第6回予測国際会議
フォーサイトのレビューと今後の方向性
～政策立案への貢献に向けて～

「エビデンス・ベースの科学技術政策」の確立
～技術予測と政策オプションの作成～
“Evidence-based Policy of Science & Technology :Forecasting STI trends and Making Policy Options ”

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- **What are “Policy Options” ?**
- **How to forecast future trends of Science & Technology ?**
- **How to evaluate their social and economic impacts of Alternative Policy Options ? :**

Ⅰ. Property of Current Stages of S&T and Their Social & Economic Impacts　現代科学技術の特性とその社会経済的

Alvin M. Weinberg (1974) “Science and Trans-Science”

科学・技術と社会の係わり合いの中で生ずる多くの課題が科学に解決をもとめて回答を求める事はできるが、しかし科学にによってのみでは答えを見いだす事ができない。こうした課題に対して、トランス・サイエンスな課題という言葉で表現することを提案する。
(Many of the issues which arise in the course of the interaction between science,or technology and society hang on the answers to questions which can be asked of science and yet which cannot be answered by science. I propose the term trans-scientific for these questions.

“Transcend science”の３つの場合：

①科学で答えを出すには費用がかかりすぎる問題：Science is inadequate simply because to get answers would be impractically expensive.

②課題が複雑過ぎて、科学的な方法では合理的な答えを見つけることができない場合：Science is inadequate because the subject-matter is too variable to allow rationalization according to the strict scientific cannons established within the natural science.

③課題それ自身が倫理や美的な判断を含んでいる場合：Science is inadequate simply because the issues, themselves involve moral and aesthetic judgements.

トランス・サイエンス的課題をどうして解決できるのか？ How to solve the “trans-scientific” issues？

・これらトランス・サイエンスといわれる課題領域では、もはや「科学知」だけでは、解決できない。科学者が真摯に「科学の限界」について現状を説明し、その「知」を理解した市民の社会的判断によって、解決の方策への合意形成をおこなう。合意形成のプロセスは、政治家の意思決定に最終的には委ねられるが、政治家の選択には民主的な民意の反映が不可欠。

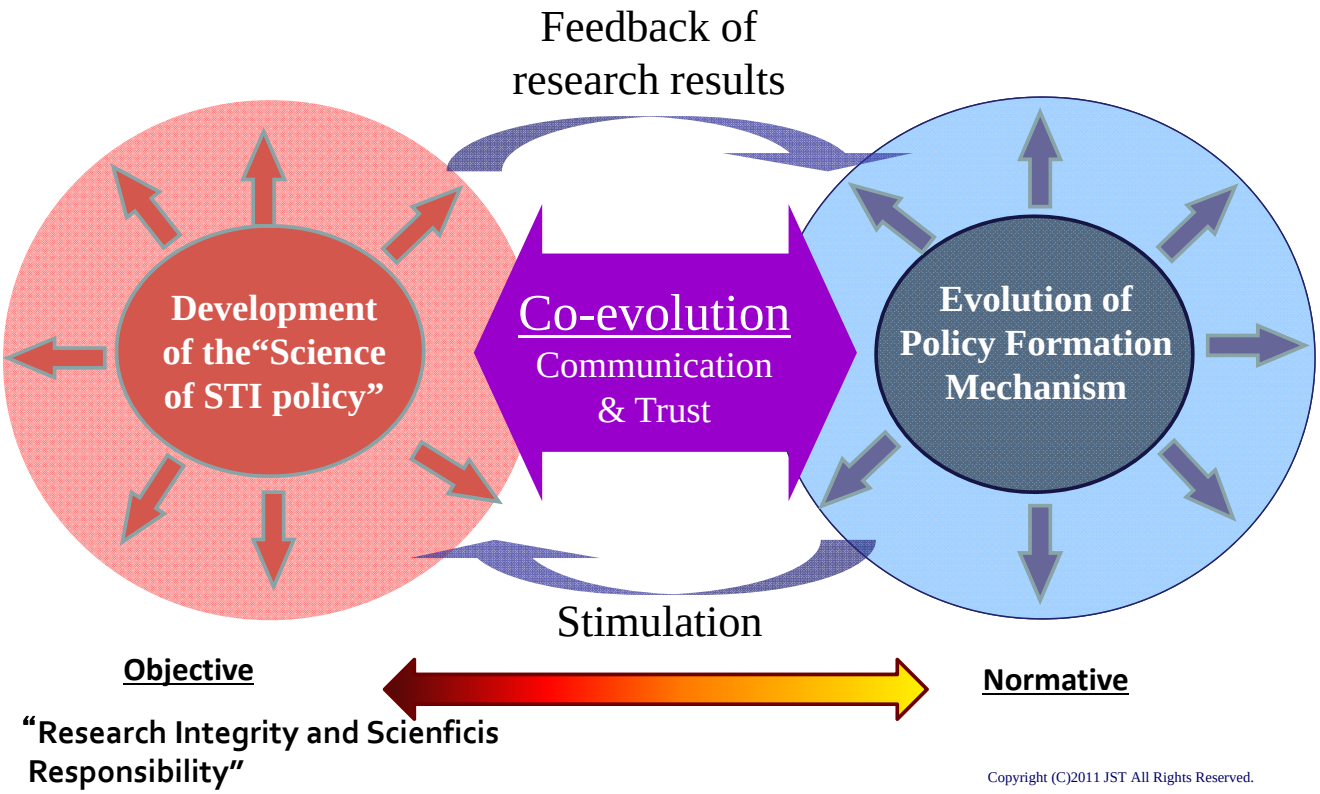
Trans-scientific issues which arise in the course of the interaction between science,or technology and society hang on the answers to questions which can be asked of science and yet which cannot be answered by science. In order to solve such complicated issues, reliable collaborations among scientists, citizen and politician, in which every actors have surely their responsibilities to make roles, are highly important .

＊Scientist has to be “Honest Broker”, who can make reliable advices to citizen and politician.
科学者は、市民の信頼の根ざした、市民・政治への助言者でなければならない。(Honest Broker)。

＊Citizen has to be independent well-educated person, who can surely understand the role of science and technology. 市民は、独立した、真の意味での科学に対する理解者であり、「教養人」でなければならない。

＊Politician has to be independent representative of the citizen, but not biased representatives of the special interests. 政治家は、既得権益の代表者ではなく、独立した市民の代表者でなければならない。

II. *Co-evolutionary development of the "Science of STI Policy" and the "Policy Formation Mechanism"*



III. 課題解決型ための科学的な政策構築のフレームワーク
Framework of "Science for Redesigning Science, Technology and Innovation Policy " (SciREX Program)

Development of "Science of science, technology and innovation policy"

Chapter 1 Toward Establishing a National Based on Science, Technology and Innovation
Chapter 2 Challenges to be Addressed by Science, Technology and Innovation
Chapter 3 Creating an Environment Suitable for Science, Technology and Innovation
Chapter 4 Fulfilling the Headquarter Function of the Council for Science, Technology and Innovation

「Comprehensive Strategy on Science, Technology and Innovation 2014
- Bridge of Innovation toward Creating the Future – 」 June 24, 2014 Cabinet Decision

*1. Deepening the understanding for the properties in the modern sciences and society :*科学技術／経済社会の現状俯瞰構造化(A)

*2. Setting "Policy issues to be solved :*課題の発見同定 (B)

3. Importance of the "Impact Analysis" of STI policy alternatives as "Policy Options" :
政策手段の選択(C) と政策オプションの形成(D)

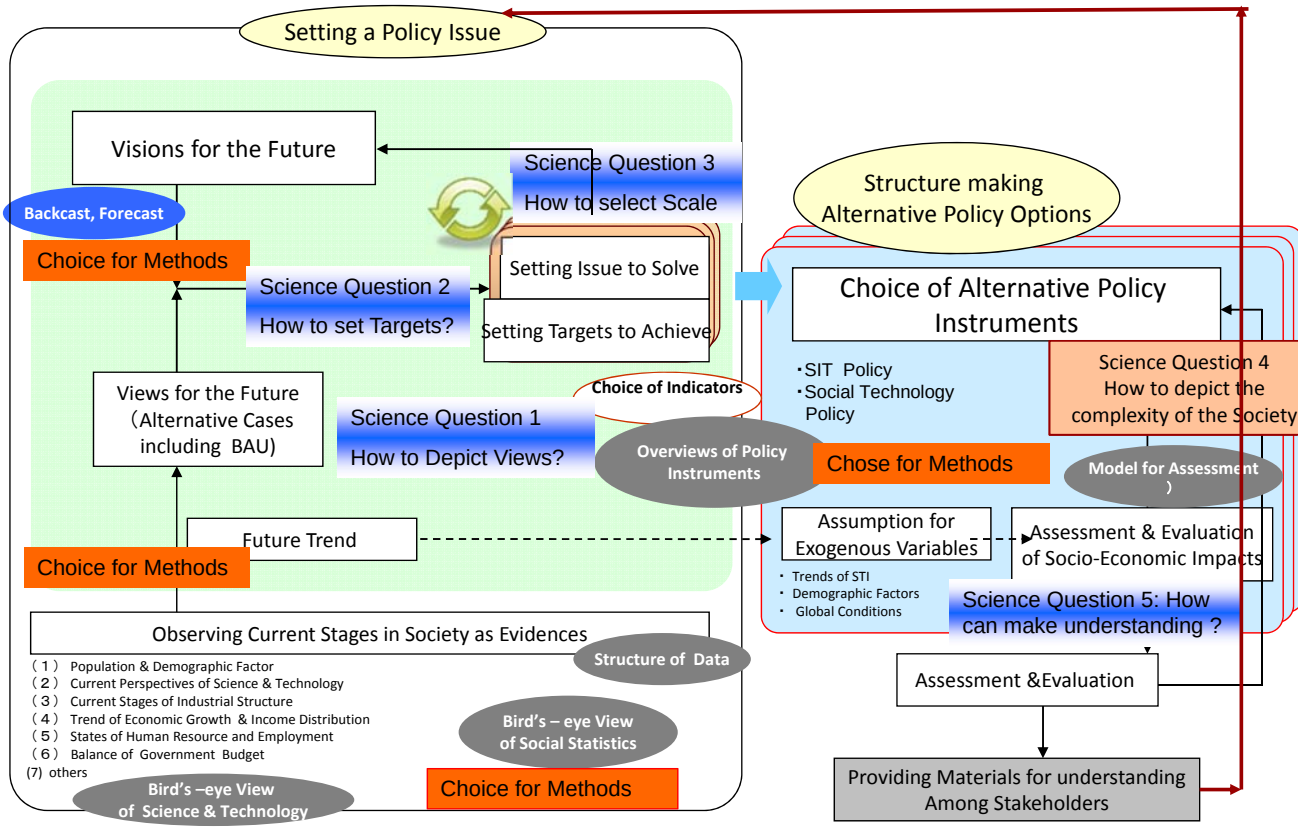
4. Assessment of "Policy Options" and Policy making: 政策目標達成度評価と政策選択(E)

5. Explanation of the policy to the public & getting understanding and consensus building:
国民への政策説明と理解・合意の形成（F)

6. Ex-ante policy evaluation : 事後的政策評価 (G)

7. Co-evolutionary development of the "Science of STI Policy" and the "Policy Formation Mechanism"

A Bird's eye View of Science for Science, Technology and Innovation Policy

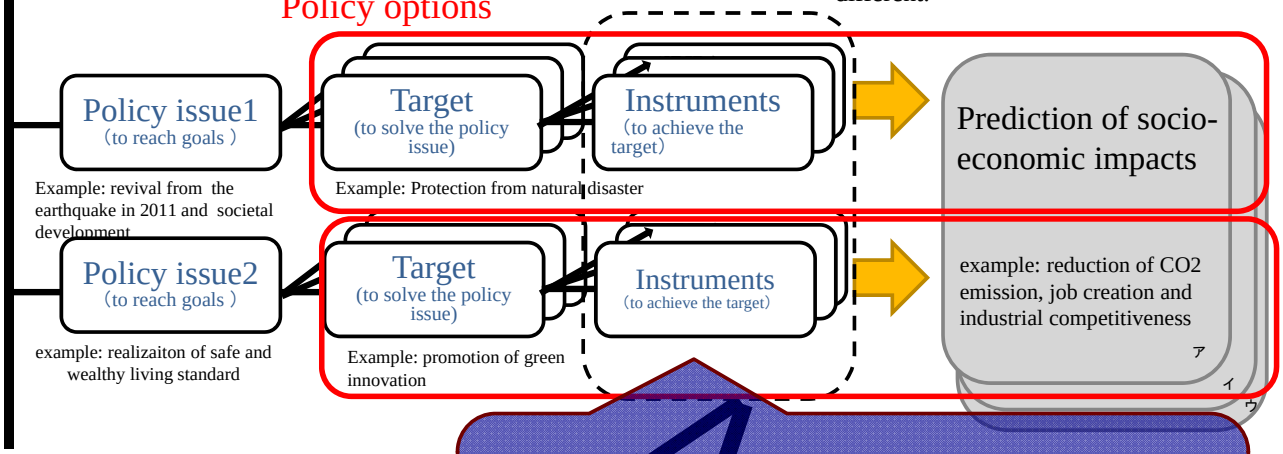


iv. Forecasting future trends of science and technology and making alternative policy options : What are "Policy Options" ?

Visions (**Goals for the country**) e.g. "realization of a sustainable society by STI"

There would be several possible sets of targets, conditions and policy instruments and their socio-economic impacts are different.

Policy options



Policy instruments for the promotion of STI

examples: allocation of R&D investment in areas, quantities and organizations.

Making policy options in trial

Policy issue: "prediction-prevention-oriented promotion of healthy and long-lived society"

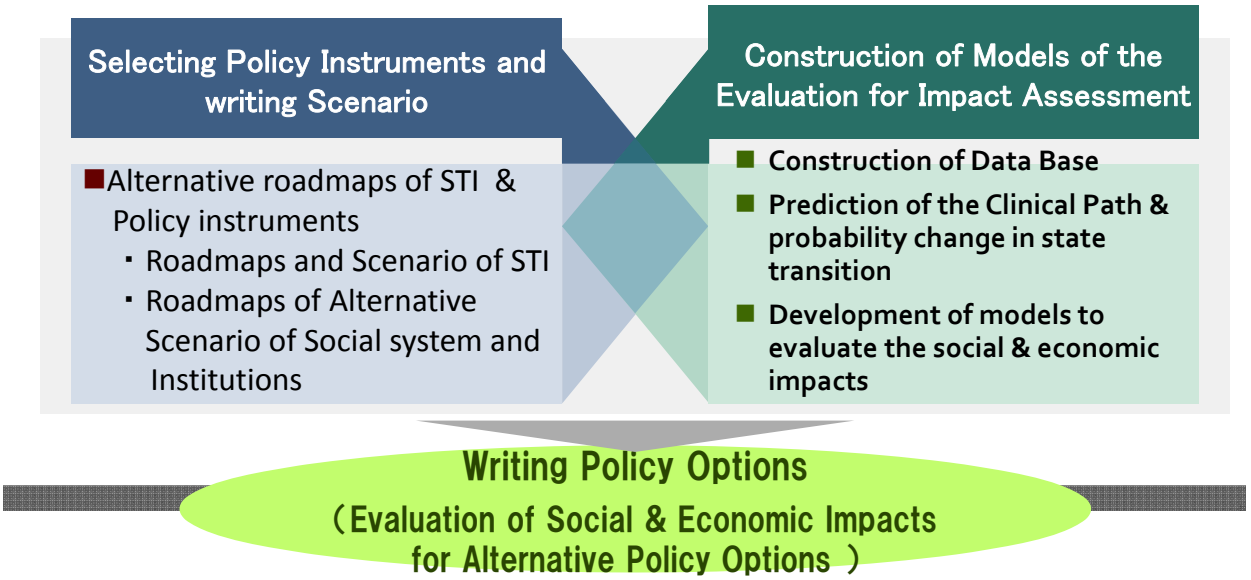
Target: "prediction and prevention of diabetes"

Policy insturments for social system reform

examples: relaxation of regulations, organizational reform in industries, academia and public administration in STI policy, social infrastructure, education and human resource management, enhancement of international projects

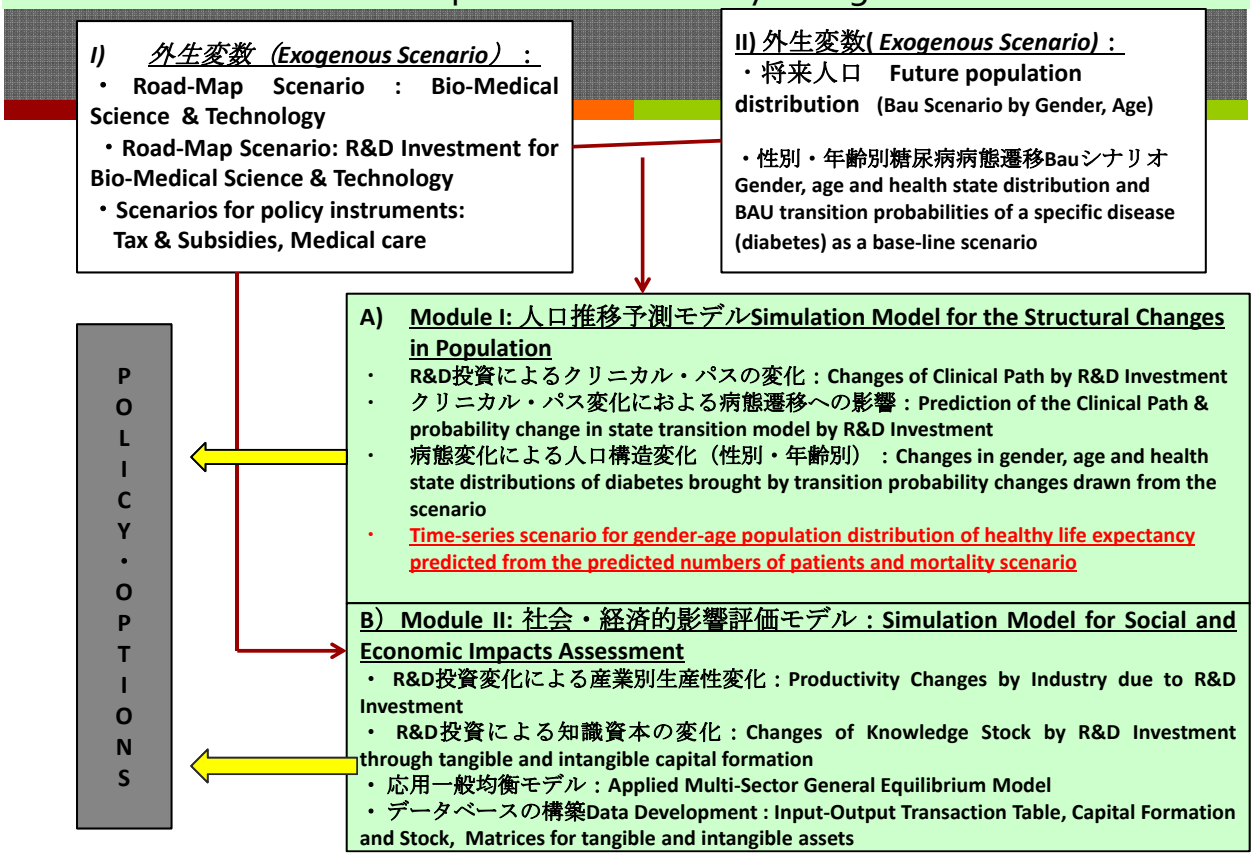
Experimental Case of Policy Option: "Prediction-Prevention-Oriented Promotion of Healthy and Long-lived Society"

Policy target is to realize the promotion of healthy and log-lived society by the development of "prediction and prevention" technology" in the case of diabetes. We tried to forecast the development of the technology for prediction and prevention by the collection of ideas and opinions from experts in these fields and write roadmaps for the development of SIT as several alternative scenarios

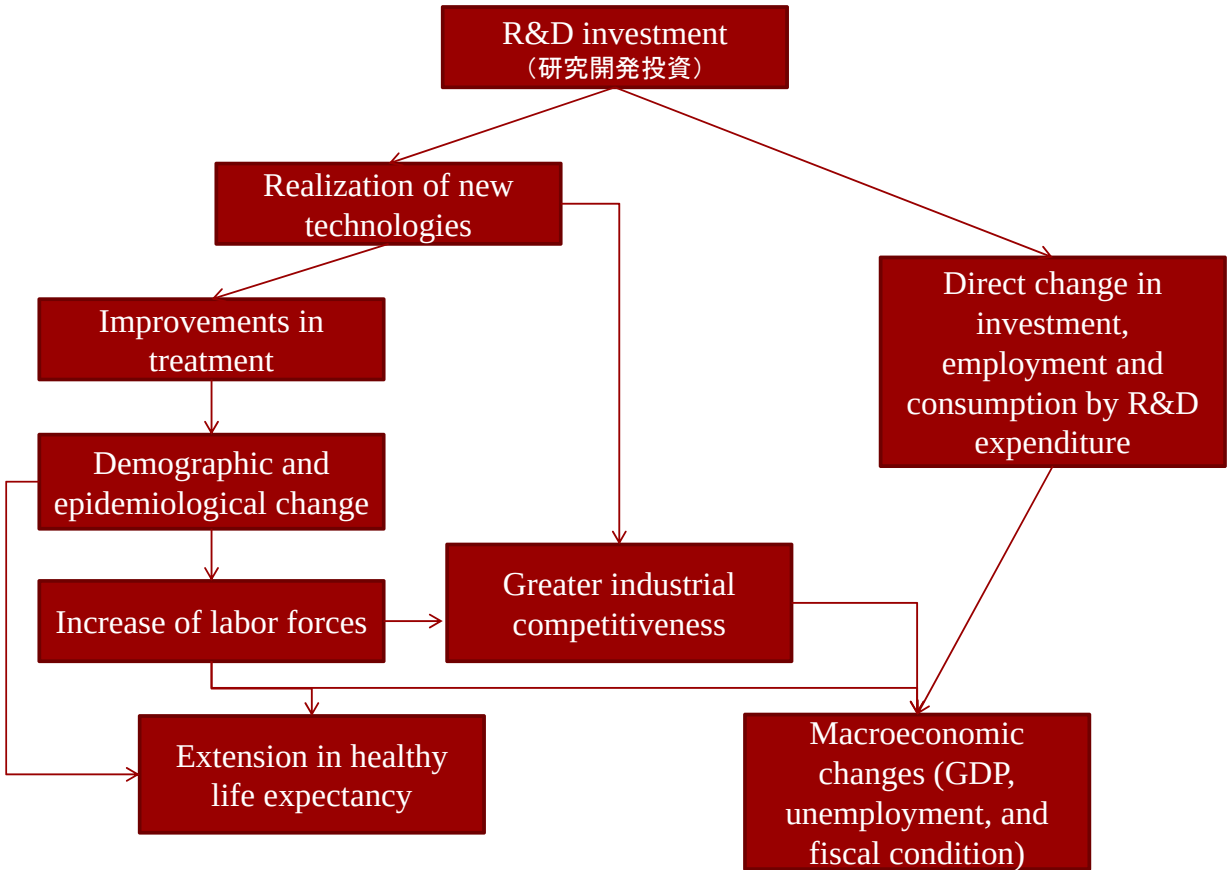


Flow-chart of the Model for Policy Option

- An Experiment for Policy Design -



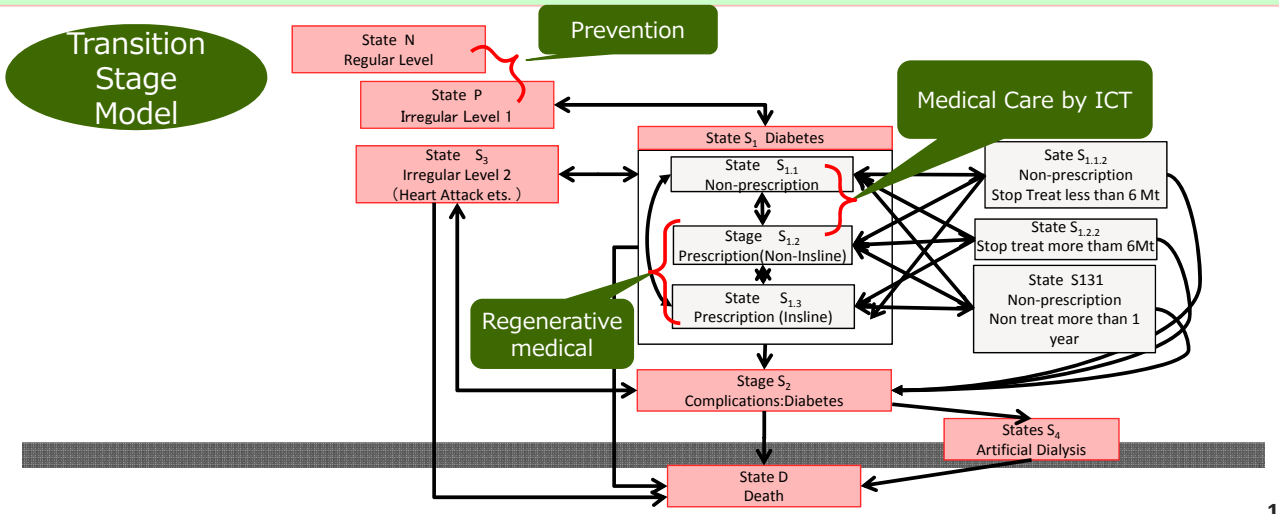
R&D投資の社会・経済的影響フロー
Flow chart from R&D investment to social impacts



Methodology	contents	Description of data and methodology
基盤データ:: Basic Data	■ 産業連関表 Input-Output Table	◆ Input-Output Table for analyzing interdependency of the economy, which are related the medical progress as science and technology development to various economic activities in the market.
	■ 知識ストック Knowledge Stock as intangible assets	◆ Progress in knowledge stock by R&D investment in tangible assets as well as intangible assets.
糖尿病の状態別患者数の推計手法 **Gender, age and health state distribution and transition probabilities of a disease (diabetes) as a base-line scenario**	■ マルコフ連鎖モデル Malkov Chain Model	◆ **the Clinical Path & probability change in state transition by receipt data (more than 20,00 persons) .** ◆ **Methodology for estimation od health states distribution and transition probabilities of a disease(diabetes) by gender and ages classes.**
経済的影響の分析手法 Method of Impact Assessment Model	■ 多部門経済一般均衡的相互依存モデル Applied General Equilibrium Model	● Construction of quantitative model building to evaluate the social and economic impacts by the development of orevention and prediction technologies.

Estimation of patients by transition of stages on diabetes

- Concerning the transition stages of diabetes patients, we tries to estimate from medical stages data observed by receipt data classified by age and gender, which are recorded by individual patient in time-series. We can estimate the transition probabilities in each medial stages
- Date could be observed during Jan. 2008～Dec.2012 by monthly. Transition probability between clinical stages can be estimated monthly. From the estimated number of patients related to the clinical states we tries to estimate the necessity of the level of technical progress for the diabetes, by which the target of number of patients will be expected by targets scenario.
- Technologies are classified into “Preventing technology by marker“, ”Primarily Health Check Technology by personal medical care“, “Medial Care through transition stages by ICT”, and “Regenerative medical” until the year2030. Technology roadmaps are estimated by Bachcast method.



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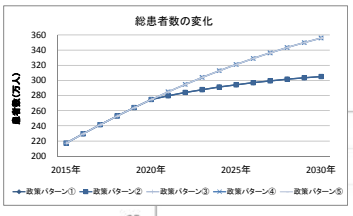
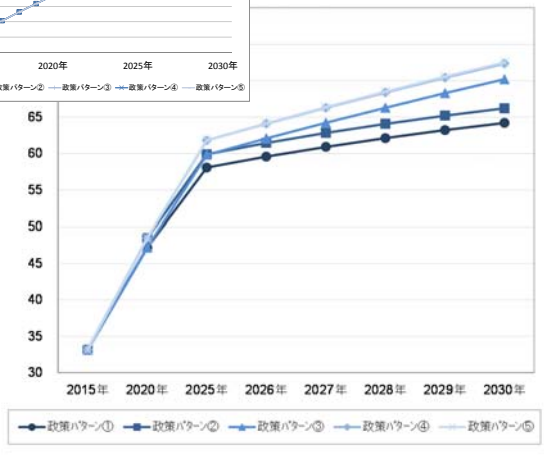
Impact on Number of Diabetes Patients by Alternative Policy Scenarios

- Five cases of alternative patterns of “Policy Scenario” in STI
- By most efficient policy scenario, number of serious patients are expected to decrease about 100,000 persons and save 159 billion yen for medical treatment cost totally.

Policy Patterns	Estimates of Number of Patients	Difference of No. Patients compared with ⑤ in 2030
① Introduction of available tech.		▲100,000
② Focus on preventing technology		▲80,000
③Focus on medical care personally by ICT		▲40,000
④Focus on regenerative medical		▲20,000
⑤ No introduction of new technology		–





ew technologies

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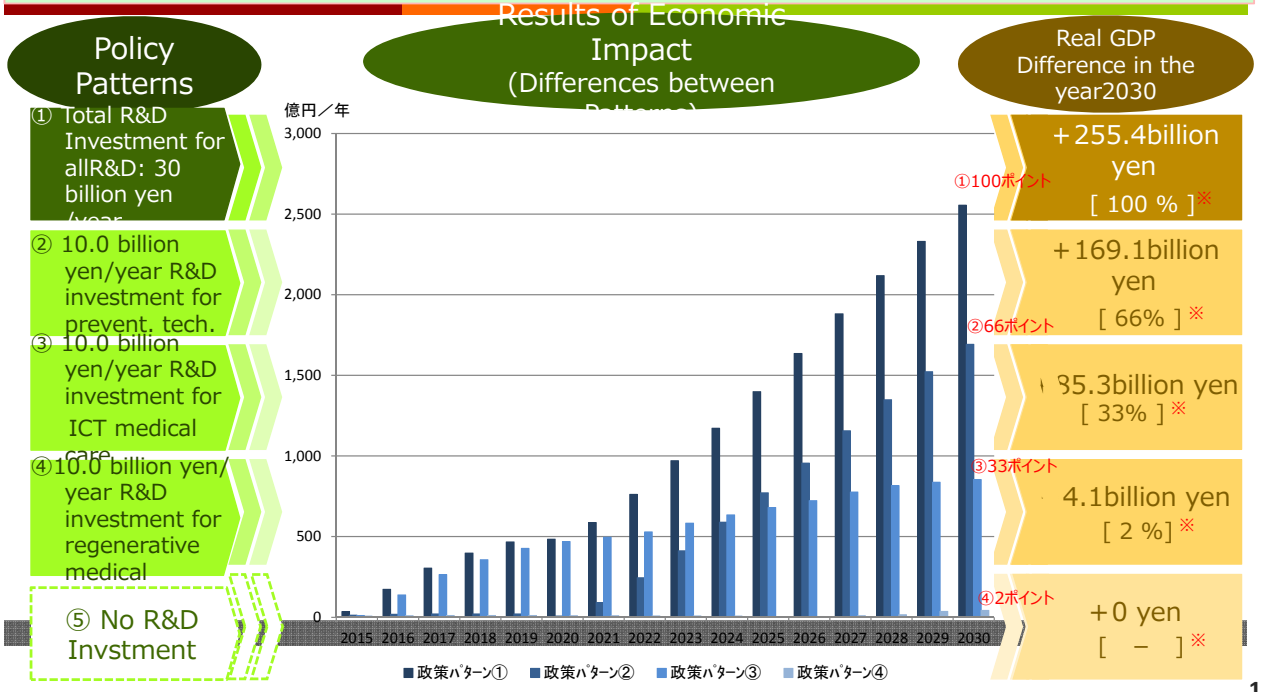
Example: Macro Economic Impact on Real GDP

- Difference of real GDP in the year 2030 between policy pattern ① and ⑤ is estimated about +255.4billion yen (100%), while in the cases ②、③、④ the impacts on real GDP are estimated about 66%, 33% and 2% of case ⑤ respectively.
- Be careful to use these results, because the absolute results are meaningless. We are focusing on the comparisons of the size of differences among cases.



※ 2030年時点における「政策パターン①と政策パターン⑤の実質GDP差」に対する比率

Summary

① This experimental program gave us an empirical methodology in which we can estimate quantitatively social and economic impacts of expansion of knowledge stock through R&D investment and implementation of alternative scenarios for medical treatment as policy options

- We proposed a backcast methodology to forecast the future trend of development of science and technology due to R&D investment, in which we collected the information from the interviews to experts more than 200 persons in the science fields.
- We call our methodology as “Backcast Method”, in which we ask to expert in interview a set of the prediction of the future development as a roadmap as well as the R&D investment plan from now to the target period simultaneously, in order to reach to the target of the policy at the target year.
- We tried to express the future trend of science and technology as alternative policy scenarios consistently with policy instruments. We call them as alternative policy options.
- We tried to estimate social and economic impacts quantitatively by implementation of the alternative policy options.

② Several suggestions from our experiments

- When it comes to forecast the future trends of the development of science and technology, information which are collected by experts shows a distribution as concerns the timing of the realization of the event. How to treat such uncertainty included within the information.
- When it comes to interview, it is highly important that the current situation as concerns the progress of the knowledge is commonly understood among all

Reference

Hiromi Omoe and Atsushi Ogasawara :

“An Overview of Disease Prediction, Prevention, Diagnosis, and Treatment Techniques for the Realization of a Health and Active Aging Society – A Study on Lifestyle-related Disease (Type 2 Diabetes) –”, Science and Technolgy Foresight Center, National Institue of Science and Technology Policy, Research Note No. -227, May, 2014