CIRRELT The Science of Networks La science des réseaux

# THE SOCIAL ACCEPTABILITY OF THE PHYSICAL INTERNET:

## The unforeseen challenge?


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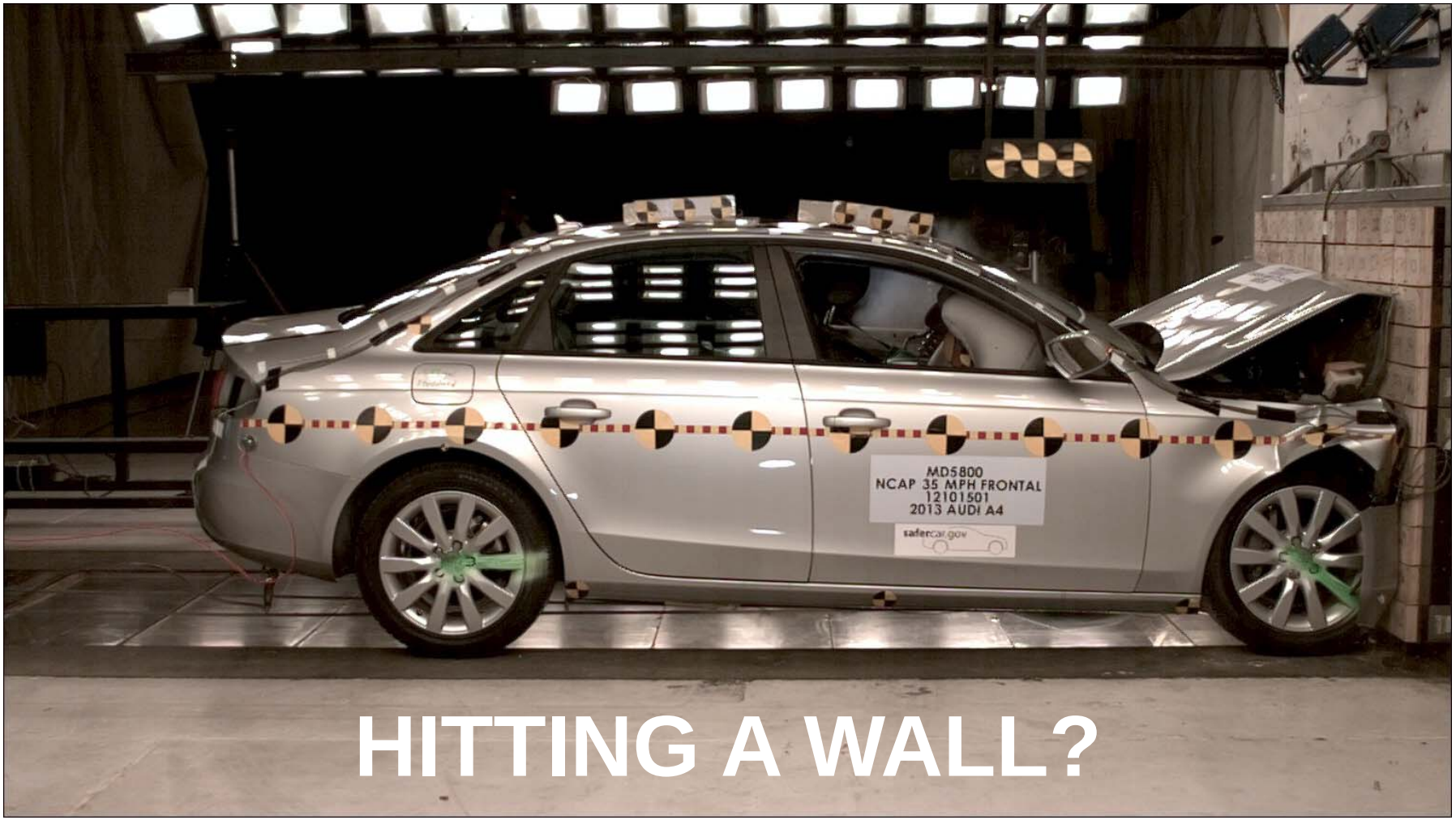
***3rd Int'l Physical Internet Conference***
**June 29th, 2016**


UNIVERSITÉ LAVAL




# HITTING A WALL?

Source: NHTSA

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# *TODAY*

- The global context is evolving
- About CSR
- Methods
- Beyond certification
- Macro-level considerations
- Micro-level considerations
- Conclusion and implications

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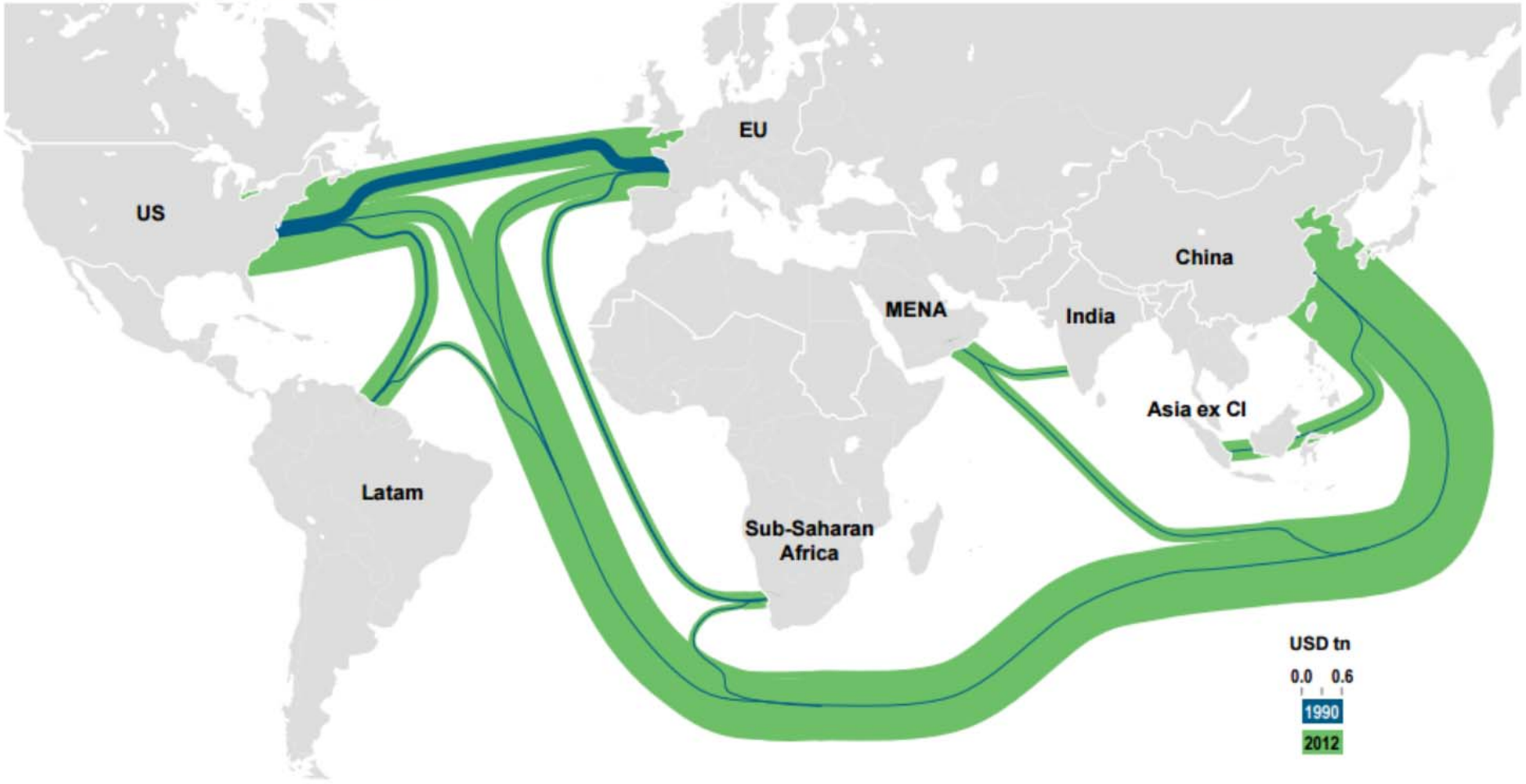
# CONTEXT

**Figure 3: China has emerged as a mega-trader**

*Exports, major trade corridors, 1990 and 2012*




Source: IMF DOTS, Standard Chartered Research

Source: Standard Chartered (2014), Global Trade Unbundled, Special Report.

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US Department of Transportation
Federal Highway Administration
Office of Freight Management and Operations
Freight Analysis Framework

**National Highway System Estimated Peak Period Congestion**

**(2020)**

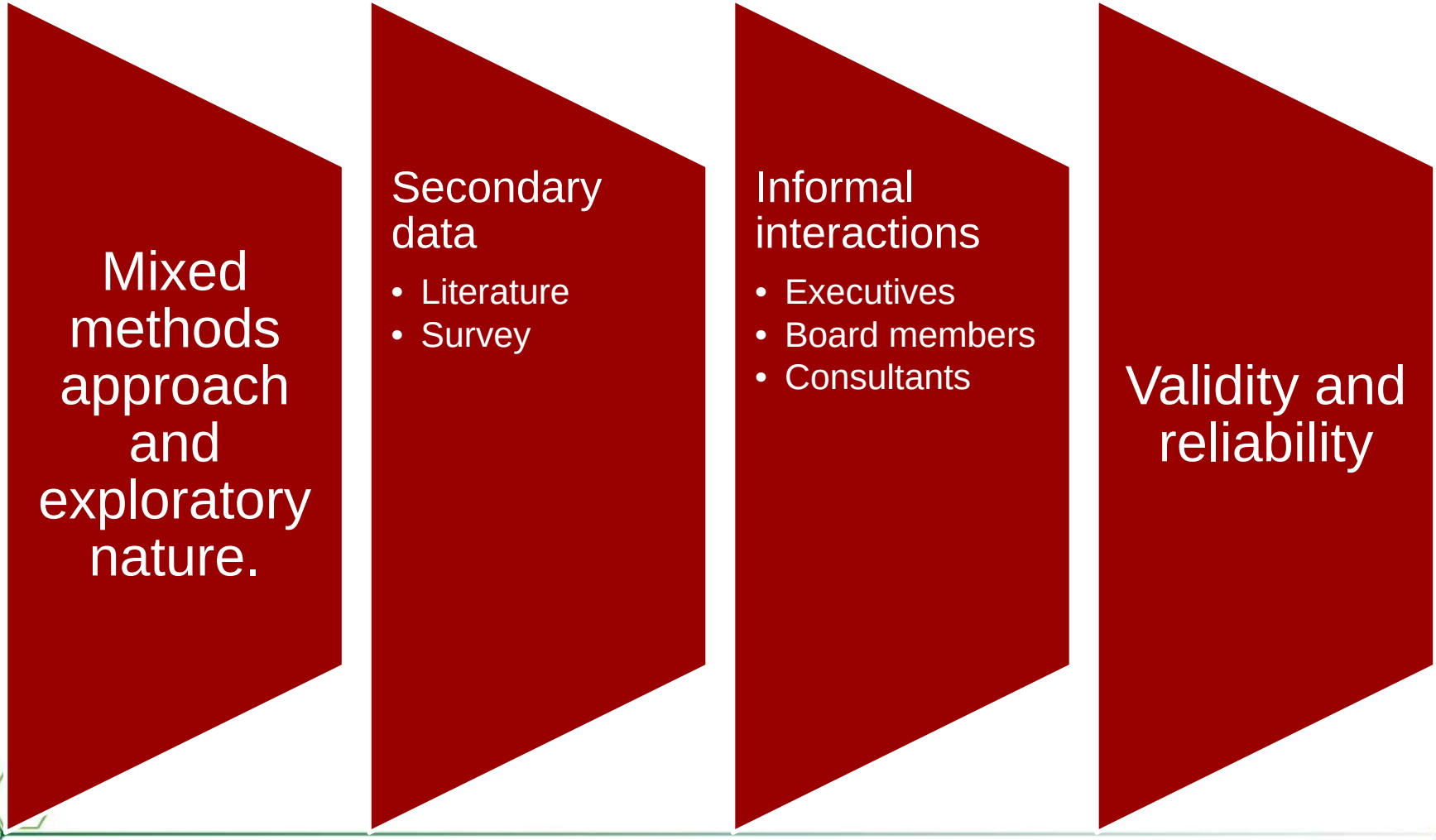
**NHS Highways**
- Below Capacity
- Approaching Capacity
- Exceeding Capacity

Source: http://www.seabridgeusa.com/images/overview/National-Highway-System-Estimated-Peak-Congestion-In-2020.jpg et http://ops.fhwa.dot.gov/freight/publications/fhwaop03004/nhs_congestion_2020.pdf

# *CSR*

- Doing the right thing vs. doing things right
- A classical dilemma:
  - Ethical vs. legal
- Impacts ALL industries
- Differentiated reactions of the public:
  - Larger projects: NIMBY
  - Individual repercussions: Credit Card Contracts
- Certification
  - Cost of doing business vs tool to add value
  - A marketing fad? (e.g. fair trade/carbon offsets)
- NOTE: your company policies matter!!!


# *METHODS*

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# *CERTIFICATION*




FOREST
STEWARDSHIP
COUNCIL

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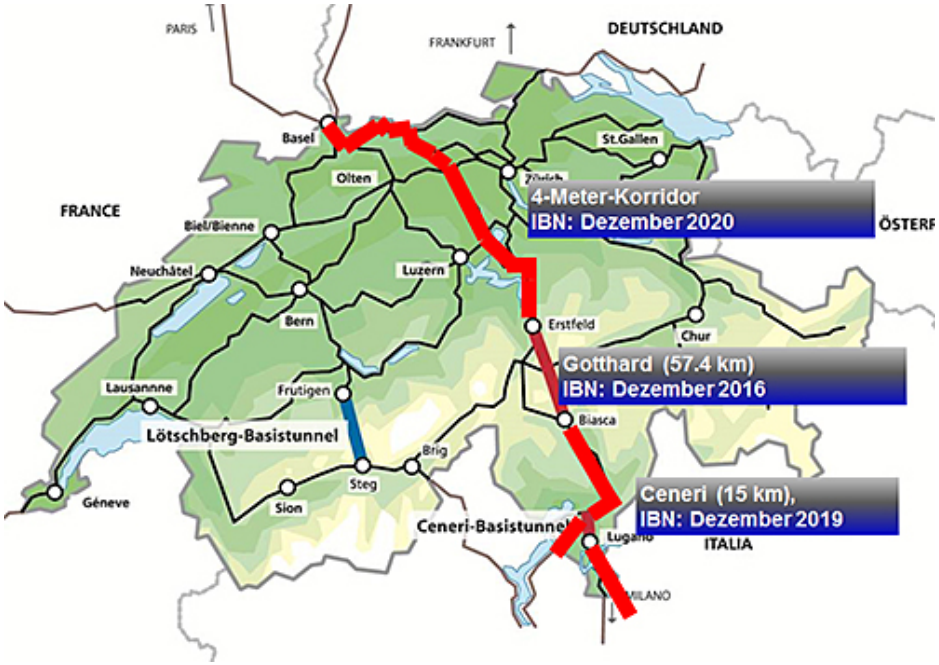
# *MACRO-LEVEL CONSIDERATIONS*

## St-Gothard tunnel (57 km; CHF10 bn)




Source: CFF

## The Nicaragua canal ($50 bn)


Source: e360.yale.edu

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YC1

# *MICRO-LEVEL CONSIDERATIONS*

1. The Defence Ethics Program (Canada):

2. The Mining Industry:
   - Polaris Materials: http://www.polarmin.com/index.php


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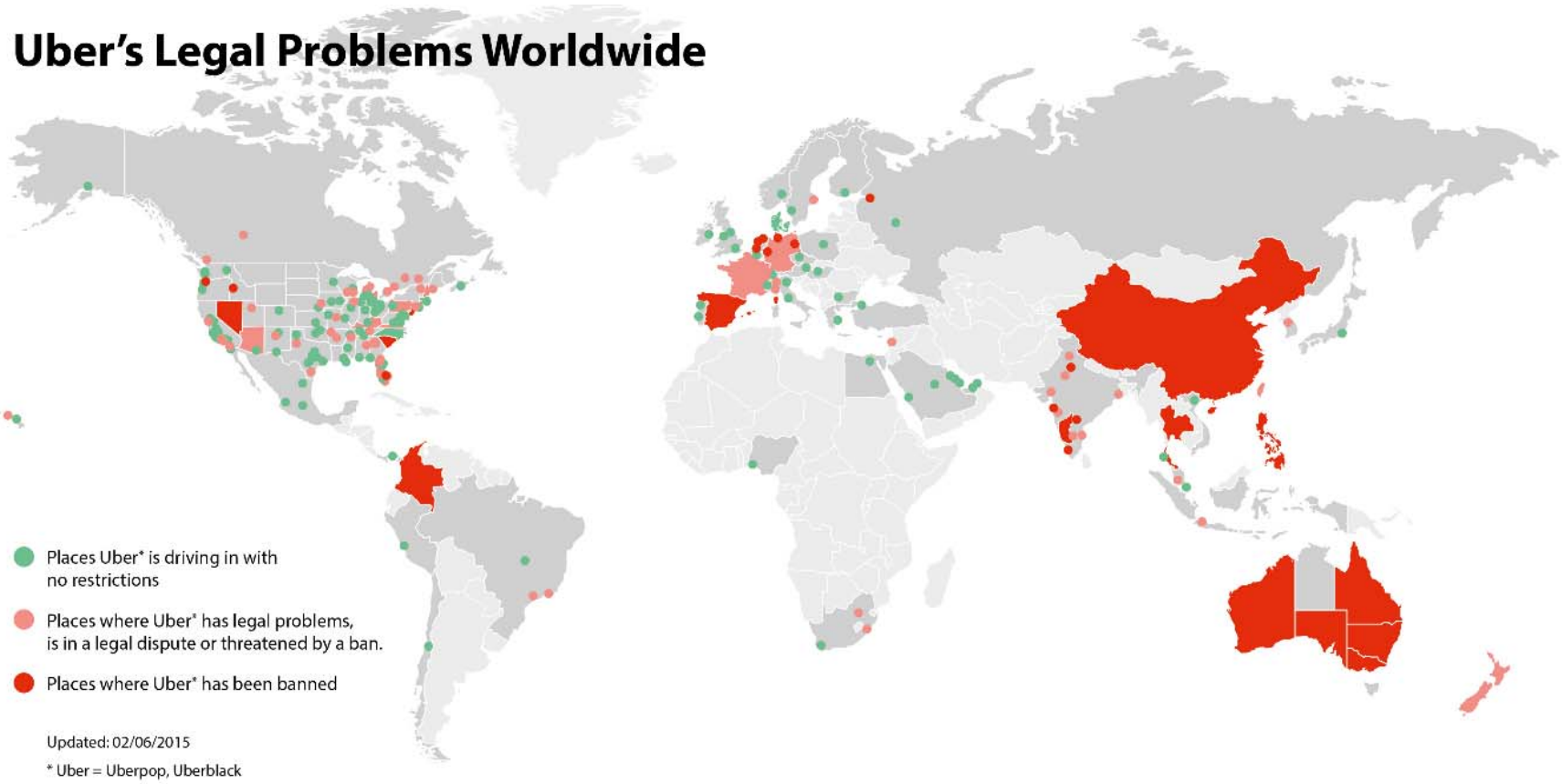
## Slide 10

**YC1** YAN CIMON, 6/20/2014

# *MACRO-MICRO "GAMES"*

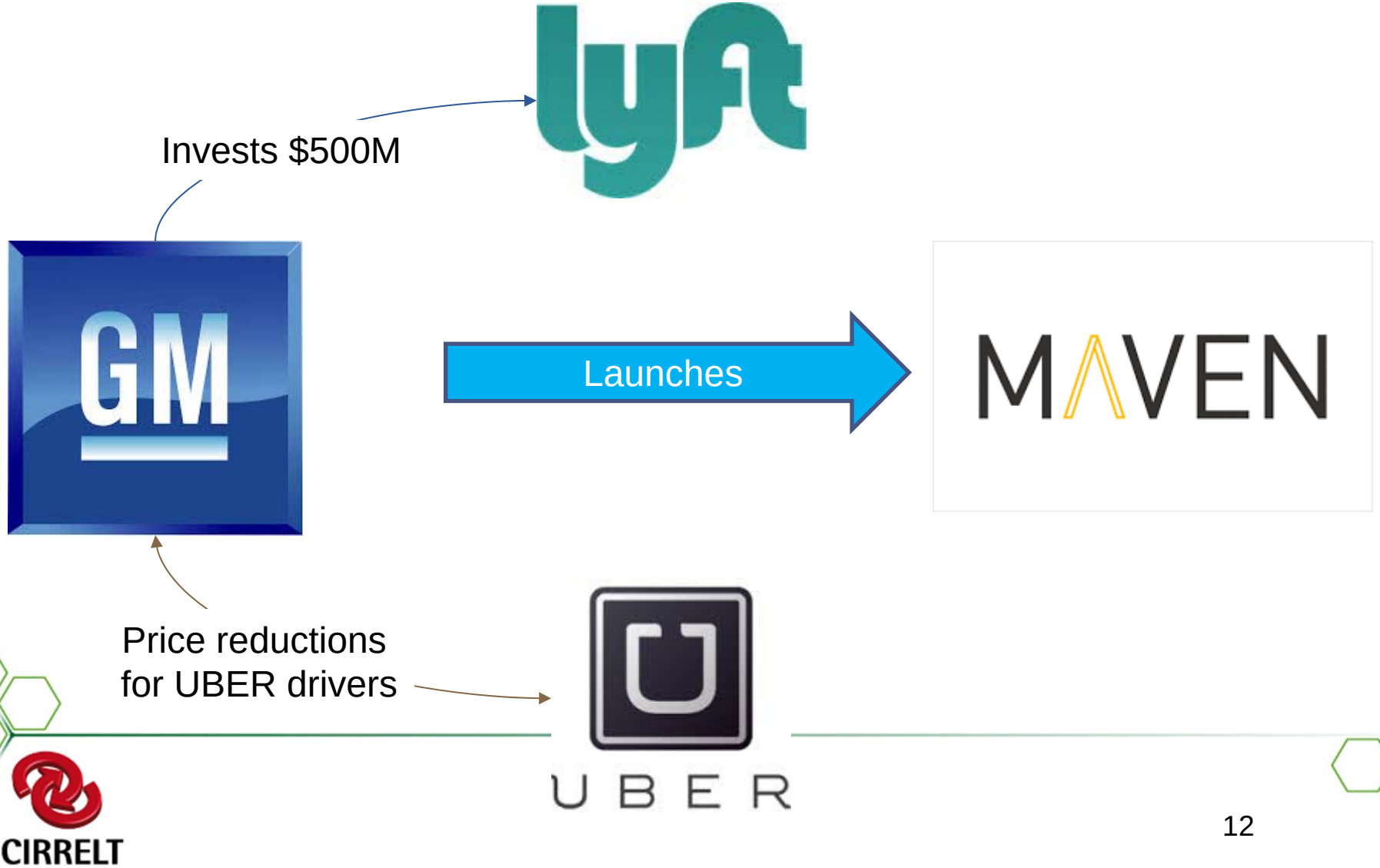





Source: http://www.taxi-deutschland.net/

Source: Bloomberg

# *THE GM BETS*


lyft
Invests $500M
GM
Launches
MAVEN
Price reductions
for UBER drivers
UBER
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Good for CO2 reductions

May not survive political fights…

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# *CONCLUSION*

- Proposition 1: Certifications have an impact on the perception of CSR involvement
  - Signalling theory
- Proposition 2: Macro-level issues are better shaped in long-run discourse
- Proposition 3: Micro-level issues are better shaped through extensive fieldwork

# *IMPLICATIONS*

## Academics…

- …will need to measure and model the impact of CSR on the PI

## Practitioners from the « real world »…

- …will need new « science-based tools » when implementing the PI

Source: www.vkmaheshwari.com

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Comments and suggestions are welcome

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# Antecedents of the Physical Internet: A Cross-Country Analysis of Transportation Volume Change

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IPIC 2016

**The 3rd International Physical Internet Conference**
**Atlanta, GA**
**June 29-July 1, 2016**

# Research Motivations

- The recent development of the Physical Internet (PI) enables transportation and logistics to be more efficient.
  - The question arises whether it may have a varying impact on countries' economic performance.
  - Thus, it is crucial to understand the drivers of transportation volume in the first place.
- Limited previous research on the PI: simulations and case studies
  - Empirical research on relevant drivers and enablers is needed
- From the viewpoint of innovation diffusion
  - Research on the diffusion of transportation technologies

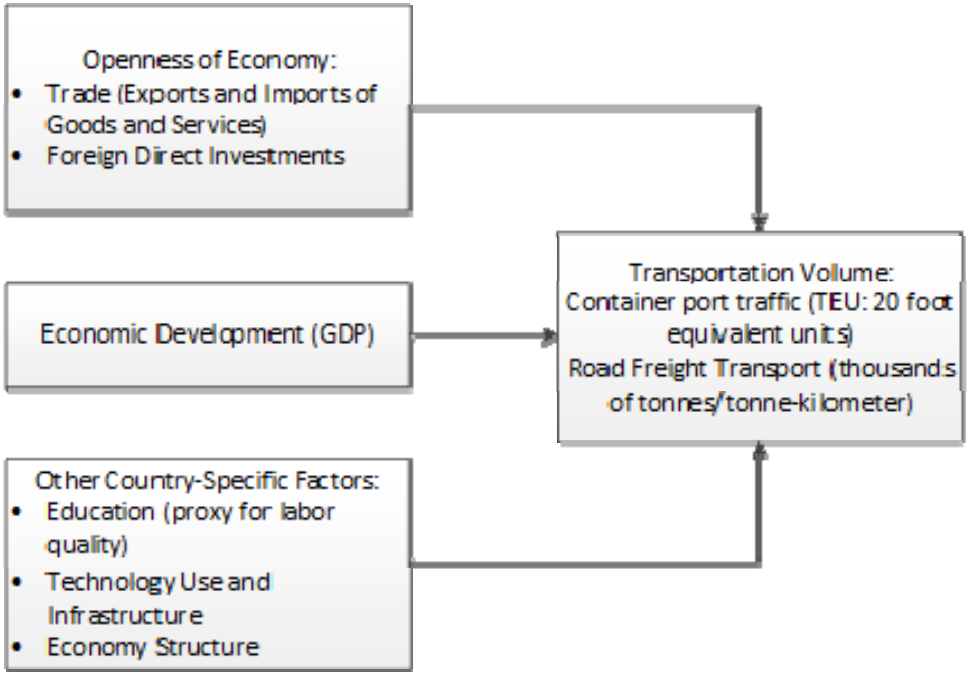
# Research Objectives

- A country-level analysis of the determinants of growth of transportation volume by employing data collected from 28 European countries for the 10 year period of 2004-2013 from two data sources: (1) Eurostat and (2) World Bank.
  - Focuses on two modes of transportation technologies: water transport and road transport.
- By examining factors influencing countries' growth of transport volumes, we extend the general framework of the Physical Internet, explicitly taking factors into account which in most cases cannot be directly influenced by logistics decision makers.

# Factors Influencing Technology Diffusion

- Roger's diffusion theory of innovation (1995)
  - The growth pattern of adoption of a specific technology takes the form of a cumulative normal distribution, which is a S-curve.
  - Gompertz and logistics curve are the most widely used specifications of S-curve.
- Epidemic model of technology diffusion (Fagerberg et al., 2014)
  - Widely used in econometric studies of economic growth and technology change across countries.
- Based on diffusion theories and models, previous research has examined various country-level factors influencing technology diffusion within a country (Comin and Hobijn, 2004; Dewan et al., 2005; Kiiski and Pohjola, 2001; Ganley et al. 2003; Pulkki-Brannstrom and Stoneman, 2013).
  - We consider human capital, openness of economy, levels of economic development, technology use and infrastructure, and structure of the economy.

# Determinants of Transportation Volume: Model and Hypotheses



# Model

$$(\Delta \ln H_t/H_t - \Delta \ln H_{t-1}/H_{t-1}) = c + \beta \Delta \ln H_t + \gamma \Delta \ln Z_t$$

- The model is derived from an S-curve diffusion model, which assesses the effects of environmental (country-specific) factors on technology diffusion (or use) across countries (Ganley et al., 2003)
- There are a few choices of the form of curve, and we chose the Gompertz model of diffusion.
- Taking log-differencing corrects the simultaneity bias inherent in the model and also minimizes multicollinearity issues between explanatory variables.

# Derivation of Model

- Gomperz Model: $dH_t/d_t = \beta(H_t(\ln H_t^* - \ln H_t))$
  - Technology growth in logarithms and S-shape diffusion process due to internal influence: $\ln H_t - \ln H_{t-1} = \beta(H_t(\ln H_t^* - \ln H_t)$ **(1)**
  - Saturation level of $\ln H_t^* = \ln H_{t-1}^* + \gamma\Delta(\ln Z_t)$ **(2)** where $\gamma\Delta(\ln Z_t)$ is the deviation from the saturation level in the previous period ($Z_t$ represents exogenous variables affecting growth)
  - Thus, $\ln H_t^* - \ln H_{t-1}^* = \gamma\Delta(\ln Z_t)$ **(3)**
  - Divide equation **(1)** by $H_t$ and take the first difference: $(\ln H_t - \ln H_{t-1})/H_t - (\ln H_{t-1} - \ln H_{t-2})/H_{t-1} = \beta[(\ln H_t^* - \ln H_t) - (\ln H_{t-1}^* - \ln H_{t-1})$ **(4)**
  - Insert equation **(3)** into equation **(4)**: $(\Delta\ln H_t/H_t - \Delta\ln H_{t-1}/H_{t-1}) = \beta\Delta\ln H_t + \gamma\Delta(\ln Z_t)$
  - Include constant to account for the potential of systematic bias in countries' actual growth patterns: $(\Delta\ln H_t/H_t - \Delta\ln H_{t-1}/H_{t-1}) = c + \beta\Delta\ln H_t + \gamma\Delta\ln Z_t$

# Other Models to Consider

- Caselli and Coleman, 2001; Comin and Hobijn, 2003; Dewan et al., 2005

$$T_t = \beta_0 + \sum_{k=1}^{n} \beta_k X_{kt-1} + \varepsilon_t$$

- Fagerberg et al., 2013
  - Standard epidemic model of technology diffusion

$$\Delta T = T_t - T_{t-1} = \beta_0 + \gamma T_{t-1} + \sum_{k=1}^{n} \beta_k X_{kt-1} + \varepsilon_t$$

- Logistic Model

$$dH_t/d_t = \beta(H_t(H_t^* - H_t))$$

# Sample Statistics for Full Sample (2004-2013)

| Variables | Full Sample | | |
|---|---|---|---|
| | Mean | St. Dev. | N |
| TEU (in thousand) | 3,929 | 4,953 | 211 |
| Thousands of tonnes (road freight) | 24,372 | 45,185 | 230 |
| TKM, tonne-kilometer (road freight) | 2,801 | 5,891 | 230 |
| GDP per capita | 34,188 | 23,795 | 280 |
| FDIs (% of GDP) | 6.9 | 14.8 | 280 |
| Trade (% of GDP) | 106.8 | 54.5 | 280 |
| School enrollment, tertiary (% gross) | 65.1 | 15.5 | 256 |
| School enrollment, secondary (% gross) | 103.7 | 10.6 | 269 |
| % of individuals using the Internet | 64.1 | 19.1 | 280 |
| Employment manufacturing (% of total) | 16.7 | 5.2 | 280 |
| Employment trade, transport, accommodation, food and business administration (5 of total) | 37.6 | 4.5 | 280 |
| Valid N (listwise) | | | 160 |

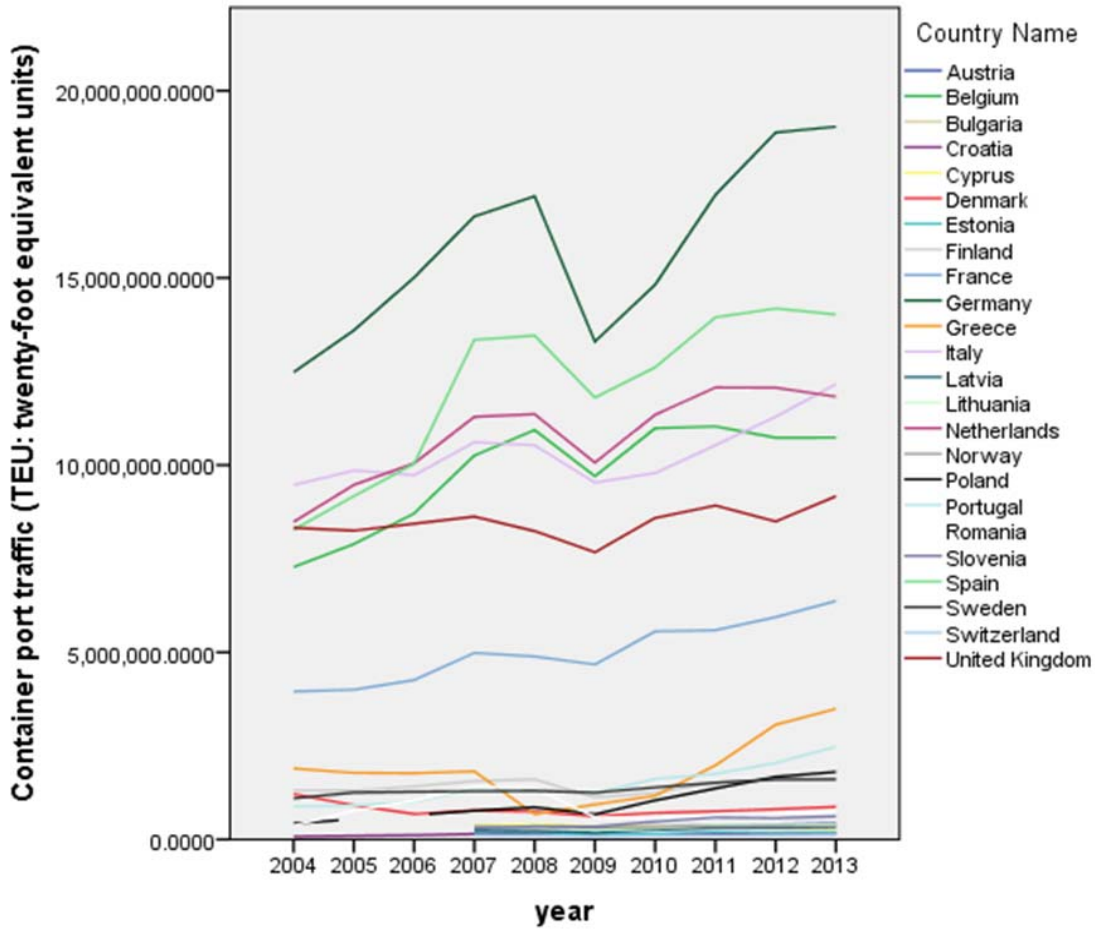
# Sample Statistics for Western and Eastern European Countries (2004-2013)

| Variables | West (17 Countries) | | | East (11 Countries) | | |
|---|---|---|---|---|---|---|
| | Mean | St. Dev. | N | Mean | St. Dev. | N |
| TEU (in thousand) | 5,412.4 | 5,249.5 | 148 | 444.0 | 399.9 | 63 |
| Thousands of tonnes (road freight) | 37,820.9 | 53,948.5 | 139 | 3,829.1 | 5,134.0 | 91 |
| TKM, tonne-kilometer (road freight) | 4,215.8 | 7,212.7 | 139 | 639.3 | 851.5 | 91 |
| GDP per capita | 47,726.0 | 21,178.4 | 170 | 13,264.5 | 5,120.6 | 110 |
| FDIs (% of GDP) | 7.6 | 17.8 | 170 | 5.8 | 8.0 | 110 |
| Trade (% of GDP) | 99.1 | 64.1 | 170 | 118.6 | 31.7 | 110 |
| School enrollment, tertiary (% gross) | 65.9 | 17.3 | 149 | 64.0 | 12.6 | 107 |
| School enrollment, secondary (% gross) | 107.5 | 11.2 | 162 | 97.9 | 6.1 | 107 |
| % of individuals using the Internet | 70.4 | 18.5 | 170 | 54.4 | 15.6 | 110 |
| Employment manufacturing (% of total) | 13.9 | 3.89 | 170 | 20.9 | 4.0 | 110 |
| Employment trade, transport, accommodation, food and business administration (5 of total) | 39.8 | 2.89 | 170 | 34.1 | 4.2 | 110 |
| Valid N (listwise) | | | 112 | | | 48 |

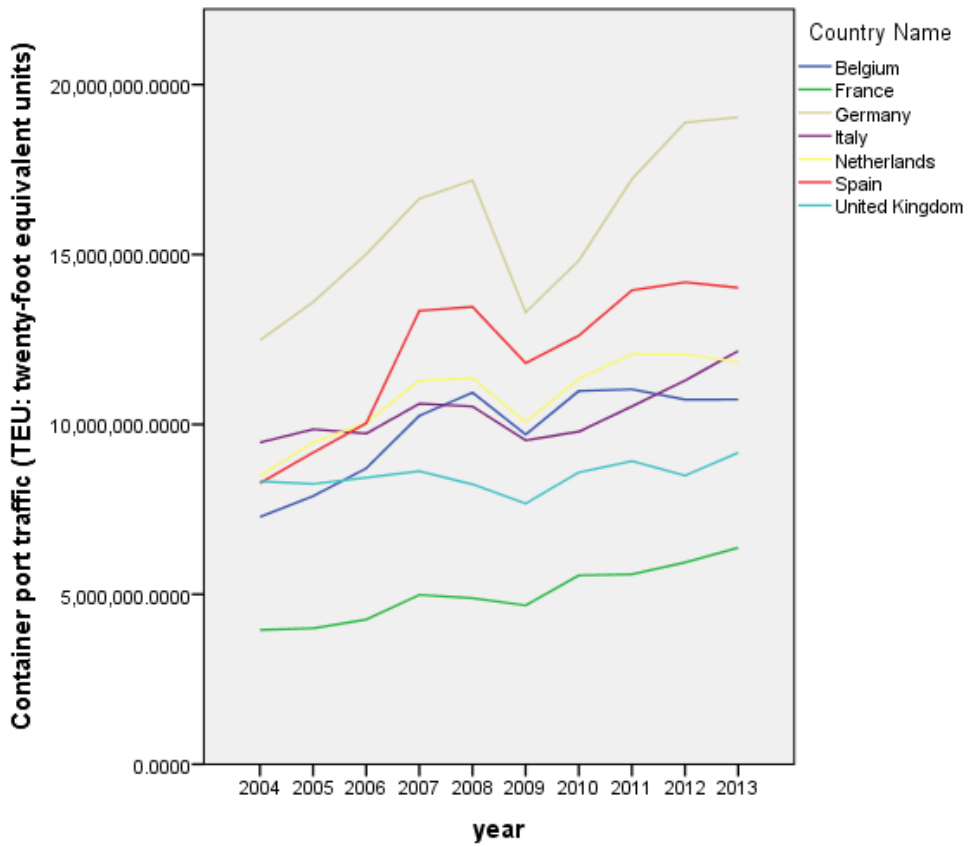
# Classification of Countries

| Western European Countries (17) | Eastern European Countries (11) |
|---|---|
| Austria | Bulgaria |
| Belgium | Croatia |
| Cyprus | Czech Republic |
| Denmark | Estonia |
| Finland | Hungary |
| France | Latvia |
| Germany | Lithuania |
| Greece | Poland |
| Italy | Romania |
| Luxemburg | Slovakia |
| Netherlands | Slovenia |
| Norway | |
| Portugal | |
| Spain | |
| Sweden | |
| Switzerland | |
| United Kingdom | |

# Volume Changes in Container Port Traffic (TEUs)



# Volume Changes in Container Port Traffic (TEUs)



# Regression Results

$$\Delta \ln H_t/H_t - \Delta \ln H_{t-1}/H_{t-1} = c + \beta \Delta \ln H_t + \gamma \Delta \ln Z_t$$

| Variables | TEU | Tonnes | TKM |
|---|---|---|---|
| | Model 1 | Model 2 | Model 3 |
| Constant (c) | -.008* (.004)[1] | -.028[+] (.016) | -.001 (.001) |
| ΔLnGDPCAP | .005 (.016) | .088 (.073) | -.002 (.000) |
| ΔLnFDI | -.001 (.001) | .000 (.003) | .000 (.000) |
| ΔLnTrade | .080** (.029) | .208* (.091) | .004 (.008) |
| ΔLnTER | .012 (.014) | .071 (.073) | .002 (.005) |
| ΔLnSEC | .001 (.011) | .020 (.045) | -.004 (.003) |
| ΔLnINT | -.018 (.012) | .048 (.041) | -.001 (.003) |
| ΔLnManuEMPL | .004 (.027) | .022 (.101) | .004 (.008) |
| ΔLnTREMPL | .048 (.055) | .117 (.179) | -.002 (.013) |
| ΔLnTRAVOL (β) | .014** (.005) | .034** (.011) | .003*** (.001) |
| WEST[2] | .003 (.002) | .009 (.007) | .000 (.001) |
| Controls[3] | Year | Year | Year |
| $R^2$ | .500 | .368 | .327 |
| F value | 2.84*** | 1.95* | 2.66*** |
| Countries | 24 | 27 | 27 |
| Observations | 126 | 141 | 141 |

[+]p<.1, *p<.05, **p<.01, ***p <.001

[1] robust (heteroscedasticity-consistent) standard error

[2] dummy variable—Western European countries coded as 1 and Eastern European countries coded as 0 (the classification is shown in Appendix—Table A1)

[3] dummy variables for year-specific effects.

# Discussion and Conclusions

- The growth rate of transportation technologies as measured by TEU (maritime transport) and tonnes (road transport) has slowed down.
- Openness of economy as measured by trade has a significant impact on the growth rate.
- There is no effect of economic development on the growth rate.
- There is no regional difference in the growth rate between western and eastern Europe.
  - Diffusion of existing transport technologies has passed the saturation level (at the mature stage), and its growth rate has decelerated.
  - Emerging technologies, such as PI containers, can increase transportation volume by triggering improvements in transportation efficiency and sustainability.

# Discussion and Conclusions

- Dawn of the Physical Internet
  - Several European companies are currently experimenting with the use of the PI, but these trials are in an early stage.
  - A critical mass of users is essential for its diffusion
  - Recognition of it value (benefits/costs) and government subsidies and incentives

# Contributions

- We highlight the close relationship between country-specific factors and the growth of transport volume, as measured by the flow of containers in standard TEUs and road freight transported in thousands of tonnes and TKM, both of which are antecedents of the PI.
- This research extends the general framework of the Physical Internet by explicitly taking country factors into account which in most cases cannot be directly influenced by logistics decision makers.
  - While the Physical Internet constitutes a powerful paradigm for a change toward a more sustainable and efficient way of doing logistics (Montreuil, 2011), only a handful of simulations and case studies exist (Ballot et al., 2014).
- This research integrates a macroeconomic perspective into the overall Physical Internet framework.

# Questions?