Drug Trafficking as Illegal Supply Chain - A Social Simulation

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Content

Project

- 1 year project, PoC, aim for a PhD
- AI police lab
- Agent-based simulation on cocaine trafficking

- Frank Dignum
- Vanessa Dirksen (Qualitative research)
- Ron Boelsma (Bridging university and police)
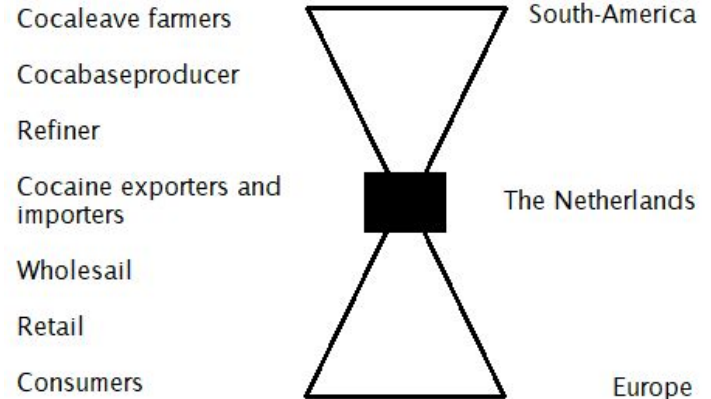
Cocaine smuggling

- Started with cartels (Medellin, Cali)
- After fall of huge cartels in the mid-90's (Desroches, F. 2007)
- Criminal groups became smaller
- Businessman/entrepreneur perspective (Vermeulen, 2008; Desroches, F. 2007)

- Still there is extortion, tax-evasion, overdosing, violence
- Hard to get a grip on

Cocaine trafficking in the Netherlands

- Cocaine from South-America
- Transported to the Netherlands and Spain
  - Rotterdam harbor (biggest in Europe)
- To be transported further into Europe

- Most of the cocaine in the Netherlands is for other countries (UK, Scan, Ger, Fr)

Cocaleave farmers — South-America
Cocabaseproducer
Refiner
Cocaine exporters and importers — The Netherlands
Wholesail
Retail
Consumers — Europe

Vermeulen, I., van der Leest, W., & Dirksen, V. (2018). Doorvoer van cocaïne handel via Nederland. Zoetermeer: Dienst Landelijke Informatieorganisatie.

Social concepts in criminal organizations

Trust in criminal networks

- Many roles, nationalities, no legal system (racket system)

Trust can form a basis of cooperation

- The collapse of a network by lack of trust (Neumann M. 2018)
- Dealing with large quantities of money/contraband (Lampe K. 2004)
- Trust can create an efficient supply chain (Jalbut A. 2018)
- Give up trust for more monetary income (Morselli C. 2007)

Violation of trust

Trust can be violated in many ways

- Not delivering in time, not a high enough quality, stealing

Responses to trust violation can be

- Exclude person/group from business, extortion, violence

Risk in criminal networks

Another important social concept is Risk

- Violation of trust can create risk
- The risk of getting caught
- Risk influences choices

Research questions

Main question:

- What is the effect of trust within the illegal cocaine supply chain in the Netherlands?

Sub question

- What is the difference between a legal and illegal supply chain?

Simulation

Why simulation?

- There is a lot of sociological research
  - Waiting to get used
- Clandestine nature, so data gathering is difficult
  - Estimated only ±5% is confiscated by authorities
  - Simulation could help here
  - There is always data missing, especially the best networks
- Gaining new insights
  - Better interventions and/or policies

Simulation

- Each node is an agent
- 5 layers
- Send orders (3 steps)
- Send shipments (3 steps)
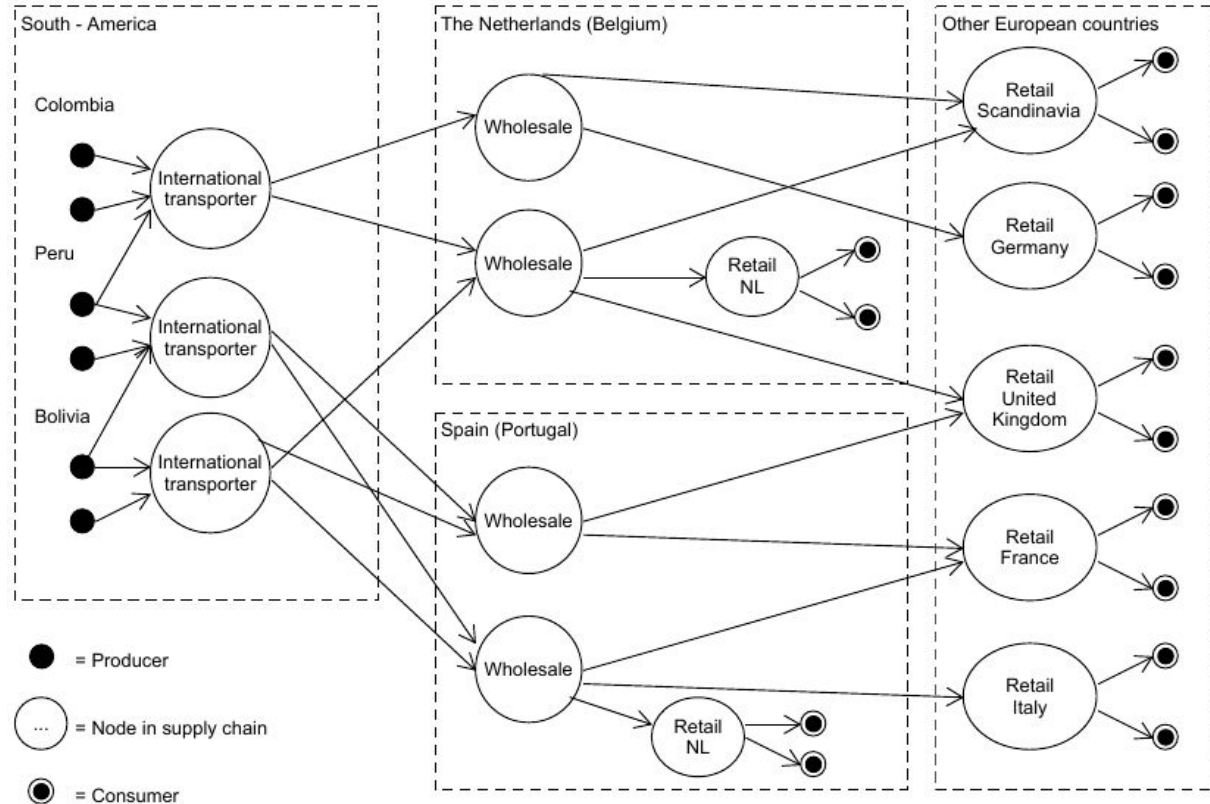
Agent types

- **Producer:** First agent, produces fixed quality, varies quantity
- **International:** Sells largest amounts
- **Wholesaler:** Possibility of cutting
- **Retailer:** Spread in different countries
- **Consumer:** Graves quality dependent on country, removed when not able to find drugs
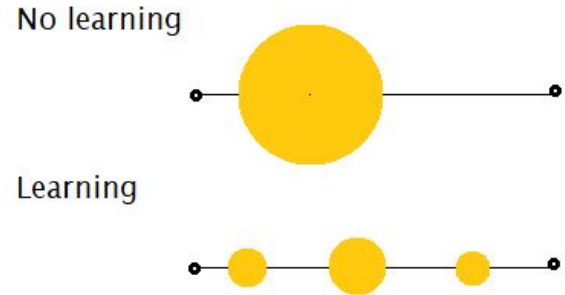
Simulation - Process

Algorithm 1: Model schedule, based on [10]

```
1  foreach tick do
2  |    Agent: Pay living cost & removal of bankrupt nodes
3  |    Country: Spawning of new agents
4  |    Shipments: Move one step further
5  |    Orders: Move one step further
6  |    Agent (consumer): Receive income
7  |    Agent: Choose new suppliers and clients
8  |    Suppliers: Receive orders AND send shipment to client
   |      Consumer: Consumes
9  |    Clients: Send order to supplier
   |      Producer: Create a shipment for himself
10 end
```

Simulation - keeping stocked

- Security stock vs current stock
- Standard learning function:
  requiredStock = λ * calculatedRequiredStock + (1 - λ) * requiredStock
- For each quality different learning
- Learning function applied in:
  - Sending orders, to progressively build a chain of supplies

No learning

Learning

Simulation - sizes

- Prevent blockade at wholesalers

Vermeulen et al. 2018

Layer (ScType)	Min shipment	Max shipment
1. Producer (P)	10	100
2. International (I)	50	500
3. Wholesale (W)	10	100
4. Retail (R)	1	10
5. Consumer (C)	-	-

Vermeulen, I., van der Leest, W., & Dirksen, V. (2018). Doorvoer van cocaïne handel via Nederland. Zoetermeer: Dienst Landelijke Informatieorganisatie.

Simulation - deriving prices

- Divide by 800

Supply chain stage	Price per kg	Price in simulation per kg
Production & refining	$ 800	1
Import (Mexico)	$ 2,147	≈ 2.5
Export	$ 34,700	≈ 43
Wholesale & retail (U.S.)	$ 120,000	≈ 150 (country dependent)

Simulation - data

- EMCDDA (European monitoring centre for drugs and drug addiction)
- Mean cocaine purity->
- Determines quality per country

Country	Study	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005
Austria	AT-1	45.93	33.37	31.6	26.05	28.07	27.52	27.3	27.6	32.1	32.6	32.3	38.4
Belgium	BE-1	68.86	78.2	64.2	57.61	59.16	56.1	55.1	51.3	61.4	65.5	:	:
Bulgaria	BG-1	47.5	47.7	35.8	30.5	24.8	21.9	27.2	24	25	23	36	35
Croatia	HR-1	52.8	47.3	39.1	34.8	29.6	27	28.8	22.7	29	32	37	32
Cyprus	:	:	:	:	:	:	:	:	:	:	:	:	:
Czech Republic	CZ-1	:	39.1	25.9	33.02	36.9	45.04	27.9	33.1	43.5	49.1	40.18	55.9
Denmark	DK-1	55	37	30	29	24	22	24	18	23	22	22	27
Estonia	EE-1	46.4	35	39	41	46	33	36	38	42.9	43.9	34	38.6
Finland	FI-1	49	33	27	42	32	30	29	35	28.2	42	51	:
France	FR-1	58.3	55.2	51.9	55.7	49	45	45.8	29	32.1	53.2	52.3	54.3
Germany	DE-1	74.1	:	:	:	:	:	:	:	:	:	24.6	34.2
Greece	GR-1	75	72	51.2	75	59	61.1	:	:	:	54.81	50.2	69
Hungary	HU-1	53.4	50	40	44	41	50	22	23	31	32	34	36
Ireland	IE-1	:	43.2	41.9	36.1	:	:	:	11.8	:	:	:	:
Italy	IT-2	66	50	55	59.8	50.2	47	46	46.3	47	43	53	:
Latvia	LV-1	51.64	40	37	30	42	29	36	26	28	25	31	39
Lithuania	LT-1	46.1	44	38	43	38	26	37	37	36	46	46	49.15
Luxembourg	LU-1	44.435	41.63	38.1	41	44.45	46.74	47.9	42.46	52.13	54.65	61.78	51.52
Malta	MT-1	:	15	:	20	15.5	35.5	29.5	19.8	35	:	47	46.3
Netherlands	NL-2	66.8	64	59.1	61.3	58.3	49.2	52.3	48.7	55.4	56.6	52.8	54.3

Simulation - Trusting suppliers

- Trust of **i** in **j**: 0 <= trust <= 1
- S: the arrived shipments
- O: the send orders
- r: tick

$$Trust_{ij}(n) = \sum_{r=6}^{n} S_{ji}(r) / \sum_{r=1}^{n-6} O_{ij}(r)$$

- Could also be used for quality and price

Simulation - Legal vs Illegal

- Create a difference for the Illegal supply chain
- Looking at two social concepts
  - Trust
  - Risk

Simulation - Trust

- Limited visibility for agents in illegal supply chain

$$\rho = max(\alpha, (1 - min(1, \frac{abs(y_j - y_i)}{h * \beta}))) \qquad (2)$$

- ρ : probability to add agent to possible agents
- $\alpha = 0.1$: minimum probability
- $\beta = 0.5$: probability multiplier
- $h = 50$: grid height
- y_i: y-position of agent i

Simulation - Risk

- Legal: can always send shipments
- Illegal: can send shipments with a 40% probability

Results

Simulation Demo

- Demo about emergence

Supply chain emergence

- Based on the micro rules,
- a supply chain should emerge

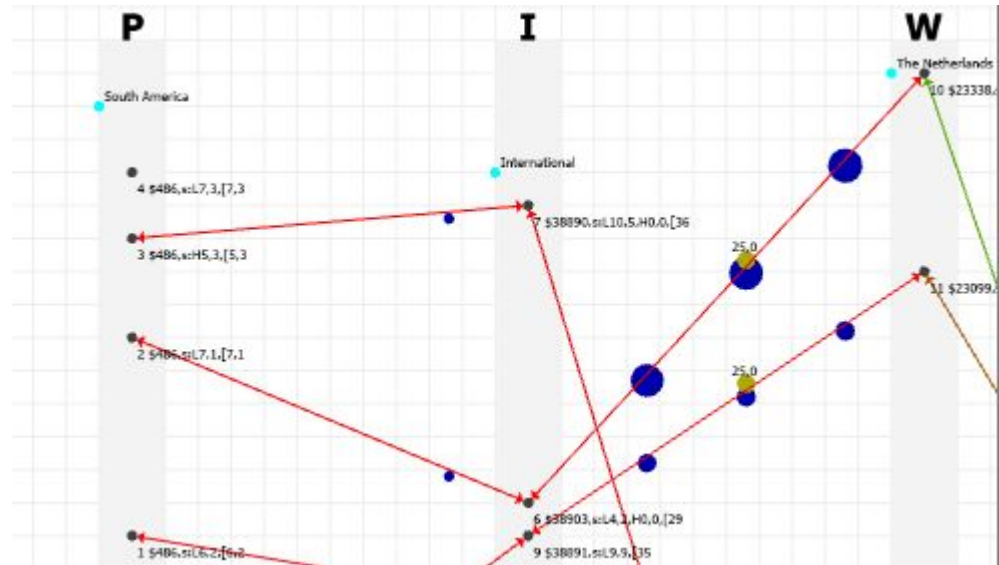# Supply chain emergence - Tick 11

- Sending orders to suppliers
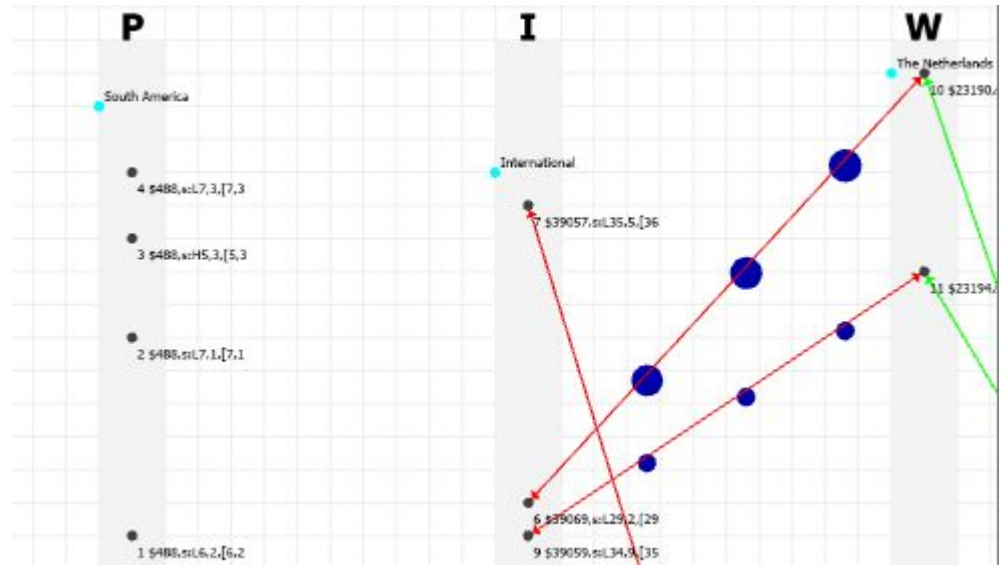
Supply chain emergence - Tick 12
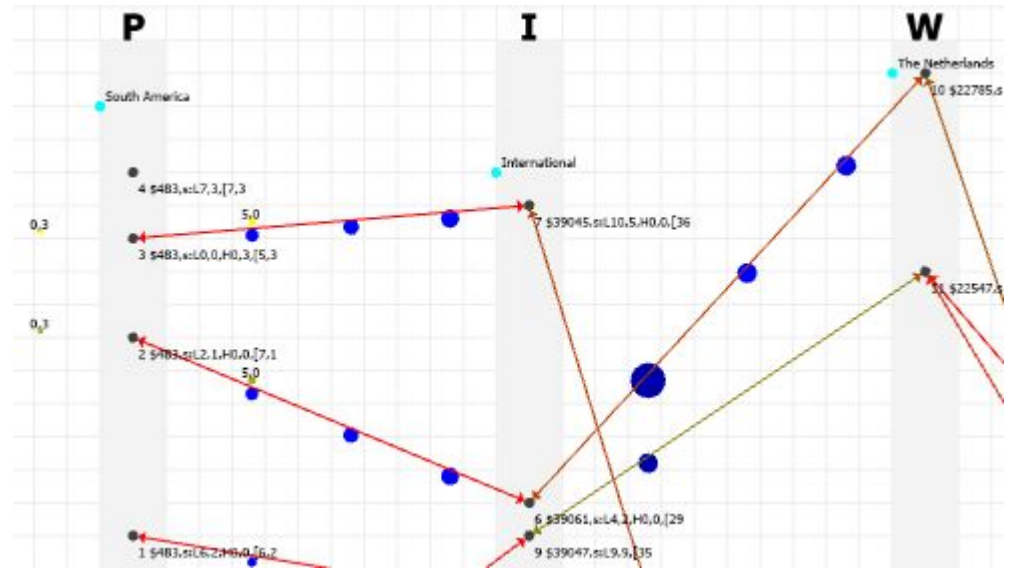
- Sending shipments to clients
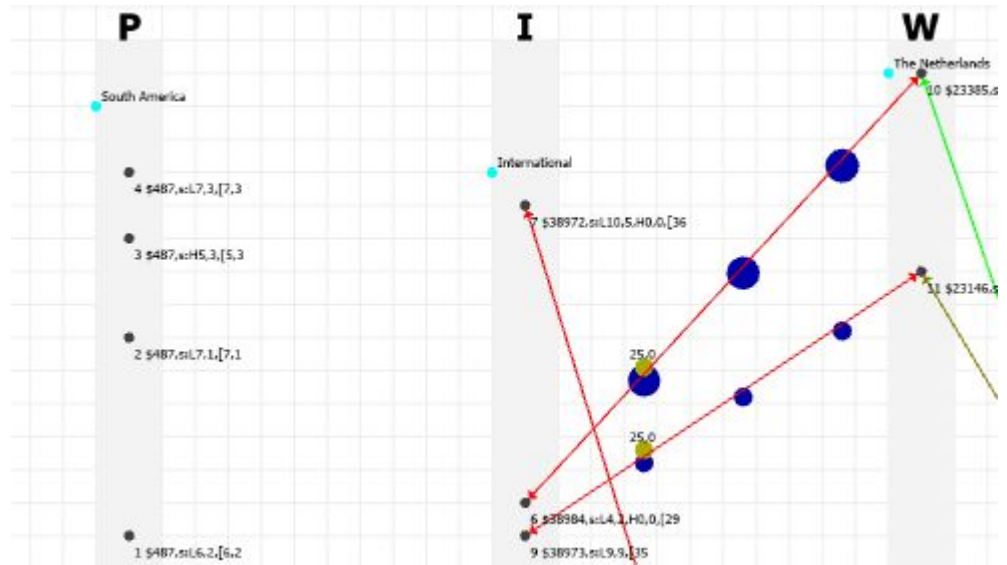
Supply chain emergence - Tick 13

- Stock is empty so find new suppliers

Supply chain emergence - Tick 16

- Orders arrive at producers
- Producers send shipments
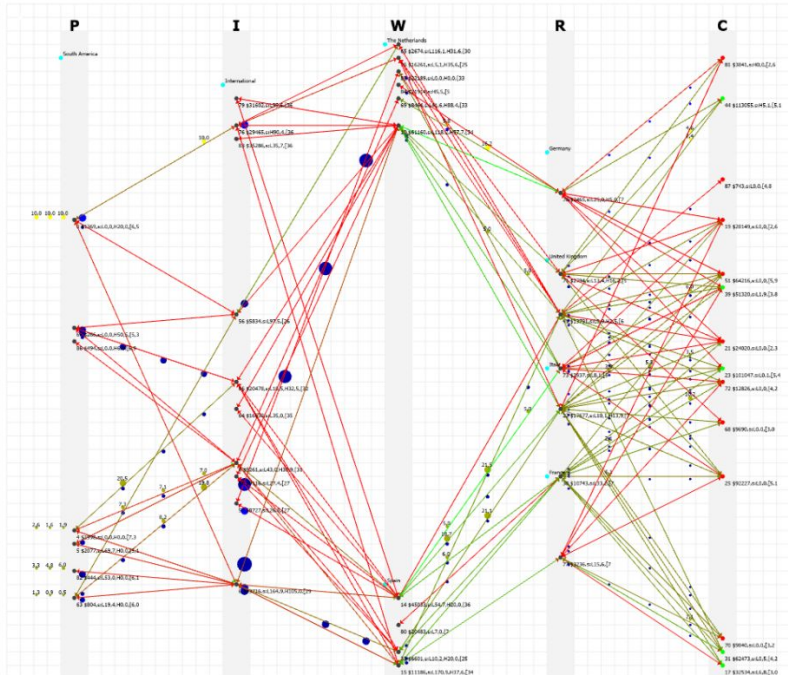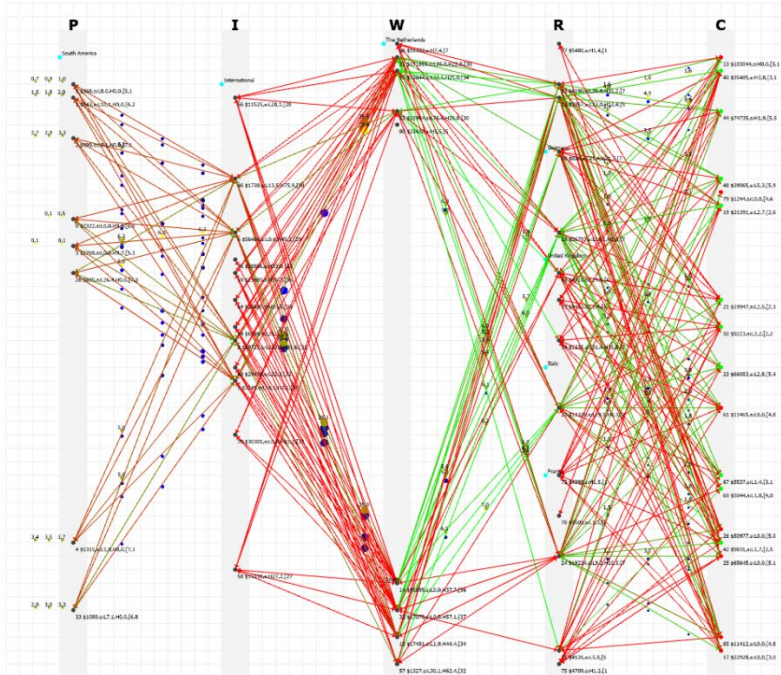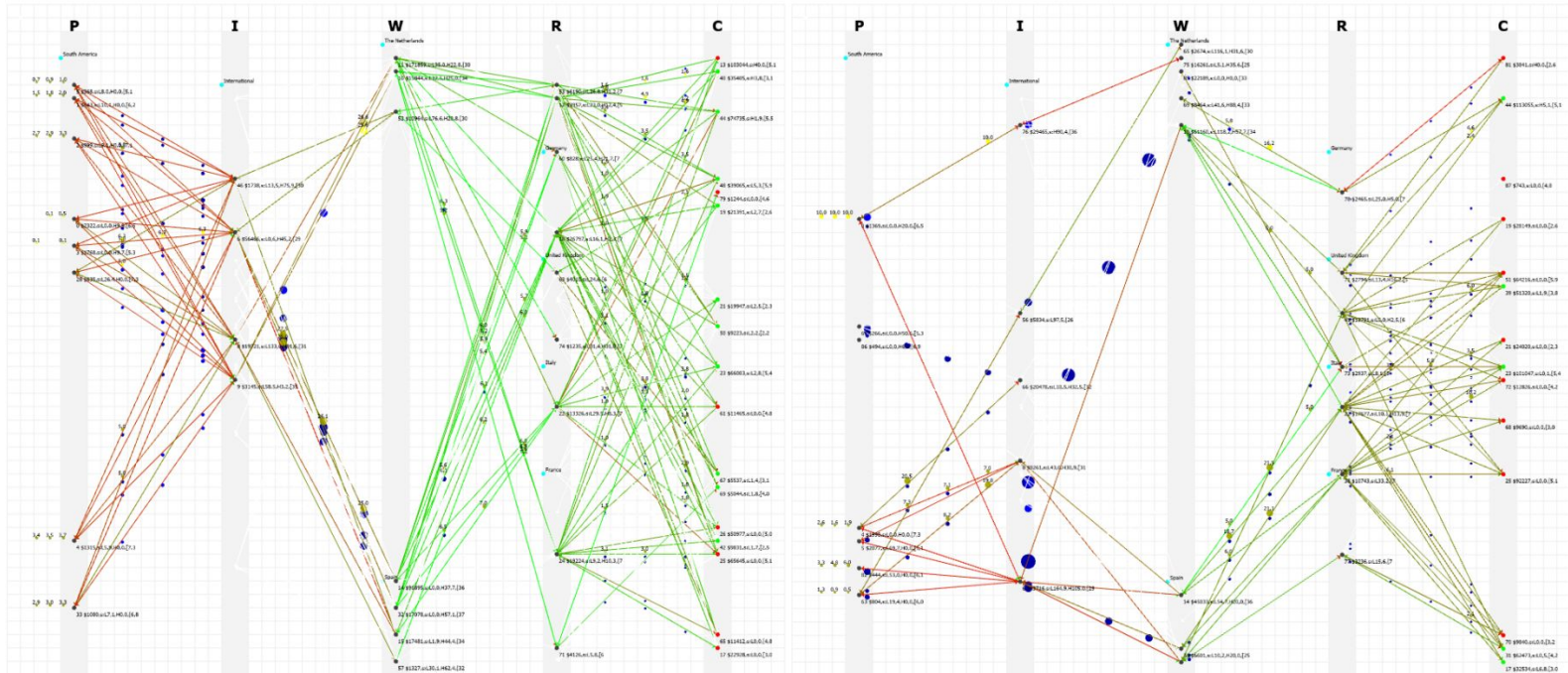- Producers start production

Legal vs Illegal

- Analyzing the outcome of a few runs
- Expectation
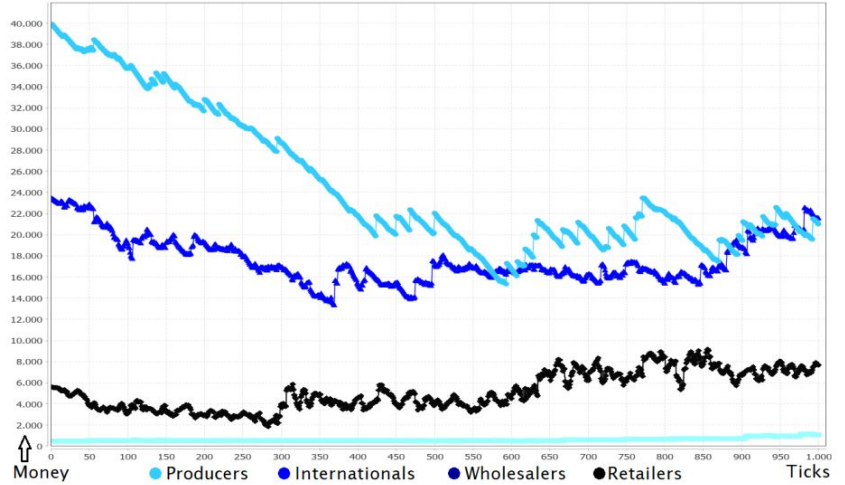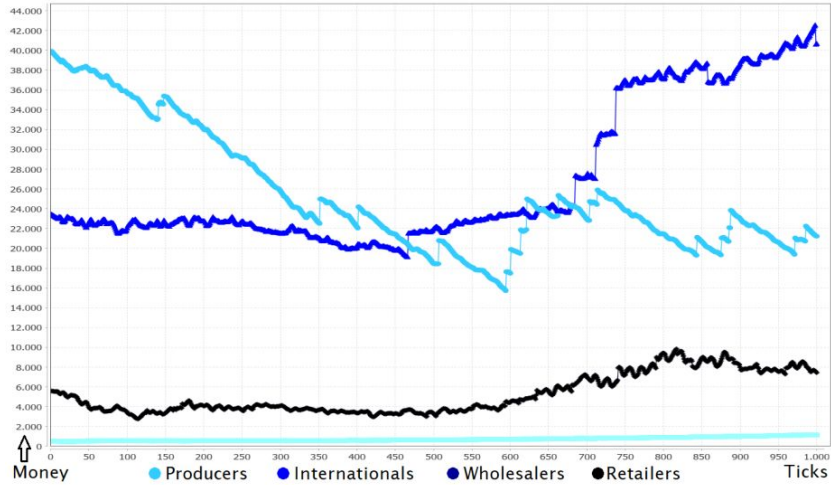 - Illegal has more local supply lines
  - Illegal is less efficient

Legal vs Illegal - Full View

Legal vs Illegal - Only Active Agents

Average Money Plot

Differences Legal and Illegal based on sim

Legal SC	Illegal SC
○ Generally a higher trust level	○ Generally a lower trust level
○ Retailers are spread through all countries	○ Not all countries have retailers
○ Trade routes are spread out	○ Trade routes seem to bundle more
○ More efficient thus it can satisfy more consumers	○ Less efficient thus it can satisfy less consumers
○ Few goods are lost because of agent removal	○ Some goods are lost because of agent removal

Table 1. Summary comparison between the legal and illegal SC

Discussion

Future Work

- What would happen if criminals in the simulation were modeled as individuals instead of syndicates?
- How would the cocaine trafficking market with a supply push behave?
- What happens when agents can adjust pricing themselves and start to compete?
- What would the effect of police interventions be on the cocaine supply chain?
- How do the criminals use the legal trade for their cocaine trafficking?
- How would the chain behave with dynamic quality?

Discussion and conclusion

- The difference in trust and risk leads to the changes
- The illegal SC seems to reproduce real world trends

- There is still much to do!

The end

- Thank you!

- Questions?

Extra slide 1 : transportation types

Transportation types

- Truck, car, public transport, plane (UK)

- FTL (10 - 60 kg, XL > 60 kg)
- Grouping: combination of different drugs/suppliers/buyers (10 - 60 kg, XL > 60 kg)
- Cash-and-carrytransit: payment upfront (1 - 15 kg)
- Mierenhandel: ant-trade (< 0.5 kg)

Vermeulen, I., van der Leest, W., & Dirksen, V. (2018). Doorvoer van cocaïne handel via Nederland. Zoetermeer: Dienst Landelijke Informatieorganisatie.

Extra slide 2 : support roles

Illegal: Drug Quality Testers, Cross-border smugglers, Transport runners, Stash house managers, Money Launders

Grey zone: Information Communications Technology, Real Estate Brokers, Lawyers, Bankers, Logistics service providers

Basu, G. (2013). The role of transnational smuggling operations in illicit supply chains. *Journal of Transportation Security*, *6*(4), 315-328.