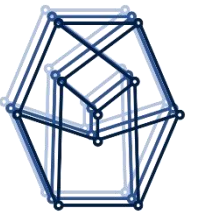


Management Practice

12. Scheduling in a global context

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MPiE

17/11/2020

Course

Literature for the course:

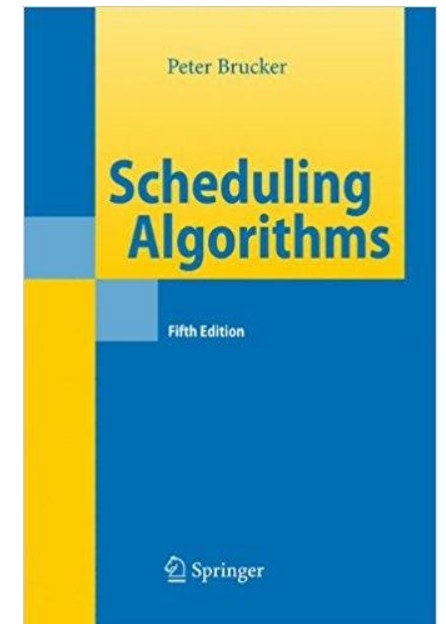
Eisner, Howard. *Essentials of project and systems engineering management*. John Wiley & Sons, 2008.

Learning objective for this session:

- Able to describe preceding constraints
- Able to apply Lawler's Algorithm
- Able to explain aggregation and constraints in global context
- Understand Hofstede's model
- Explain the global value chain
- Understand barriers and inhibitors in global context

Literature for this session:

www.springer.com/gb/book/9783540695158



Optimality criteria and cost

For example

- Single machine (1), where
- subject to precedence constraints
- the maximum cost for late jobs should be minimized (h_{max})

We denote this problem as $1 | \text{Prec} | h_{max}$

$h_j(C_j)$ is the cost for completing job j at time C_j , so we could get

$$h_j(C_j) = C_j - d_j$$



Lawler's Algorithm

- $O_{1j} \rightarrow O_{2j} \rightarrow \dots \rightarrow O_{n(j)j}$ for Precedence Constraints
- The algorithm is applicable for single machine problems with the objective of minimizing
 - Makespan
 - Maximum lateness
 - Maximum tardiness
- It schedules a set of simultaneously arriving tasks on one machine with precedence constraints to minimize maximum tardiness or lateness.



Lawler's Algorithm

- **General scheme:** The algorithm first assigns a job to the last position, then a job to the position next to last, and so on.
- **Candidate job for a position:** Due to precedence constraints, not all the jobs are candidates for a position. For example, if a job has a successor, the job cannot be assigned to the last position. Hence, candidates for the last position are the ones without any successor.
- **Lawler's proof** - single machine, can be given by contradiction
- In short, Lawler's algorithm minimizes e.g. the maximum flow time subject to precedence constraints.



Lawler's Algorithm

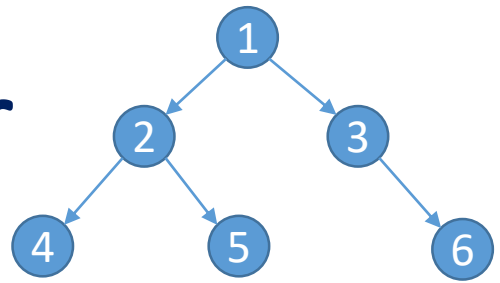
- A set of simultaneously arriving jobs on one machine needs to be scheduled with precedence constraints to minimize maximum lateness (or tardiness).

$$L_i = C_i - d_i$$

- At each step a selection is made from the jobs that are not required to precede any other unscheduled job. The job is selected that achieves $\min(h_j) = \min(F_j - d_j)$



Single machine scheduling - Lawler



i	1	2	3	4	5	6
p_i	1	1	1	1	1	1
d_i	2	5	3	4	5	6
r_i	0	0	0	0	0	0
$CMax_a$				6	6	6
F_a				6	6	6
h_a L_a				2	1	0

$C_{max}=6$; available jobs {4,5,6}; find min(h); update; repeat



Scheduling

- The main objective of the scheduling is typically reducing the project's **cost and duration**.
- The numerous possible assignments of tasks to the team members and the dependencies between tasks make task scheduling an **NP-hard** problem.

NP-Hard

- A minimal requirement for an algorithm to be considered “efficient” is that its running time is polynomial: $PT(n^c)$ for some constant c , where n is the size of the input and PT represents the Polynomial time.
- Researchers recognized early on that not all problems can be solved this quickly, but had a hard time figuring out exactly, which ones could and which ones couldn't.
- There are several so-called **NP-hard** problems, which most people believe *cannot* be solved in polynomial time, even though nobody can prove a super-polynomial lower bound.

Scheduling

- Problems which are NP-hard cannot be solved efficiently using heuristics and devising efficient algorithms to approximate the optimal solution.
- A set or property of computational decision problems solvable by a **nondeterministic** Turing Machine in a number of steps that is a **polynomial** function of the size of the input. The word "**nondeterministic**" suggests a method of generating potential solutions using some form of nondeterminism or "trial and error"
- Trade optimality, completeness, accuracy or precision to increase the speed and thus competitive advantage.

Decision problem

- A *decision problem* is a problem whose output is a single Boolean value: Yes or No.
- There are three common classes of decision problems:
- **P** is the set of decision problems that can be solved in polynomial time. Intuitively, P is the set of problems that can be solved quickly. $n=5$

Polynomial

$$PT(1)=1$$

$$PT(n)=5$$

$$PT(n^2)=25$$

Non-Polynomial

$$PT(2^n)=32$$

$$PT(n!)=120$$

$$PT(n^n)=3125$$

- **NP** is the set of decision problems with the following property: If the answer is Yes, then there is a *proof* of this fact that can be checked in polynomial time. Intuitively, NP is the set of decision problems where we can verify a **Yes** answer quickly if we have the solution in front of us.
- **co-NP** is essentially the opposite of NP. If the answer to a problem in co-NP is **No**, then there is a proof of this fact that can be checked in polynomial time.



Scheduling in the global context

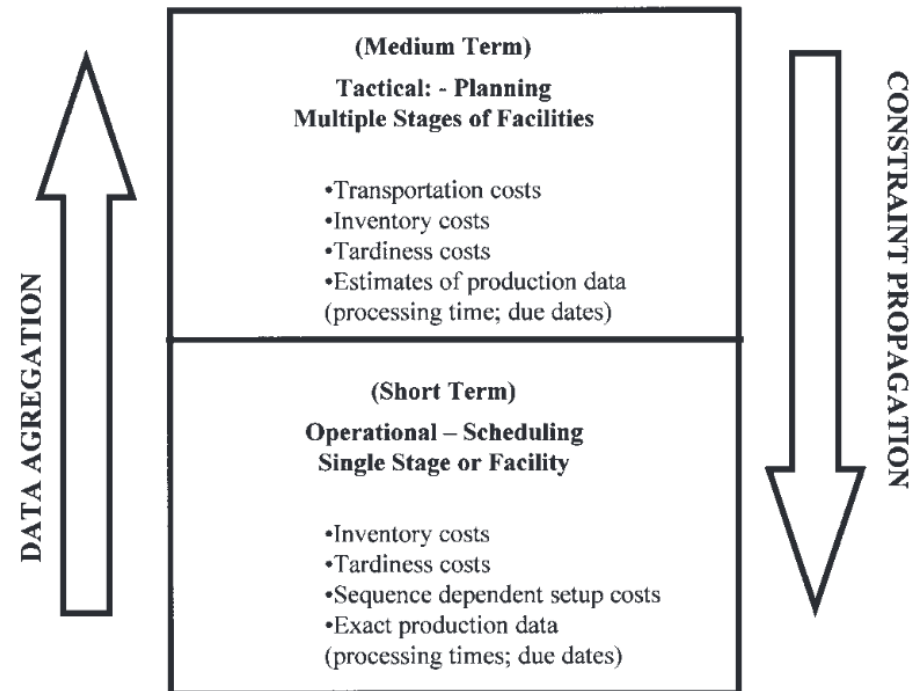
In these case the scheduling can be further influenced by differences in e.g.:

- Regulations
 - Social, economical, political and cultural difference
 - Fluctuations in exchange rates
 - Time zones
 - ...
-
- The global nature of business provide further possibilities in terms of assignments and dependencies.



Global supply chain

- Data Aggregation and Constraint Propagation



Global supply chain

The output of the medium term planning process is an input to the detailed (short term) scheduling process. The scheduling phase of the optimization process is partitioned according to:

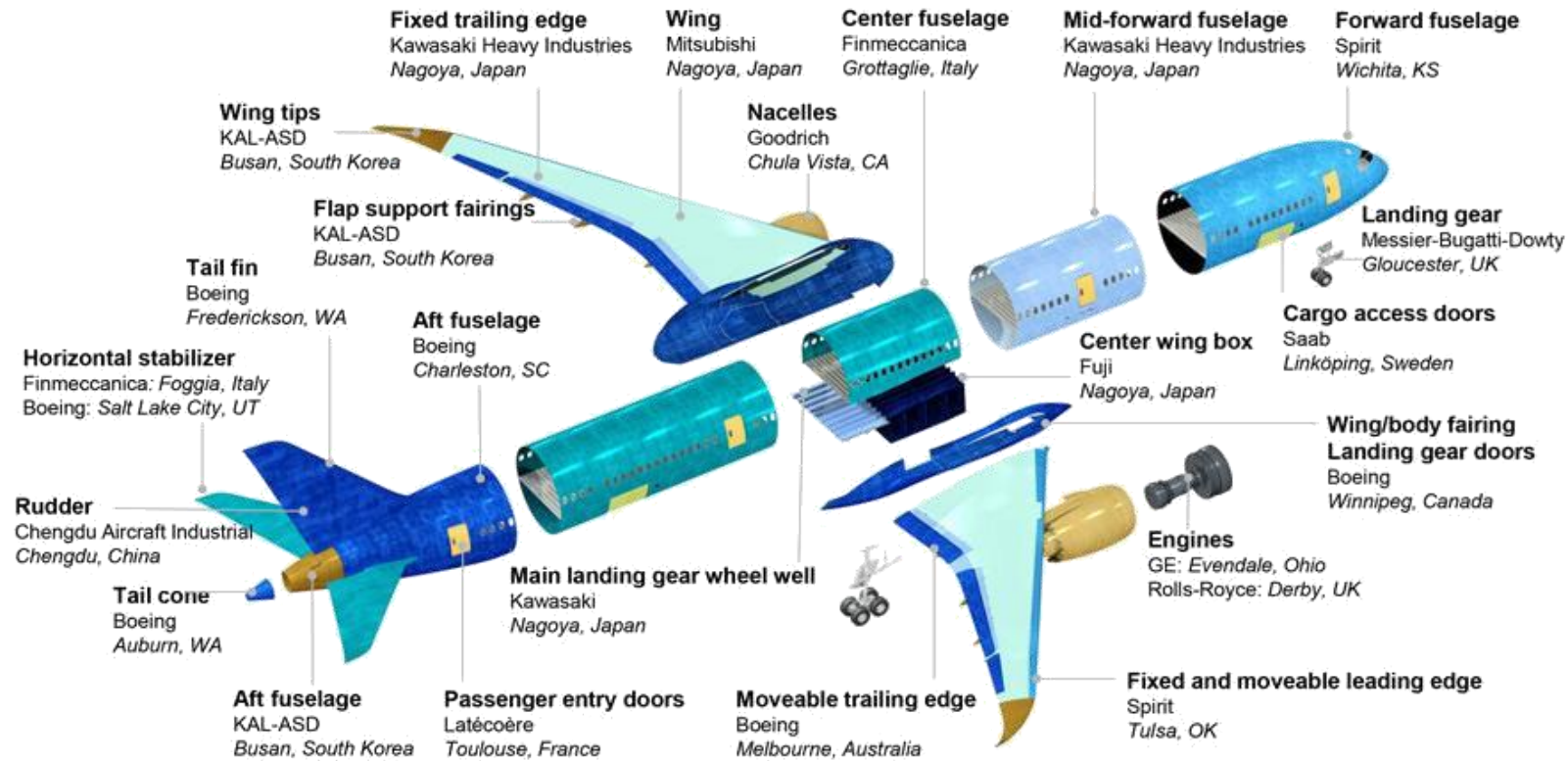
- *The different stages and facilities*
- *The different time periods*

So, in each detailed scheduling problem the scope is considerably narrower (with regard to time as well as space), but the level of detail taken into consideration is considerably higher. This level of detail is increased in the following dimensions:

- The time is measured in a smaller unit (e.g., days or hours); the process may be even time continuous
- The horizon is shorter
- The product demand is more precisely defined
- The facility is not a single entity, but a collection of resources or machines.

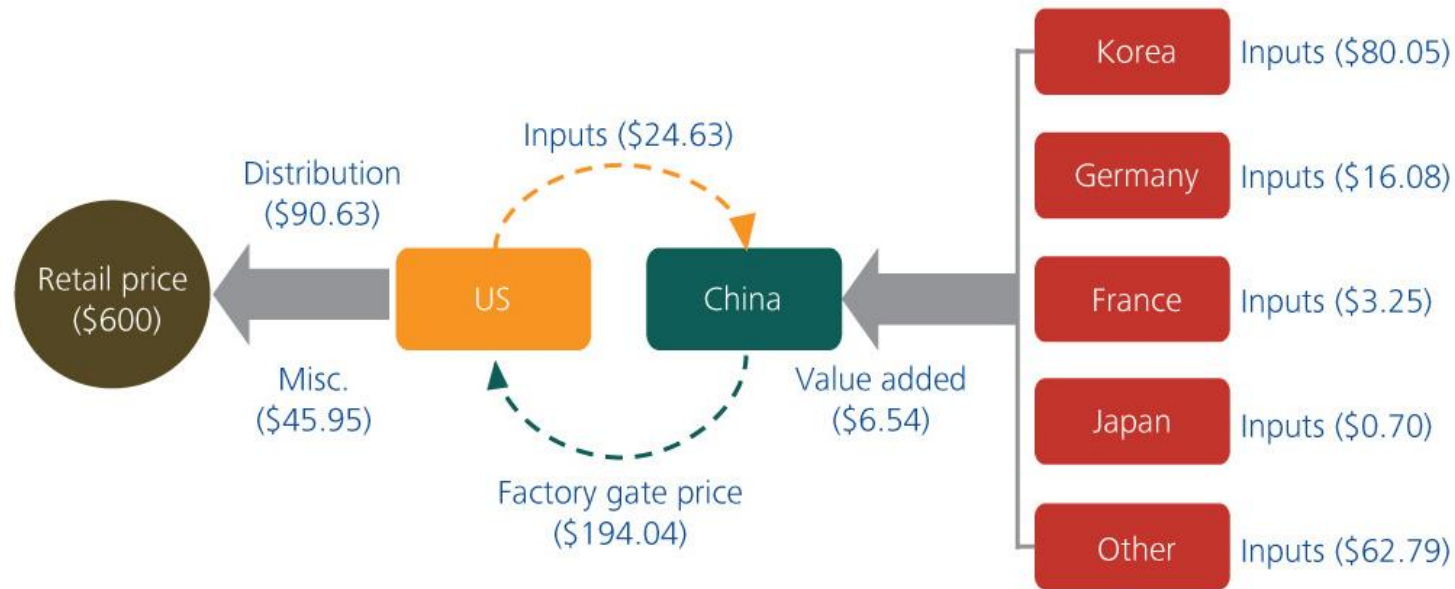


Global supply chain



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Global value creation for Apple iPhone 4



* Apple is a trademark of Apple Inc., registered in the United States and other countries.
 "Global value chains: More development strategy than process" is an independent publication and has not been authorized, sponsored, or otherwise approved by Apple Inc.

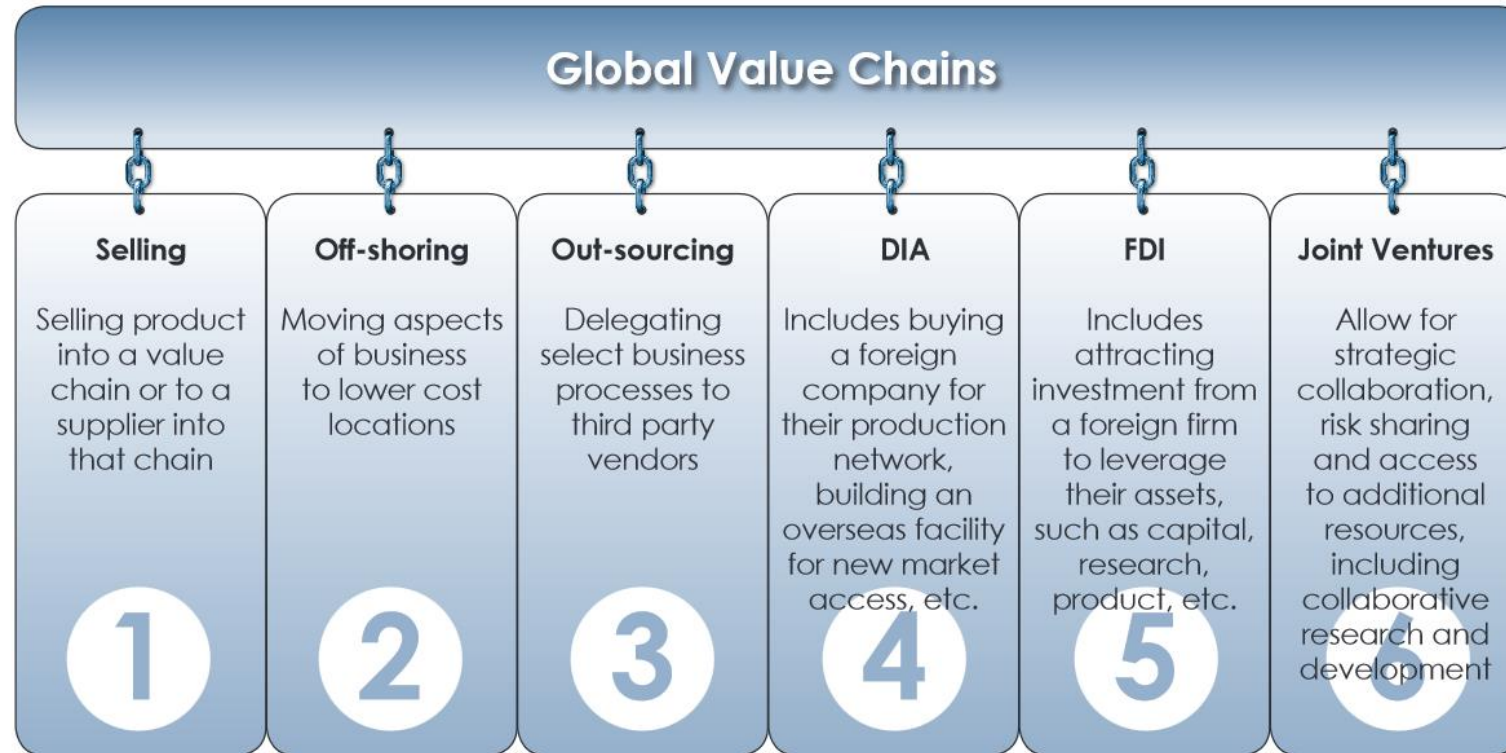
Source: Organization for Economic Cooperation and Development, "Global value chains: Preliminary evidence and policy issues," March 2011, http://unstats.un.org/unsd/trade/globalforum/publications/gvc/n%20-%20OECD%20-%202011%20-%20GVCs%20-%20Preliminary%20Evidence%20-%20Policy%20Issues_March%204.pdf; Deloitte Services LP economic analysis.

Graphic: Deloitte University Press | DUPress.com

Value chains in the global context

- Imports are increasingly a key complement of local production for many economies .
- Since 2000, WTO trade figures in East Asia show that intermediate goods have comprised over 50% of exports and over 60% of imports in Asia.
- That is also why it is important to measure trade in **value added** terms, rather than just looking at the gross figures. We need to know what **each company in each economy contributes to** production at **each stage of the supply chain**.

Global value chain



Trade costs and globalization

Globalization over 5 centuries (1500-2011)

Shown is the sum of world exports and imports as a share of world GDP (%)
The individual series are labeled with the source of the data

Our World
in Data



Data sources: Klasing and Milionis (2014), Estavadeordal, Frantz and Taylor (2003) and the Penn World Tables Version 8.1
The interactive data visualization is available at OurWorldinData.org. There you find the raw data and more visualizations on this topic.

Licensed under CC-BY-SA by the author Max Roser.

ICT and globalisation

- Coordinating production requires a complex exchange among stages of goods, technology, people, training, investment and information.
- Some of the coordination costs are related to communication, which became easier in the mid-1980s with the global integration of ICT.
- The ICT revolution made it possible to coordinate complexity at distance and across the globe
- The vast wage differences between low-/middle- and high-income countries made separation profitable



Network economics

- Today's business environment has been fundamentally transformed as a result of the world's recent evolution into the **information age**, along with the advent of the global economy.
- The modern information age has led to competition based on the mastery of ideas and technology, which is not restricted by geography and which is governed by new **network economics**.
- Research in network economics has addressed two distinct, though strictly related, issues:
 - (i) How **network structures affect** the behaviour of social and economic actors
 - (ii) What incentives agents face in forming the network by means of link creation and deletion.
- An actor can be defined as the **source of an action** regardless of its status as a human or non-human
- Agents are so called because they have agency, which means a thing or person that acts to produce a particular result



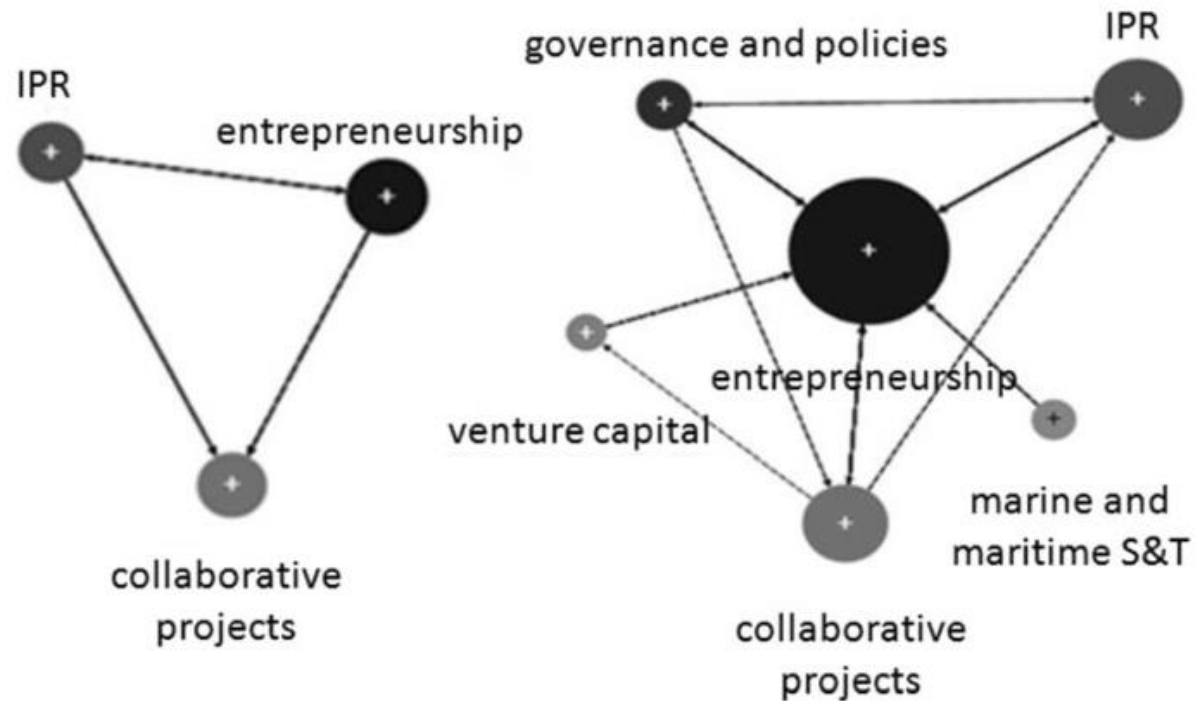
Network economics

- Recent research has shown how explicitly modelling the network structure of social and economic relations can provide significant theoretical insights, as well as account for previously unexplained empirical observations.
- Relevant areas of application range from labour markets (Calvo-Armentgol, 2004; Jackson and Calvo-Armengol, 2004), trade and financial markets (Eliott, Golub and Jackson, 2013), and R&D collaborations (Goyal and Moraga Gonzales, 2001).

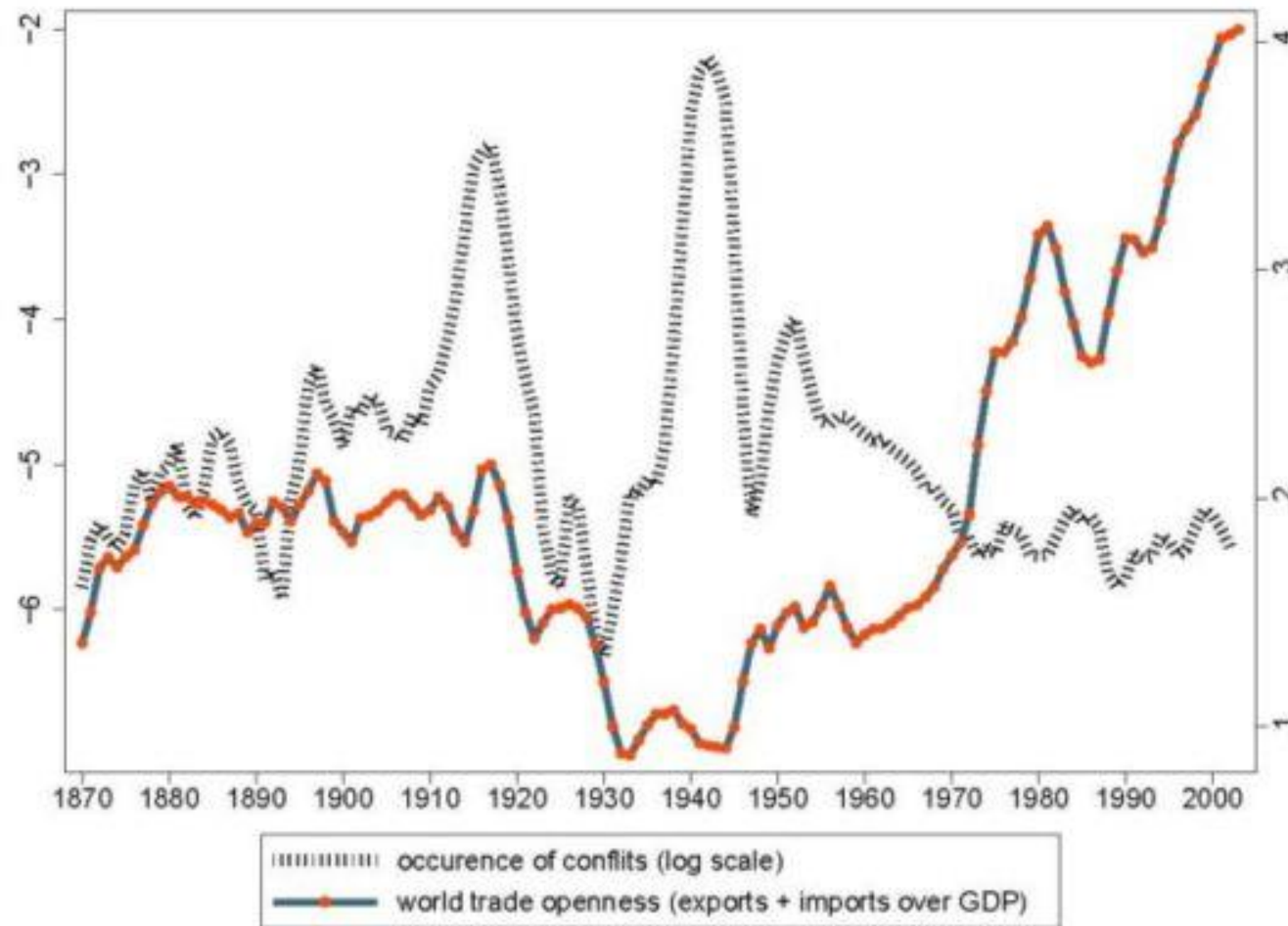
Actor-network example

A network that shows the knowledge transfer, with different levels of complexity

IPR=Intellectual property registration

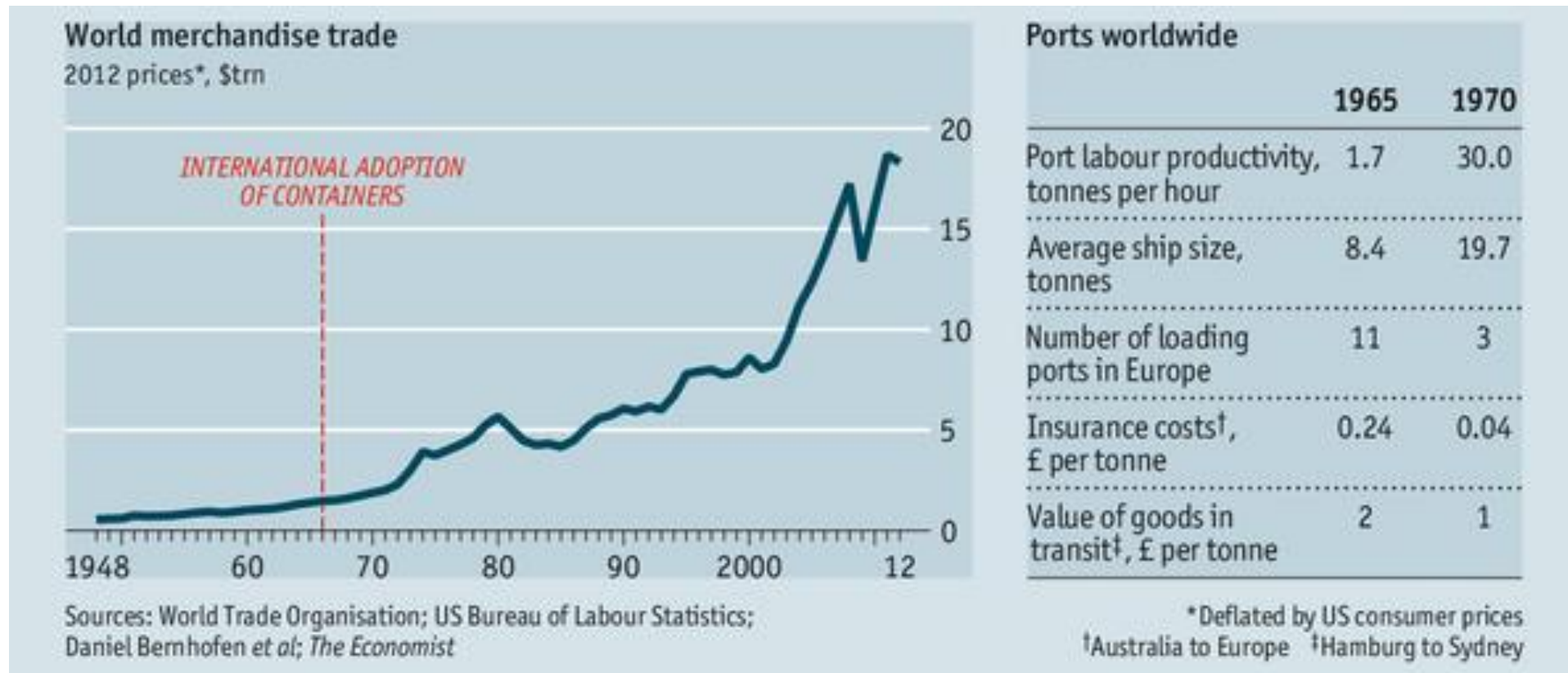


Large global factors



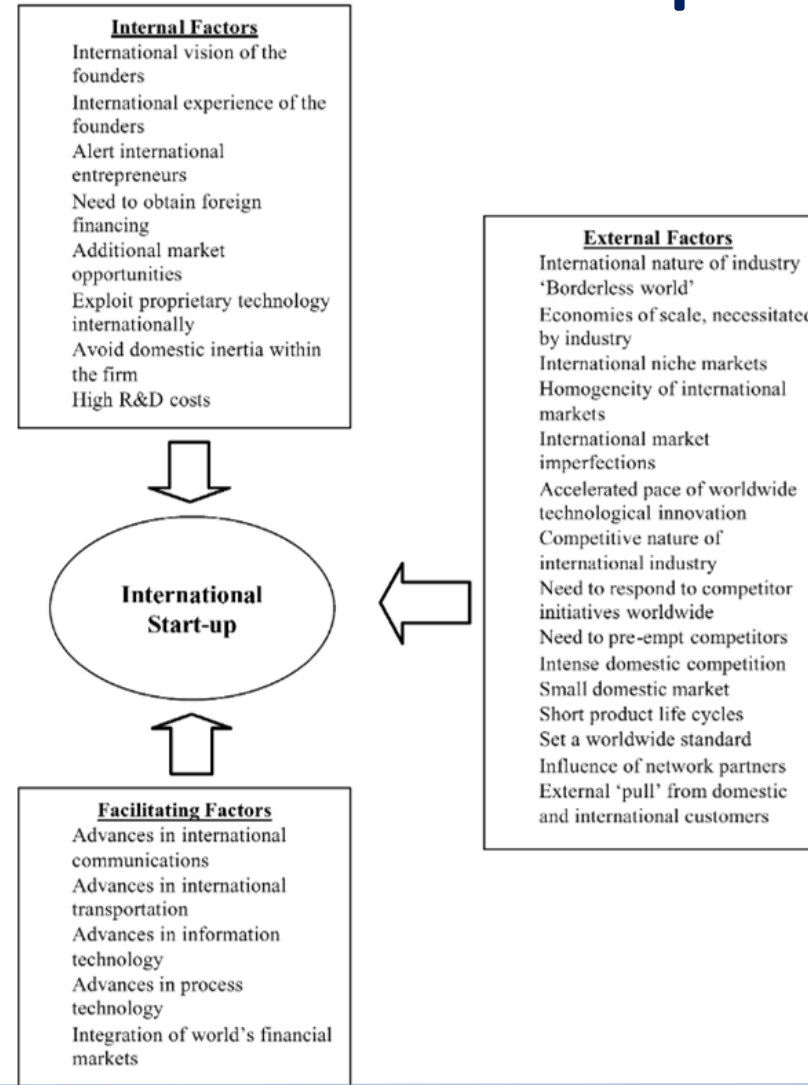
Source: VoxEU, CEPR's policy portal

Specific factors



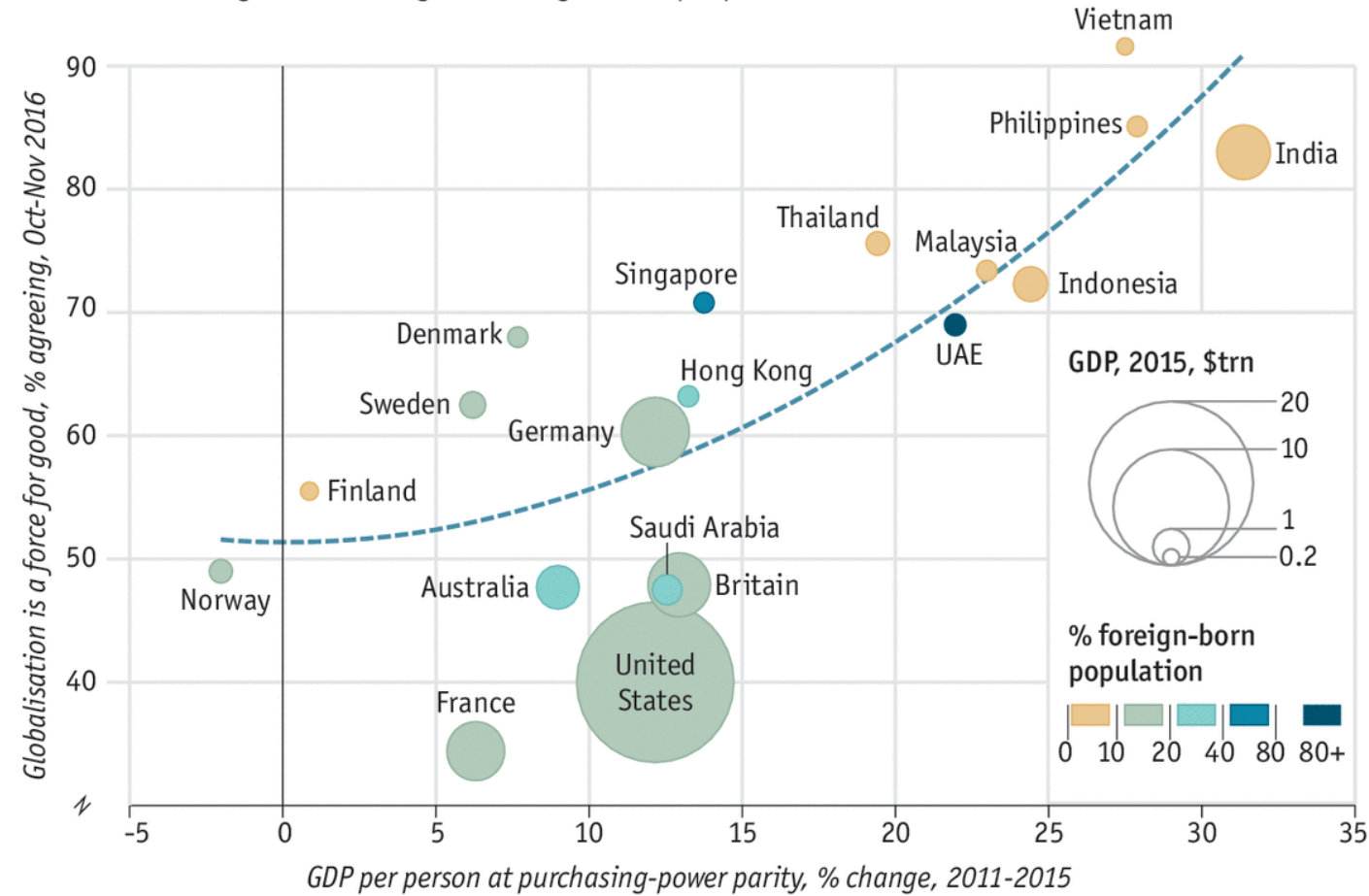
Source: The Economist, May 18, 2013

Globalisation even at the start-up stage



The perception of globalisation

Attitudes towards globalisation against change in GDP per person



Sources: YouGov/The Economist; World Bank; UN

Economist.com

Managing international network

- Culture has been shown to affect aspects of social and organizational life including **negotiation behaviour** (Graham, Mintu, & Rodgers, 1994), **acceptance of new products** (Yeniyurt & Townsend, 2003), **whistle blowing** (Sims & Keenan, 1999), **reward allocation** (Kim, Park, & Suzuki, 1990), **conflict management** (Swierczek & Onishi, 2003), **ethical perception** (Cohen, Pant, & Sharp, 1995; MacArthur, 1996), **entrepreneurial potential and innovativeness** (Mueller & Thomas, 2001) and **expectation of service quality** (Furrer & Sudharshan, 2001).

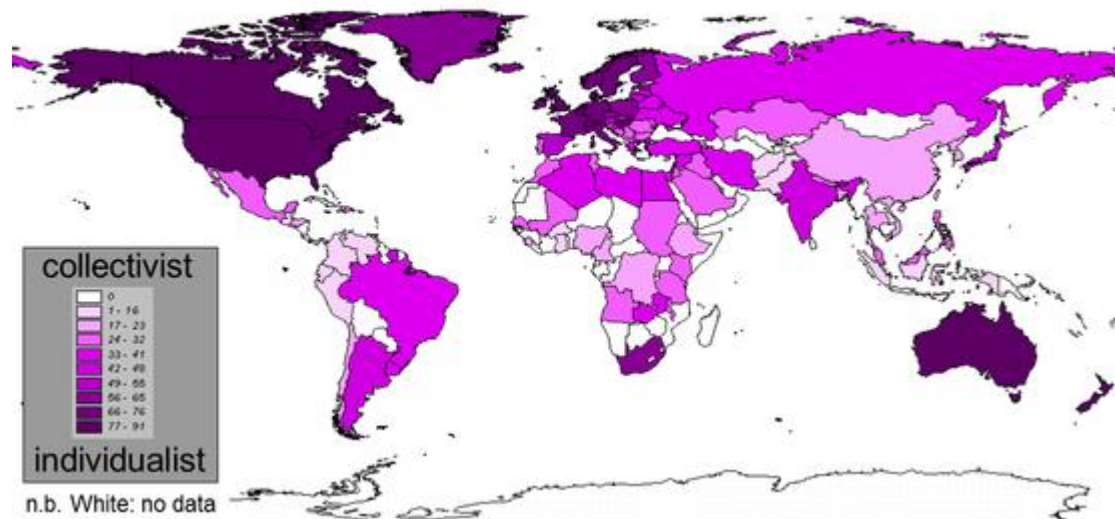
Hofstede's model of culture

There are six dimensions, but the last two have been added later

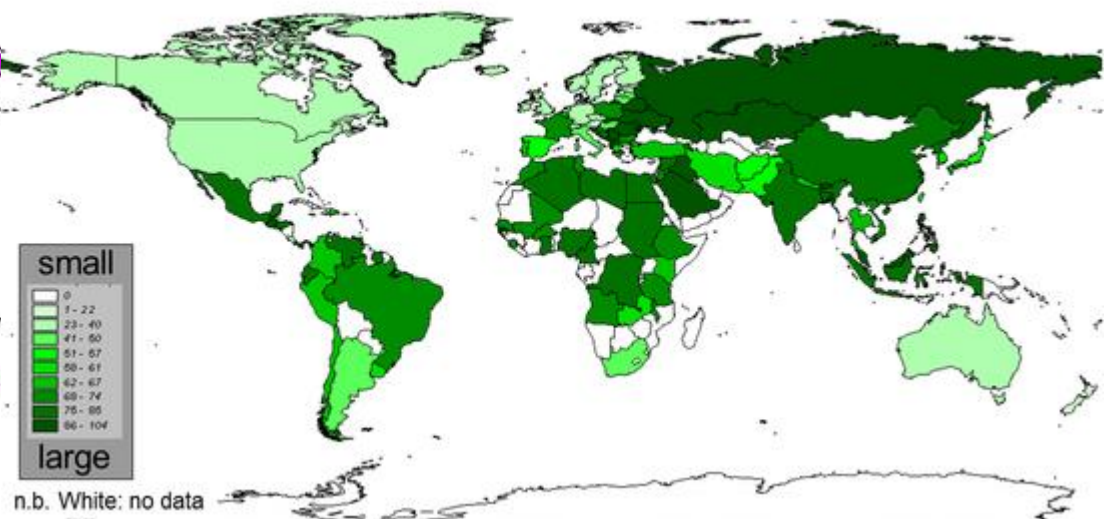
1. Power Distance related to the different solutions to the basic problem of human inequality;
2. Uncertainty Avoidance , related to the level of stress in a society in the face of an unknown future;
3. Individualism versus Collectivism, related to the integration of individuals into primary groups;
4. Masculinity versus Femininity, related to the division of emotional roles between women and men;
5. Long Term versus Short Term Orientation, related to the choice of focus for people's efforts: the future or the present and past.
6. Indulgence versus Restraint, related to the gratification versus control of basic human desires related to enjoying life

Hofstede's model of culture

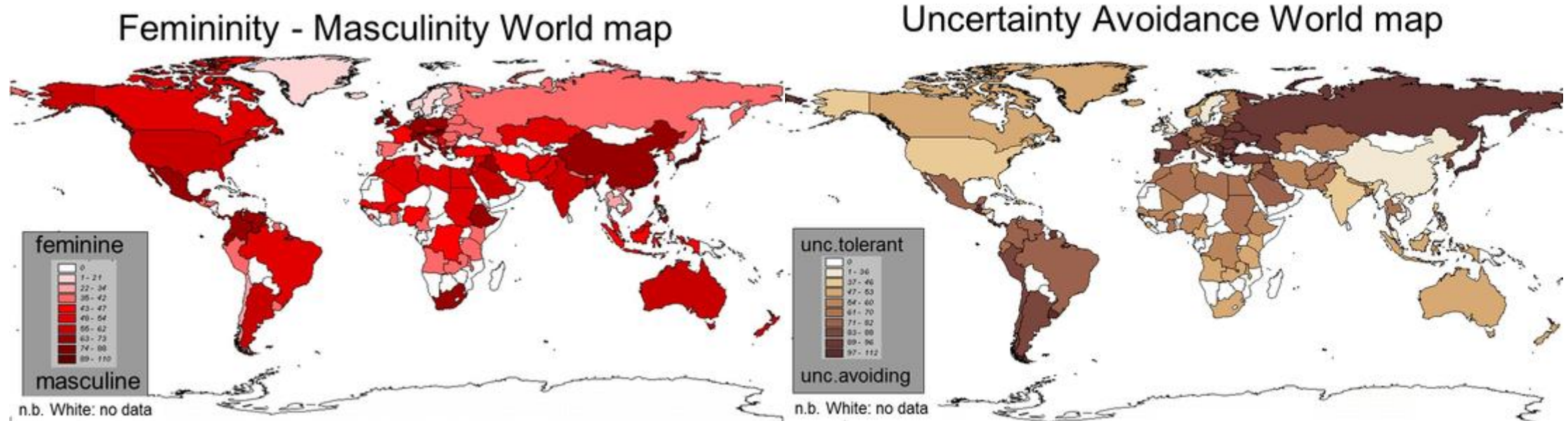
Collectivism – Individualism World map



Power Distance World map

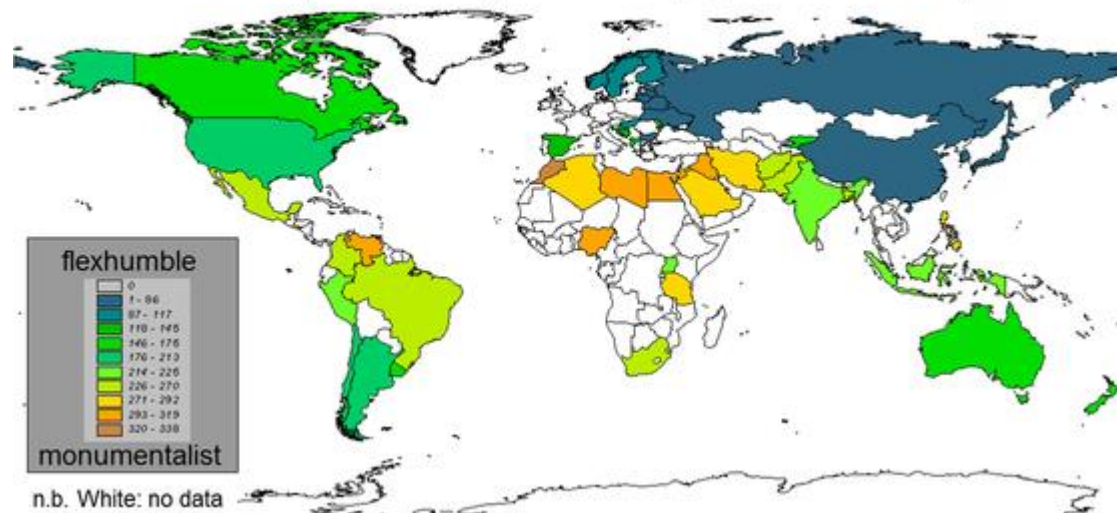


Hofstede's model of culture

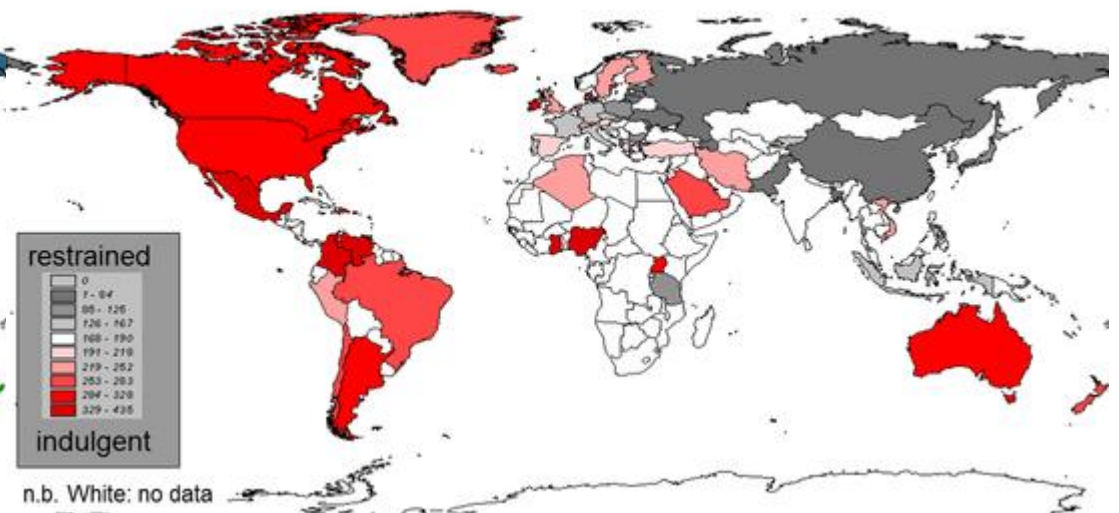


Hofstede's model of culture

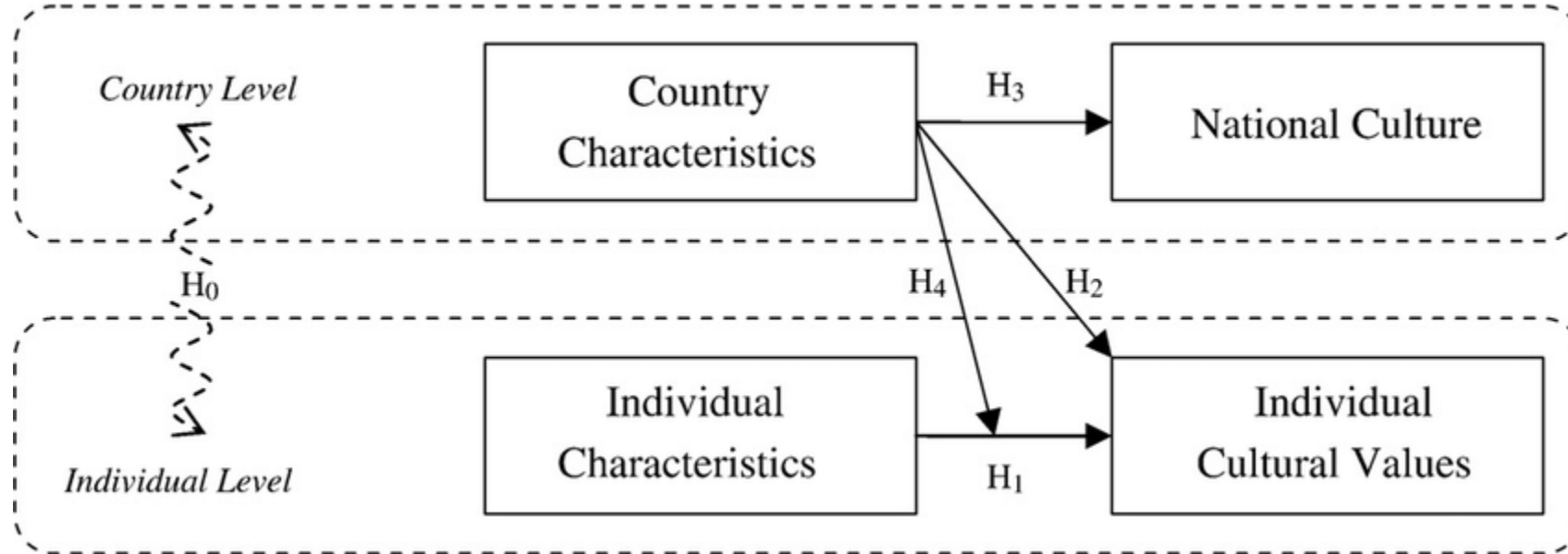
Short-term orientation (Monumentalism) – Long-term orientation (Flexhumility) World map (based on WVS)



Indulgence - Restraint World map (based on WVS)



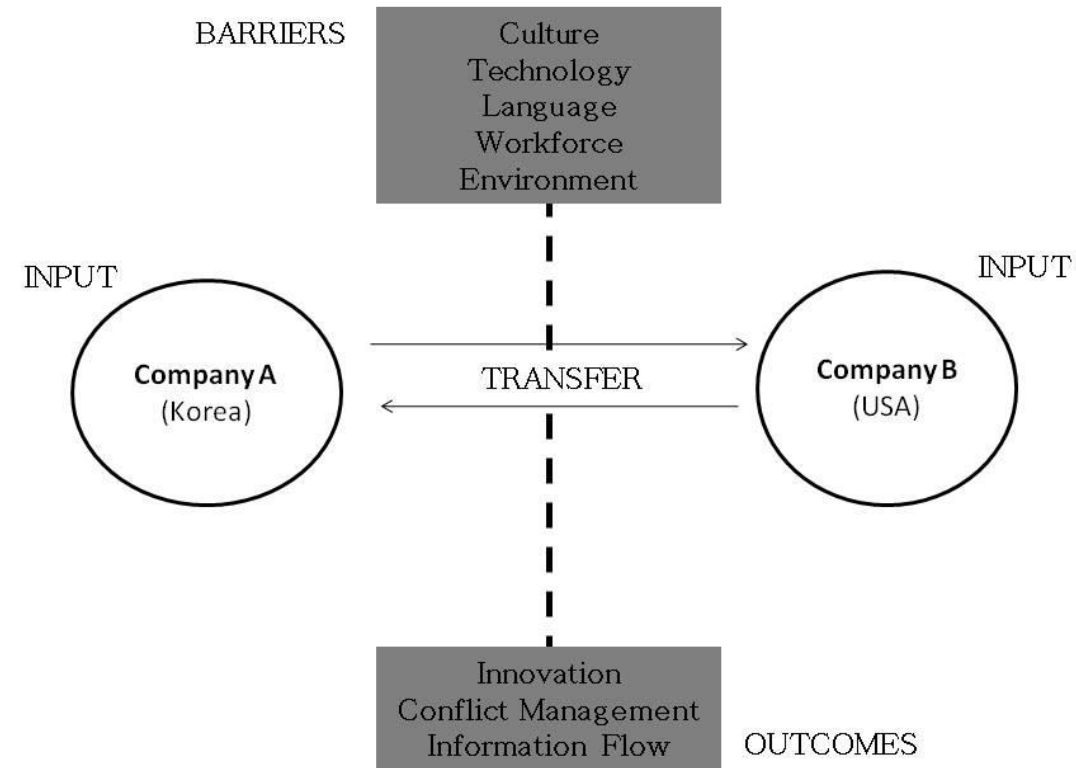
Multi-level model of cultural values



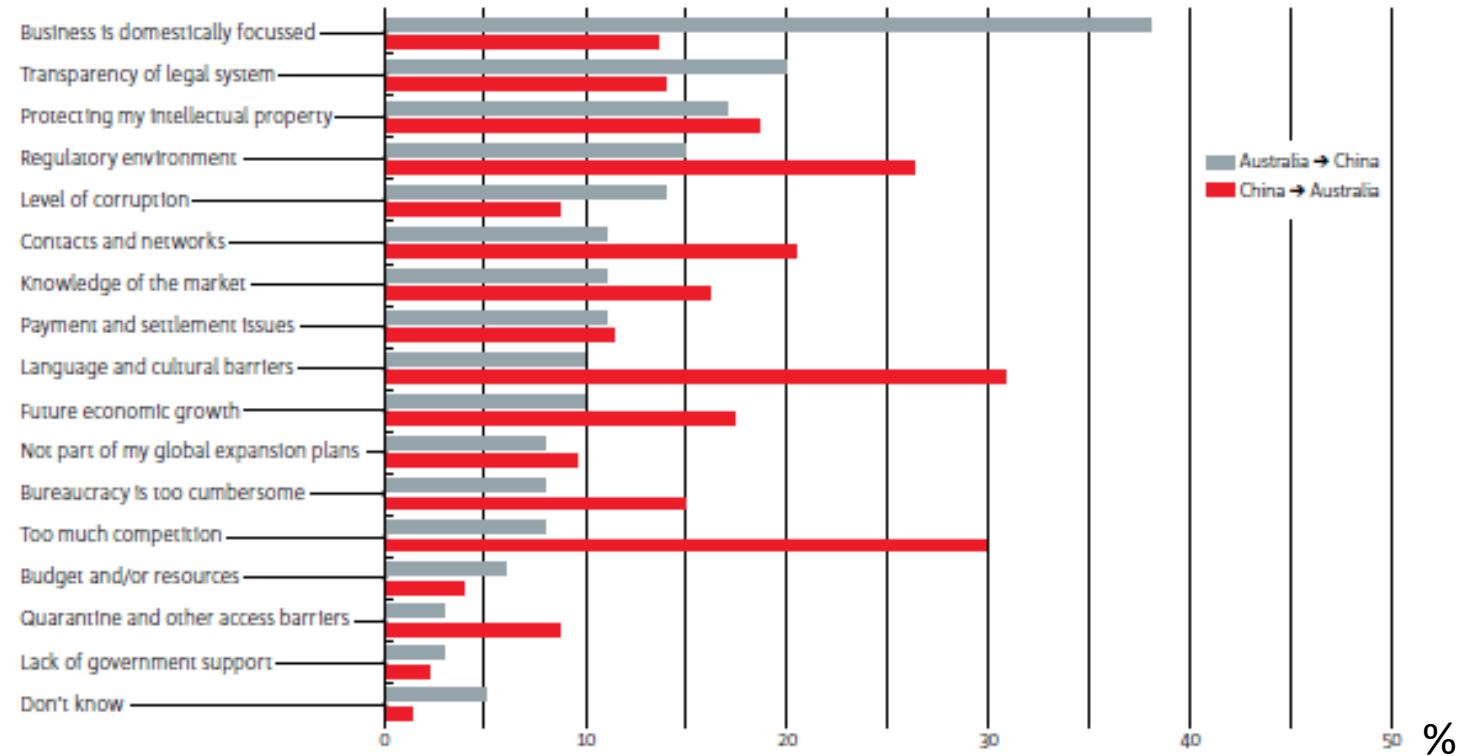
Hofstede's model of culture

- A review showed that the existing measures of culture are fairly consistent in terms of their approach and closely resemble the methodology used by Hofstede (1980). The vast majority of the existing instruments operationalize culture through values and the data are collected via self-report questionnaires.
- Culture is a multi-level, multi-facet construct. It has been generally agreed that culture is distinctively different from personality or individual temporal states as it is a group phenomena. "Culture is a group's shared set of distinct basic assumptions, values, practices, and artifacts that are formed and retained over a long period of time".
- Keep in mind that the data is limited and numbers are ordinal if not nominal in terms of interpretation.

Barriers



Inhibitors for business engagement



Source: NAB ACRI Australia-China Business Index 2016

Questions?

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