



Overcoming Inconvenience:

How Society can Incentivize Individual Recycling Behavior,
An Agent Based Model



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Which ones are recyclable?

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The answer is...

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Yes



No



No



- 8 million metric tons of plastic enter the ocean every year. The weight of nearly 90 aircraft carriers.¹
- 70 percent in the U.S. were sold in and shipped to Chinese processors in 2017.²



- Rahbar and Ramayah, 2013. Applied psychological Theory of Planned Behavior
Recycling driven by intention and norms.³
- Tucker and Smith, 1999. Neighbors and Social Circle as prime influencers.⁴
- Van Liere and Dunlap, 1980. Ideological Divide.⁵

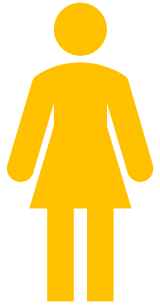


Why Agent Based Models?

- The individual as central unit of analysis
- Identify causal factors as they emerge
- Directly observe the decision-making processes of individuals and groups
- Lack of availability of real-world data



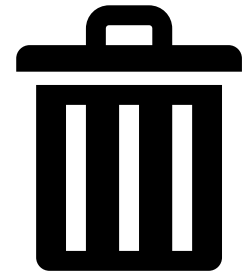
Entities



Individual Agents



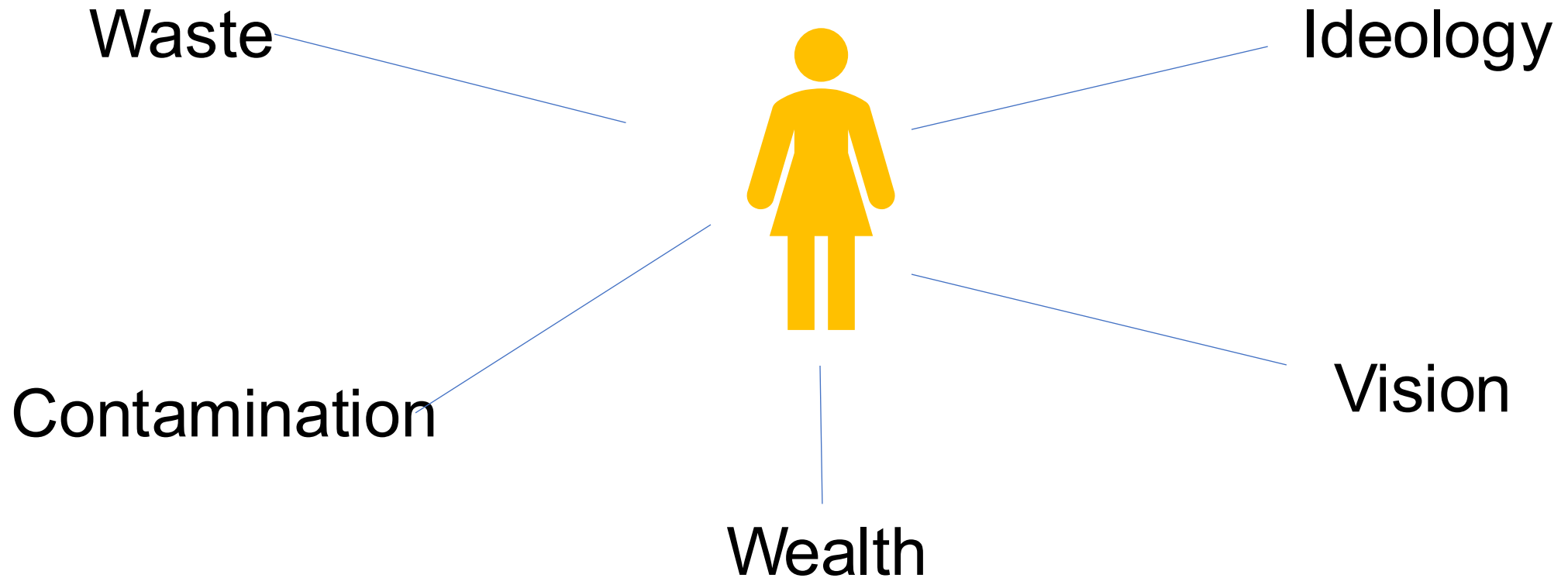
Recycling Bins



Trash Bins



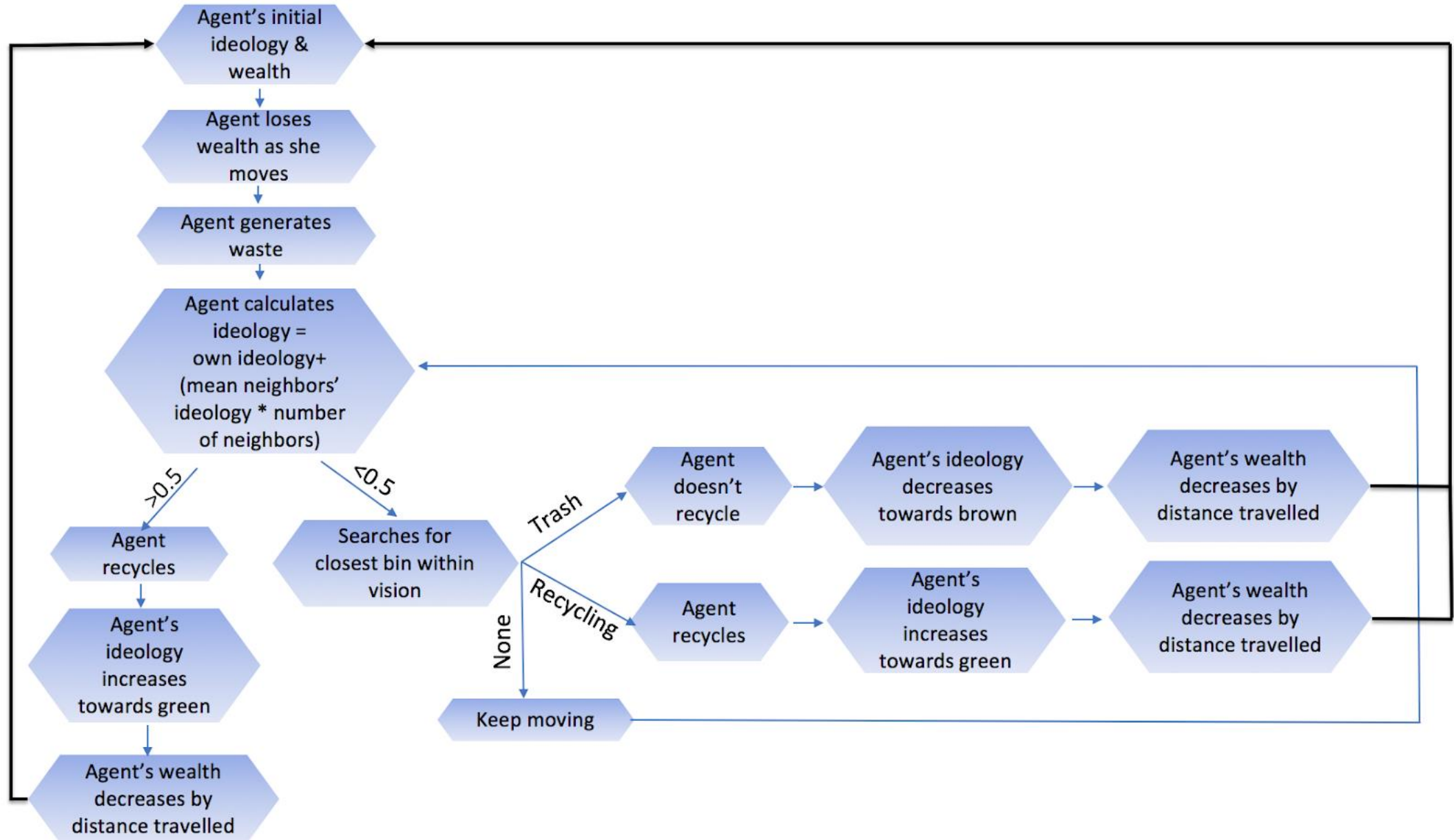
Agent Attributes





Model Architecture

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Results



Initial Conditions

- Agents **50**
- Trash bins **4**
- Recycling bins **4**
- Vision **1**
- Initial Wealth **10**

Output

- Even number of turtles by behavior type
- Normally distributed ideology
- Stable low contamination levels



Scenario 1- Increase Recycle Bins

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Initial Conditions

- Agents **50**
- Trash bins **4**
- Recycling bins **7**
- Vision **1**
- Initial Wealth **10**

Output

- More recycling agents
- Ideology skewed negatively
- Contamination consistently decreasing



Scenario 2- Location of Bins

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Initial Conditions

- Agents **50**
- Trash bins **4**
- Recycling bins **7**
- Vision **1**
- Initial Wealth **10**
- Recycling Bins clustered

Output

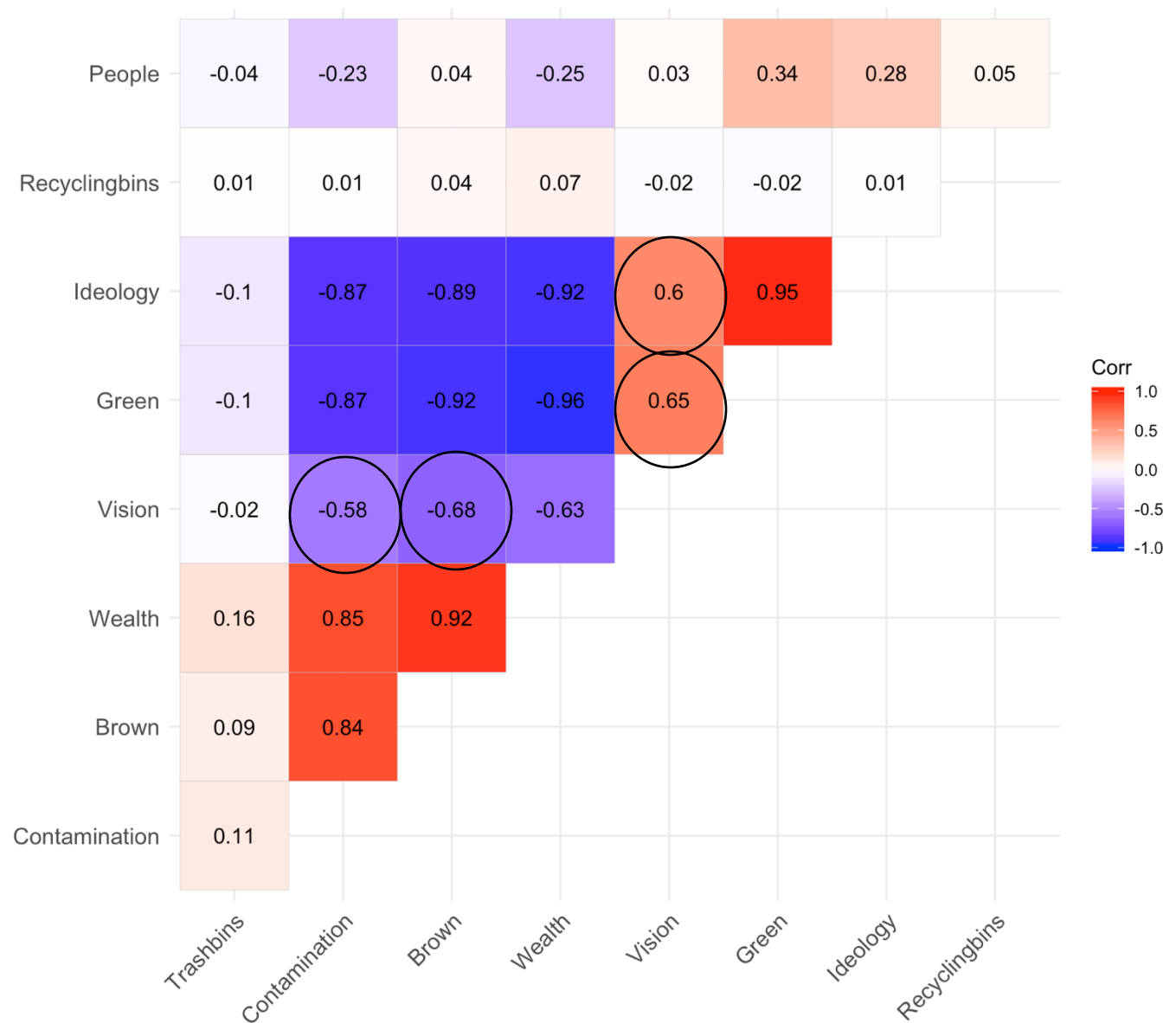
- More recycling agents, yet smaller effect relative to Scenario 1
- Ideology centered around mean
- Contamination consistently decreasing



Sensitivity Analysis



Correlation Plot





Regression Outputs

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VARIABLES	(1) Recycling Agents	(2) Agent Ideology
wealth	-14.43*** (0.224)	-0.545*** (0.0122)
vision	4.944*** (0.789)	0.0576 (0.0507)
recyclingbins	1.067*** (0.230)	0.0672*** (0.0118)
Constant	-12.47*** (1.137)	-0.643*** (0.0560)
Observations	1,000	1,000
R-squared	0.924	0.860

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1



Policy Implications

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1. Assuming individuals possess equal knowledge, more recycling bins encourage recycling behavior and increase ideology
2. The location of bins matters. The more evenly disperse they are, the better
3. Wealth is negatively correlated with recycling. Agents need more incentives.

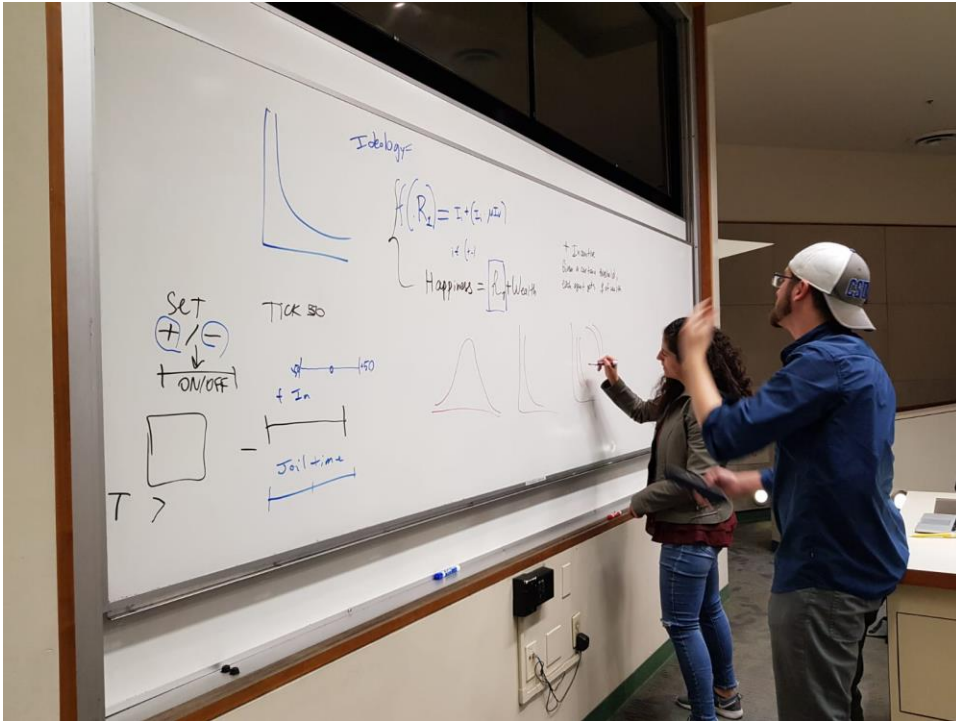


1. Case Specific Model
2. Economic Incentive
3. Add socio-economic data (e.g. education)
4. Long Term Behavior



Thank you

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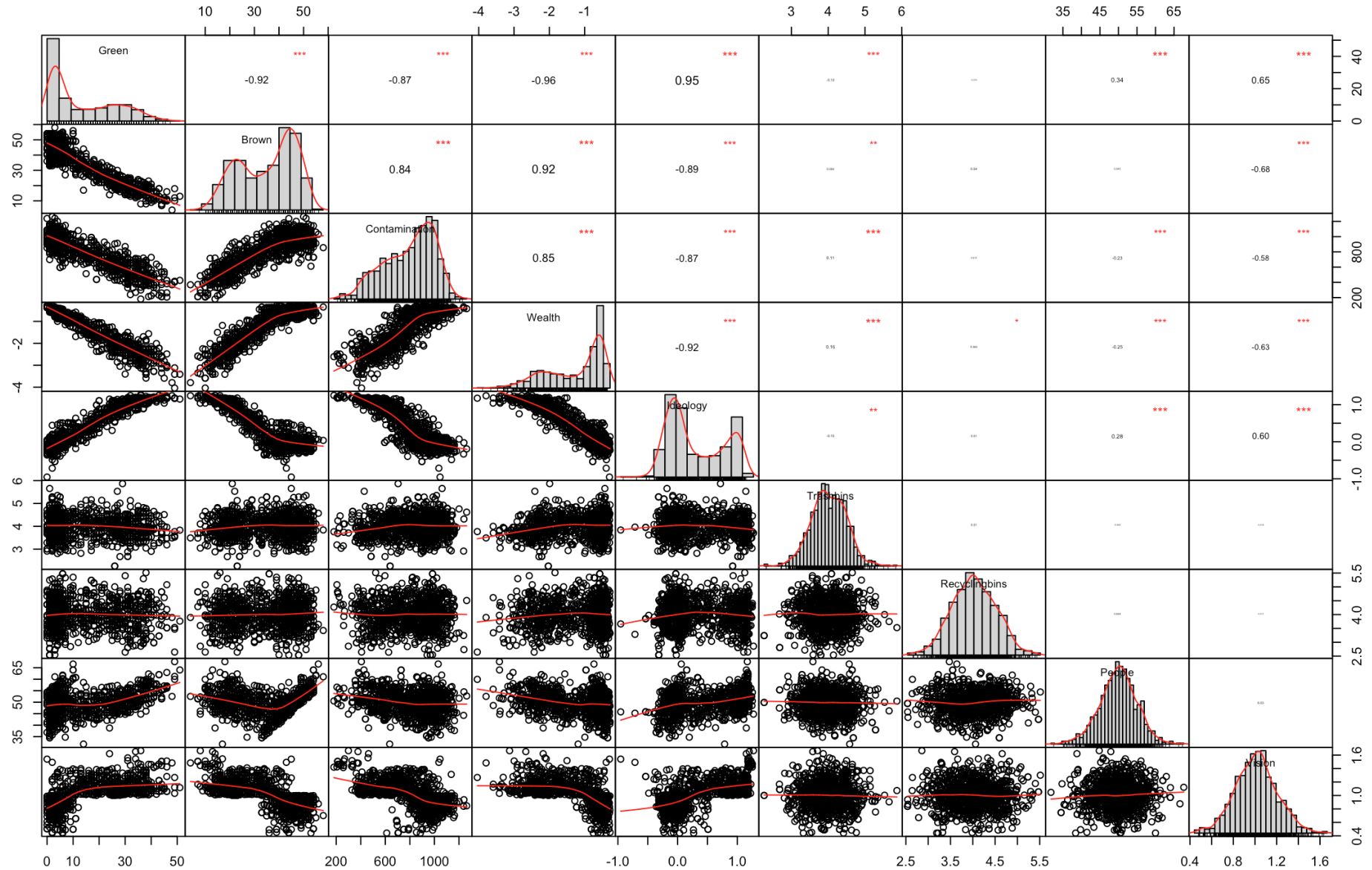


Appendix



Correlation Plot

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Additional Sources

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1. <https://oceanservice.noaa.gov/hazards/marinedebris/plastics-in-the-ocean.html>
2. <https://www.theguardian.com/global-development/2018/oct/05/huge-rise-us-plastic-waste-shipments-to-poor-countries-china-ban-thailand-malaysia-vietnam>
3. Ramayah and Rahbar, 2013. Greening the environment through recycling: an empirical study.
4. Tucker and Smith, 1999. Simulating Household Waste Management Behavior
<http://jasss.soc.surrey.ac.uk/2/3/3.html>
5. Van Liere, Kent D., and Dunlap, Riley E. 1980. "The Social Bases of Environmental Concern: A Review of Hypotheses, Explanations and Empirical Evidence."