Endogenous Evolution of Preferences and Complex Economic Dynamics

Section: Simulating Consumption Network Dynamics

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Content

- Discussion on Consumption Theory and Conspicuous Consumption
- Theoretical Classification of Agents
- Presenting Model
- ABM Results
- Estimation via VARgranger, Transfer Entropy and Wavelet non-stationary time-evolving correlation

Discussion on Consumption Theory and Conspicuous Consumption

- Motivation:

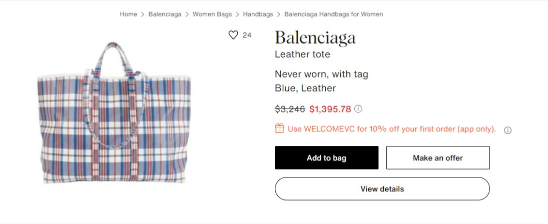
It is widely believed that preferences are static and exogenously determined in standard economics. Bowles, in his paper (1998), while criticizing the conventional understanding of preference formation, argues that standard economics follows the Hobbesian mushrooms metaphor , and poses a fundamental question: "... most economists have not asked how we come to want and value the things we do"

The idea of endogenously defined dynamic preference has been known since Veblen.

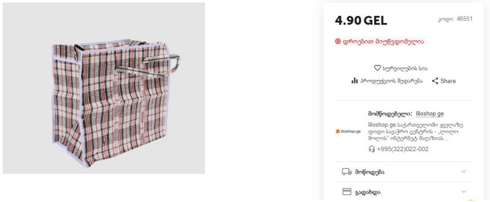
Motivation

- The phenomenon of conspicuous consumption and its influence on consumer behavior, in general, has become more prevalent since the development of modern technologies.
- Furthermore, the degree of demonstration substantially changed after the emergence of social media: the demonstration effect became omnipresent. The emergence of social media created a new pattern of social existence, which defines "existence" through what an individual consumes socially in social media.
- The co-existence of social media platforms and active use of Big Data broadly characterizes this (Post)modern era of social existence. Specifically, business enterprises actively use data generated by Social Media platforms and design their marketing strategies based on this. Co-existence of Social Media Platforms and Big Data instruments created the foundation of a new regime of consumption behavior, which is distinct from all other periods.

Extra Motivation: Balenciaga Marketing Strategy



Extra Motivation: Balenciaga Marketing Strategy (2)



Previous Works

One of the important aspects of endogenous preferences is its linkage to wealth and income distribution. For instance, Parker and Semmler (2021) propose a model with heterogeneous households, where they use social interaction theory based on the works of Veblen (1899) and Drechsler-Grau and Schmid (2014). In this model, household A is a consumption-smoother, it has income capital assets and labor income, both of which are stochastic. A fraction of consumers, household A, follows an optimal consumption behavior in the sense that it can plan consumption-saving actions long-term. Household B's consumption is more spontaneous, and consumption-saving behavior is formed through adaptation and social emulation. In the present paper, the analysis provided by Parker and Semmler (2021) is extended and the aspects of the dynamic network effect are incorporated.

Previous Works

Another important aspect refers to current policies to decarbonize the economies. Mittnik et al (2014) developed a macro model that analyzes how preferences change over time (as a baseline model) and then introduced certain decision variables which may influence the evolution (trajectory) of preferences. The decision variables are the carbon taxes and also subsidies for low-carbon-intensive industries. Within the current paper we extend this model via the inclusion of micro-network effects in the macro dynamic model.

Theory of the Leisure Class, Veblen

- Absence of static maximization of utility
- Preferences are determined socially.
- Individuals emulate consumption patterns of those who are located on higher hierarchy in income distribution ladder
- "The result is that the members of each stratum accept as their ideal of decency the scheme of life in vogue in the next higher stratum, and bend their energies to live up to that ideal", p.84

Modern Inrepretation and Macroeconomic Implications

- Consumption is driven by the relative rather than the absolute level of income
- Individuals are paying attention to consumption of "reference groups"
- The social nature of preferences lead economic agents to overconsume and undersave (Alvarez-Cuadrado and Van Long, 2011)
- Disconnection of household consumption from household income, which is causes by "the propensity of households to emulate contemporary standards of consumption established by others", Setterfield and Kim (2016)
- Since 1980s stagnant wages was compensated through debt-driven consumption With the deregulated financial markets, consumers were able to borrow more to Keep up With Joneses By maintaining household consumption at high level through debt-driven consumption, low level of unemployment maintained (even though wages stagnated)

Marx I

"A house may be large or small; as long as the neighboring houses are likewise small, it satisfies all social requirement for a residence. But let there arise next to the little house a palace, and the little house shrinks to a hut. The little house now makes it clear that its inmate has no social position at all to maintain, or but a very insignificant one; and however high it may shoot up in the course of civilization, if the neighboring palace rises in equal or even in greater measure, the occupant of the relatively little house will always find himself more uncomfortable, more dissatisfied, more cramped within his four walls."

Wage Labour and Capital, 1847

Marx II,

"Our wants and pleasures have their origin in society; we therefore measure them in relation to society; we do not measure them in relation to the objects which serve for their gratification. Since they are of a social nature, they are of a relative nature."

Wage Labour and Capital, 1847

Previous Works Using Network Theory (1)

- Mayerhoffer M.D, Schulz J., A Network Approach to Consumption, 2022
- upward-looking consumption model at the micro level
- perception networks
- Avoids Problem of “excess smoothness” and “excess sensitivity”.

Previous Works Using Network Theory (2)

- Emprical work:
- Giacomo De Giorgi, Anders Frederiksen, Luigi Pistaferri, 2020
- Focuses on Consumption Network Effects
- Uses administrative panel data on Danish Households
- Constructs measure of consumption based on tax records
- Identifies peer groups based on workplace

The Key Justification for Standard Models

- Standard models produces empirically observed macro results
- Heterodox Criticism: completely different microfoundations can lead to the aggregate macro results observed empirically (such as the downward-sloping demand curve and Engel's Law).
- Work of Anwar shaikh (2016) ==> Simulations for Neoclassical Homogeneous, Neoclassical Heterogeneous, Whimsical (Beckerian Irrational Agents) and Imitate-Innovate agents (based on the work of Dosi) can lead to the same results

Veblen-Bourdieu Type of Agent

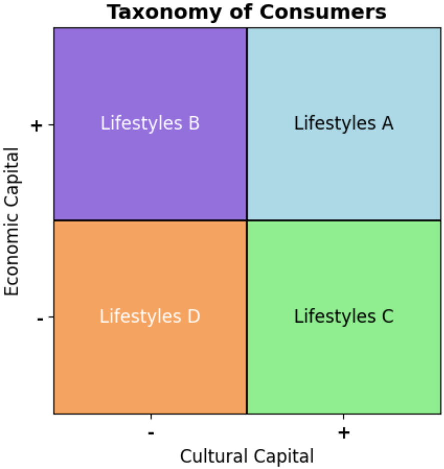


Figure 1: This graph represents the distribution of lifestyles based on economic and cultural capital. Source: Modified Version of Rosengren, 1995

Veblen-Bourdieu Type of Agent in Row Stochastic Matrix

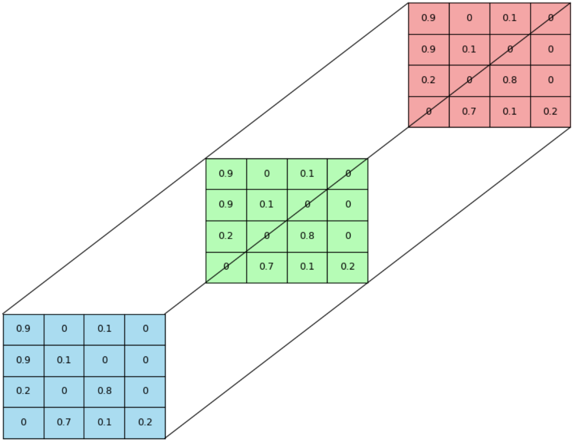


Figure 2: Dynamics of Consumption Matrix

Simulation: Weight Set-up

This framework classifies consumers along two axes: cultural capital and economic capital. This creates a 2 by 2 matrix with elements of the matrix elements: a) high economic capital, high cultural capital b) high economic capital, low cultural capital c) low economic capital, high cultural capital d) low economic capital, and low social capital.

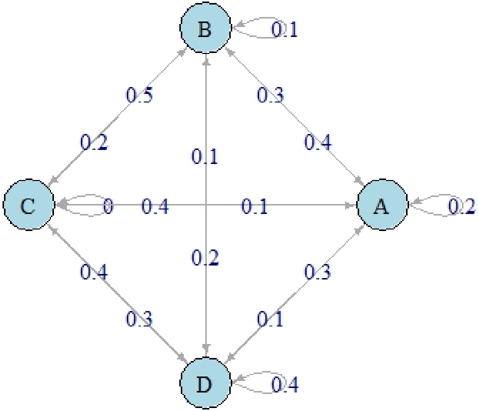
Simulation Set-up

We assume that, group A with high social capital and economic capital pays little to no attention what other groups consume, therefore, the first element of the matrix is 1. Group B with high economic capital, low cultural capital, will emulate itself (its peers from group B) and group A. The group C will be less interested in imitating other groups, since it has high social capital. Group D with low economic capital, and low social capital will be more prone imitate group B and lesser degree A. According to this formulation, major driver of the consumption behavior associated with Veblen effect will be group B and A. Group A's consumption pattern is determined by process of learning and not emulation. However, since B emulates A, consumption patterns of A has an overall effect on total consumption. B emulates A, and also learns from itself, and by doing so increases overall consumption since D emulates B.

Modeling Strategy

- We use simple model to capture both effects of diffusion and homophily.
- As a basis, we use DeGroot model (1974)
- $W(i,j) =$ amount of attention i assigs consumption of j
- Matrix W is row stochastic matrix: $\sum_{j=1}^{n} W_{ij} = 1$ for all i
- Matrix W can be understood as an adjacency matrix $E = \{(i,j) \in V \times V : T(i,j) >= 0\}$

Simple Network with 4 nodes



How the vector of consumption expenditure will evolve?

$$c_i(t) = \sum_{j=1}^{n} W_{ij} c_j(t-1) \text{ for all } i \in N \text{ and } t > 0$$

By iterating t times, we get:

$$c(t) = W^t c(0)$$

Depending on the structure of the Matrix W, there could be convergence or periodicity (cyclicality) in the dynamics of the vector c.

Diffusion Process in Consumption Networks

The element of networks can be included in dynamic equations. e.g.:

$$\frac{dc_i}{dt} = \alpha \sum_{j \in N_i} (c_j - c_i)$$

c_i In this case is consumption expenditure of node i, while c_j is the consumption expenditure of i-th neighbor. Given the difference in consumption expenditures $(c_j - c_i)$ governs change in consumption expenditure node i. In the formula α is the diffusion constant.

Diffusion Process in Consumption Networks

This equation further can be extended by inclusion of row stochastic matrix W, which contains weights on how much attention agent i pays to consumption decision of agent j. The diagonal element a_{ii} of matrix W is the learning weight, or the consumption which is not determined by social process.

$$\frac{dc_i}{dt} = \alpha \sum_{j \in N_i} (c_j - c_i) w_{ij}$$

Different Versions of Model - time-varying diffusion coefficient

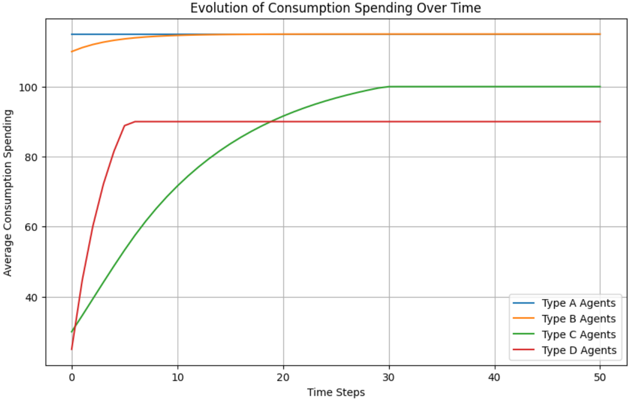
It is possible to make the α time-varying, which would capture, different coefficient for different time-periods. For instance, adoption of smartphones, usage of internet and social media would make diffusion process faster.

$$\frac{dc_i}{dt} = \alpha(t) \sum_{j \in N_i} (c_j - c_i) w_{ij}$$

$$\alpha(t) = k \cdot t$$

- α is the function of time, where k is proxy for growth rate of ICT
- It should be noted, that k can be understood as regime switching parameter: specifically, k will be higher when there is technological breakthrough in information technologies and people are becoming more aware what other people consume.

Simulation Results: Simple Deterministic Process



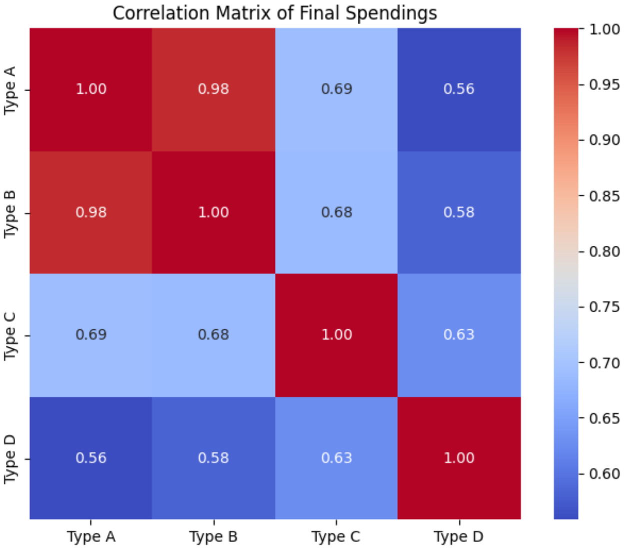
Algorithm for Monte Carlo Simulation of Agent Spending Behavior with Correlation Analysis

Algorithm 1 Monte Carlo Simulation of Agent Spending Behavior with Correlation Analysis

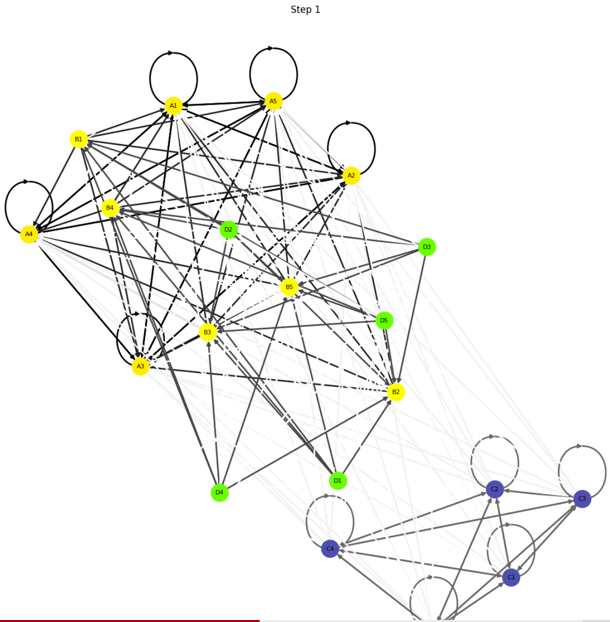
Require: N: Number of agents
Require: S: Set of agent types $\{A, B, C, D\}$
Require: W_{base}: Base influence weight matrix, a 4×4 matrix
Require: σ_W: Standard deviation for stochasticity in W
Require: σ_{spending}: Standard deviation for stochastic spending fluctuations
Require: T: Number of time steps
Require: α: Diffusion constant
Require: R: Number of Monte Carlo runs
Ensure: Correlation matrix of final average spendings across agent types

```
Initialize final_spendings as a zero matrix of size |S| × R
for r = 1 to R do
    Initialize agents with types in S, initial spendings, and constraints
    Randomize weight matrix W using W_base and σ_W
    for t = 1 to T do
        for all agents a do
            Calculate Δ_spending for a using W, α, and σ_spending
            Update a.spending with Δ_spending, respecting spending constraints
        end for
    end for
    for all agent types s in S do
        Compute final average spending for s and store in final_spendings[s, r]
    end for
end for
```

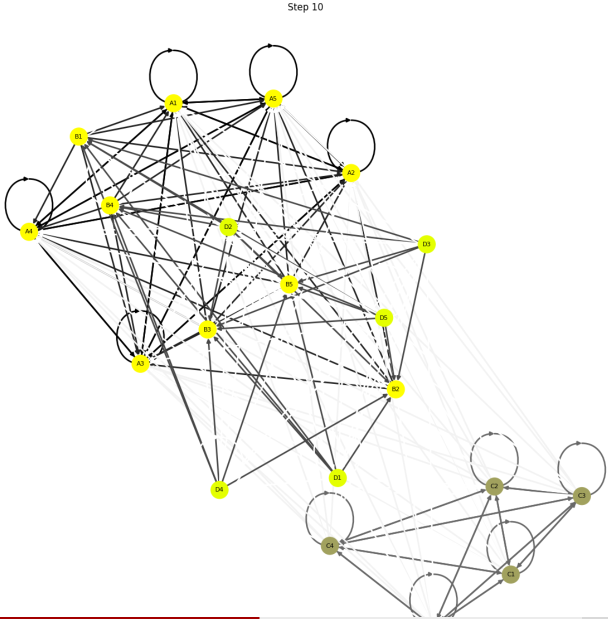
Simulation Results - Correlation in Spending



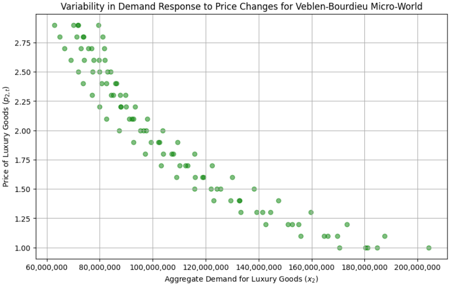
Initial Consumption Level Represented by Colors



Final Consumption Levels Represented by Colors



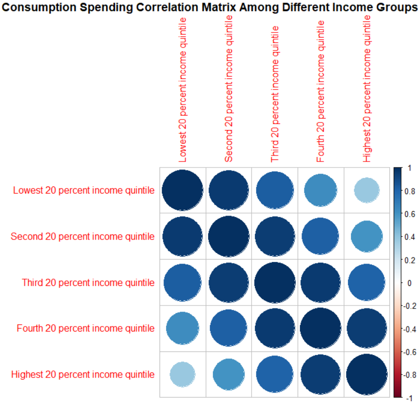
Reproduced Demand Downward-Sloping Demand Curve



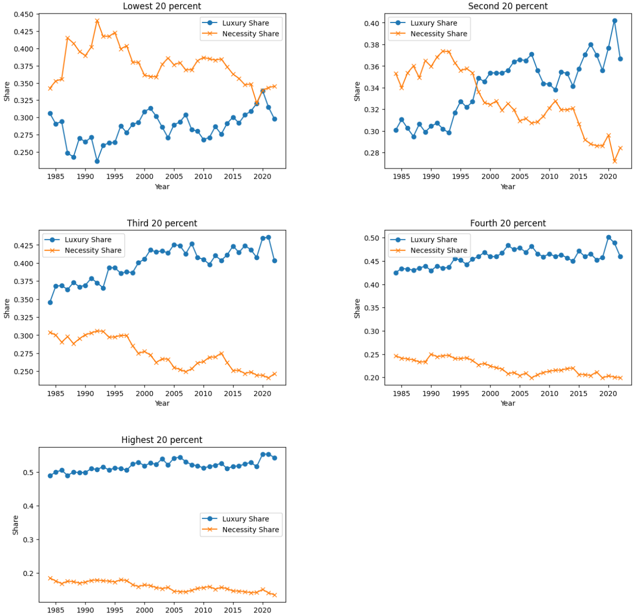
Data: The Consumer Expenditure Surveys (from BLS)

Category	Lowest 20%	Second 20%	Third 20%	Fourth 20%	Highest 20%	Vis. Score	Lux.
Alc. bev.	0.899	0.884	0.951	0.931	0.963	0.61	Lux.
Apparel	6.250	5.990	5.913	5.841	6.076	0.71	Indet.
Cash cont.	2.351	2.888	2.915	2.974	3.943	0.34	Lux.
Education	2.703	1.131	1.069	1.288	2.282	0.56	Indet.
Entertain.	4.384	4.424	4.645	4.974	5.386	0.66	Lux.
Food home	10.937	9.803	8.340	7.414	5.798	0.51	Nec.
Food away	5.216	5.210	5.516	5.671	5.547	0.62	Indet.
Gasoline	4.634	4.922	4.956	4.556	3.414	0.39	Indet.

Consumption Spending Correlation Matrix Among Different Income Groups



Consumption Expenditure Trends



Transfer Entropy: Consumption Expendtiture Shares

Quantile	Direction	TE	Eff. TE	Std.Err.	p-value	sig
First to Second	$X \rightarrow Y$	0.1360	0.0900	0.0442	0.0333	*
	$Y \rightarrow X$	0.0150	0.0000	0.0469	0.5000	
Second to Third	$X \rightarrow Y$	0.1369	0.0736	0.0684	0.1267	
	$Y \rightarrow X$	0.0813	0.0000	0.0623	0.2667	
Third to Fourth	$X \rightarrow Y$	0.1281	0.0449	0.0650	0.1233	
	$Y \rightarrow X$	0.2465	0.1765	0.0639	0.0100	*
Fourth to Fifth	$X \rightarrow Y$	0.1281	0.0371	0.0534	0.0767	.
	$Y \rightarrow X$	0.2465	0.1639	0.0662	0.0167	*

Vehicle Consumption By Quintiles: Granger Causality Test

Lowest20

Equation	Excluded	Prob $>$ chi2
Lowest20	Second20	0.000
Lowest20	Third20	0.000
Lowest20	Fourth 20	0.006
Lowest20	Highest20	0.055
Lowest20	ALL	0.000

Second20

Equation	Excluded	Prob $>$ chi2
Second20	Lowest20	0.509
Second20	Third20	0.746
Second20	Fourth20	0.167
Second20	Highest20	0.043
Second20	ALL	0.018

Vehicle Consumption By Quintiles: Granger Causality Test

Third20

Equation	Excluded	Prob >chi2
Third20	Lowest20	0.043
Third20	Second20	0.376
Third20	Fourth20	0.454
Third20	Highest20	0.013
Third20	ALL	0.000

Fourth20

Equation	Excluded	Prob > chi2
Fourth20	Lowest20	0.000
Fourth20	Second20	0.229
Fourth20	Third20	0.000
Fourth20	Highest20	0.003
Fourth20	All	0.000

Vehicle Consumption By Quintiles: Granger Causality Test

Highest20

Equation Excluded	Prob > chi2
Highest20 Lowest20	0.037
Highest20 Second20	0.120
Highest20 Third20	0.814
Highest20 Fourth20	0.393
Highest20 All	0.150

Granger Causality for Housekeeping supplies by Income Quintiles

Lowest20

Equation	Excluded	Prob > chi2
Lowest20	Second20	0.000
Lowest20	Third20	0.115
Lowest20	Fourth 20	0.002
Lowest20	Highest20	0.424

Second20

Equation	Excluded	Prob > chi2
Second20	Lowest20	0.000
Second20	Third20	0.000
Second20	Fourth20	0.417
Second20	Highest20	0.000

Granger Causality for Housekeeping supplies by Income Quintiles

Third20

Equation	Excluded	Prob >chi2
Third20	Lowest20	0.027
Third20	Second20	0.127
Third20	Fourth20	0.788
Third20	Highest20	0.244

Fourth20

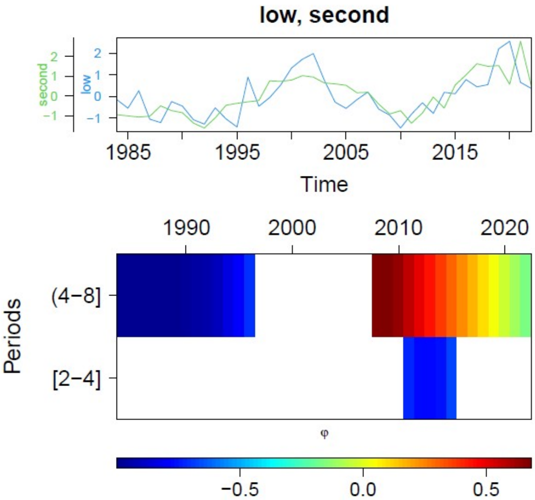
Equation	Excluded	Prob > chi2
Fourth20	Lowest20	0.147
Fourth20	Second20	0.078
Fourth20	Third20	0.177
Fourth20	Highest20	0.673

Granger Causality for Housekeeping supplies by Income Quintiles

Fifth20

Equation	Excluded	Prob $>$ chi2
Highest20	Lowest20	0.119
Highest20	Second20	0.283
Highest20	Third20	0.069
Highest20	Fourth20	0.380

Estimation of Non-stationary Time-evolving Correlation



Estimation of Non-stationary Time-evolving Correlation

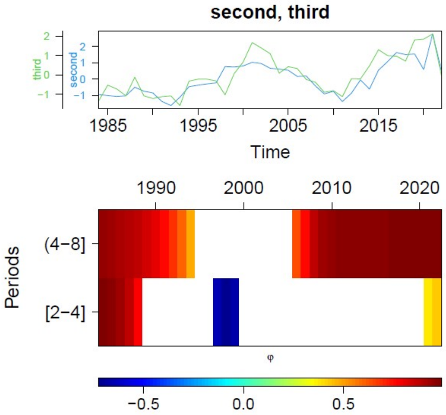


Figure 5: For Vehicles

Estimation of Non-stationary Time-evolving Correlation

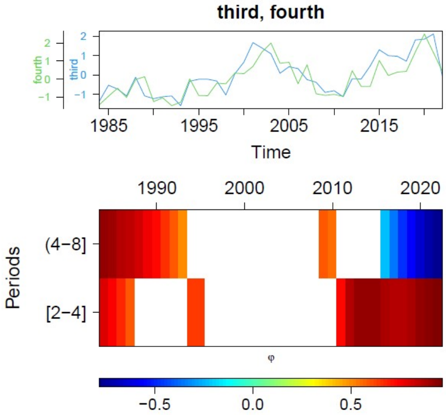


Figure 6: For Vehicles

Estimation of Non-stationary Time-evolving Correlation

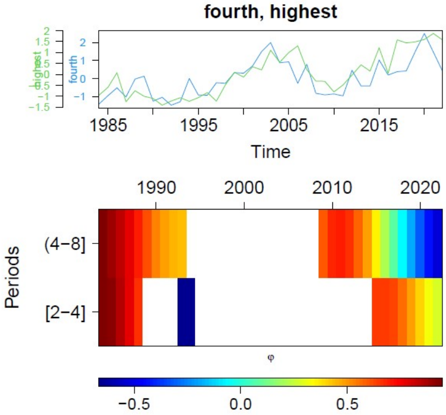


Figure 7: For Vehicles

Conclusion I

- One can re-create empirically observed macro results with more realistic agents.
- Bourdieu-Veblen Agents are more realistic and describe better emulation process in complex social world.
- ABM simulations allow to re-create the observed macro processes
- Granger Causality tests and Transfer Entropy estimation on disaggregated data provides important insights.
- Specifically, consumption expenditure on luxurious goods are mostly upward-looking.
- However, for certain income groups, such as highest income group, we may have opposite tendency, depending on the good.
- Results for time-varying correlation requires further investigation.

Conclusion II

- DeGroot learning and Markov Matrices are actively used information diffusion and Analysis of Influence, but not the analysis of consumption.
- Row stochastic matrices can be useful instrument for modeling Consumption Networks in the Era of Social Media
- The simulated simple models shows that consumption expenditure may be accelerated and decelerated via changing diffusion parameter.
- Making diffusion parameter time-varying could have important implications for the pace of convergence.
- Implications for the Social Determinants of Preference Formation: presented model demonstrates, how the structure of the network and the mentioned parameters accelerate and de-accelerate social emulation process.

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