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Maritime Security and Regulatory Risk-Based Models: Review and Critical Analysis

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Plan

Background: port and maritime security regime

Engineering risk-based models: precursor & risk analysis of maritime security

Supply chain risk based models: Interplay between supply chain risk & security

Economic appraisal and cost impact of security

Current work

- **Benchmarking and productivity change due to procedural security**
- **Analysis of robustness of the port and maritime network**
- **New models for the assessment of security investment**

Conclusion and discussion

International: IMO ISPS Code, WCO framework, IMO/ILO Code of Practice

US regime: C-TPAT, 24-Hour Rule, CSI, OSC, etc.

Other initiatives: AEO, Swedish Stair-Sec, Canada/ Mexico 24-h rule, FAST, APEC /STAR, US-New Zealand SEP, etc.

Private programmes: SST, ISO 28000, BASC, TAPA, etc.

Future programmes: SFI.

Scope:

- Conventionally, risk can be defined as being the chance, in quantifiable terms, of an adverse occurrence.
- Risk therefore combines a probabilistic measure of the occurrence of an event with a measure of the consequence, or impact, of that event.
- When introducing the risk factor, the concept and measure of uncertainty must be considered

Process:

Risk assessment: what can go wrong, the probability of it going wrong, and the possible consequences

Risk management: what can be done, the options & trade-offs available between costs, benefits & risks

Risk impacts: Management and policy decisions on future options and undertakings.

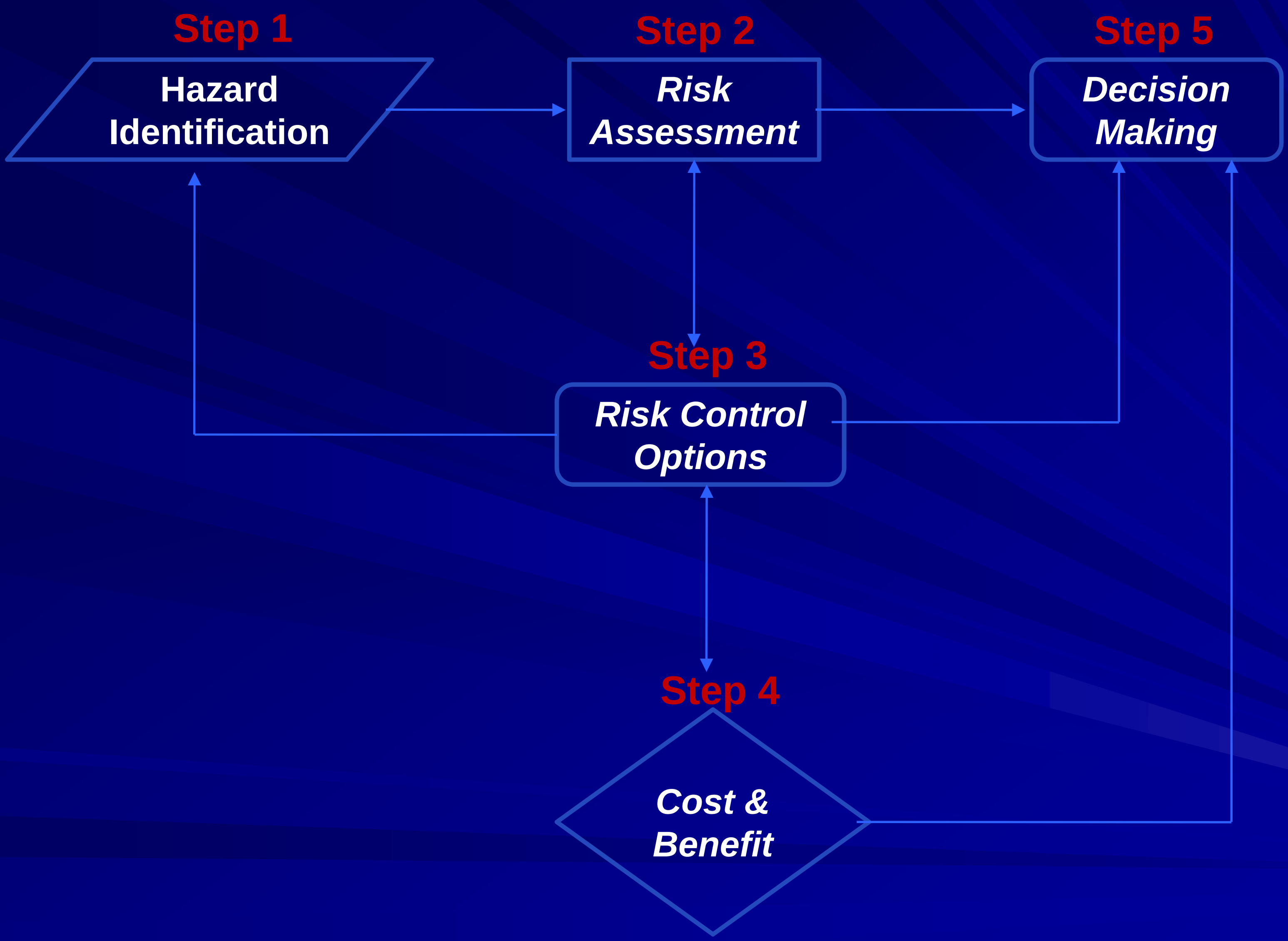
Methodology:

Incident (s) —FTA→ Critical event —ETA→ Consequence

Methodology:

	Consequence analysis	Cause analysis
Sequence dependent	Event Tree Analysis	Markov Process
Sequence independent	Failure Mode and Effects	Fault Tree Analysis

Risk assessment and management: application in maritime security: FSA



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Risk assessment and management: application in maritime security: NVIC

1. Select a scenario
2. Determine facility consequence level
3. Determine if scenario requires mitigation strategy
4. Assess impact of mitigation strategy
5. Implement mitigation strategy (protective measures)

Repeat process until all unique scenarios have been evaluated

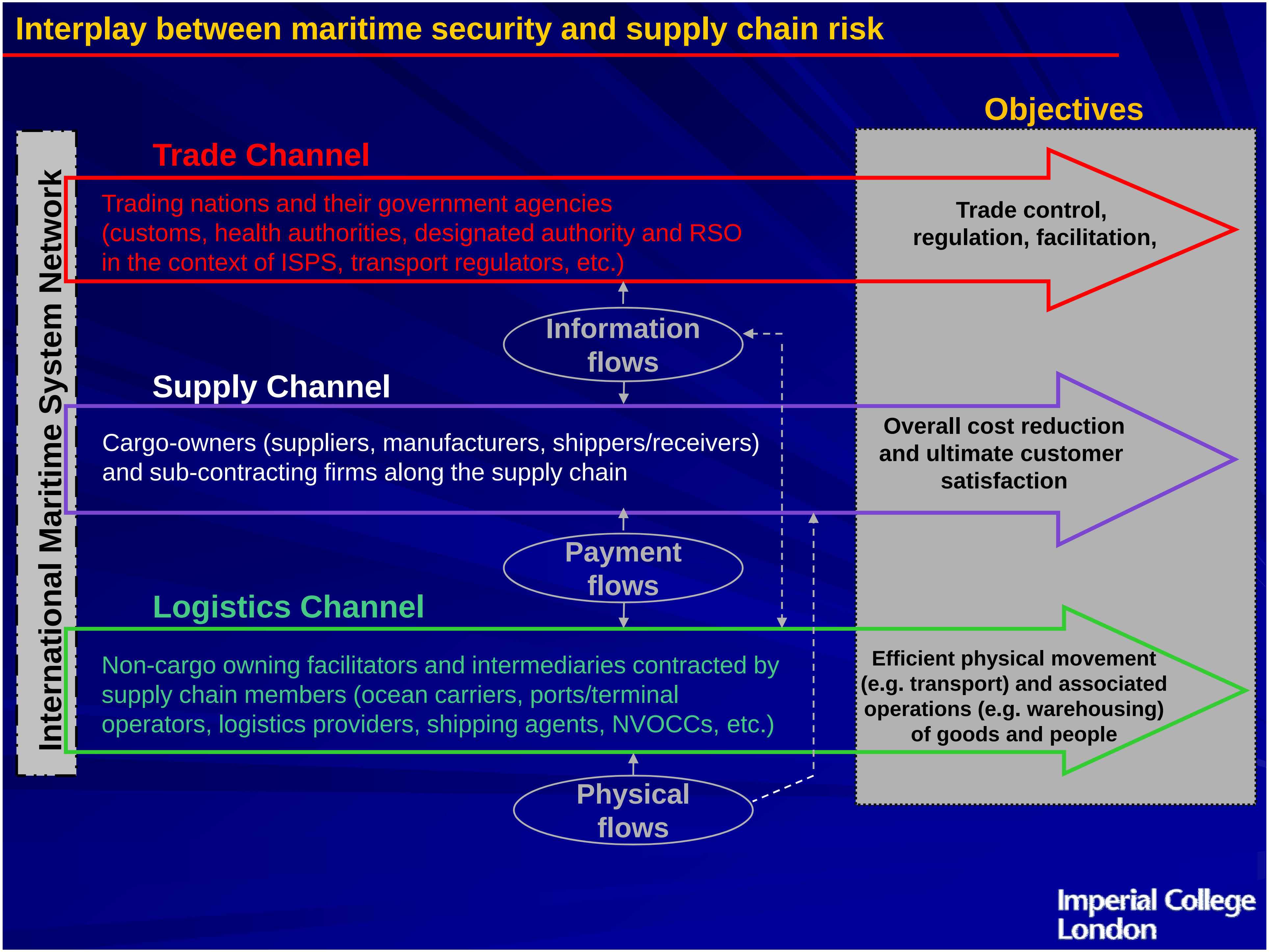
Shortcomings of conventional models in the context of maritime security

Reporting systems and maritime security:

- Event reporting and warning thresholds
- Reliability and validity of information resulting from fears of regulatory action
- Dissemination of reported information given sensitivity of and restrictive access to data
- False negative and false positive errors

Maritime security and reporting procedures:

- Exempt ion from regular customs inspections when trading within same economic block
- Errors in filing detailed data/ documentation
- No standardised system for ICT and port community systems (e.g. ASYCUDA, EDIFAT)
- No standardised system for container security/ integrity (e.g. container seals)


Interplay between maritime security and supply chain risk
International Maritime System Network
Objectives
Trade Channel
Trading nations and their government agencies (customs, health authorities, designated authority and RSO in the context of ISPS, transport regulators, etc.)
Trade control, regulation, facilitation,
Information flows
Supply Channel
Cargo-owners (suppliers, manufacturers, shippers/receivers) and sub-contracting firms along the supply chain
Overall cost reduction and ultimate customer satisfaction
Payment flows
Logistics Channel
Non-cargo owning facilitators and intermediaries contracted by supply chain members (ocean carriers, ports/terminal operators, logistics providers, shipping agents, NVOCCs, etc.)
Efficient physical movement (e.g. transport) and associated operations (e.g. warehousing) of goods and people
Physical flows
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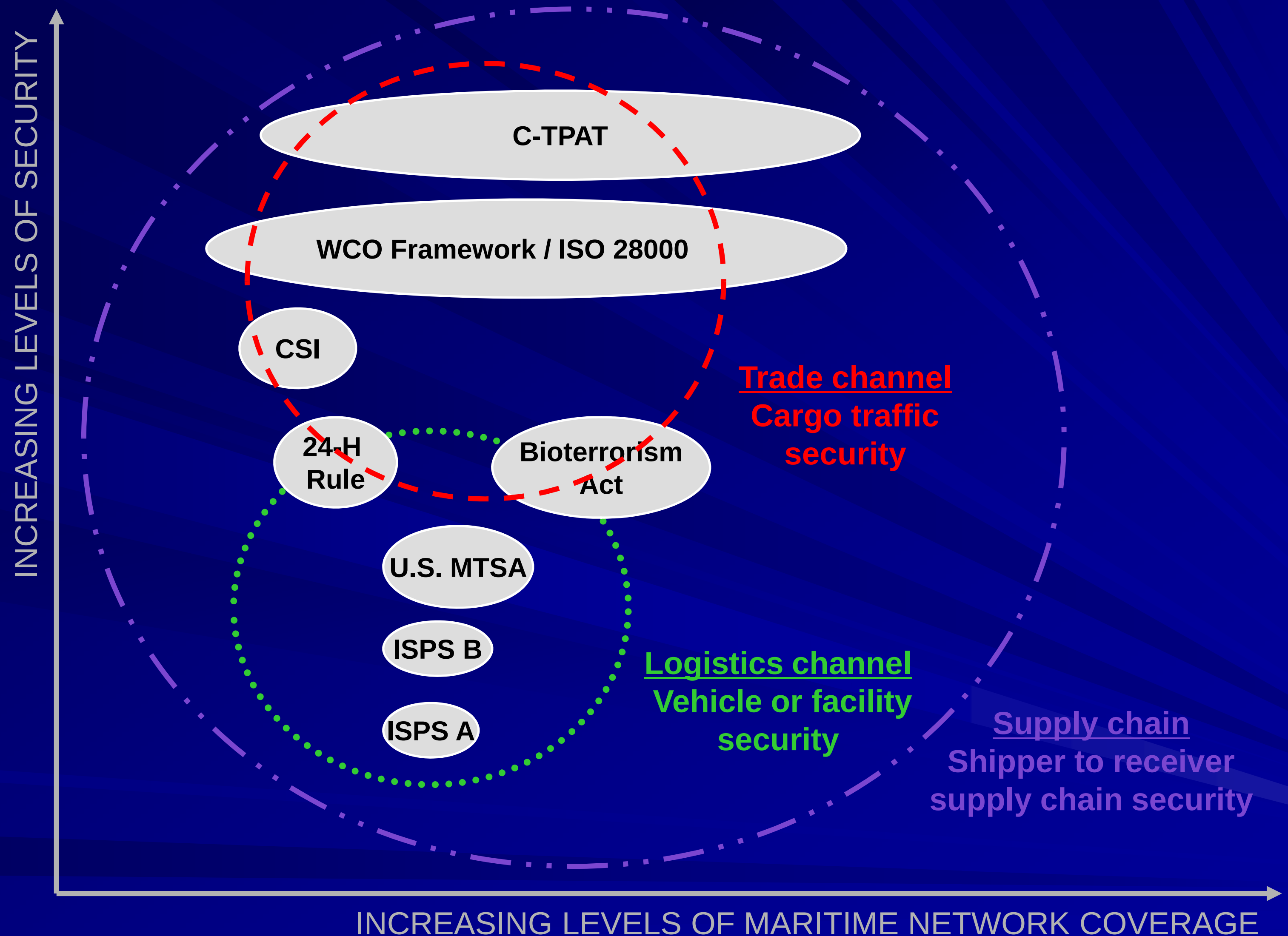
Multi-level / multi-layer security system



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Economic evaluation and appraisal: Cost assessment models

- **Econometric analysis** measures the impact of a regulation such as through a production or a cost function;

- **Productivity studies** look at efficiency gains from the implementation (or absence) of a regulation;

- **General equilibrium models** examine the impacts of a regulation on changes of output / employment under perfect competitive market conditions;

- **Engineering and actuarial** approaches both look at the added cost for equipment/procedure installation;

- **Expenditure analysis** relies on market surveys of additional costs borne by various stakeholders (both direct participants and indirectly affected parties).

Economic impacts: Estimates

Martin Associates (2001) estimated that the West Coast port lockout in the fall of 2002 would cost the U.S. economy $1.94 billion a day, based on a 10-day shutdown of port facilities

By the time the labour dispute had been resolved, Anderson (2002) has estimated a total economic cost of $1.7 billion, based on a 12-day shutdown

Other competing studies (Pritchard, 2002; Rivera, 2002; Zuckerman, 2002) were reporting that the above figures were overestimated

Lee and Whang (2005) use a hypothetical case study to model the benefits of reduced lead times and inspection levels in the context of SST. Their results show substantial cost savings in SST over the conventional process, as well as significant gains in the level and quality of service

Babione et al (2003) examined the impacts of security initiatives on import and export container traffic of the US port of Seattle. Their findings suggest that specific measures such as the 24-hour rule and C-TPAT would have lesser impacts in the longer run

Cost impacts: Regulatory risk assessment

Regulatory Assessment (ISPS)

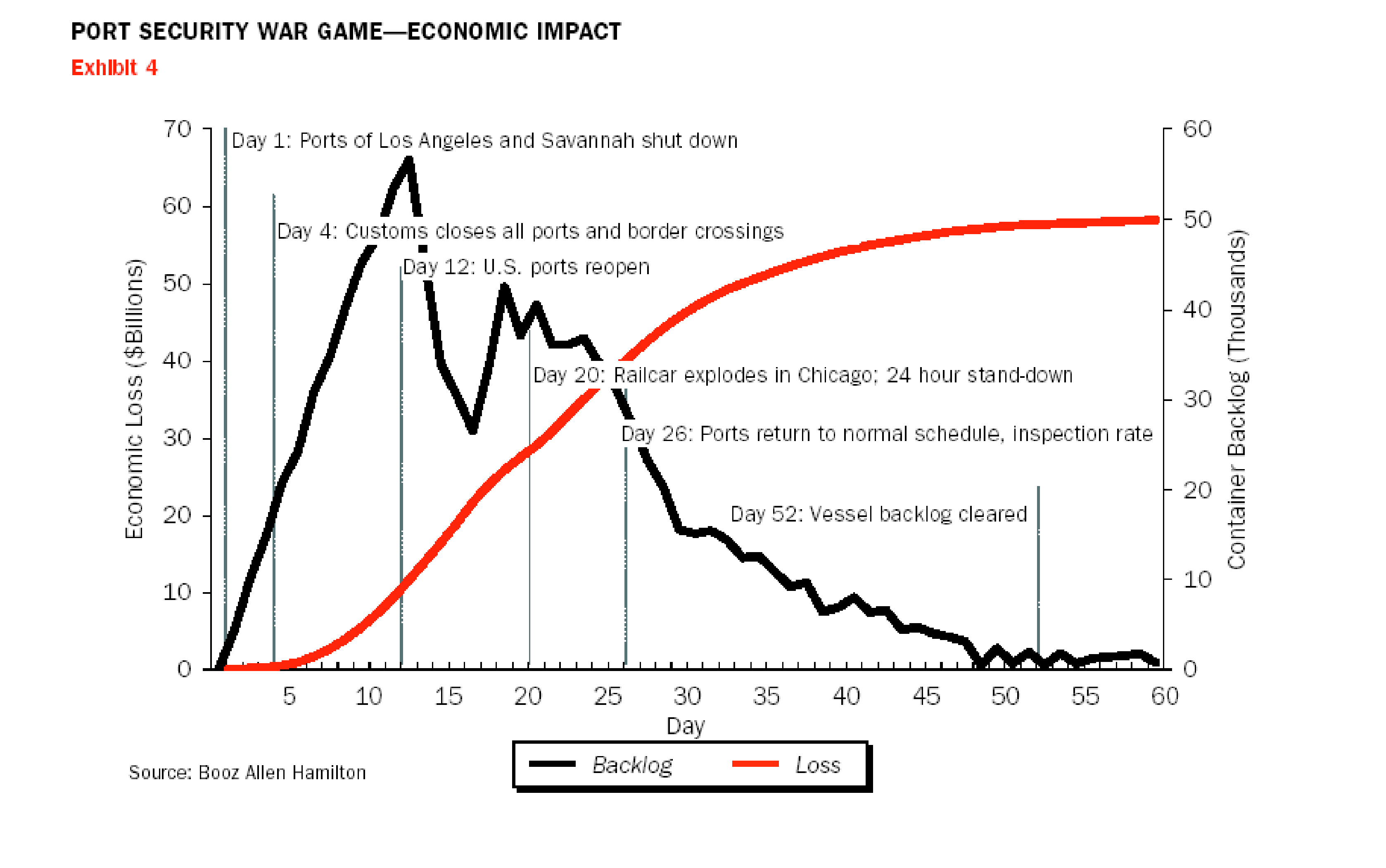
- U.S N-RAT (USCG)
- UK RIA (CGA)
- Australia /APEC
- OECD, RAND

- Reaction driven
- Pre-implementation
- Based on N-RAT model (e.g. aggregation)
- Not valid for post-ISPS management

Industry Assessment Framework

- None?

Cost impacts: Simulation (Booz Allen simulation)



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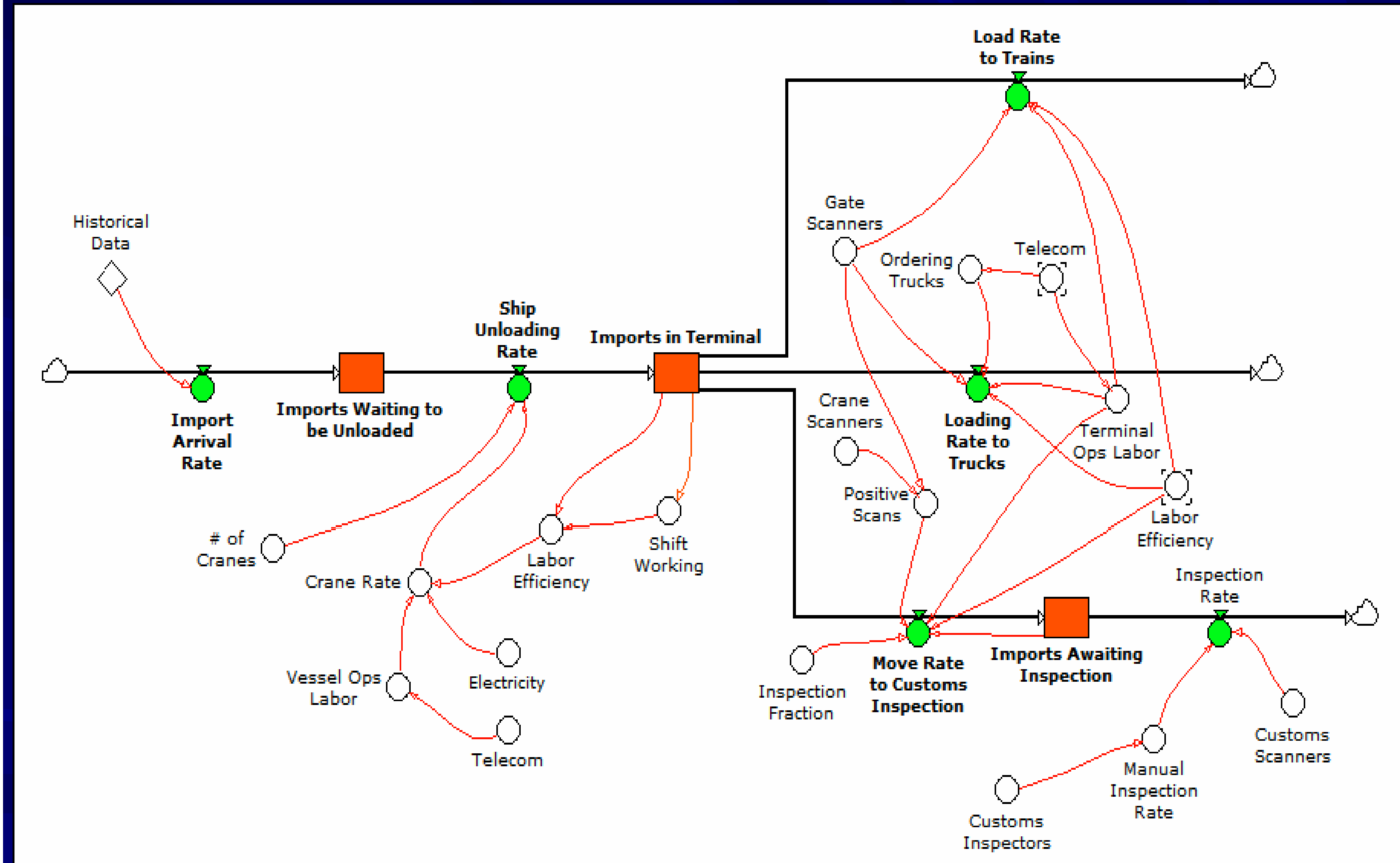
Cost impacts: Simulation (NISAC port operations simulator)



Cost impacts: Post-implementation

Example of average terminal security fees			$/TEU
Australian Ports (P&O Ports operated)			3.8
Europe	Belgian ports		10.98
	Denmark		61
	Dutch ports		10.37
	French ports		10.98
	Italian ports		9.76
	Latvian ports		7.32
	Norwegian ports		2.44
	Spanish ports		6.1
	Irish ports		8.54
	Swedish ports (Gothenburg)		2.6
	UK ports	Felixstowe, Harwich and Thames port	19 for import and 10 for export
		Tilbury	12.7
Canada	Vancouver		2.7% increase in harbour dues
	TSI Terminal handling charges		1.5
USA	Charleston, Houston and Miami		5
	Gulf seaports marine terminal conference		2
Others	Shenzhen		6.25
	HK		6.41
	Mexico		10

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Cost estimate bias

Non-computation of supply chain disruption & redundancy costs

Cost spin-off & exponential computations of security expenses

Overlooking dissimilarities between global operators / facilities

- Various institutional / organisational systems, e.g. private vs. public, central vs. regional
- Different resource systems, e.g. financing models
- Absence of an international benchmark rate (or compensation scale) for cost computation, e.g. differences in labour pay, interest rates, depreciation, tax systems
- Unclear procedures for ISPS implementation, e.g. PFSO additional responsibility vs. PFSO additional function

Operational impacts- 24 hr rule

Carriers

• Average increase DwT at port of origin
• Cost for new data filing (passed-on to shippers)
• Cost for data errors: $5,000 penalty for the first violation, $10,000 for subsequent violations + Lost earnings in case of cargo missing schedule

Ports

• DwT increase due to advance cargo arrival
• Operational problems at ports of origin, transit & destination
• Pressure particularly felt by ports at the end of the transhipment network

Shippers

• Manifest surcharges (£25~$50)
• Advance cargo cut-off times (72~96 hrs)
• Possible cargo delay / mismatching & errors (e.g. re-stows)

Case: In 2003, the Grand alliance (OOCL, NYK, P&O Nedlloyd and Hapag-Lloyd), changed its "First Port of Call" from the Port of Seattle, USA to the Port of Vancouver, Canada.

Operational impacts- CSI & C-TPAT

CSI

Ports
- Direct cost for NII Equipment (and cost of implementation for US ports)
- DwT and operational problems
- Lost of carrier-clients if not a CSI-port, particularly for transit and transhipment ports

Shippers
- Charges for each inspection
- Increased DwT (both import & export cargo)
- Possible cargo delay, mismatching & errors

C-TPAT

Carriers, FF, brokers, 3PLs, etc.
- Cost of C-TPAT enrolment and implementation (possibly offset by fast-lane treatment)

Ports (U.S), Shippers (U.S importers)
- Cost of C-TPAT enrolment and implementation
- Container inspection rate DwT

Case: Operators at the port Colombo complaining about operational deficiencies since CSI implementation, e.g. 20% DwT increase.

Current work: Productivity analysis in view of procedural security (Bichou, 2008)

Non-computation of supply chain disruption & redundancy costs

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Originality of the research

First attempt to measure and benchmark container-terminal operational efficiency based on configuration topologies,

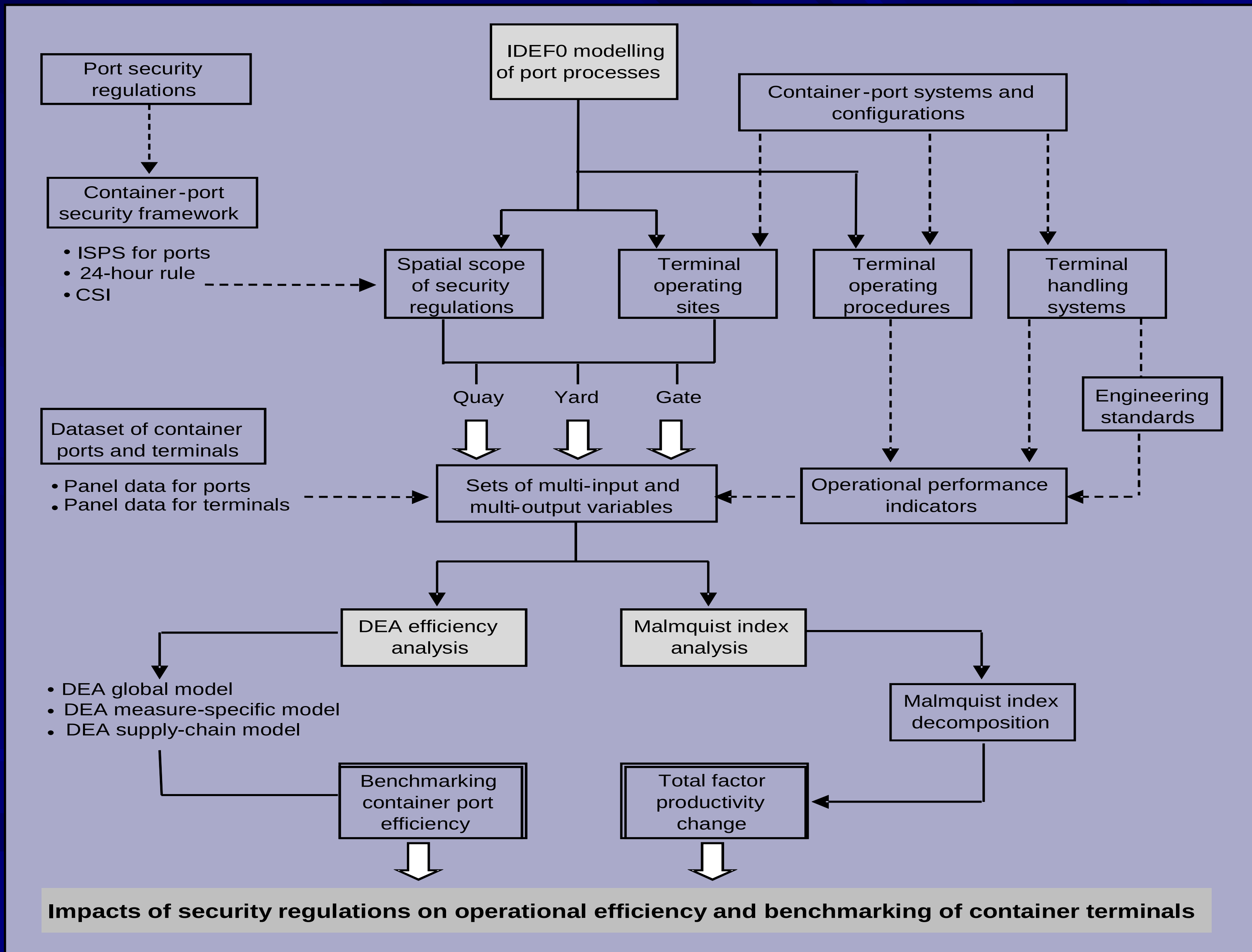
First attempt to measure (model) the ex-post impacts of security on port operational efficiency,

The combination of three analytical models (DEA, IDEF0, Malmquist TFP).

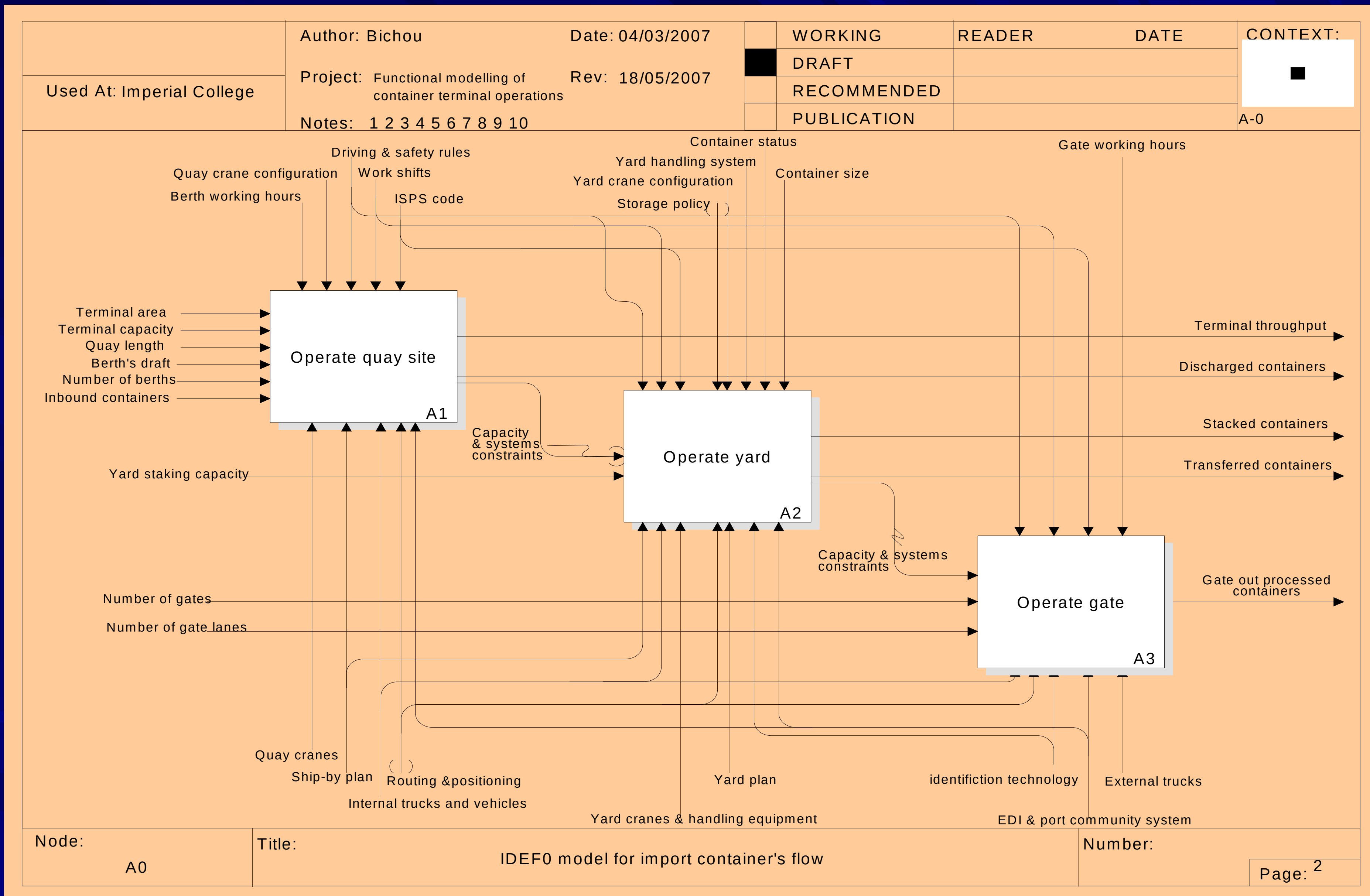
First Supply Chain/ Network DEA Model for ports

An attempt to account for both internal and external system's bottlenecks and constraints.

Research Design and Procedure



Operationalisation: IDEF0 prescriptive modelling



Operationalisation: DEA Analysis and Malmquist Index Composition

Model assumption and orientation

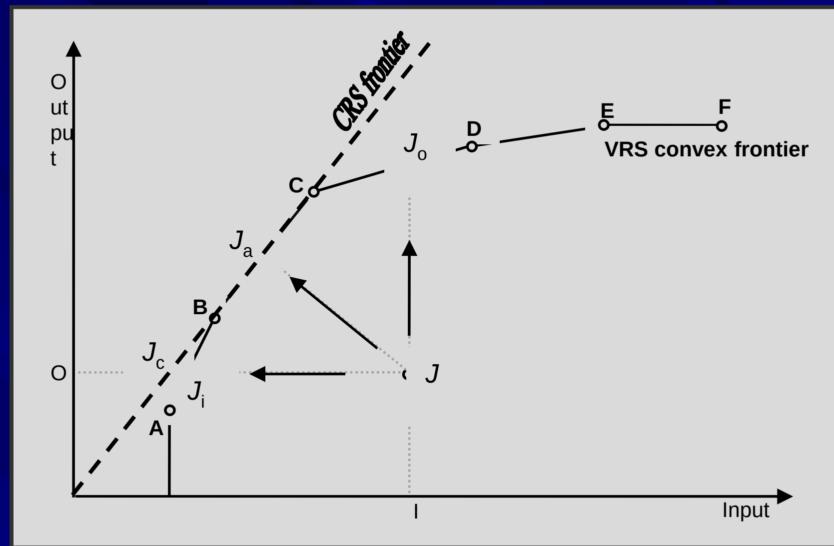
- *VRS technology*
- *Input-orientation*

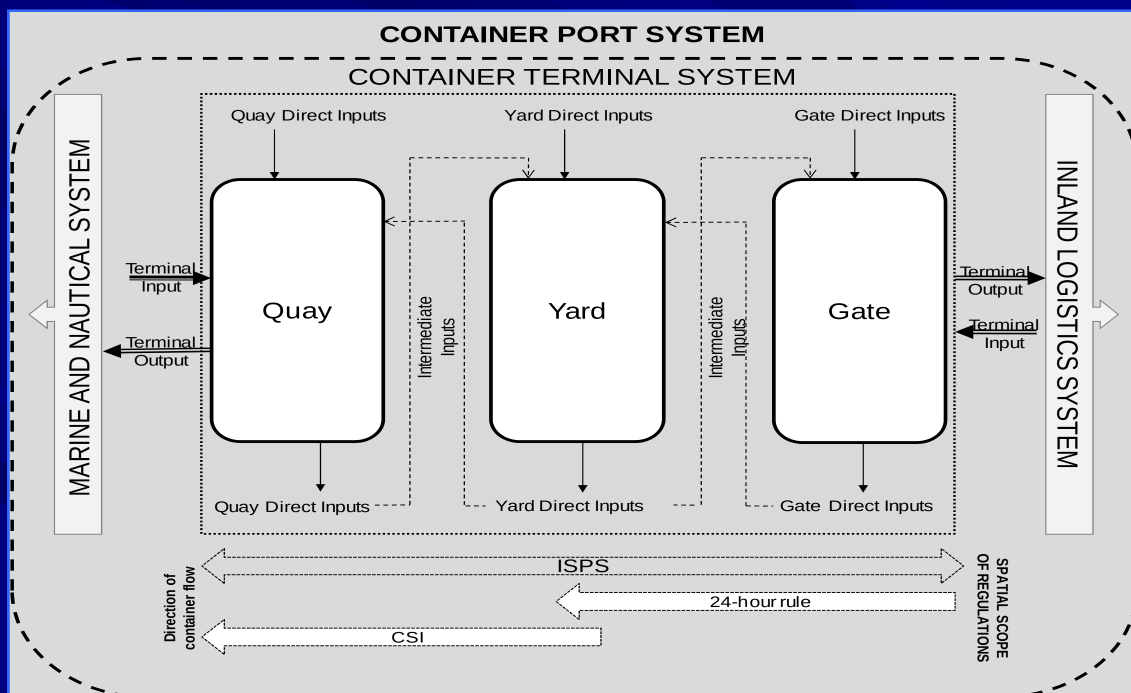
DEA Models

- *Slack-based DEA*
- *Measure specific DEA*
- *Supply chain DEA*

Malmquist index decomposition

$$TTEC = TEC \times SEC \times TC$$





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Methodology: Data and Variable selection

Panel data set for 38 ports and 60 container terminals from 2000 to 2006 is used resulting into 266 container-port and 420 container-terminal decision-making units (DMUs), respectively.

Variables

Site	Inputs	Outputs
Quay	Quay crane index Berth index Berth length	Crane move per hour Terminal throughput
Yard	Yard capacity Stacking capacity Yard gantries Straddle carriers Tractors Trailers/Chassis	Crane move per hour Terminal throughput Average dwell time
Gate	Gate indicator	Terminal indicator Average waiting time

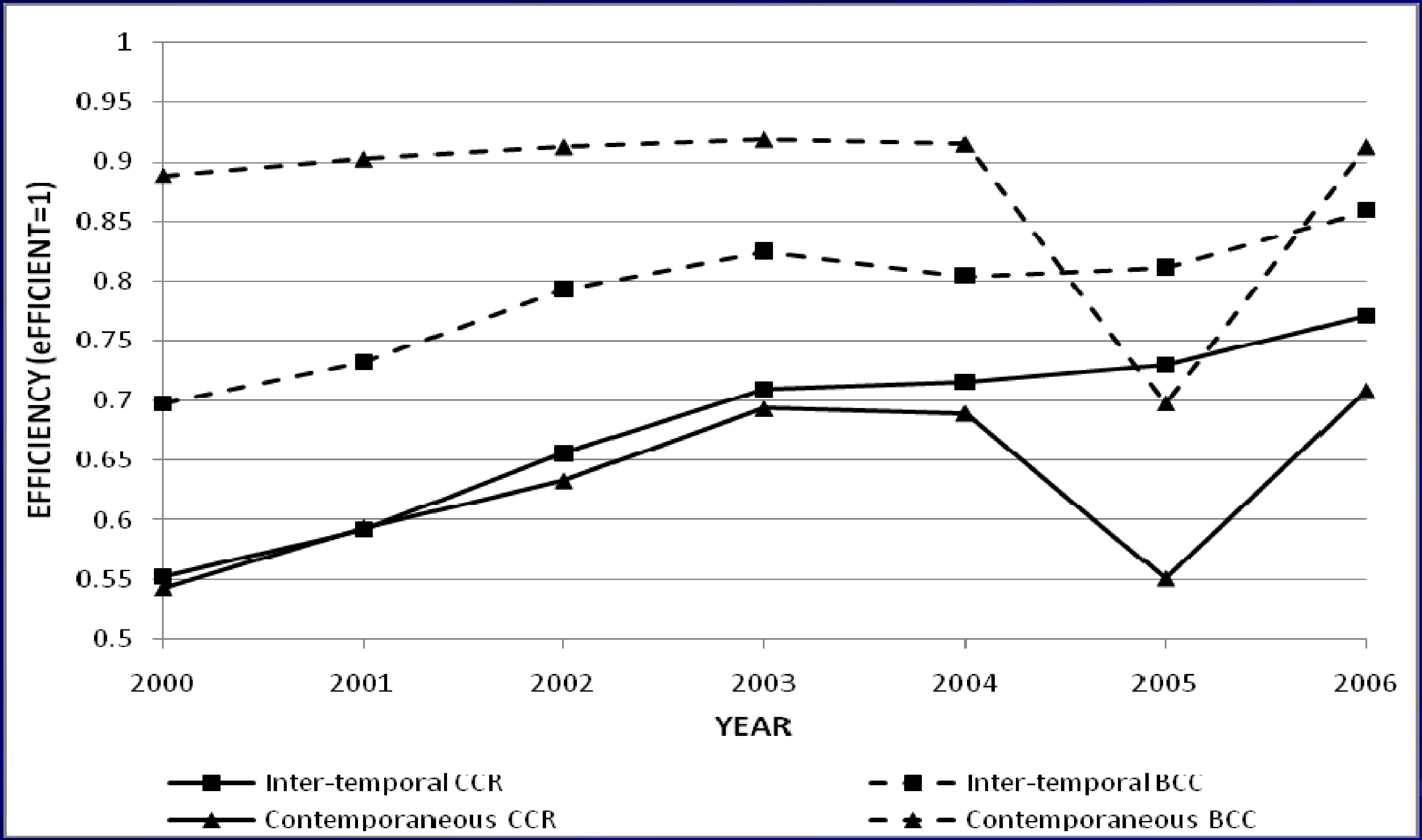
Descriptive statistics of the aggregate container terminal dataset

Variable	Minimum	Maximum	Mean	Standard Deviation
Terminal area (1000 m^2)	25	4000	714.4	547.9
Terminal capacity (1000TEU)	230	10,000	2,219	2,020
Berths	1	12	4	3
Quay site index	881	19,890	5,202	3,772
Quay crane index	71	4,860	468	642
Yard stacking capacity (1000TEU)	6	212	35	35
Yard crane index	12	12549	1133	2184
Internal trucks and vehicles	2	390	55	57
Yard free storage (day)	0.5	16	7	3
Gate index	21	888	201	171
Gate cut-off time (hour)	3	32	12	6
Terminal throughput (1000 TEU)	101	8,865	1,517	1,465
Crane move (Hour)	20	82	31	7

Some Results

- Uncovered inherent inefficiencies in terminal operations
- Evidence of different performance levels between operating configuration
- Terminals in the same port do not depict the same trend
- Slight decline (10%) of mean efficiency of terminals after 2004
- Generalised gains in scale efficiency
- Generalised losses in pure technical efficiency
- Improvement in TC efficiency after 24 hr implementation
- Adjustments in terminal operating procedures to cope with security
- Small ports/ terminals seem to suffer the most from security

Some Results



Year-by-year (2000-6) evolution of average terminal efficiency
(Based on input-oriented efficiency ratings)

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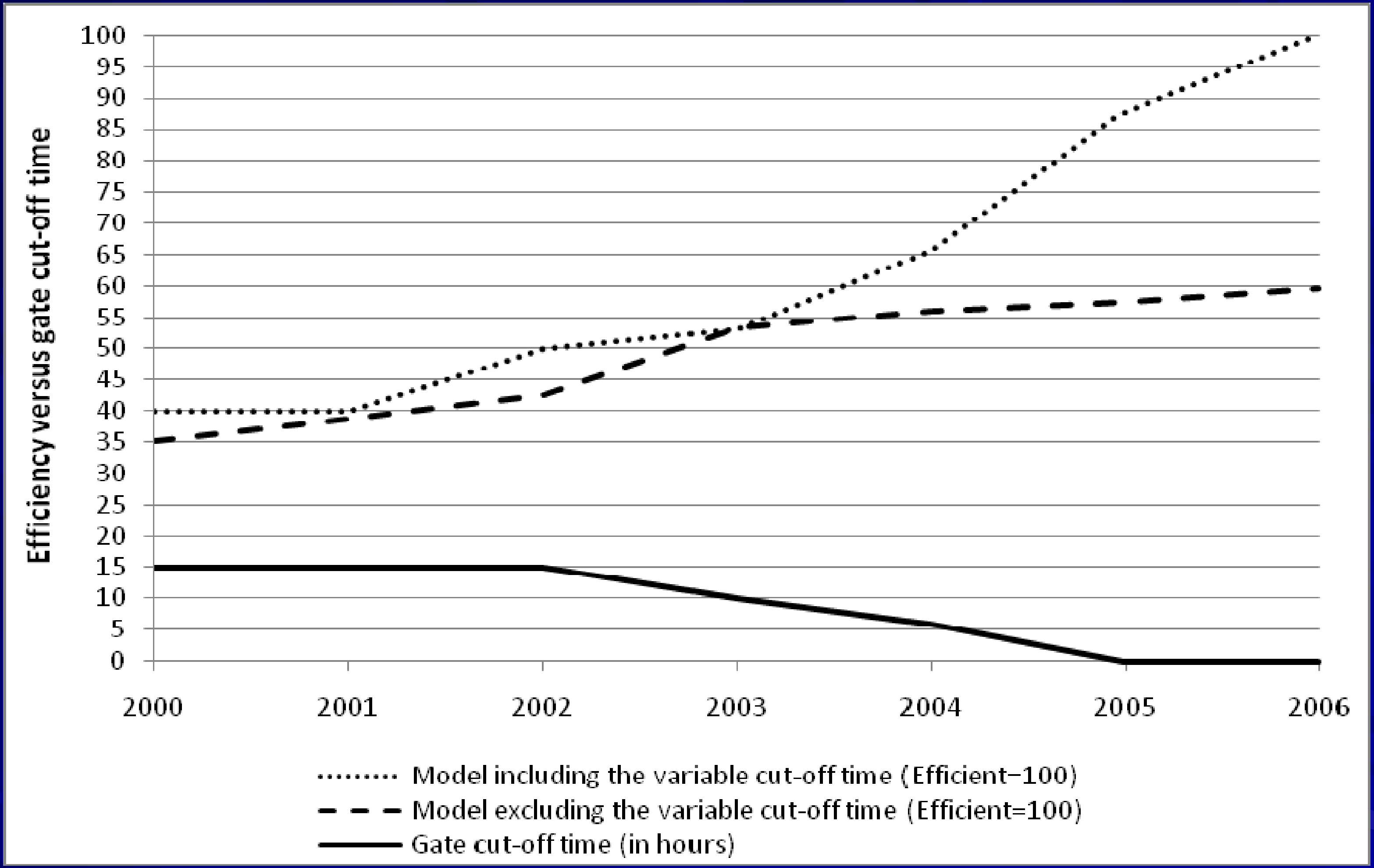
Some Results



Variations in productive efficiency of YCT following changes in gate closing time policy (Based on CCR-I panel data analysis)

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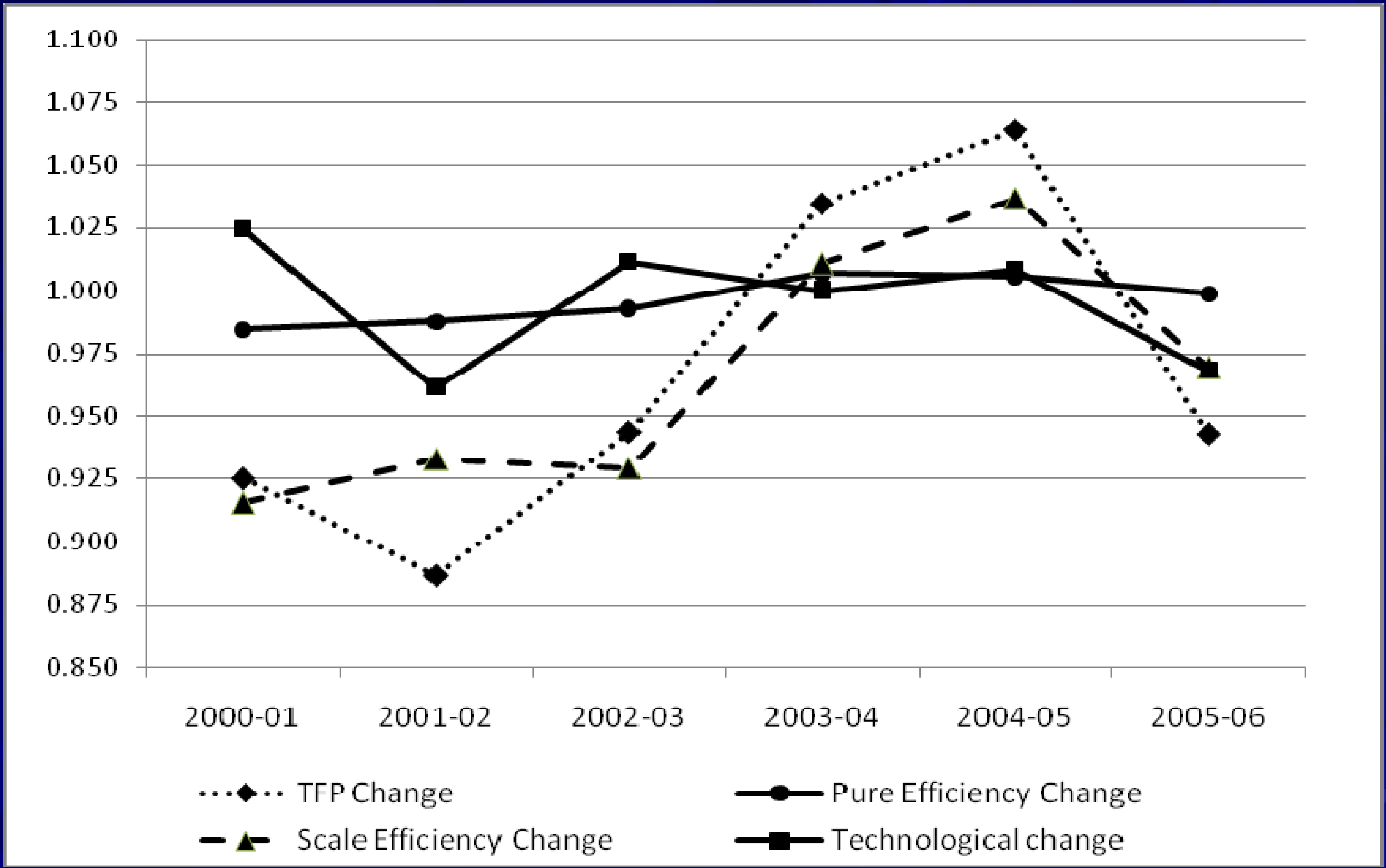
Some Results



Average values of MPI and its sources of efficiency on a year-by year basis

SFI?