

R&D in the National system of innovation: A system dynamics model

By

Sara Susanna Grobbelaar

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SUMMARY

R&D IN THE NATIONAL SYSTEM OF INNOVATION: A SYSTEM DYNAMICS MODEL

By

Sara Susanna Grobbelaar

Supervisor : Professor A. J. Buys
Department : Department of Engineering and Technology Management
UNIVERSITY OF PRETORIA
Degree : Ph.D.

There exist some concern regarding the sustainability of the production of R&D output and R&D capacity in South Africa. Recent trends indicated evidence of disinvestments and decay of South Africa's R&D capacity.

Questions arise concerning the detrimental effects these trends could have on South Africa's ability to generate R&D output. As problems are addressed insufficiently and the system is allowed to decay, the costs of rebuilding the system might increase even further.

The main research objective of this thesis is to develop a computer simulation program of R&D performance and the creation of R&D output in the NSI. This model will in turn produce a tool to be used for policy testing, what-if scenario testing or policy optimisation.

The purpose of the model is to simulate R&D output generated in the South African system of innovation and to model and explain the effect the presence/lack of long-term investment in R&D and R&D resources could have on the system's ability to produce R&D output.

In developing this model and by using the corresponding simulation programme, decision-makers in government and industry are provided with a tool to analyse policy alternatives. The model will provide a better understanding of the interrelationships between different elements of the NSI, in particular those interacting as funders and performers of R&D. This model will also aid decision makers in enhancing the efficiency of addressing problem areas within the South African R&D system.

The contribution made by this thesis to the body of knowledge is that the development of a system dynamic model will result in the establishment of a dynamic hypothesis of the development of new knowledge through R&D in an R&D performing sector. The dynamic hypothesis will in turn lead to a method for modelling the effect of R&D investment on the development of an R&D capacity, i.e. the system's ability to absorb knowledge and produce R&D output. The above is essentially a dynamic description of

the process around creating and absorbing knowledge through R&D activities.

Keywords: System Dynamics, R&D, South Africa, National System of Innovation, Research output, absorption of knowledge

DECLARATION

I declare that the thesis, which I hereby submit for the degree Philosophiae Doctor (Engineering Management) at the University of Pretoria, is my own work and has not been previously submitted by me for a degree at another University.

Sara S Grobbelaar

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Glossary

Term	Explanation
GDP	Gross Domestic Product
R&D	Research and Development
NSI	National System of Innovation
S&T	Science and Technology
HSRC	Human Science Research Council
FRD	Foundation for Research and Development
OECD	Organisation for Economic Co-operation and Development
HES	Higher Education Sector
SAPSE	South African Post Secondary Educations
FTE	Full Time Equivalent
USPTO	United States Patent Office
CLD	Casual Loop Diagram
ROI	Return on Investment
NESTI	National Experts on Science and Technology Indicators
TPP	Technological Product and Process
GDER	Gross Domestic Expenditure on Research
FDI	Foreign Direct Investment
BRD	Degree of involvement in R&D in the private business sector
EM	Employment in technology-oriented programs
EME	Engineers/scientists in R&D programs
EDU	Total education expenditures
EDUT	Tertiary education expenditures
MAS	Masculinity Index
IND	Individualism Index
PDI	Power Distance Index
UAV	Uncertainty Avoidance Index
PPP	Purchasing Power Parity
LIT	Size of a country's literate population 15 years or over
POPU	Size of country by population
LFOR	Size of country's labour force
PAUS	Patents in the US by residents of a given country
PATE	External patents by residents
PATR	Patents by a country's residents
PATT	Patents by residents and non-residents in the country
PUB	Publication counts
CIT	Citation counts
PRO	Productivity

RICYT	Red Iberoamericana de Indicadores en Ciencia y Tecnologia
HAU	Historically Advanced Universities
HDU	Historically Disadvantaged Universities
HWU	Historically White Universities
HBU	Historically Black Universities
CSIR	Council of Scientific and Industrial Research (CSIR)
HSRC	Human Sciences Research Council
MRC	Medical Research Council
MINTEK	Mineral Technology Council
SABS	South African Bureau of Standards
GCS	Council for Geosciences
ARC	Agricultural Research Council
NRF	National Research Foundation
SAAO	South African Astronomical Observatory
HartRAO	Hartebeeshoek Radio Astronomy Observatory