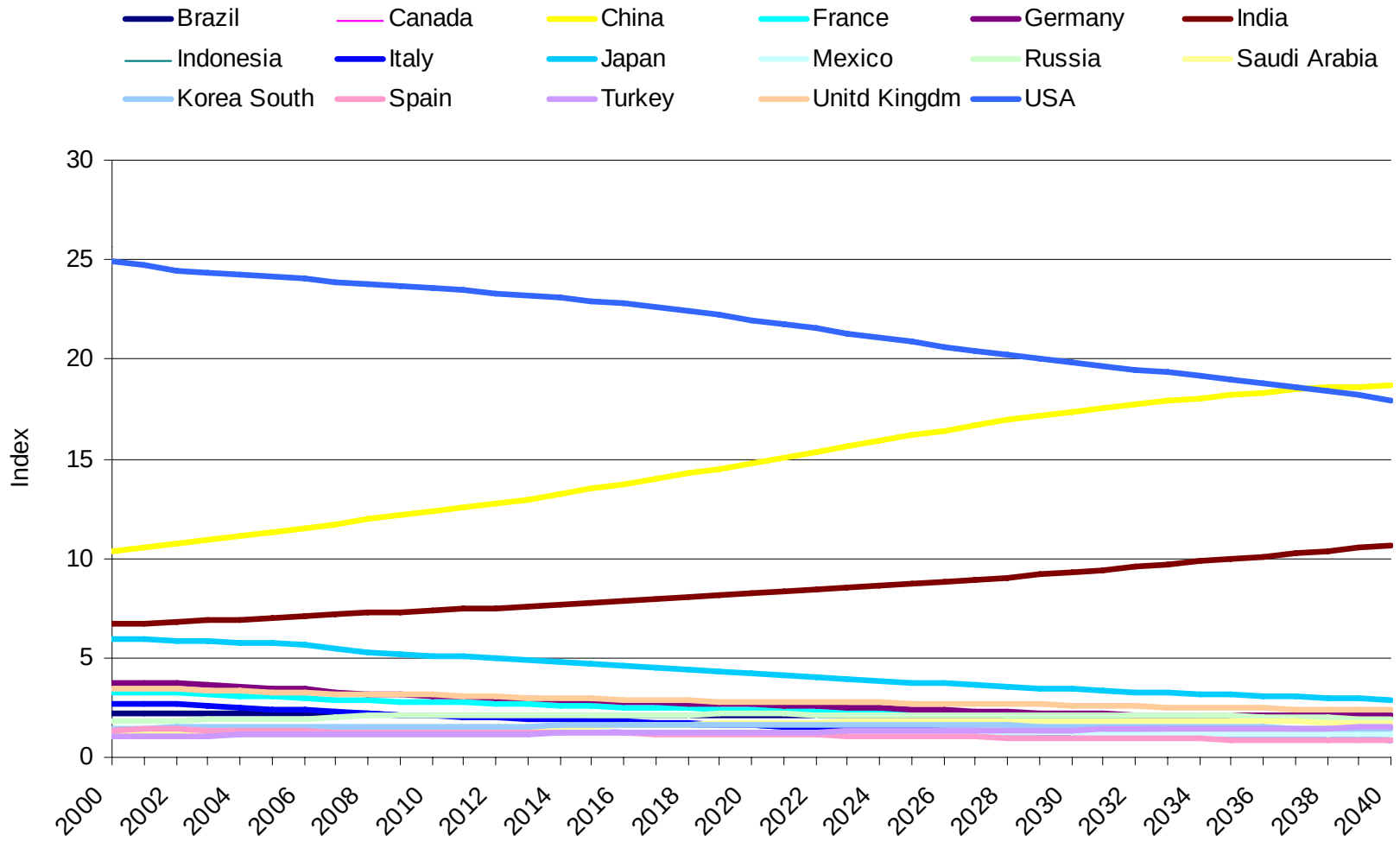
- **Global System:** Country and regional power levels, threat, and conflict
- **Economics:** Sectoral production, consumption, and trade patterns and structu change
- **Environmental Sustainability:** Atmospheric carbon dioxide levels, world forest area, fossil fuel usage
- **Social/Political Change:** Life expe literacy rate, democracy level, status women, value change
- **Demographic Futures:** Popul and growth, fertility, mortality, migra
- **Food and Agriculture:** Land us production levels, calorie availability, malnutrition rates
- **Energy:** Resource and production levels, demand patterns, renewable energy share



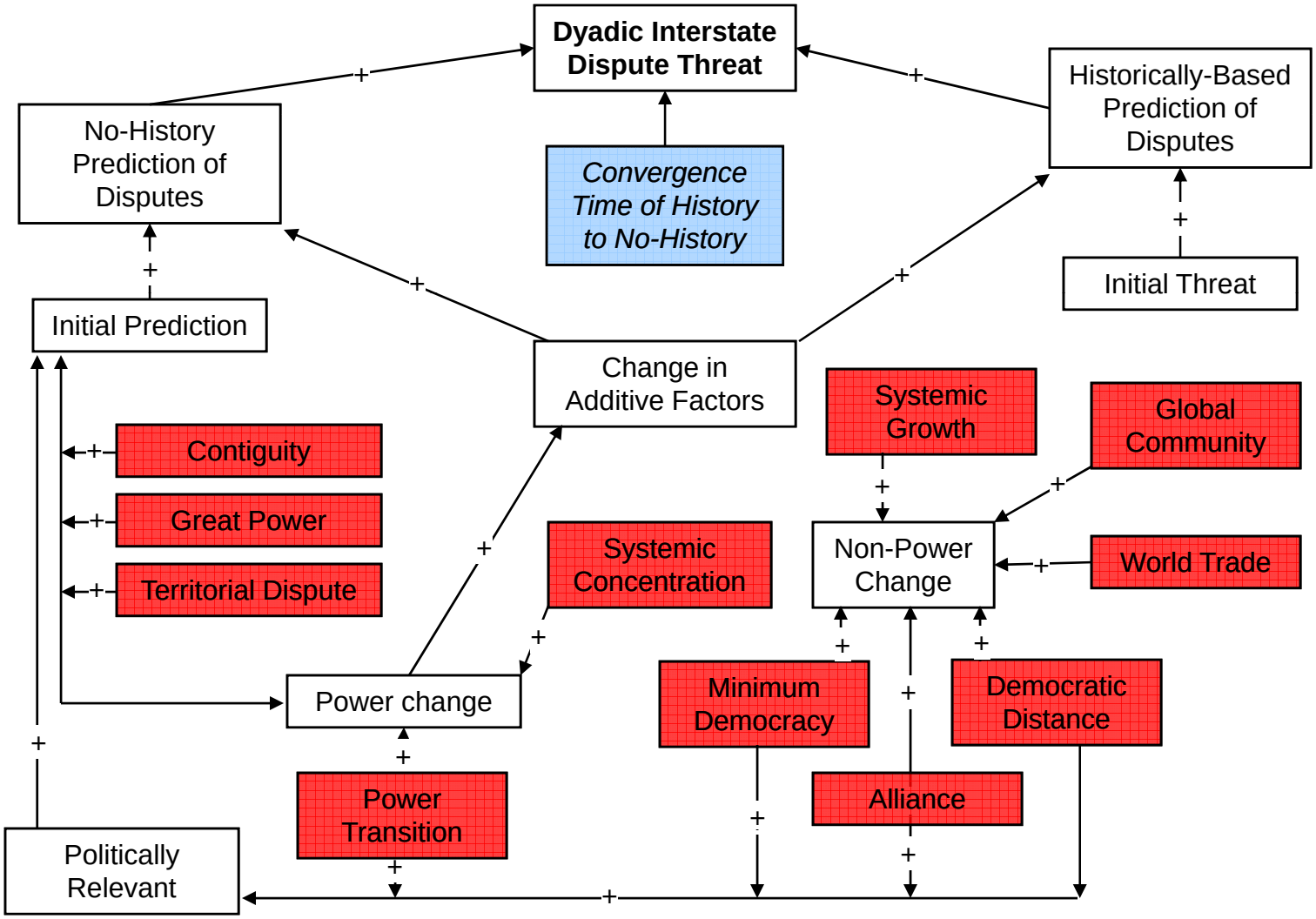
Power Forecasting Model



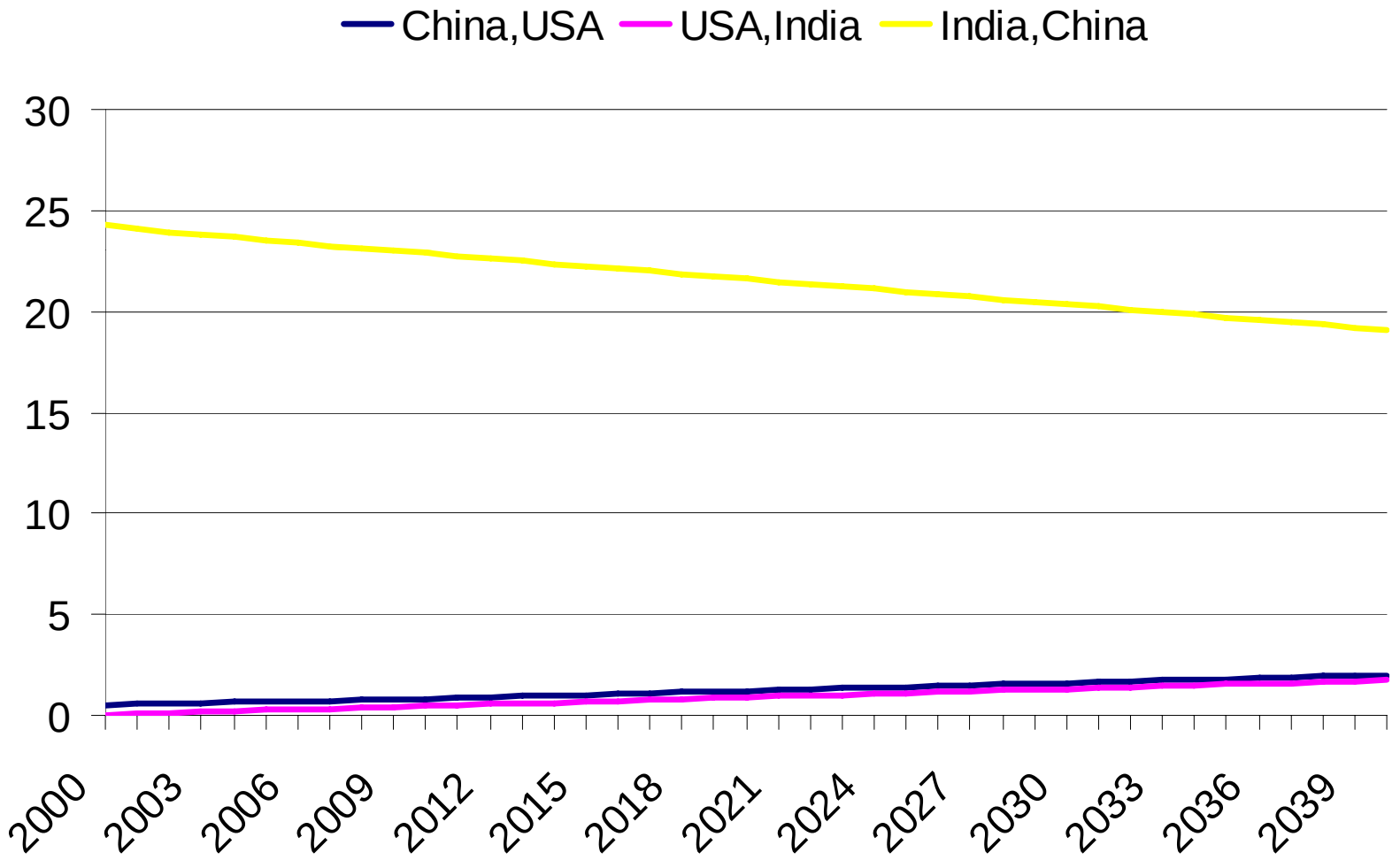
Countries with over one percent of global power



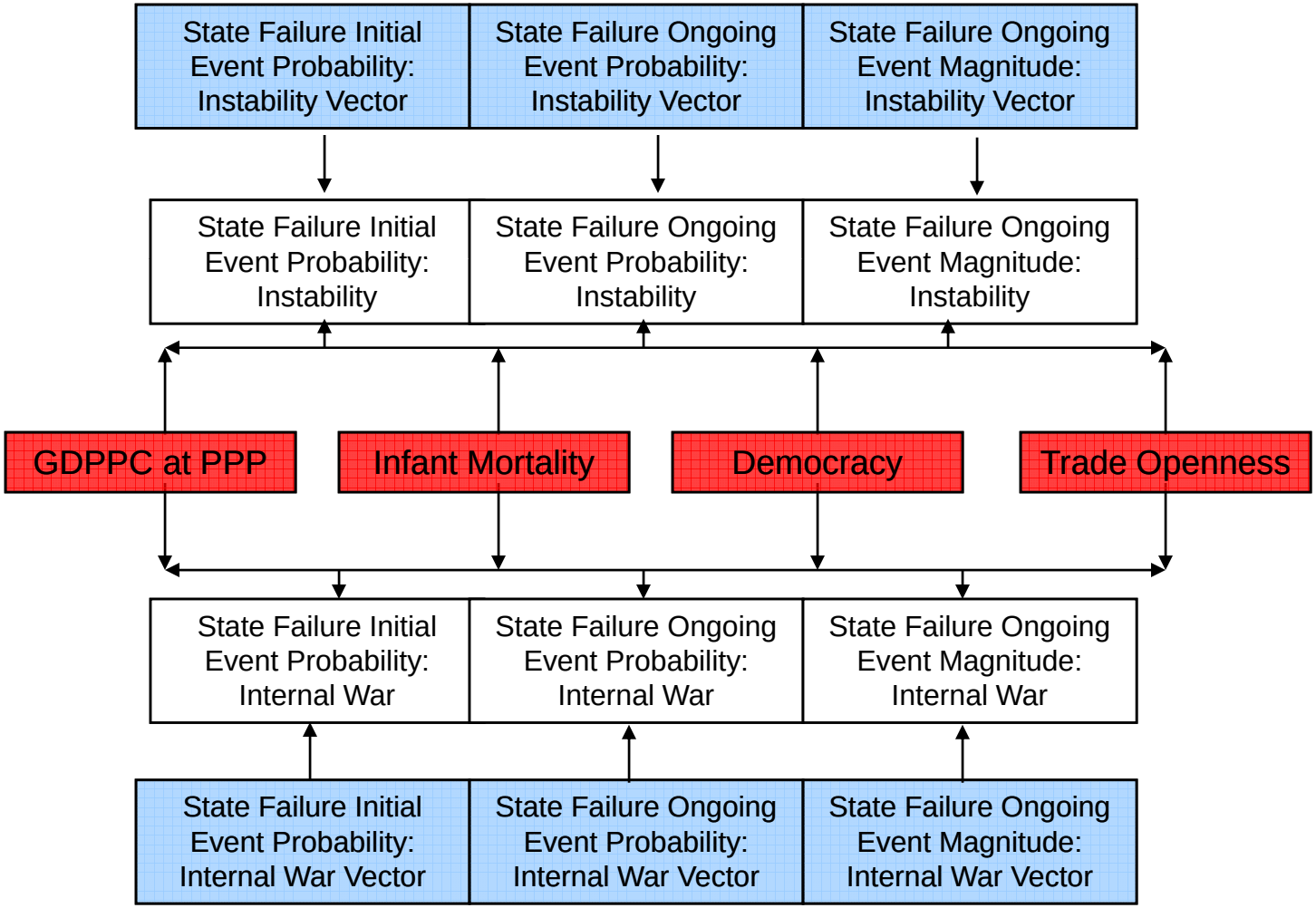
Threat Forecasting Model



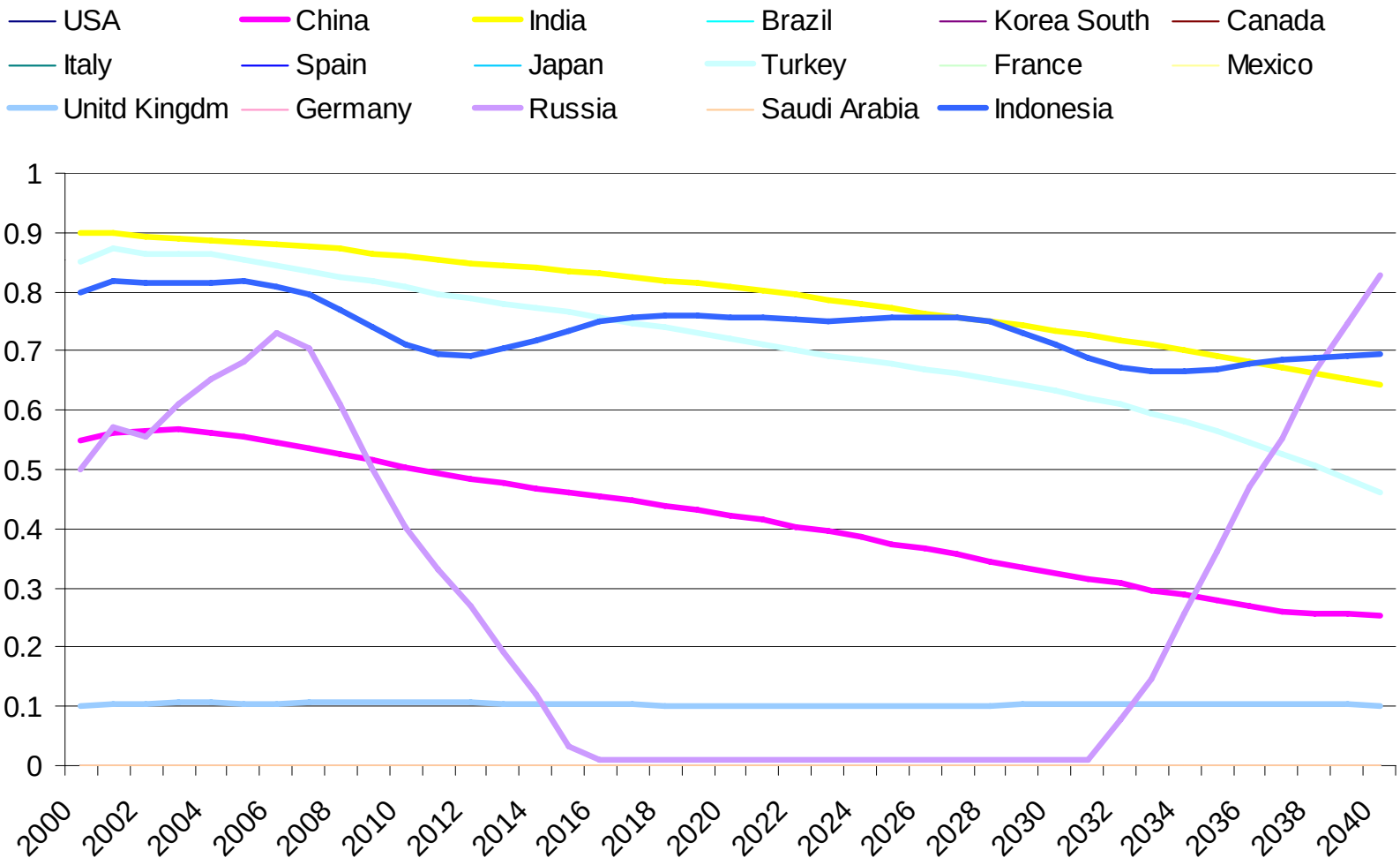
Probability of militarized conflict between top three countries with over one percent of global power



Stability/State Failure Model



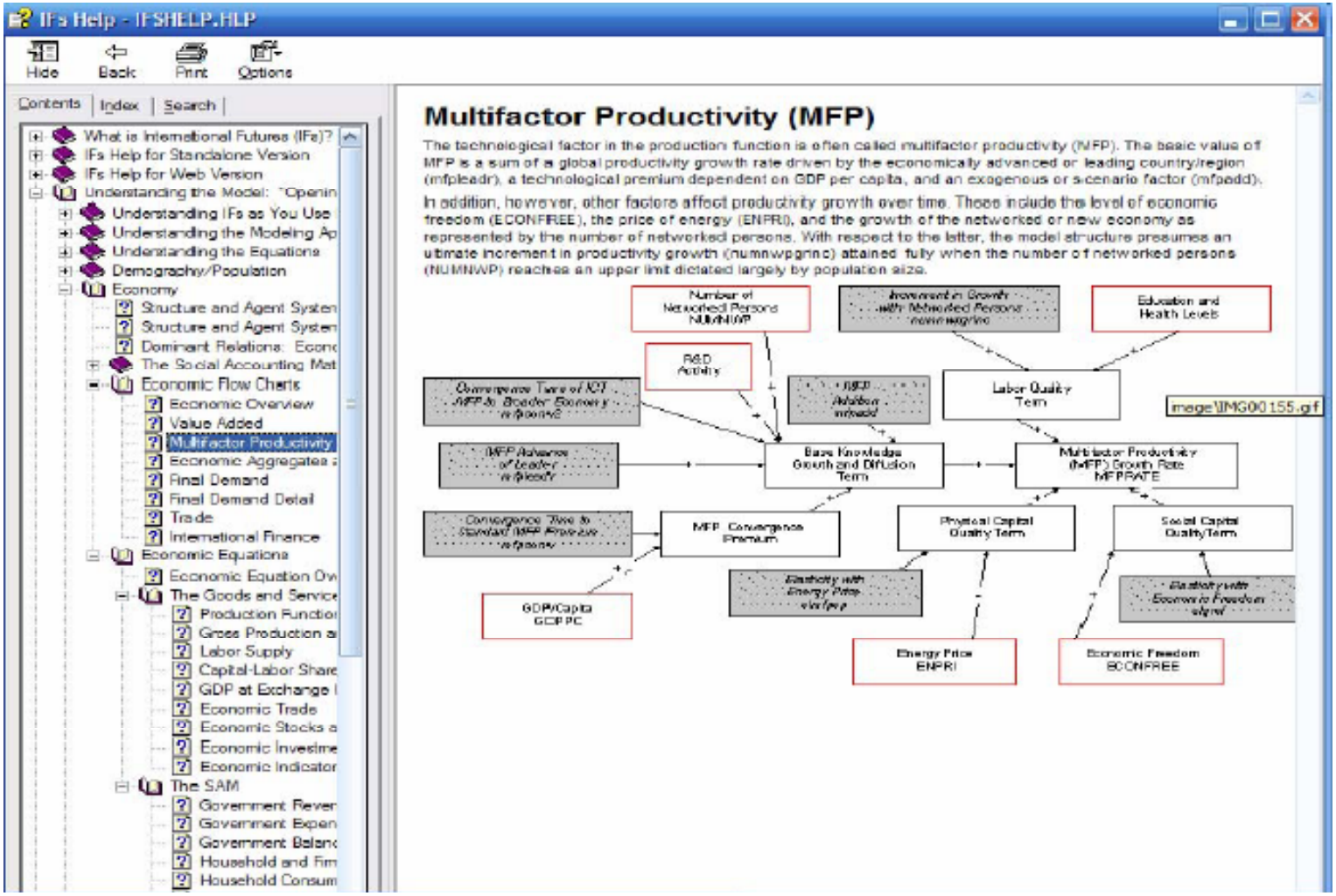
Probability of state failure due to internal war among countries with over one percent of global power



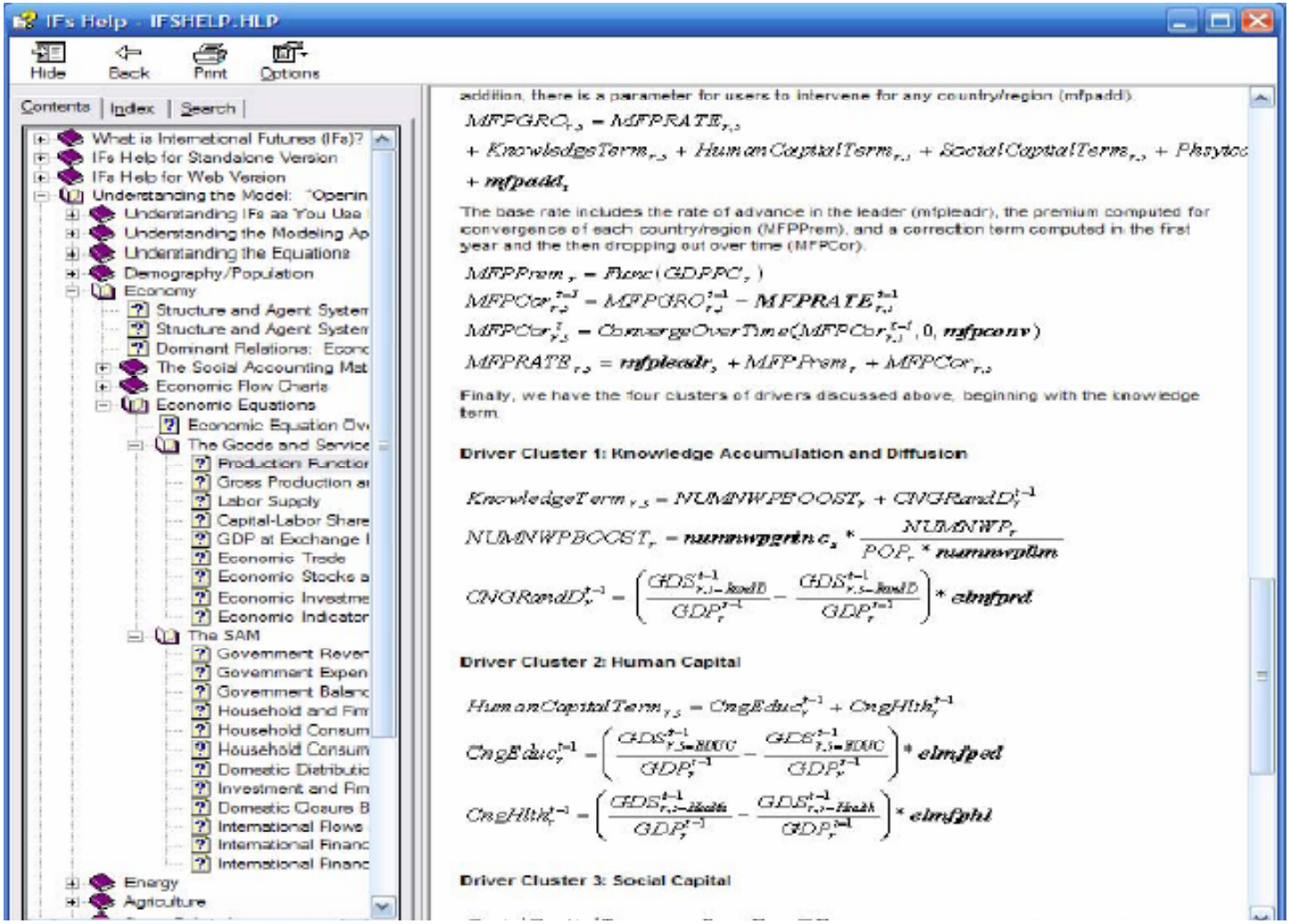
Model Verification, Validation

- Verification
  - Data transparency (Open Architecture)
    - Relational diagrams
    - Mathematical equations
    - Computer code
  - These are all available within the model help system and code can be provided upon client request

Model Verification, Validation



Model Verification, Validation

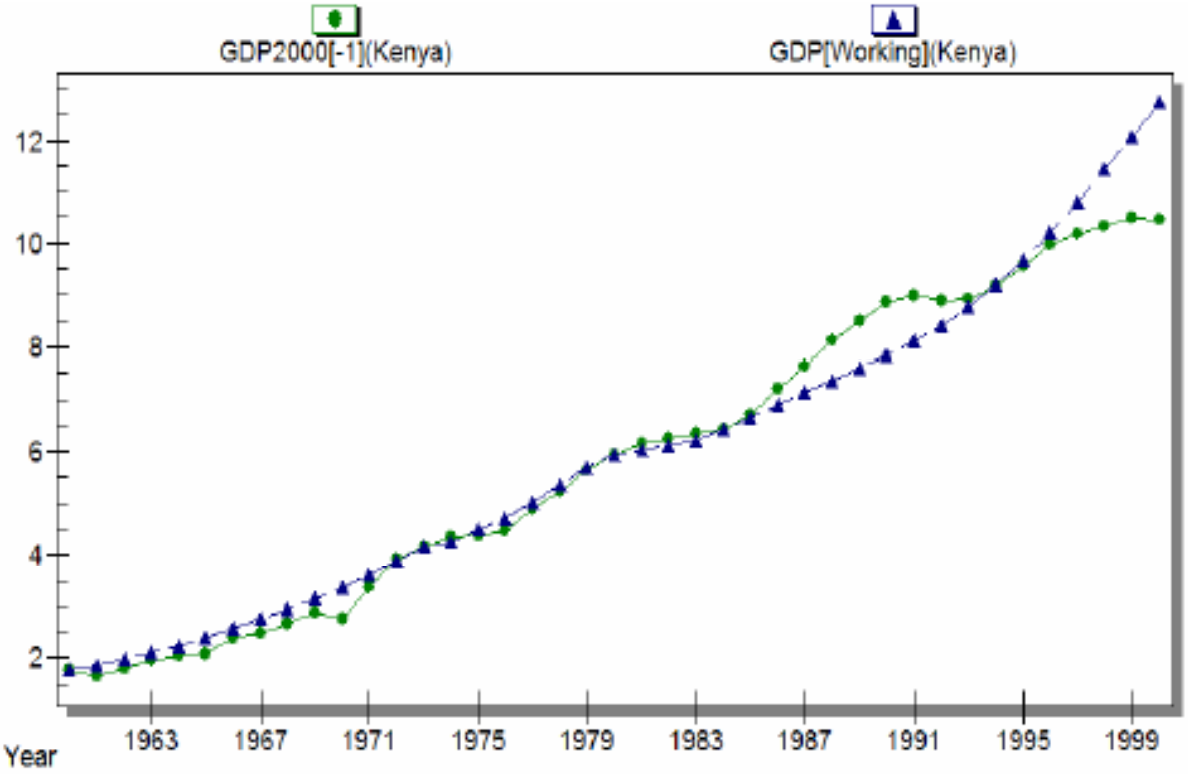


Model Verification, Validation

- **Historical Forecasting**
  - Database: Data in a variety of areas for 182 countries going back to 1960 where possible
  - Some data gaps and some countries may not exist e.g. Eritrea
  - Over 800 data inputs from reputable sources
  - Allows comparison of historical and forecasted trends

Model Verification, Validation

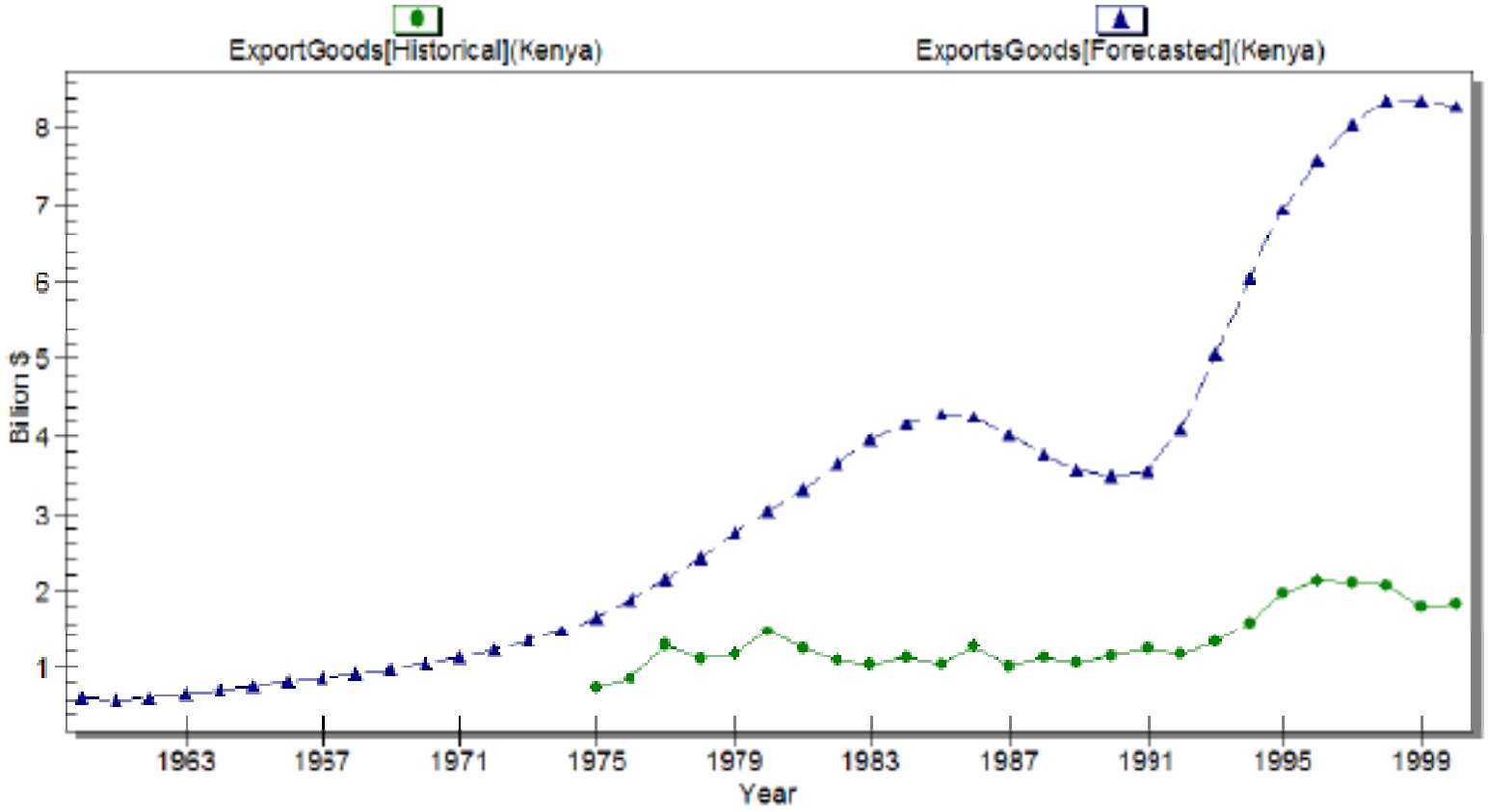
- **History Vs Forecasting (Kenya's GDP)- Very Good Fit!**



Year	1963	1967	1971	1975	1979	1983	1987	1991	1995	1999
GDP2000[-1](Kenya)	1.947	2.472	3.357	4.370	5.622	6.335	7.633	8.970	9.569	10.471
GDP[Working](Kenya)	2.105	2.750	3.603	4.503	5.695	6.231	7.140	8.126	9.667	12.071

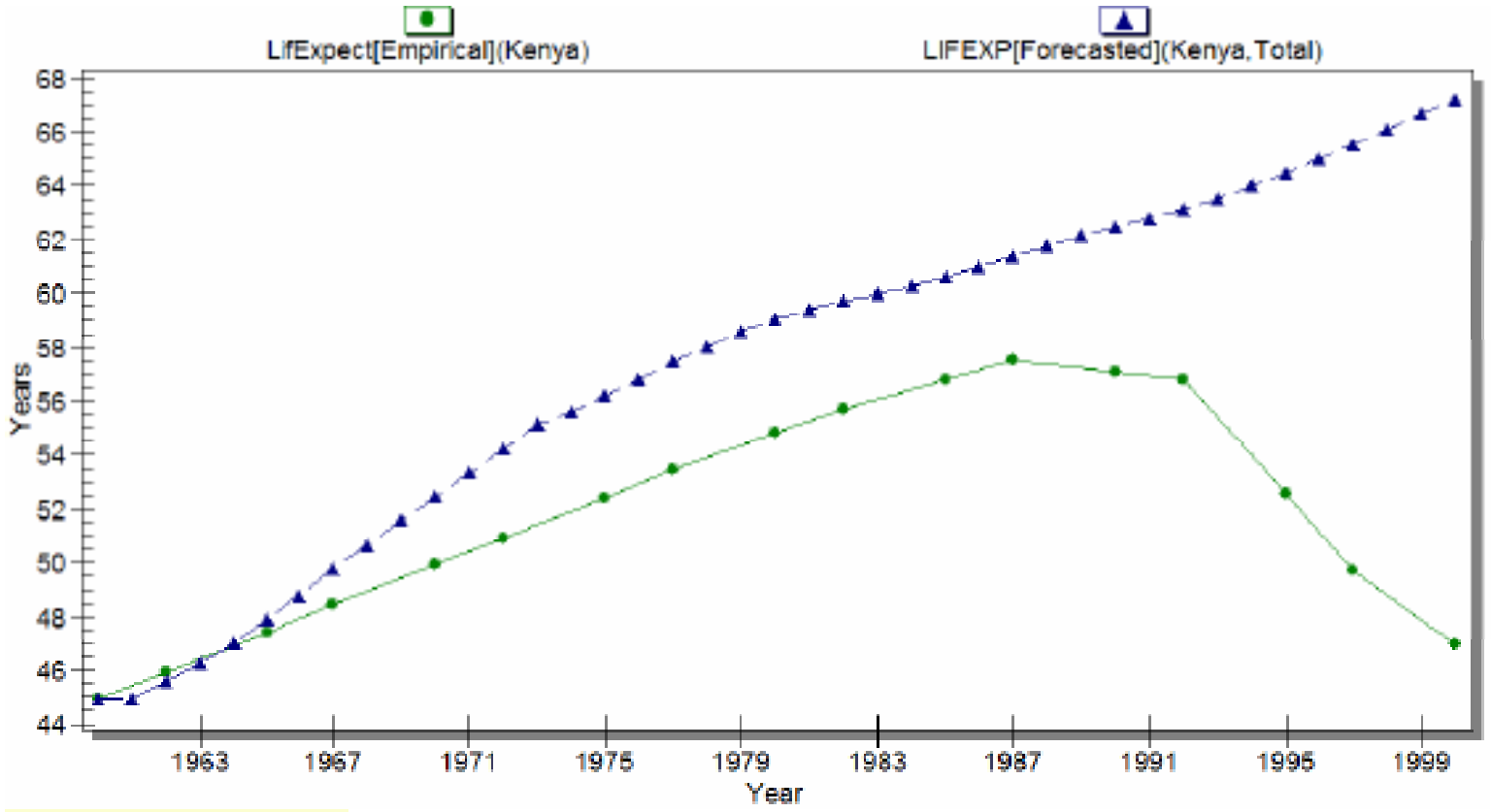
Model Verification, Validation

- **But not always that good as the forecast for Exports shows**



Model Verification, Validation

- **Can be difficult to forecast shocks (e.g. AIDS epidemic)**



Model Verification, Validation

- **Comparison with other Forecasts**
  - Most forecasts are rooted in single issue while the method we use involves an integrated architecture
  - Population: The UN median forecast for world population in 2050 has been adjusted from a 9.8 billion (in 1994) to 9.4 billion (in 1996) to 9.3 billion (in 2000) due to failure to foresee reduction in fertility while our forecast had foreseen this and as such UN forecast is now closer to what we suggest (9.06 billion)

Model Verification, Validation

Country	Our Forecast			Emerging Africa 2020 (2001)		
	2020	Growth	Avg Growth	2020	Growth	Avg Growth
Burkina Faso	330	1.90%	2.10%	420	2.50%	2.40%
Mali	354	2.60%	2.80%	240	2.00%	3.00%
Tanzania	469	4.20%	3.00%	360	1.70%	1.70%
Uganda	527	5.40%	3.80%	500	2.60%	2.60%
Cote dIvoire	915	2.80%	1.60%	1360	2.10%	2.50%
Ghana	303	0.00%	0.90%	520	1.60%	1.50%

Model Verification, Validation: Comparison with Other Forecasts

Country	OECD-Africa 2010 (1999) Base	OECD-Africa 2010 (1999) Scenario-2	Our Forecast
Ethiopia	-0.07	3.17	1.03
Mozambique	0.11	2.95	5.93
Uganda	0.91	2.59	2.48
Zimbabwe	0.97	2.31	1.48
Cote d'Ivoire	0.84	1.99	0.39
Burkina Faso	0.46	1.96	.08
Ghana	0.17	1.79	1.75
Mali	0.98	1.73	2.45
Mauritania	0.67	1.66	1.98
Kenya	0.26	1.57	0.36
Togo	-0.33	1.45	0.47
Senegal	-0.19	1.36	1.97
Benin	0.21	1.35	3.71
Gabon	0.38	0.91	0.6
Average	0.36	1.91	1.84

Model Verification, Validation

- **Comparison with Other Forecasts**

Year	Average Growth	
	World Bank (2007)	Our Forecast
2008-2030 (GDP) PPP	3.30%	3.80%

Model Verification, Validation

- **Comparison with other Forecasts**
  - Our forecasts have been as good as others, despite the fact we largely avoid single issue linear forecasts based on historical and regional trends
  - Proper comparison requires a good understanding of the assumption behind the forecasts

Model Verification, Validation

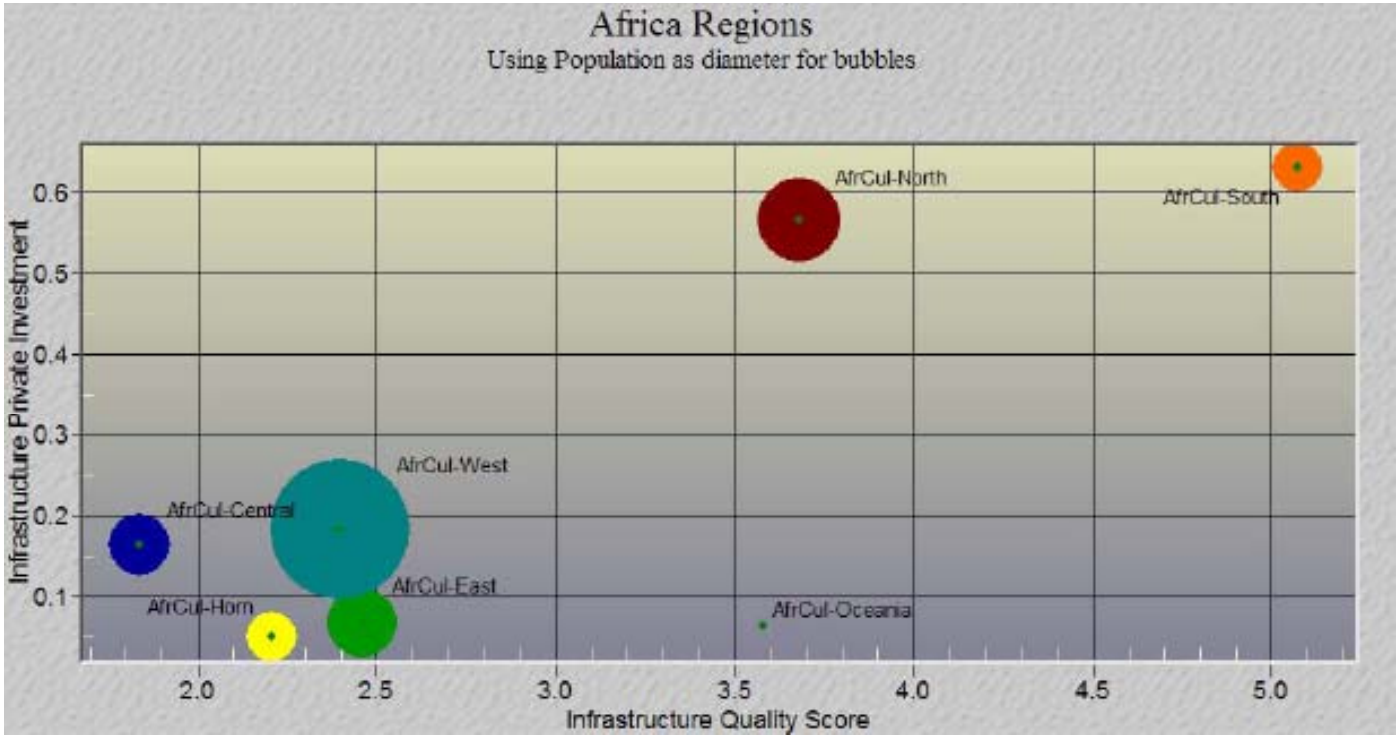
- **Accrual Validity**
  - Usage increases credibility
  - Organizations that have deployed the same modeling capabilities include:
    - European Union 3 yr Terra Project
    - CIA Strategic Assessments Group (SAG)
    - US National Intelligence Council (NIC) Project 2020
    - UNEP Global Environmental Outlook
    - IBM Global Futures Group

Data Analysis

- **Data Display Capability**
  - We employ data analysis at both cross sectional and longitudinal dimensions
  - A choice of graphical displays
  - Can display at country level or aggregate country groupings
  - Ability to export data to excel for further analysis

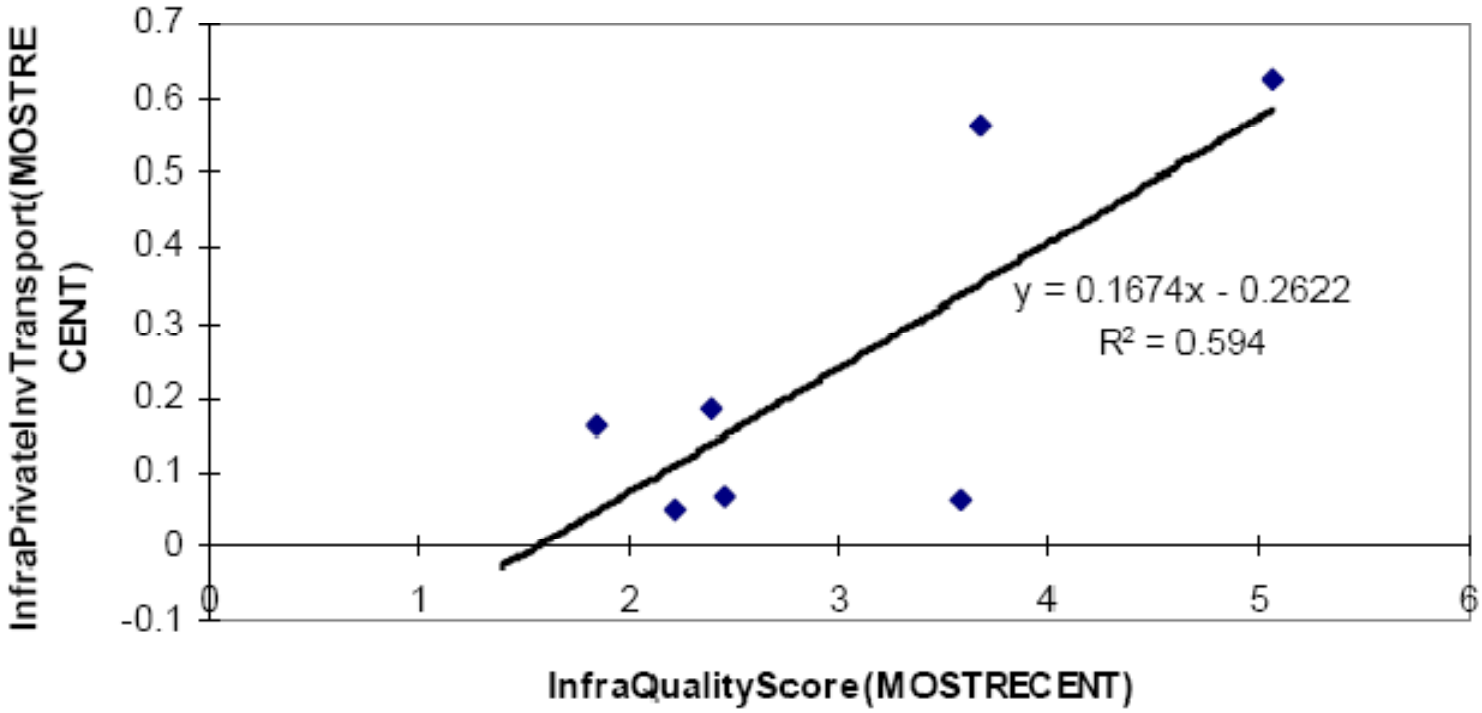
Data Analysis

- **Cross section Data Analysis**
  - It is possible to analyze up to 3 data series for a particular entity (country or grouping)



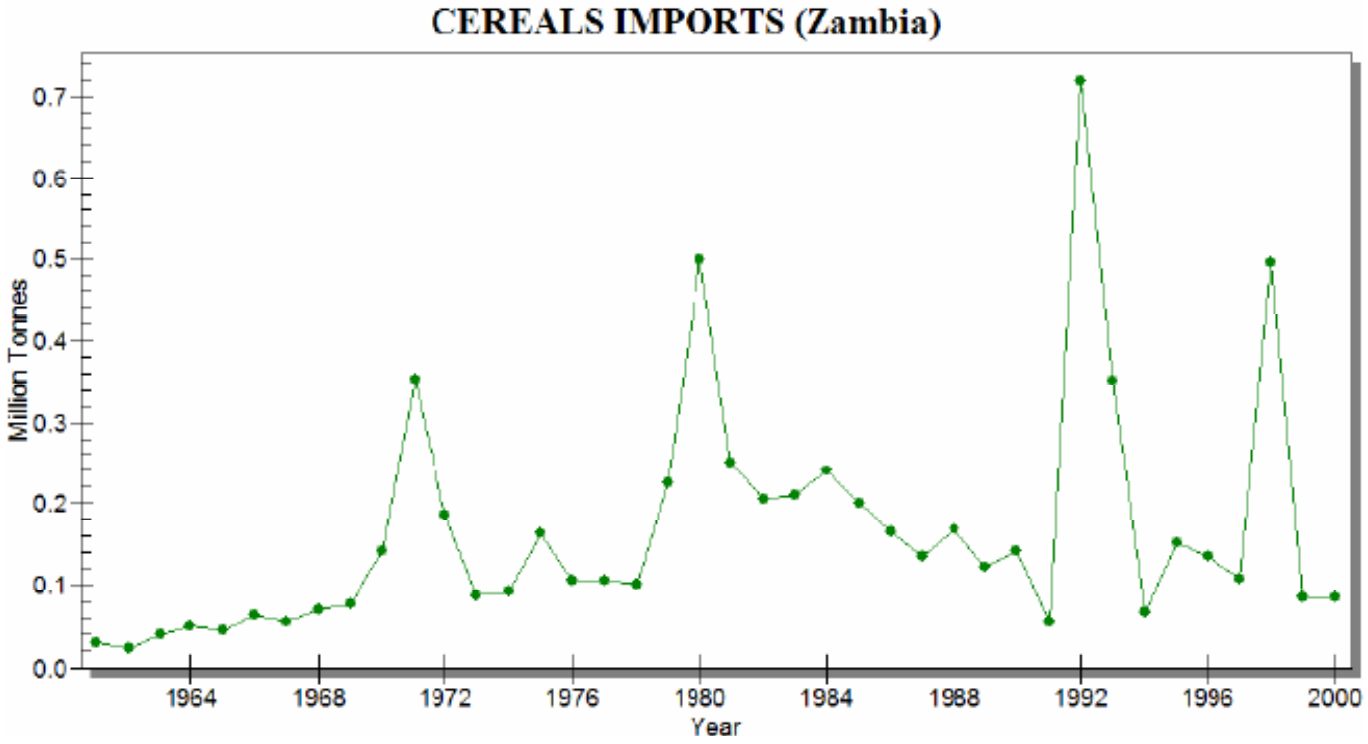
Data Analysis

- **Cross section Data Analysis**
  - It is possible to also display multi-variable trends



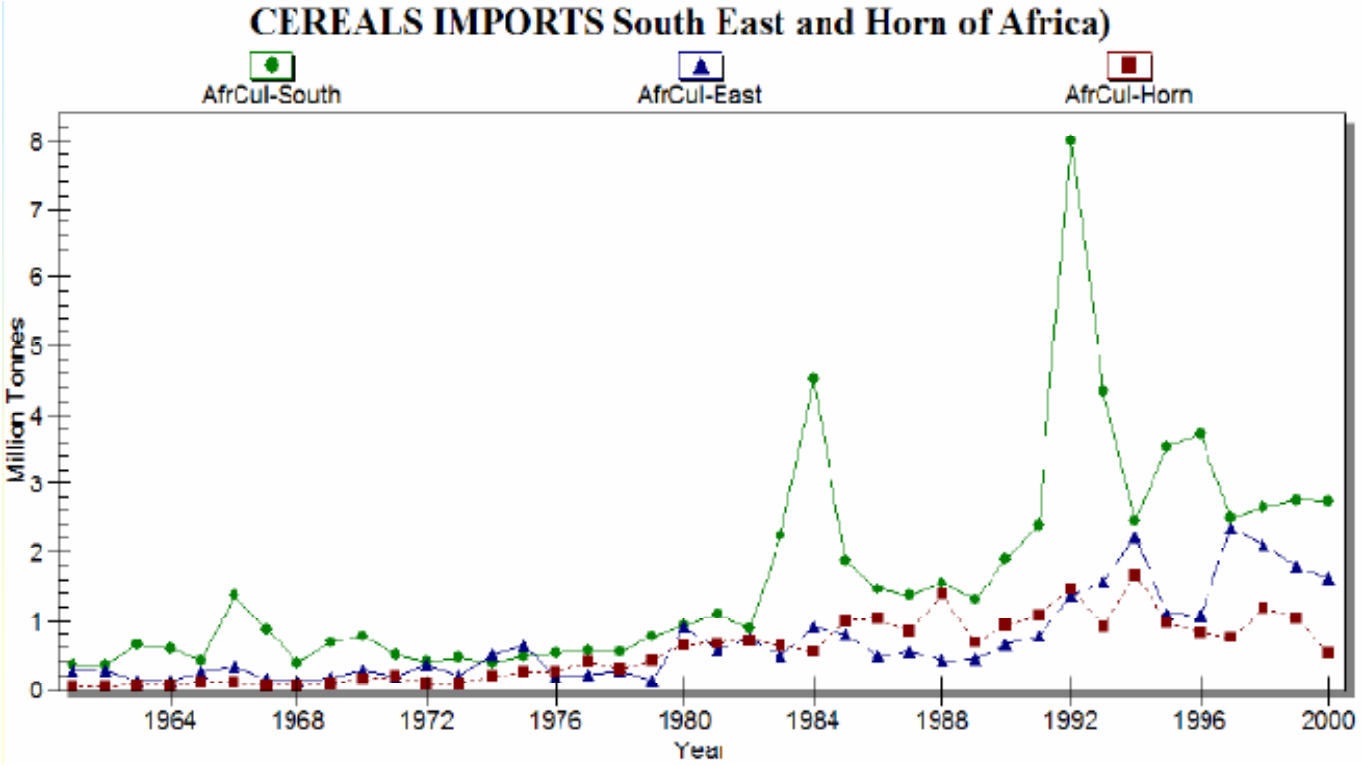
Data Analysis

- **Longitudinal Data Analysis**
  - It is possible to analyze at country level



Data Analysis

- **Longitudinal Data Analysis**
  - It is possible to analyze at regional level



Data Analysis

- **Longitudinal Data Analysis**
  - It is possible to export the data to excel

Region	1965	1970	1975	1980	1985	1990	1995	2000
AfrCul-South	0.413	0.761	0.484	0.9333	1.872	1.897	3.531	2.728
AfrCul-East	0.262	0.275	0.62	0.909	0.79	0.651	1.097	1.625
AfriCul- Horm	0.113	1.53	0.248	0.65	0.985	0.924	0.977	0.53

Simulation

- **Base Case**
  - It can be thought of as a central tendency scenario
  - It allows system to unfold along a path that seems more or less to be the direction of its historic development
  - Since we incorporate systems dynamics in our formulations the base case is not an extrapolation of the past
  - It is the starting point for analysis in order to simulate how events unfold
  - Shows the dynamics and constraints that allow for different scenarios to emerge

Simulation: Base Case Selected Variables

Variables	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Population	702.1	790	885.4	988	1096	1210	1326	1445	1561	1674
Urban Population	263.8	312.1	360	407.5	458.6	515.1	576.7	642.3	711.1	781.9
GDP (PPP)	1165	1363	1626	1929	2337	2874	3559	4451	5558	6846
GDP Per Capita	1.659	1.726	1.836	1.953	2.132	2.376	2.683	3.081	3.56	4.09
GDP Growth Rate	3.075	4.335	4.327	4.423	5.211	5.18	5.76	5.999	5.942	5.382
Life Expectancy	43.84	45.7	48.43	52.15	56.41	59.58	61.58	62.79	63.81	64.64
Years of Schooling	3.35	3.876	4.38	4.833	5.232	5.583	5.905	6.205	6.49	6.764
No. on $1/Day	289	313	333.2	356.5	373.5	391.6	407.2	418.4	426.3	430
Imports	145.2	223.3	312.1	367.9	437.9	547.4	689.6	862.7	1039	1224
Exports	116.9	141.3	195.3	239.1	307.8	380.1	495.1	647.6	852.9	1164

Simulation

- **Three Scenarios**
  - Policy 1: Self-Sustainment Focus (SSF)
  - Policy 2: Export Focus (EF)
  - Policy 3: Human Development (HD)
- Each requires different sets of assumptions and we incorporate these as deviations from base case

Simulation

- **Simulation**
  - Basic capabilities
    - Governance, Knowledge and Entrepreneurship
  - Assumptions that apply to each scenario
    - Improve governance variables by 20% over a period of 10 years (over the base case)
    - Improve education expenditure by 20% over 10 years
    - Improve economic freedom, Investment, and FDI by 20% over 10 years
  - We then create a Basic Capabilities Drivers (BCD) scenario and store it for use by the three policy scenarios

Simulation

- **Strategy 1: Self-Sustainment Scenario**
  - Assumptions
    - Double R&D expenditures over the base case over a period of 10 years
    - Increase roads density by a factor of 3 over the base case in 25 years
    - Telephone density increases by a factor of 3 over the base case in 25 years
    - Agricultural yield double over the base case over a period of 25yrs
  - Create this scenario and save it. Load the BCD scenario and run the combined scenario over the horizon of interest

Simulation

- **Policy 2: Export Focus Scenario**
  - Assumptions
    - Shift Exports by 4% per year over the forecast horizon
    - Double economic freedom over a period of 15 years
    - Increase investment levels by 50% over a period of 15 years
    - Double FDI over a period of 15 years
    - Increase number of networked people by a factor of three over a period of 2 years
    - Roads and electricity density triple over a period of 25 years
    - Internet and telephone density triple over 15 years

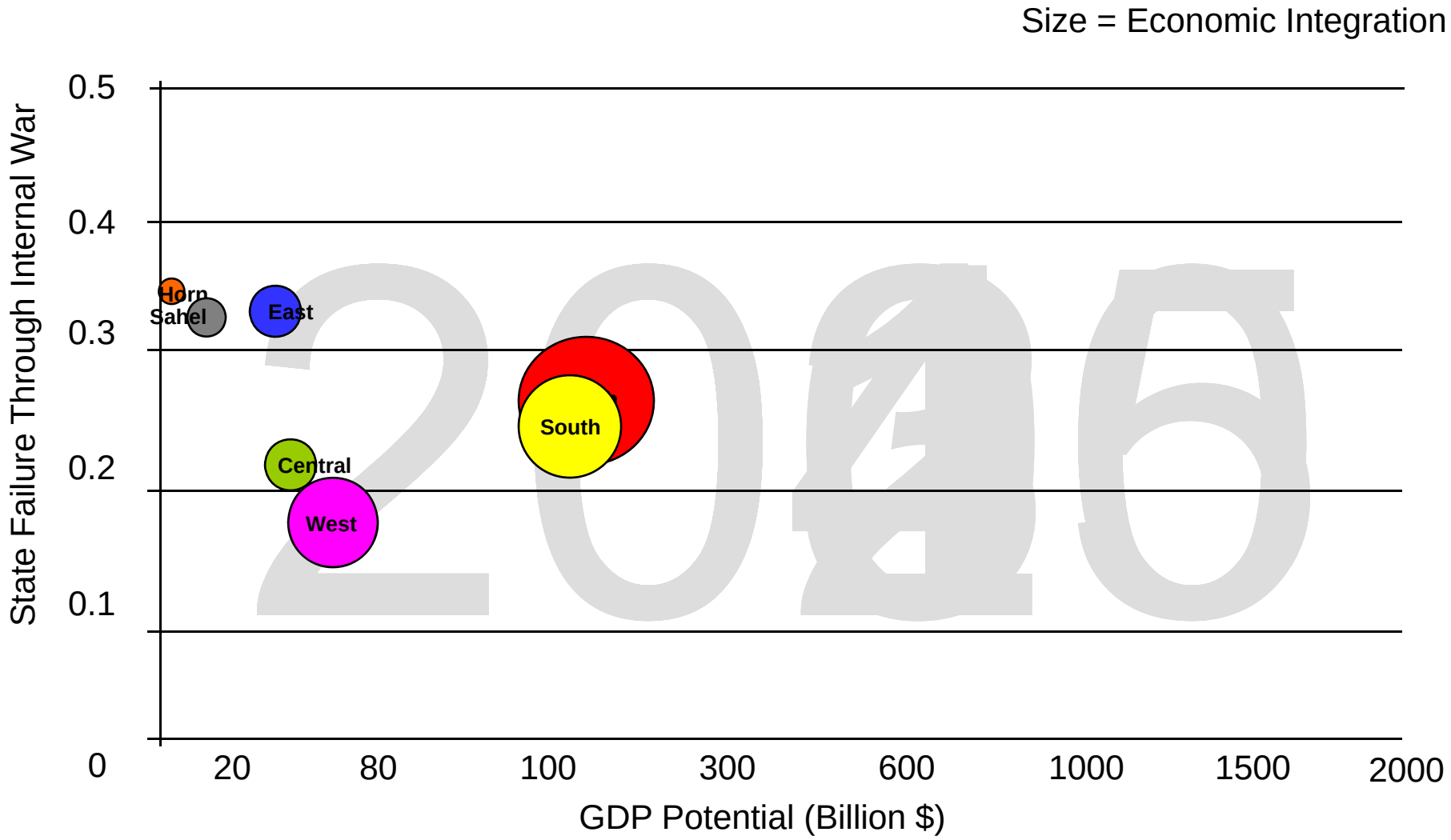
Simulation

- **Policy 3: Human Development Scenario**
  - Assumptions
    - Improve health and education spending by 30% over 15 year period
    - Improve education spending on girls at primary school by 20% over 15 years
    - Increase R&D spending by 20% over 15 years
    - Reduce military spending by 20% over 15 years
    - Increase forest protection by 20% over 15 years
    - Reduce HIV infection rate of advance by 50 over 15 years
    - Reduce Aids deaths rate as % of infection by HIV by 50% over 15 years
    - Improve agricultural yields by 20% over 15 years
    - Reduce fertility by 20% over 25 years
    - Increase number of networked people by 100% over 15 years
    - Improve telephone density by 100 % over 15 years

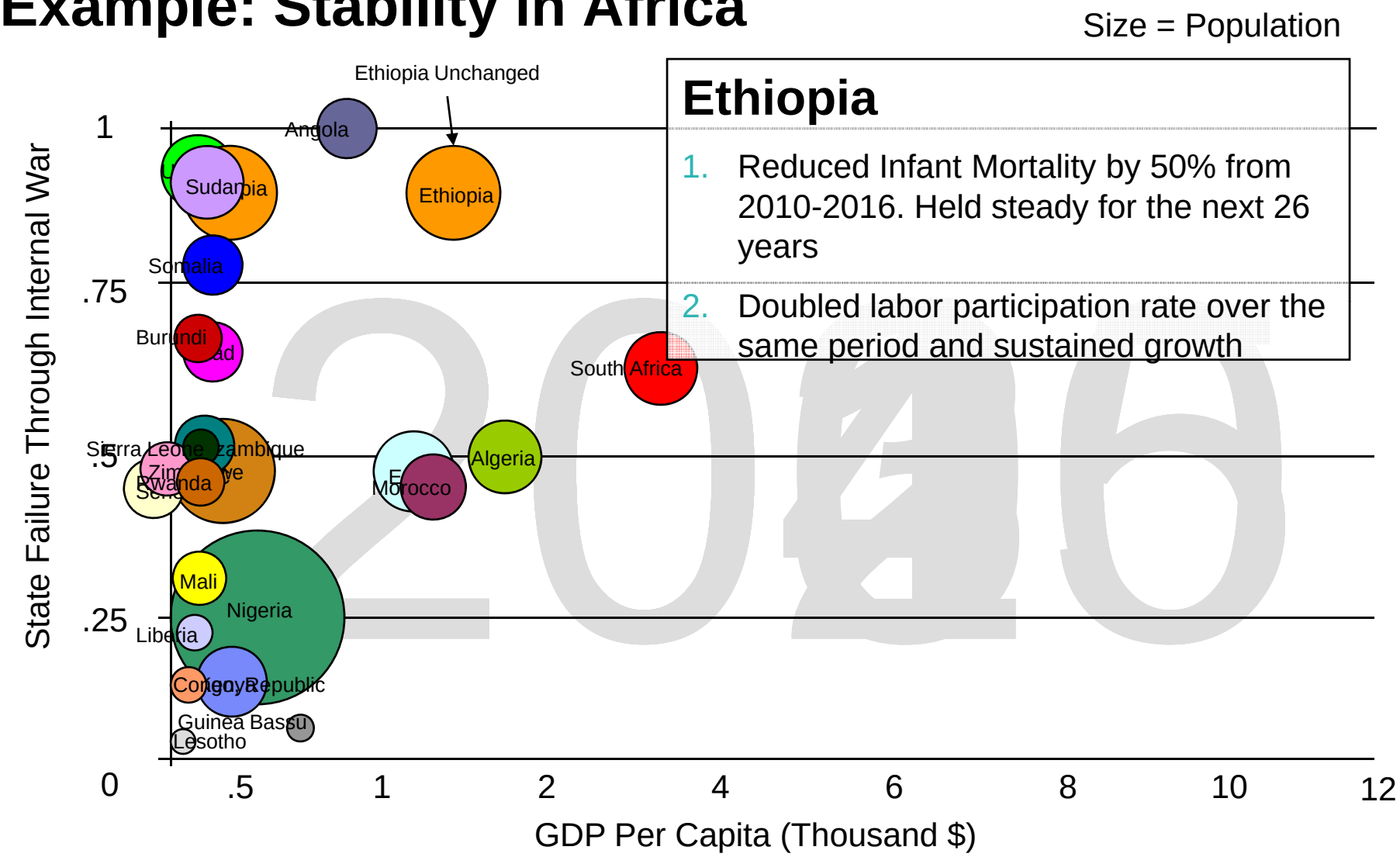
Simulation

Variables	Base	Self-Sustainment Scenario		Export Focused Scenario		Human Development Scenario	
		2050	% Change	2050	% Change	2050	% Change
Population	1674	1589	-5%	1589	-5%	1411	-16%
Urban Population	781.9	795	2%	795.7	2%	700.1	-10%
GDP (PPP)	6846	15811	131%	17276	152%	10220	49%
GDP Per Capita	5.09	9.95	143%	10.87	166%	7.242	77%
Life Expectancy	64.64	69.02	7%	69.55	8%	69.24	7%
Years of Schooling	6.764	7.295	8%	7.291	8%	7.202	6%
No. on $1/Day	430	271.2	-37%	249	-42%	248	-42%
Imports	1224	3163	158%	4519	269%	2095	71%
Exports	1164	2929	152%	4130	255%	1975	70%

Example: Stability in Africa



Example: Stability in Africa

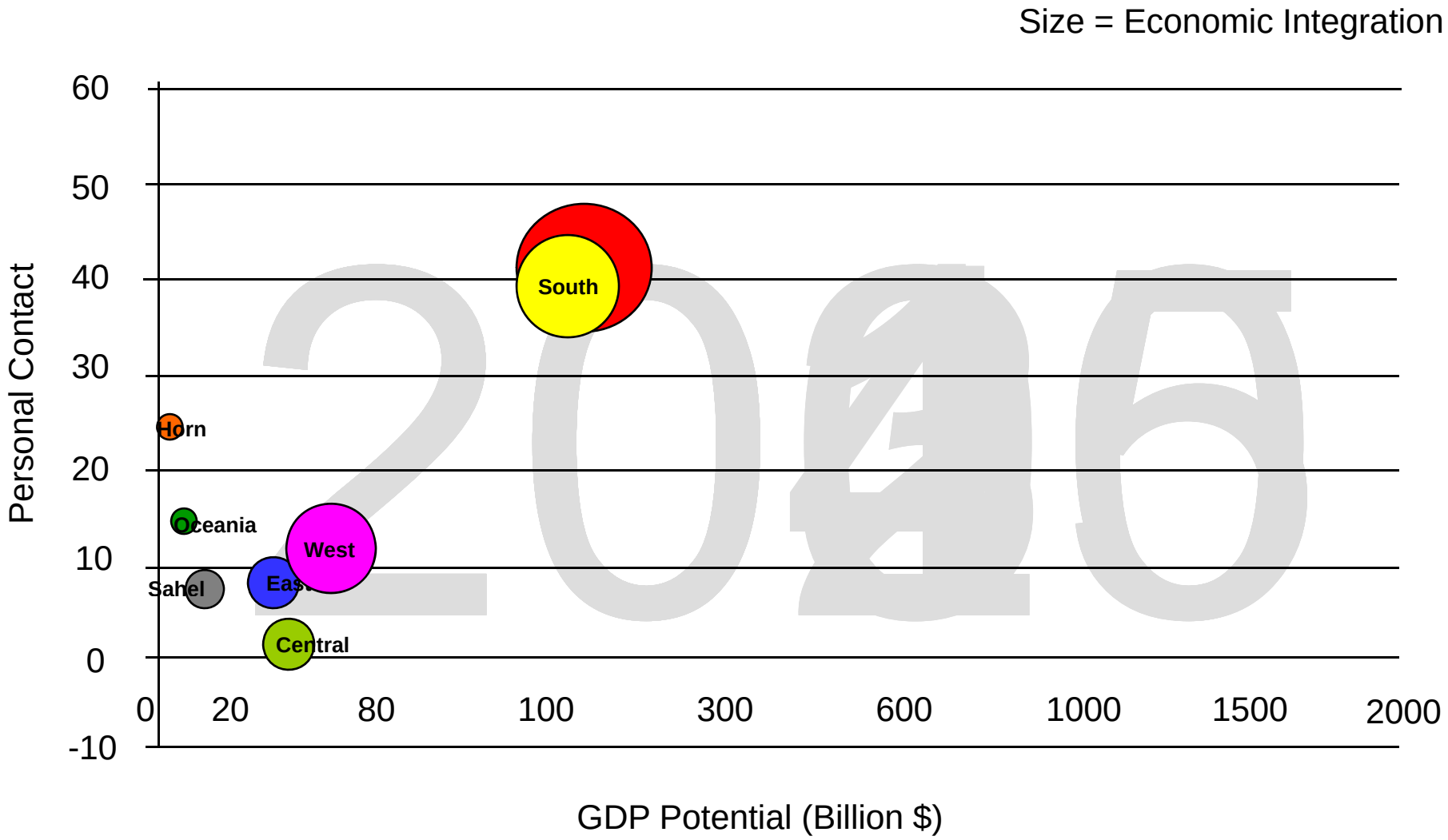


Ethiopia

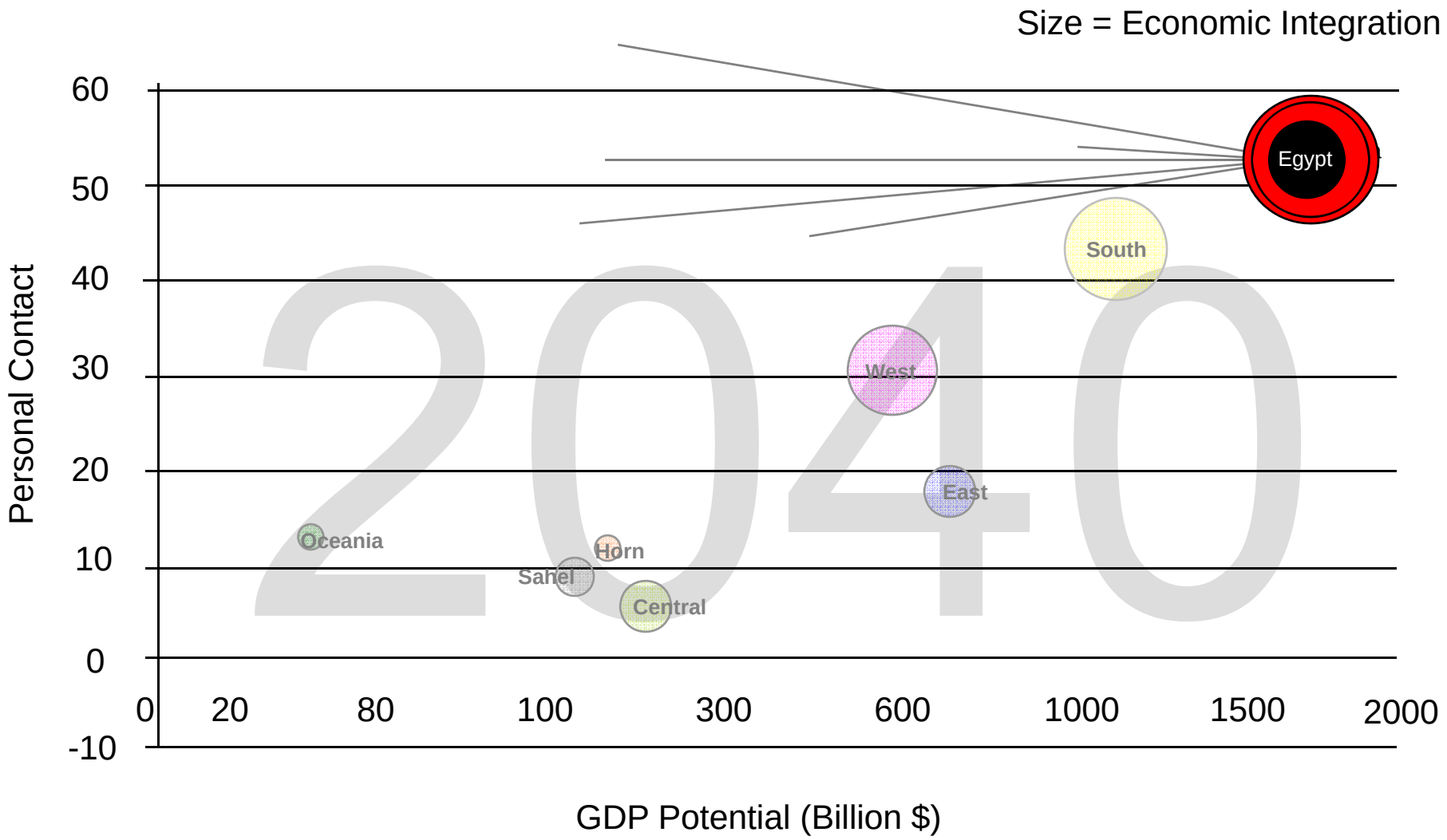
1. Reduced Infant Mortality by 50% from 2010-2016. Held steady for the next 26 years
2. Doubled labor participation rate over the same period and sustained growth

2046

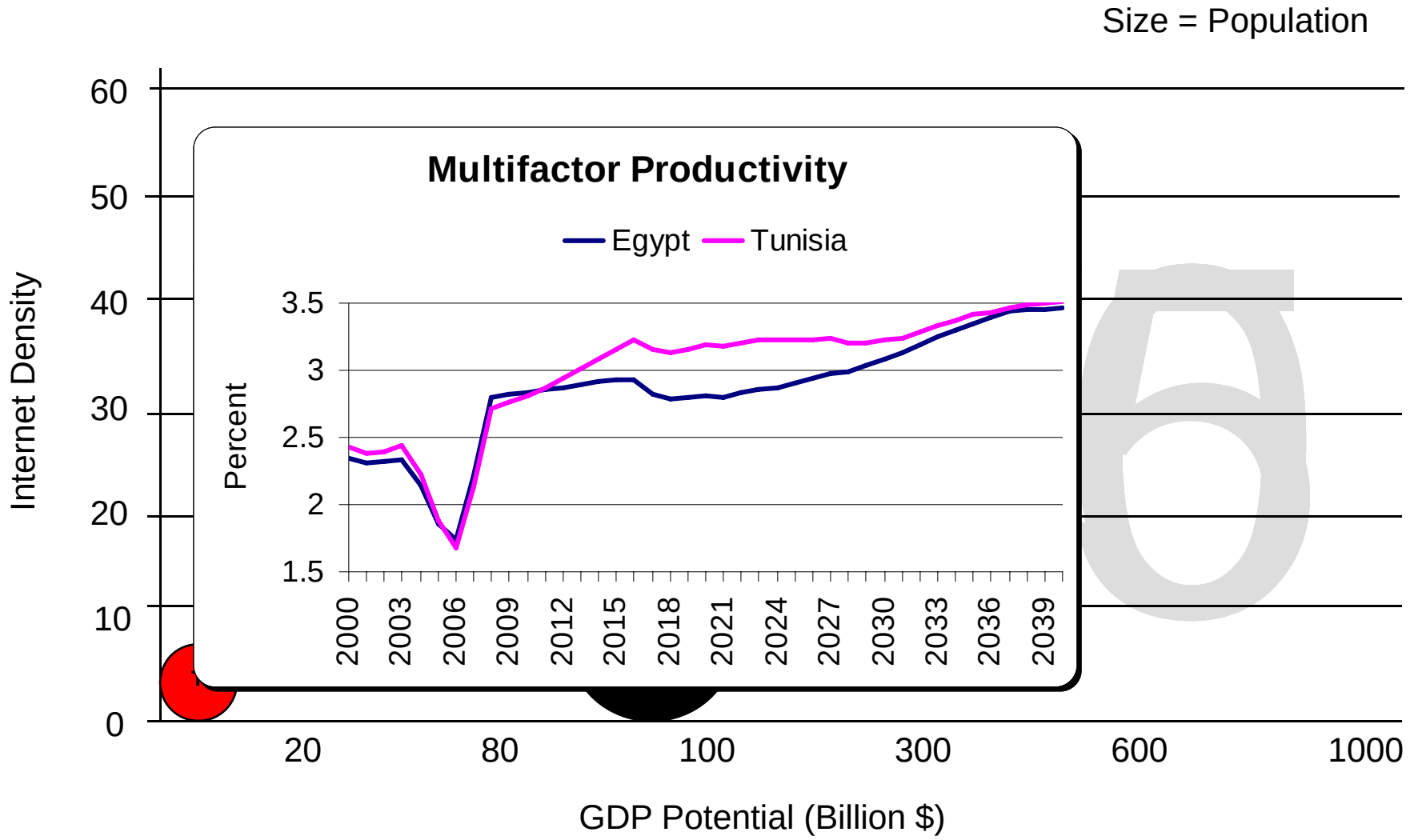
Example: Globalization in Africa



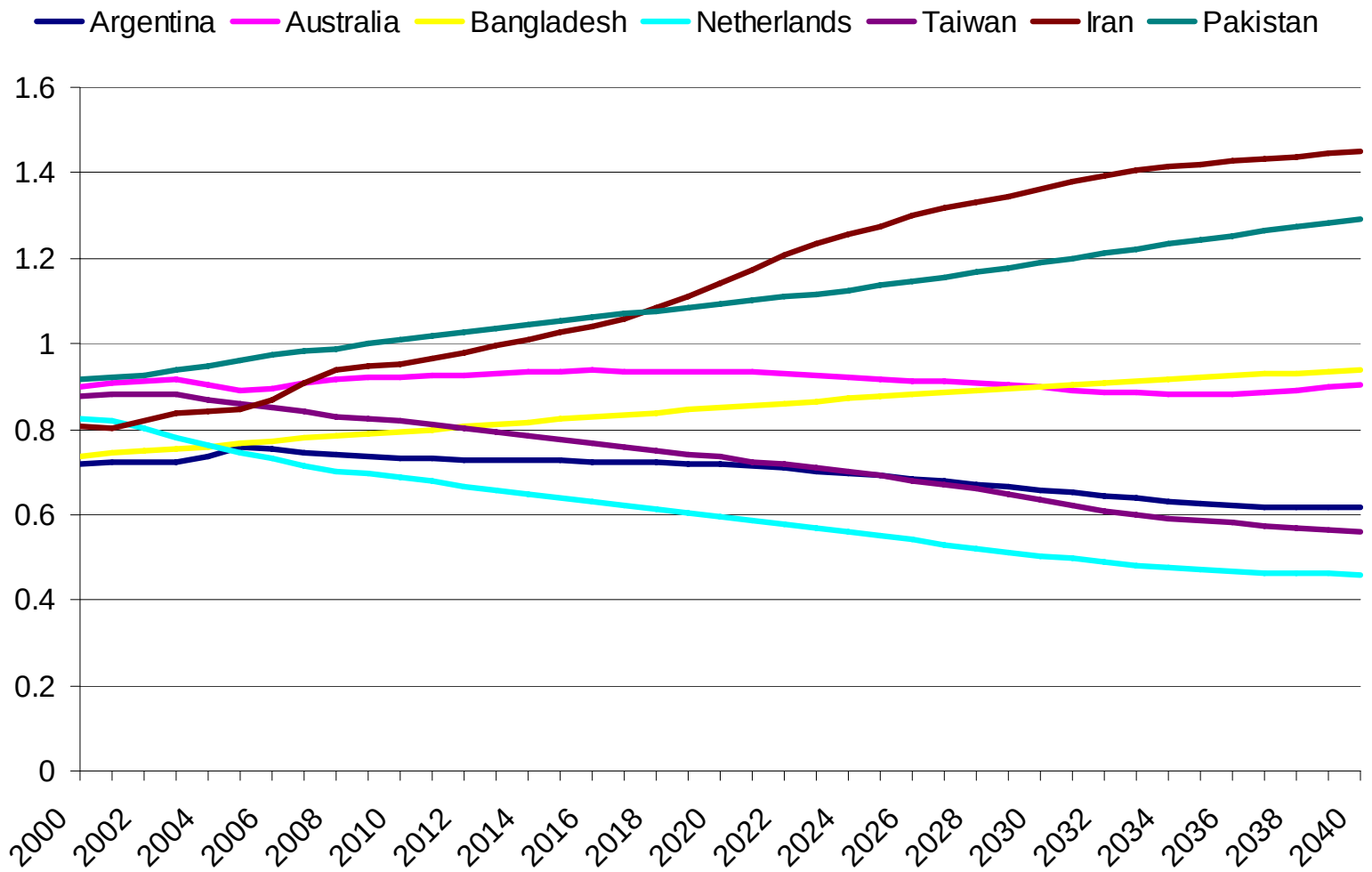
Example: Globalization in Africa



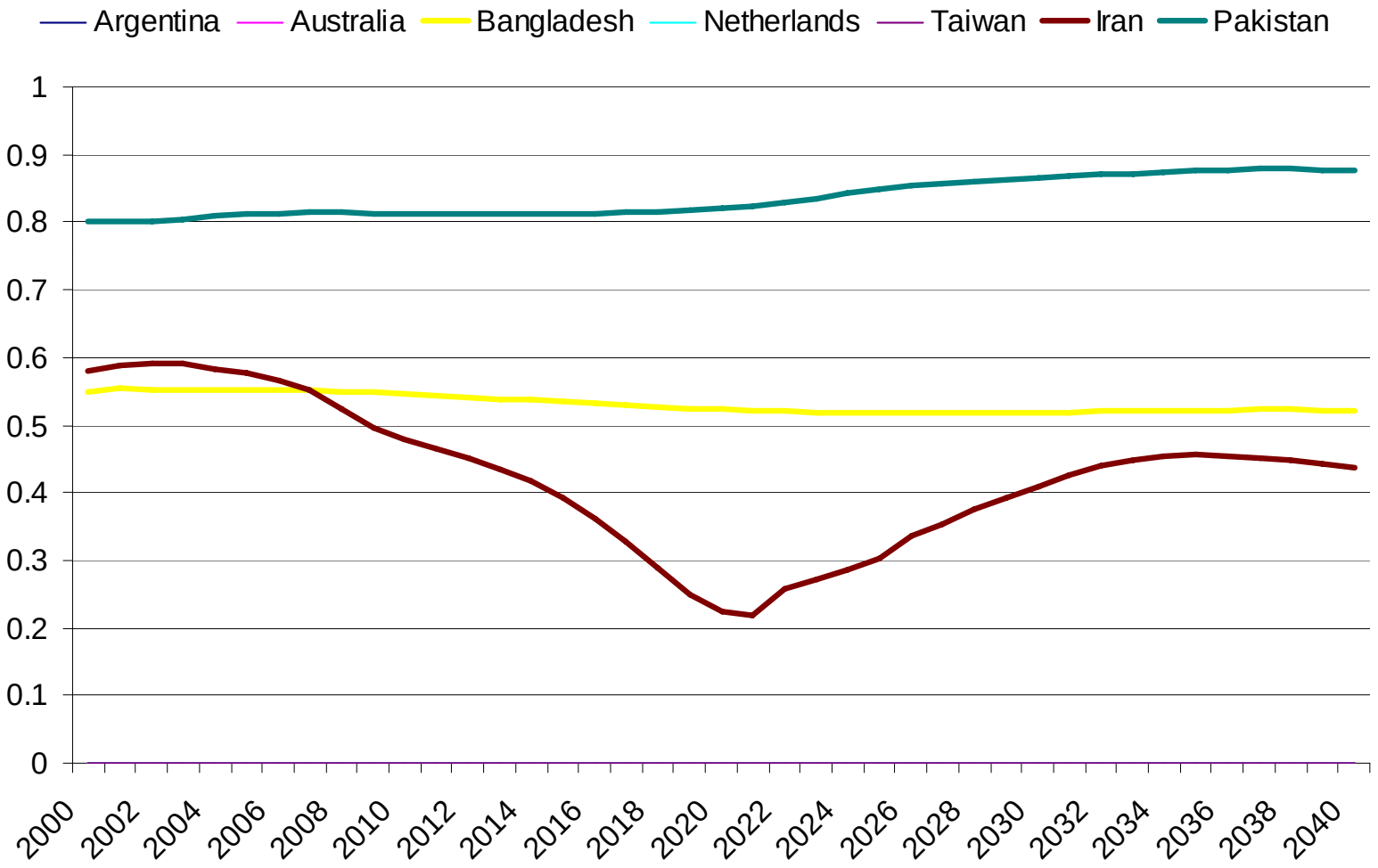
Example: Globalization in Africa



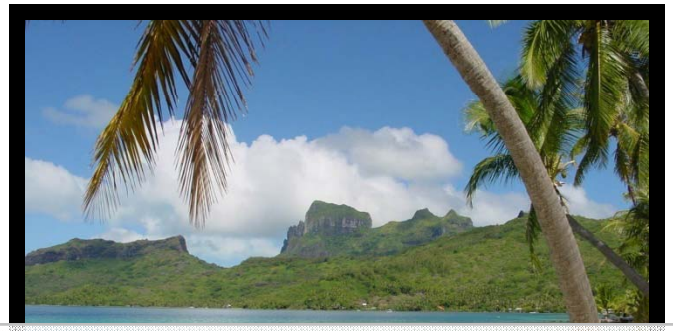
Countries near one percent of global power



Probability of state failure through internal war among countries near one percent of global power



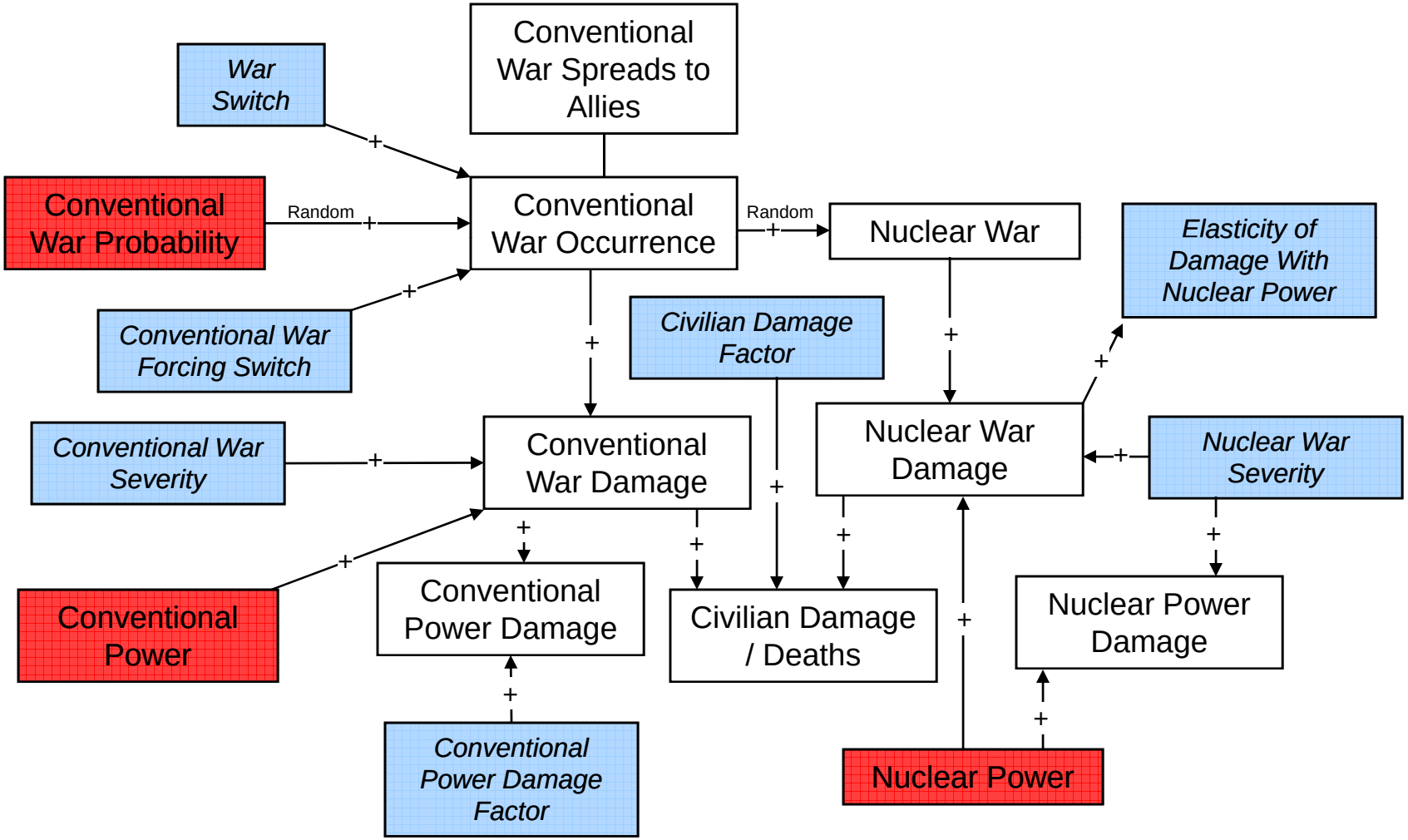
Which world do we want to see?



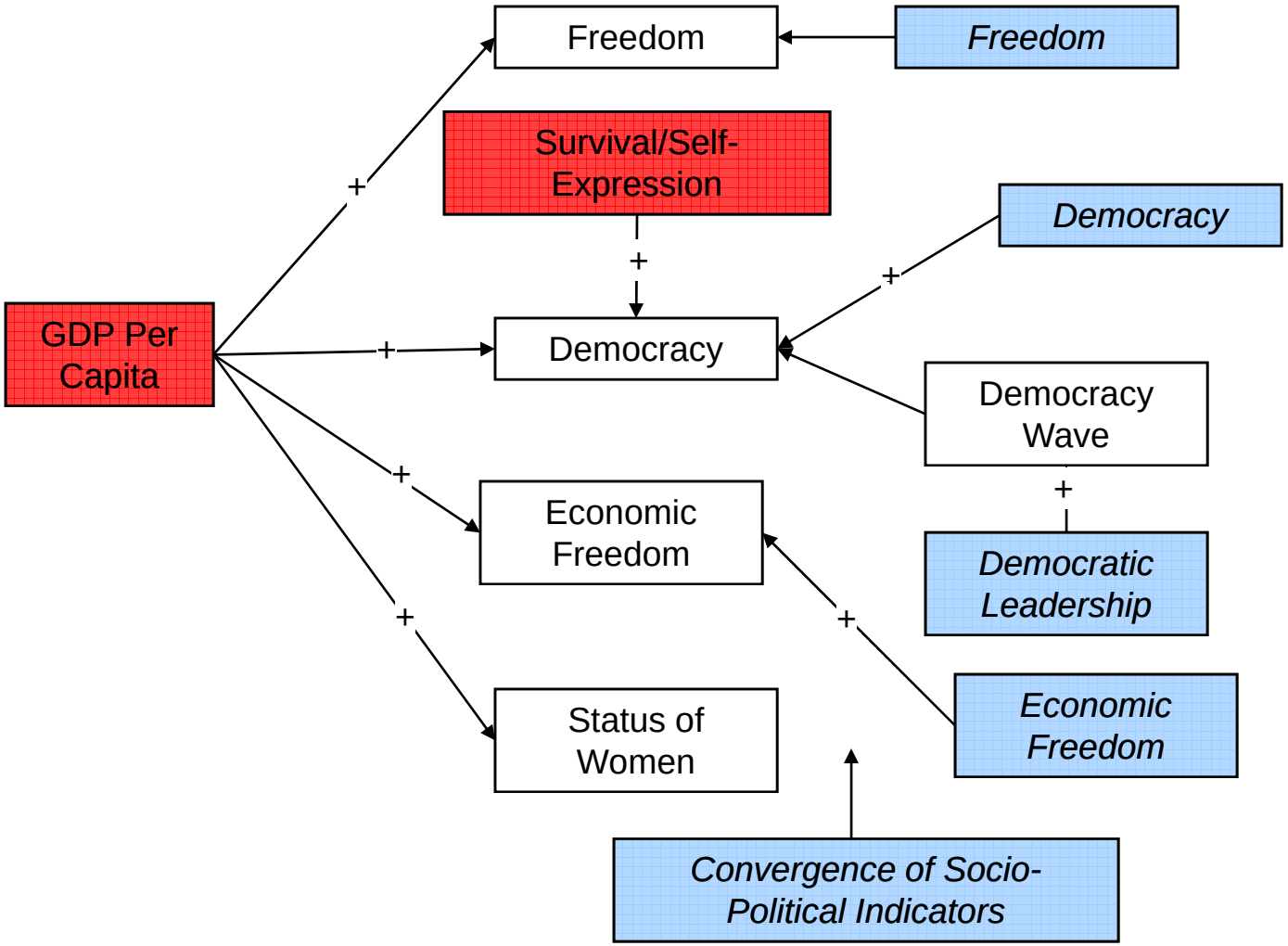
Global Futures Modeling & Simulation
Forecasting Patterns, Determining Alternatives, and Mitigating Risk

Backup Slides

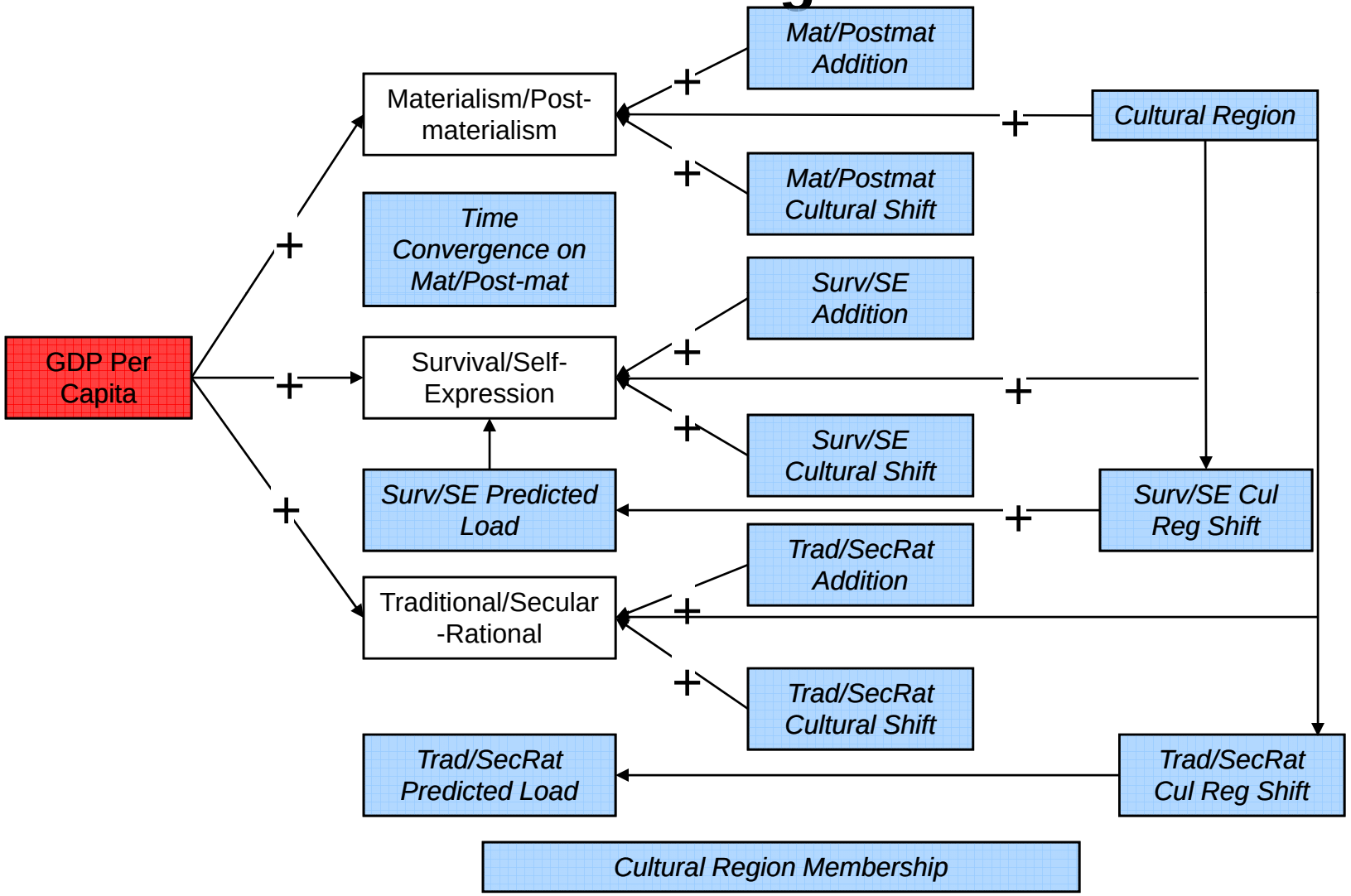
War Forecasting Model



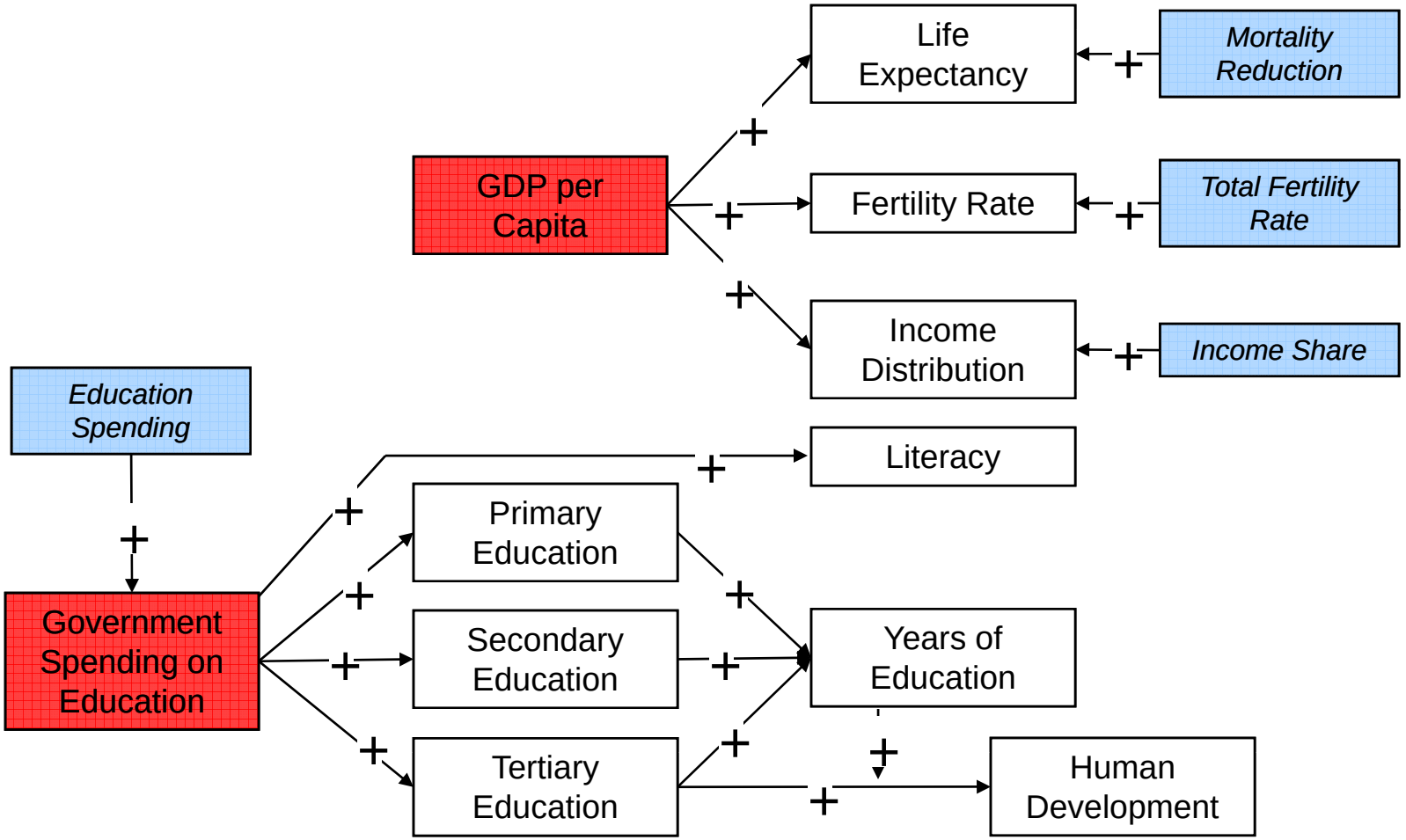
Social Organization and Change Forecasting Sub-Model



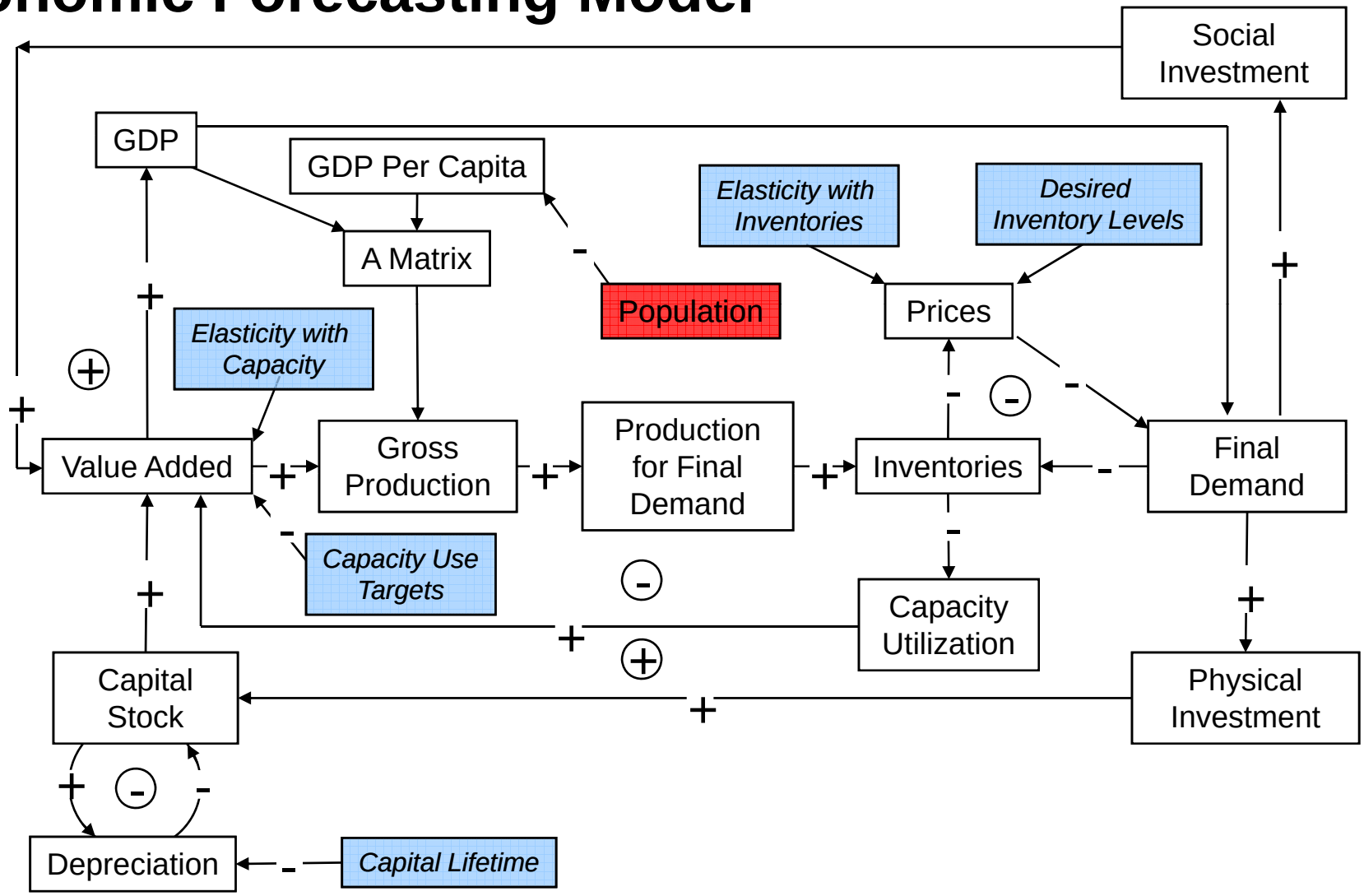
Cultural Evolution Forecasting Sub-Model



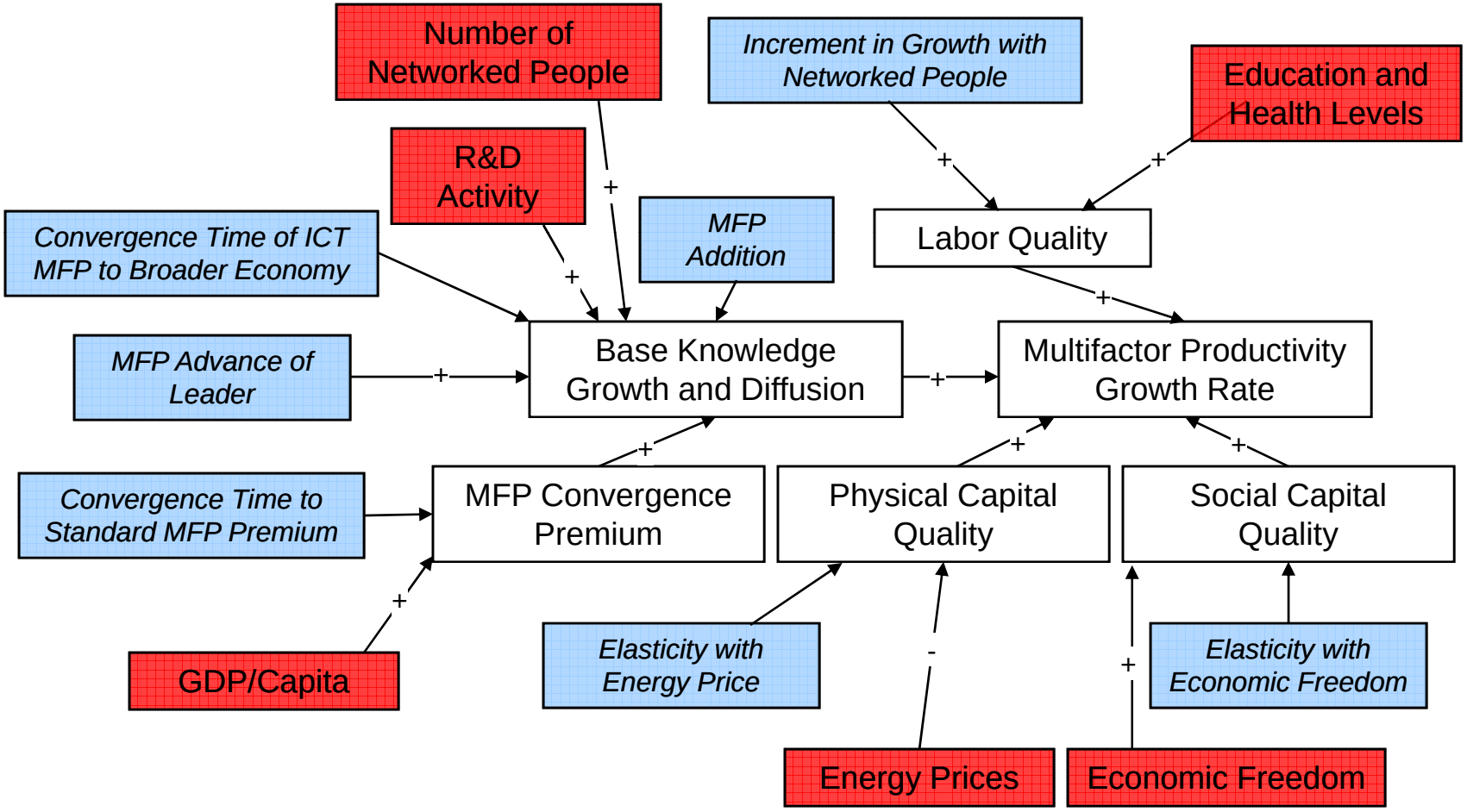
Social Characteristics: Life Conditions Forecasting Sub-Model



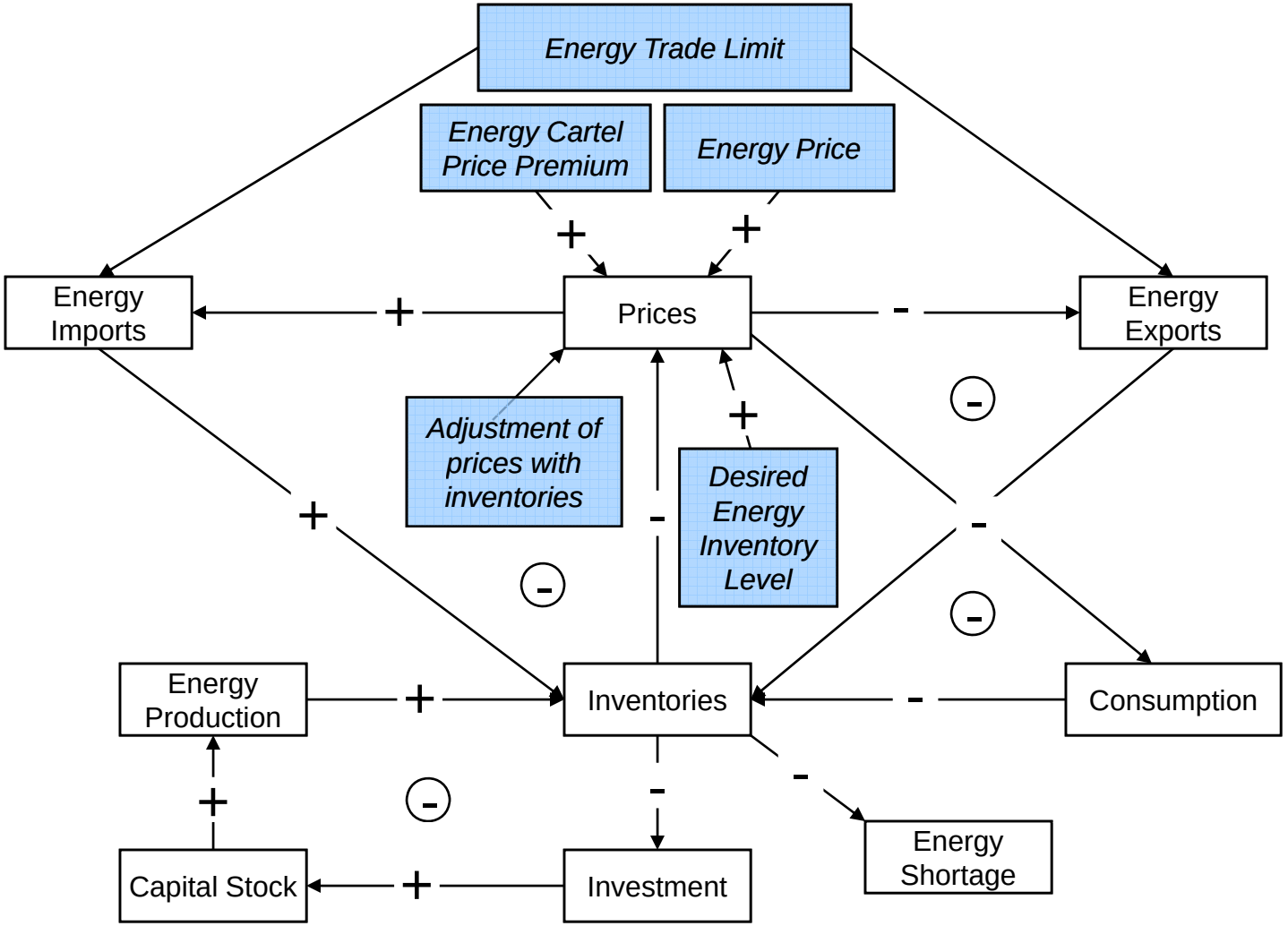
Economic Forecasting Model



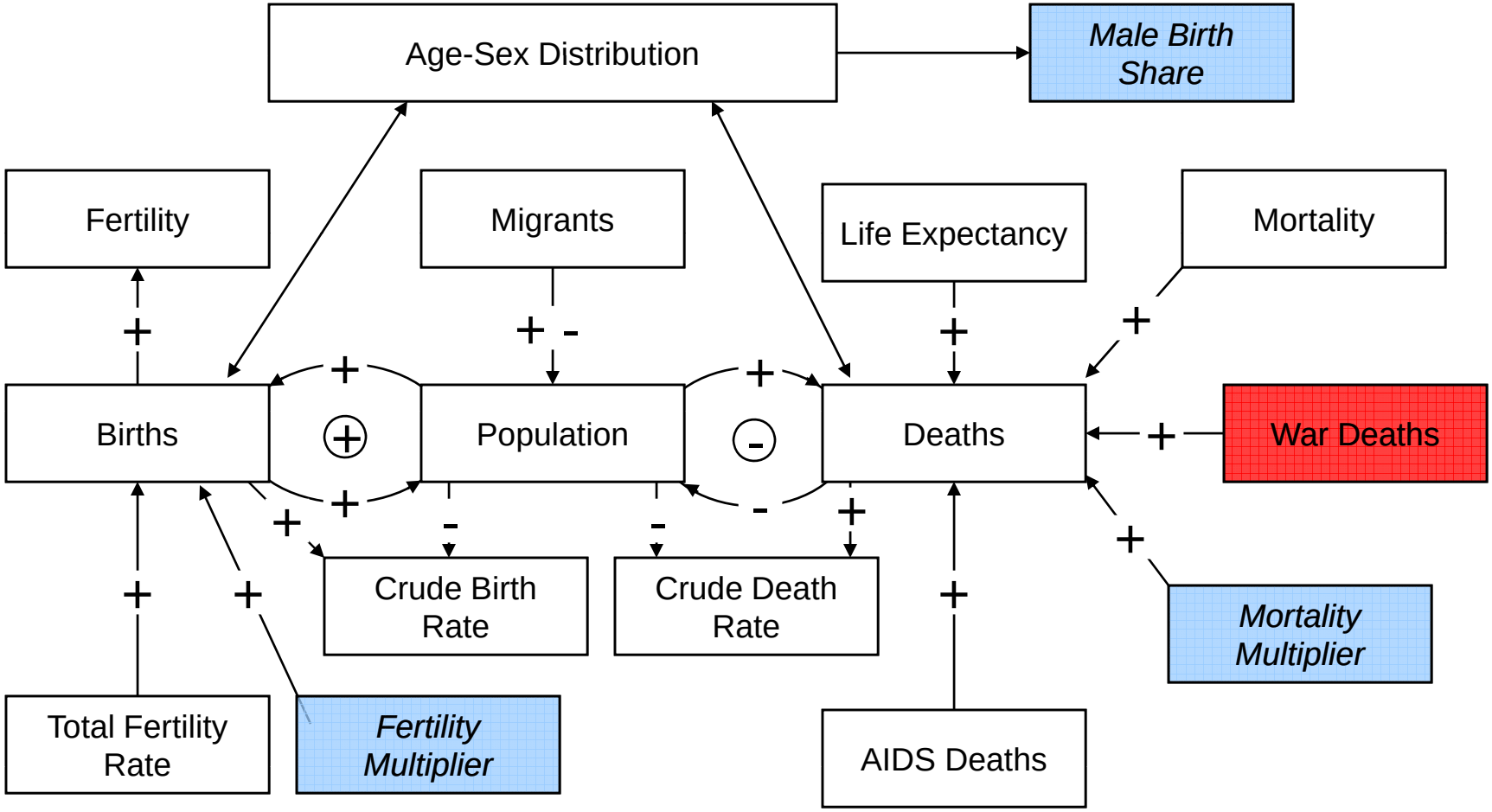
Technology Forecast Model



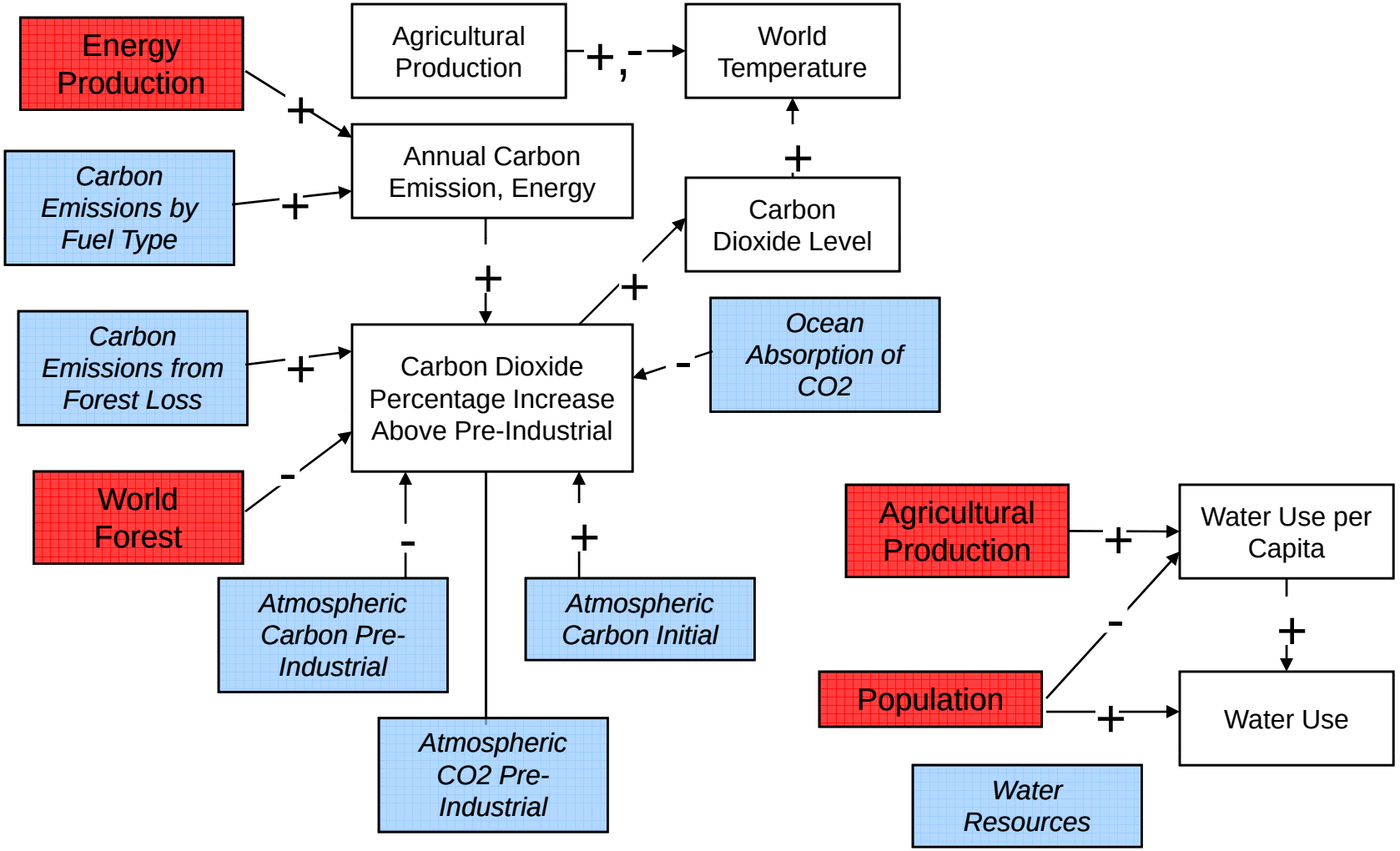
Energy Forecasting Model



Demographic/Population Forecasting Model



Environmental Forecast Model



Schedule

9:00	Introduction & Framework: Dr. Gary
9:45	Overview of IF Model: Dr. Ferleman
10:30	Break
10:50	**Capabilities of IF Model: Dr. Ferleman**
12:00	**Lunch**
1:00	**Live Case Study of IF Model: Dr. Ferleman**
2:30	**Break**
2:50	**Application of Global Modeling: Dr. Gary**
4:45	**End**

No Slides

All demo From IF

National Intelligence Council

Global Scenarios to 2025

http://www.dni.gov/nic/NIC_2025_project.html

Focal questions of the scenarios?

- NIC identified the following focal questions as the point of departure for the scenario development process:
  - *How can the world attain a high level of sustainable economic growth given the rapidly changing geopolitical landscape of the early 21st century?*
  - *What will the balance of power look like in 2025 and to what degree might collaborative policies and frameworks shape the global context?*

Borrowed Time

- This is a world in which planning for global challenges is largely glossed over until they hit. Leaders have faith that solutions can be found and they put a lot of trust in technology as a silver bullet for environmental and climate change solutions. In response to governments limited successes though, other non-state actors (NGOs, MNCs, etc) attempt to create the solutions but find success elusive without the support of clear global state-based leadership The more powerful nations tend to be suspicious of one another and avoid any long-term commitment to joint projects (except for limited economic projects). They believe that working alone, bilaterally or through informal groupings tends to bring better payoffs for national interests. For most, particularly the newer powers, continued economic growth is the top priority and they want to avoid distractions to that goal. While leaders know that the gap between the rich and poor (both between and within nations) has been widening and even causing disturbances in some countries, they believe that the solution lies in more growth. International policymaking can be characterized as cooperative where it suits short-term interests and requires little sacrifice, yet the bigger powers are not concerned about working at cross purposes if that enables the realization of their strategic goals.

Fragmented World

- This is a world in which parochial interests take priority over sustainable economic growth. The lens through which state and non-state actors view and try to address global challenges (such as climate change and proliferation) is primarily one with a local focus, that is, the supply side of the equation is the first priority. ‘International cooperation’ becomes a misnomer as nations focus on what is best for them to the exclusion of international or multilateral interests. The security landscape is characterized by growing risks because of greater national focus and waning multilateral cooperation. Hence there is an increased chance that terrorism (including the possibility of biological attacks), greater numbers of displaced persons, challenges to energy security, and the threat of nuclear proliferation in the Middle East turn into full-scale crises. R&D increasingly has a strong home bias and technological diffusion dramatically slows as a climate of protectionism takes over. Climate change polices erode, reflecting a reversal from Kyoto. Overall, this is a story of progressively deteriorating environments, a world in which events outpace actions.

Constant Renewal

This is a world in which crises create the shocks needed to force fundamental changes in mindsets among people in key countries – both developed and developing – which carry sufficient weight in the global system to shape developments. It is grassroots pressure which forces change, with various political groups, NGOs, professional organizations and "people-in-the-street" coalescing to act as an orchestrated lobbying group on government leaders in order to force inter-governmental cooperation at a global level. On the part of the leaders, a stronger international commitment "to make the system work" develops. Environmental sustainability becomes recognized as a global priority alongside maintaining global economic growth. Globalization accelerates and fewer countries are left behind. Technological innovation and R&D, supported by government, and a mix of cooperative and competitive policies becomes the norm. Leaders and pressure groups must, however, work to ensure common interests continue to take precedence. This is a world in which global cooperation is achieved through a mix of existing organizations backed up by the emergence of new global mechanisms where the current ones are found wanting. In essence, the world "learns by doing," seeking pragmatic solutions (without dogma) and constantly recalibrating what it should do, without leaving any hostages to fortune. Progress is often a case of two steps forward, one step back.

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WorldFuture 2009

Innovation and Creativity in a Complex World

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Chicago, Illinois

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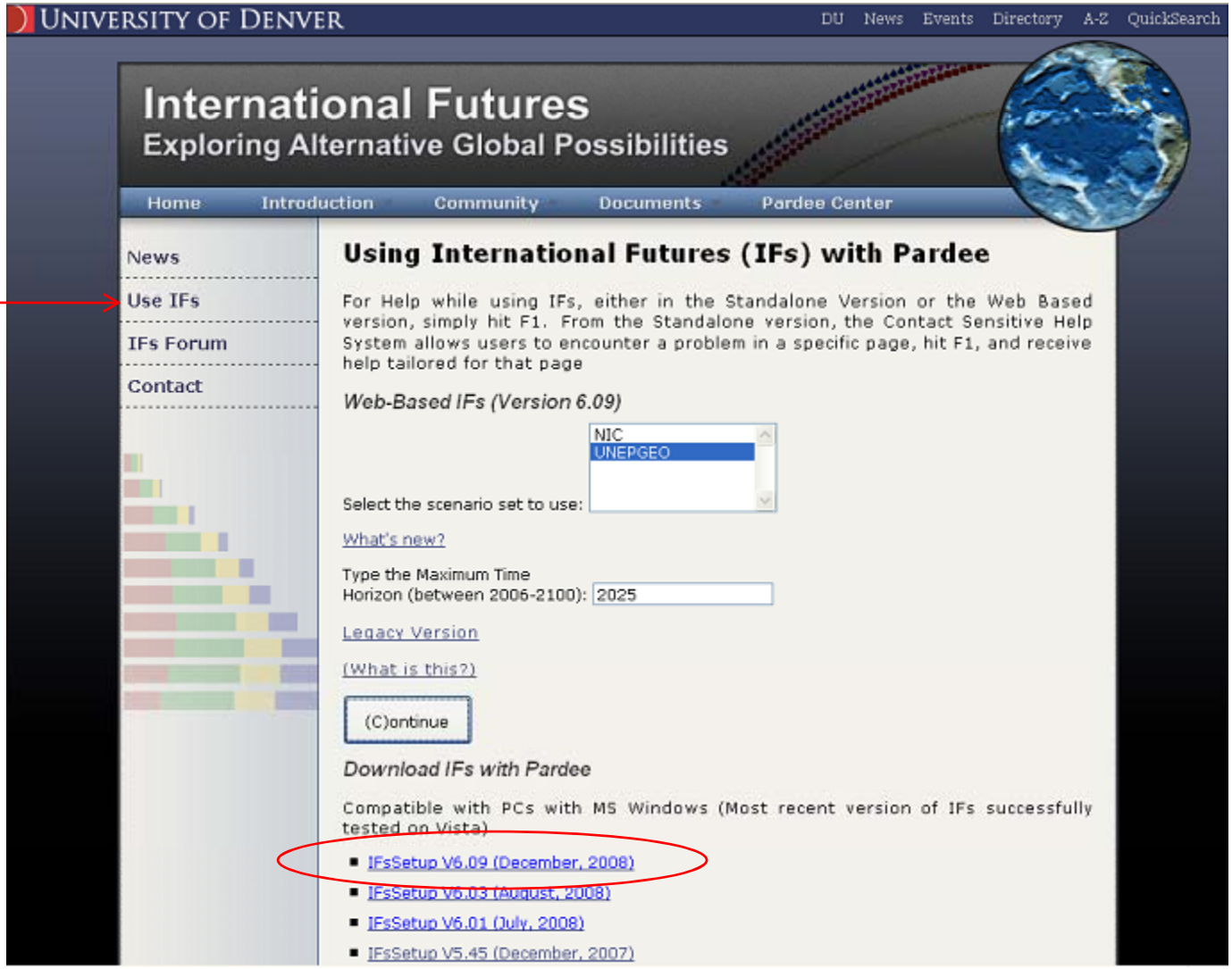
July 16-17, 2009

Education Summit:
July 17, 2009

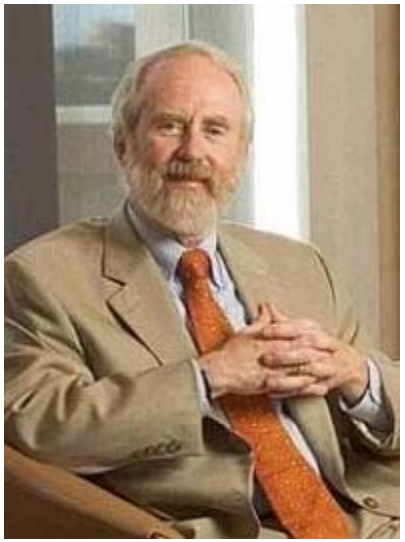
http://www.ifs.du.edu/

IF: to download the public access model



IF Model Training: Aug 31st- Sept 1st, Denver

The Frederick S. Pardee Center for International Futures will host a 2-day training program on August 31 and Sept 1 in the IF Model.



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MODSIM WORLD 2009 Conference & Expo™

21st Century Decision-Making: The Art of Modeling & Simulation

October 14 - 16, 2009

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Conference registration for exhibitors and sponsors opened in March, and attendee registration is now available online.

The third annual international Conference and Expo will feature a wide variety of workshops, exhibits and speakers focusing on the unique multi-disciplinary applications of modeling and simulation. Topics covered from previous years include the following: M&S in program & project design and management; applying 3-D development tools in modeling, simulation, and gaming for education & training purposes; preventing medical errors using simulations;

MODSIM WORLD 2009 NEWS

May 15, 2009	CALL FOR PAPERS CLOSED
May 5, 2009	MODSIM Student Career Exploration Events to be held October 15, 2009
Apr. 22, 2009	CALL FOR PAPERS deadline extended
Apr. 15, 2009	MODSIM World Pre-Conference Workshops to be held October 13
Apr. 8, 2009	Attendee Registration opens
Mar. 16, 2009	Exhibitor & Sponsorship Registration opens
Mar. 6, 2009	CALL FOR PAPERS now open
Jan. 30, 2009	New MODSIM tracks added

Internet 100%

Network Exchange

Card 1:

Is anyone else thinking about….

Name, email

Card 2:

One thing I have learned that might help others is…

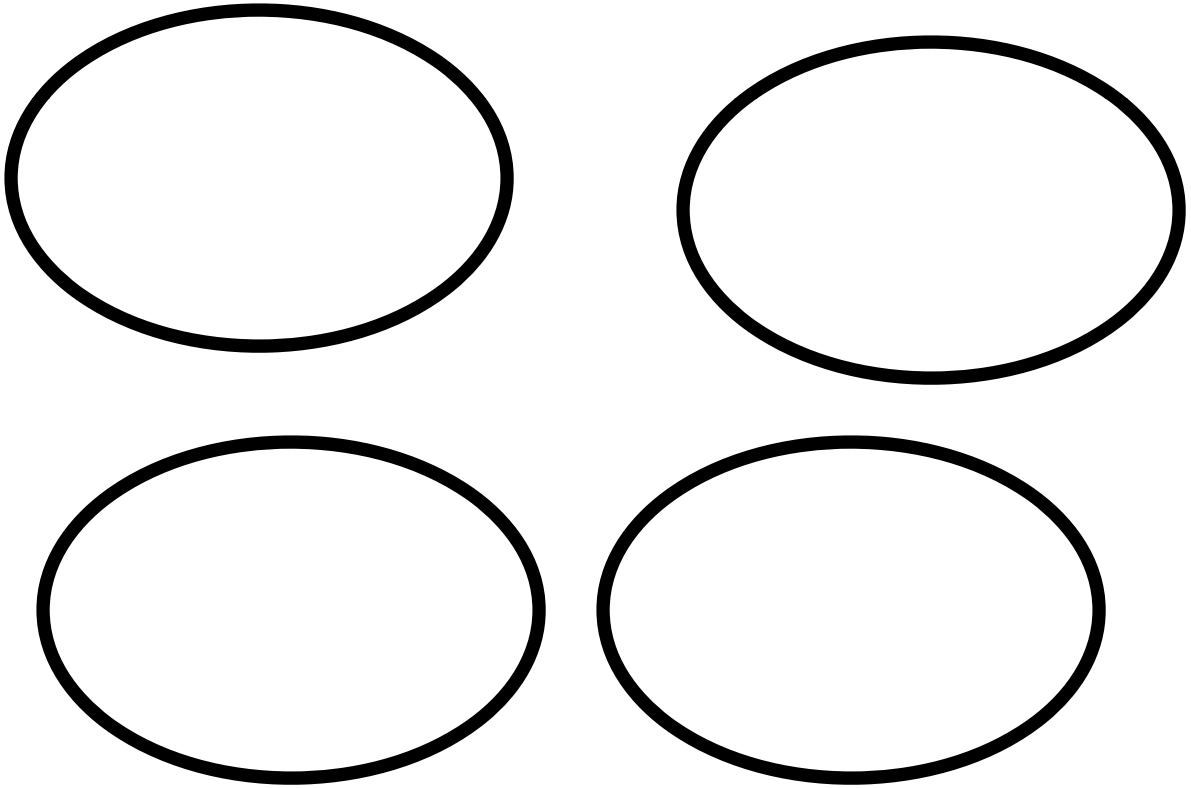
Name, email

World Café

Round 1: What do we know?

Round 2: What do others know?

Round 3: What don't we know yet?



Modeling Global Futures: Frameworks and Tools

Dr. Jay Gary & Dr. Thomas Ferleman

July 16, 2009, WorldFuture 2009, Chicago, IL

Contact: 757-352-4841
Jay@JayGary.com

Contact: 301.512.6240
Thomas@Ferleman.com

Slides: http://www.jaygary.com/model.pdf