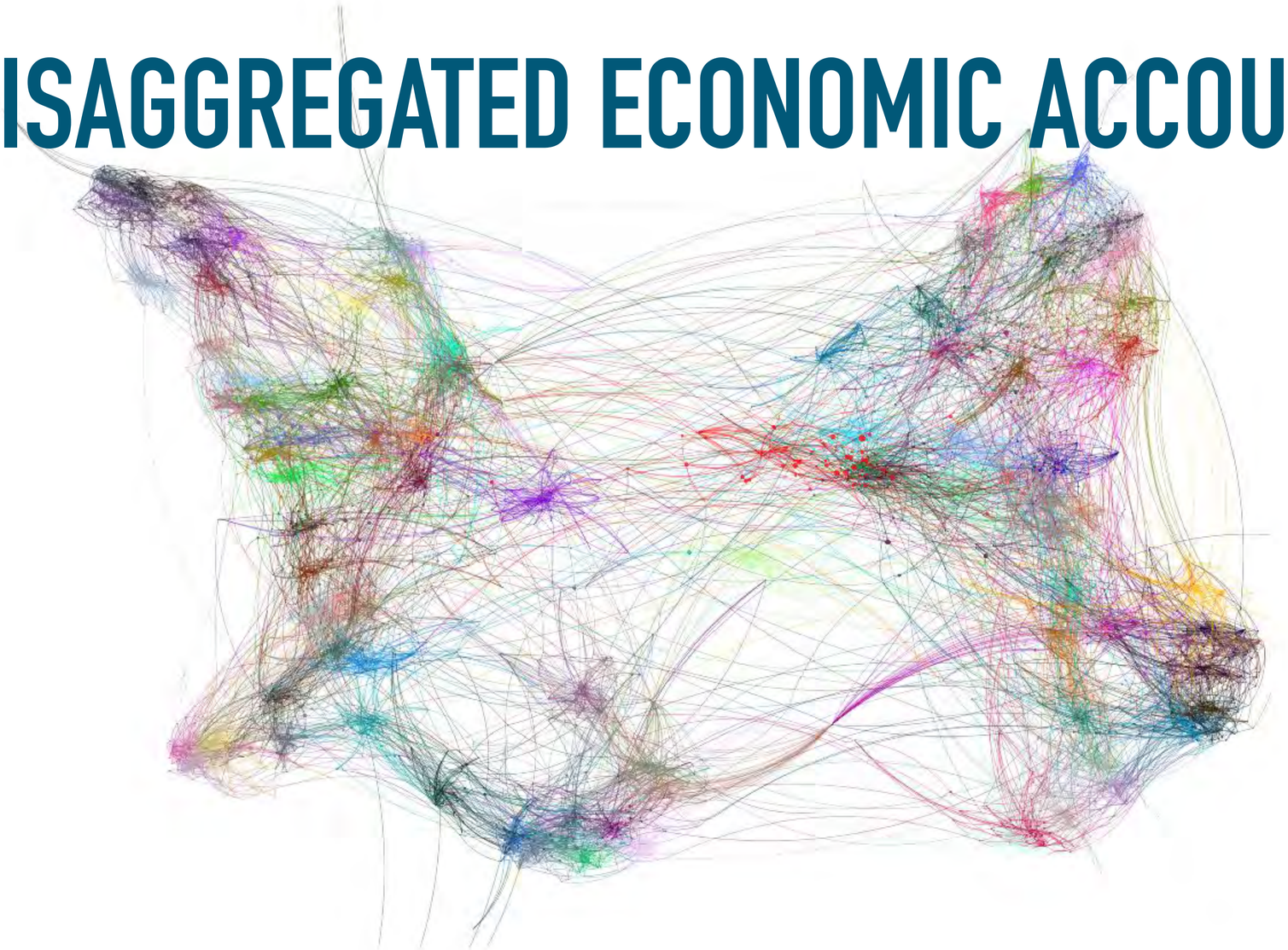
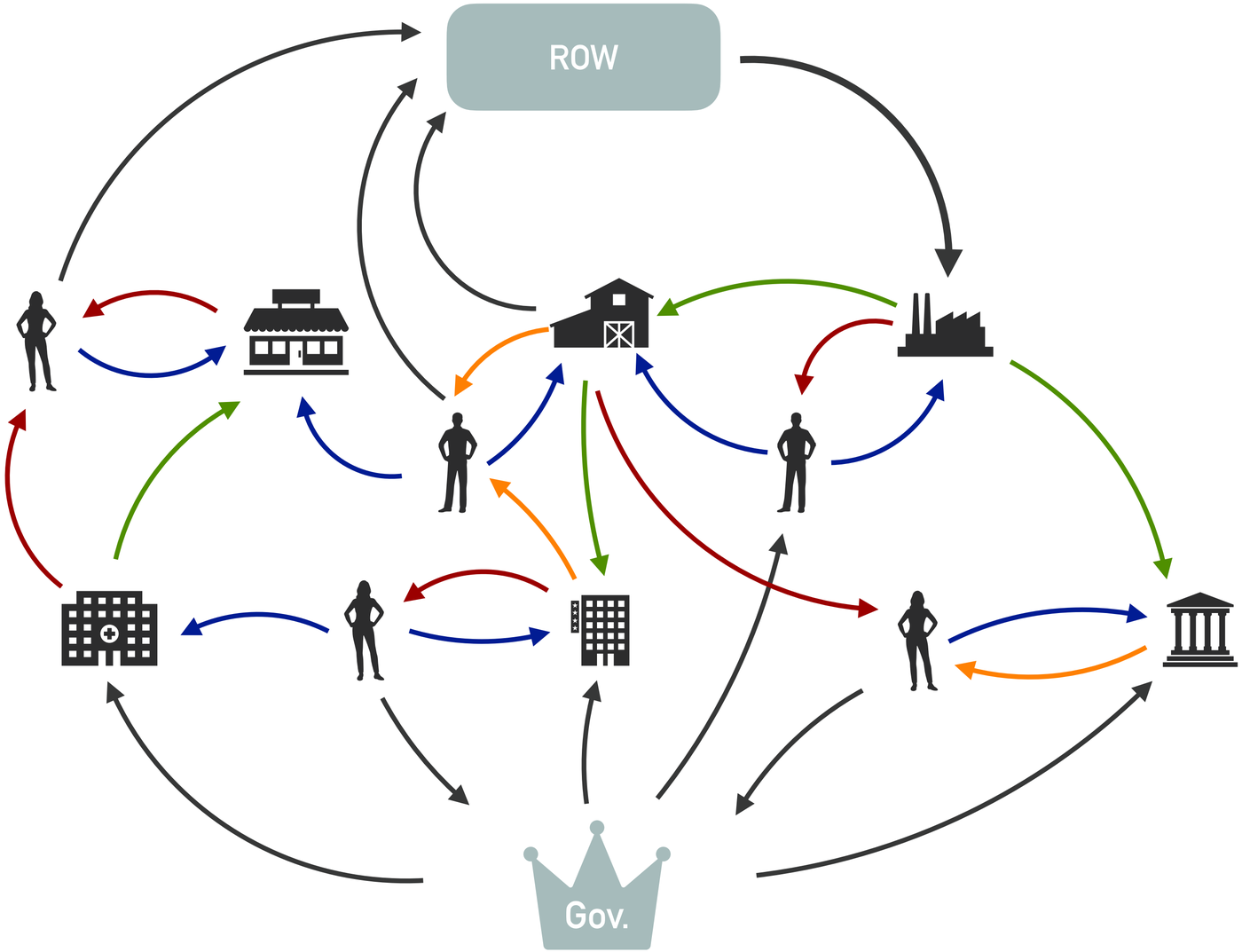
DISAGGREGATED ECONOMIC ACCOUNTS



Asger Andersen, Kilian Huber, Niels Johannesen, Ludwig Straub, Emil Toft Vestergaard

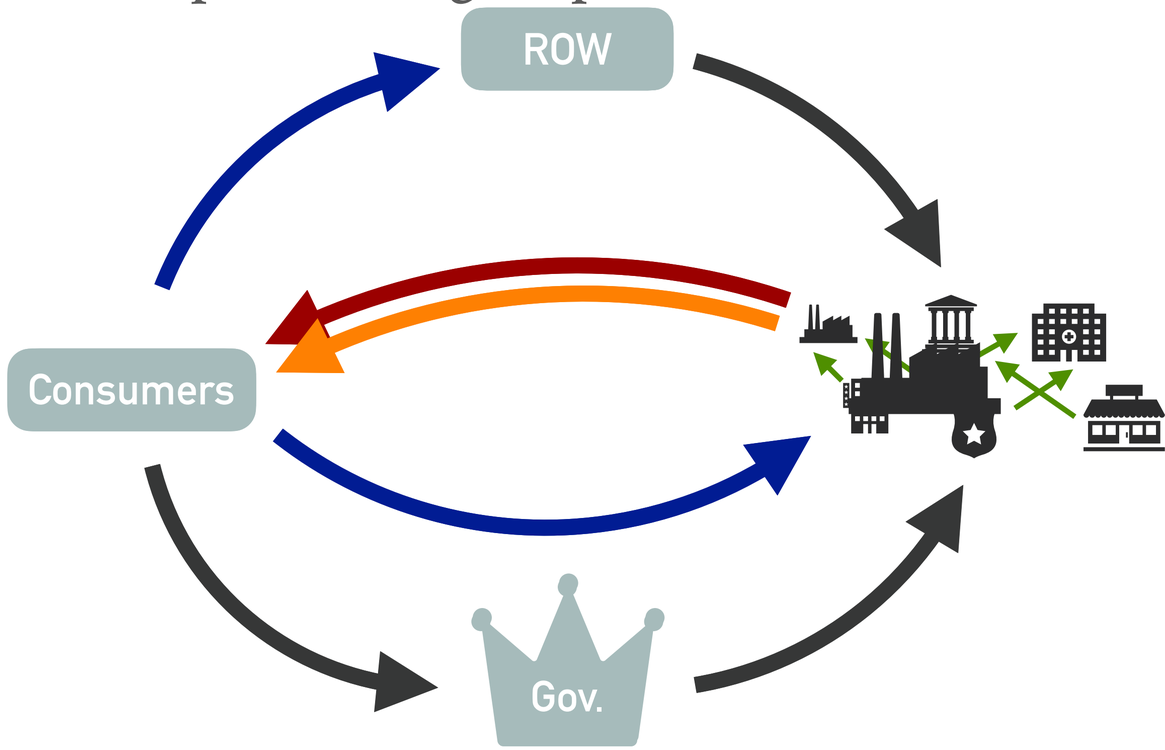
TRACING A SHOCK . . . REQUIRES MEASURING BILATERAL FLOWS



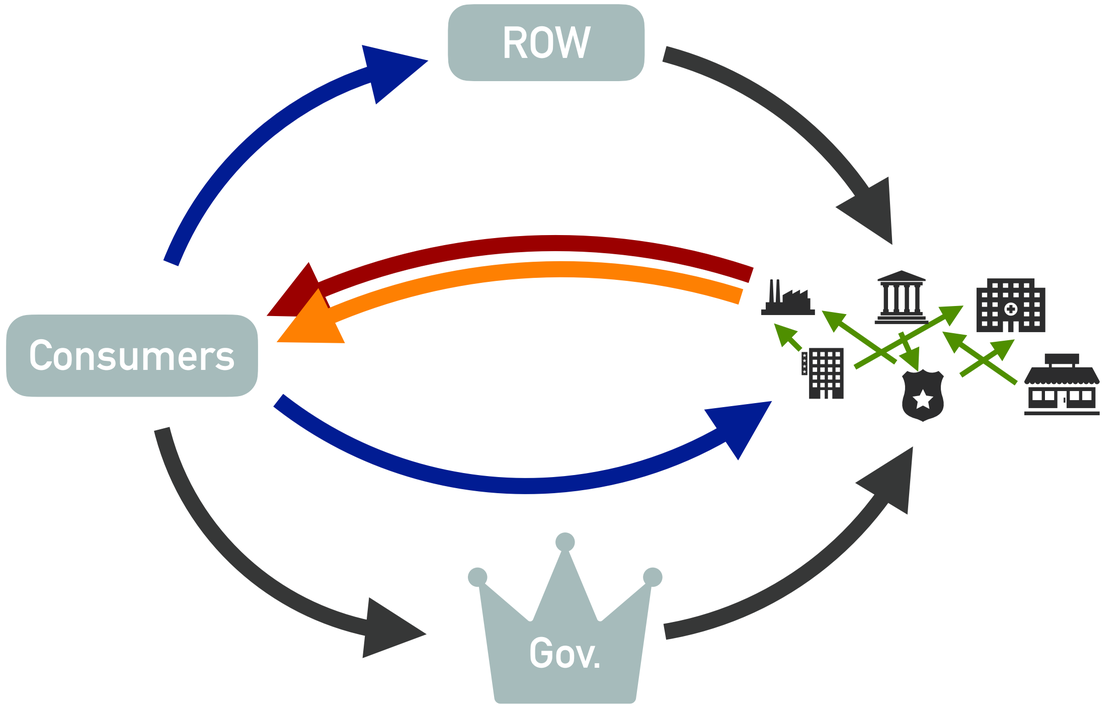
MEASURING FLOWS

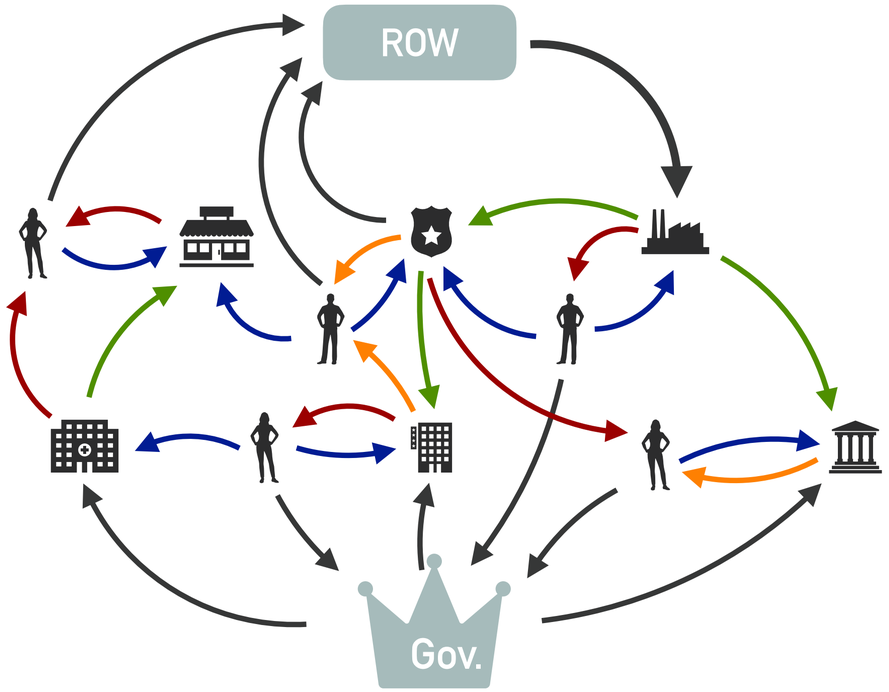
- Standard national accounts measure few bilateral flows
  - First: aggregate circular flow (Kuznets & Stone 1930s)
  - Later: bilateral producer trade (Leontief & Stone 1950s)
  - Difficult to trace shocks across small consumer and producer groups

- Today: disaggregated economic accounts
  - break down full circular flow (36 SNA flows)
  - across small “cells”
  - into bilateral flows adding up to aggregates



IN TERMS OF THE CIRCULAR FLOW





Richard "Stone Age"

- *full circular flow*
- *mostly aggregate flows, except producer trade*

"Digital age"

- *full circular flow*
- *bilateral flows across small cells*
- *sum to national aggregates*

BUILDING ON RECENT CONTRIBUTIONS CREATING DISAGGREGATED DATA

Just a few examples:

- High-frequency (Chetty et al)
- Cross-region and intl. trade (Caliendo et al, Caliendo et al, Costinot & Rodríguez-Clare, Faber & Gaubert, Eckert, Rodríguez-Clare et al, Redding & Turner)
- Regional "social accounting matrices" (Reinert & Roland-Holst, Giesecke & Madden)
- Distribution and inequality (Piketty et al, Smith et al, Mian et al, Paweenawat & Townsend)
- Consumer-producer income flows (Card et al, Adão et al, Monte et al)
- Producer-producer trade (Huneeus, Dhyne et al, Bernard et al)
- Cross-region consumer spending (Davis et al, Agarwal et al, Dunn & Gholizadeh, Allen et al, Miyauchi et al, Batch et al)
- Cross-region MPC variation (Flynn et al)
- Detailed bilateral transactions and incidence of distortions (Atkin et al)
- Estimation of spillovers (Huber, Mian et al, Gabaix & Koijen, Chodorow-Reich et al, Sarto)
- Aggregate relevance (Gabaix, Aladangady et al, Ehrlich et al, Buda et al)

THIS PAPER

- **Measurement**
  - proof of concept in Denmark, 2,700 region x industry cells
  - Key features:
    1. disaggregate all positions of the circular flow of money, facilitating shock tracing
    2. nationally comprehensive, matching national aggregates
    3. satisfying accounting identities within and across cells
- **Facts**
  - how cells are connected, e.g., triangular flows between urban, rural, and foreign regions
  - measure “spending intensity” of a cell: relevance for cells experiencing unemployment
- **Policy**
  - fiscal transfer to cells with high spending intensity raise GDP by more
  - DEA improves “bang for the buck”

MEASUREMENT

THREE STEPS TO MEASUREMENT

1) Define aggregate circular flow

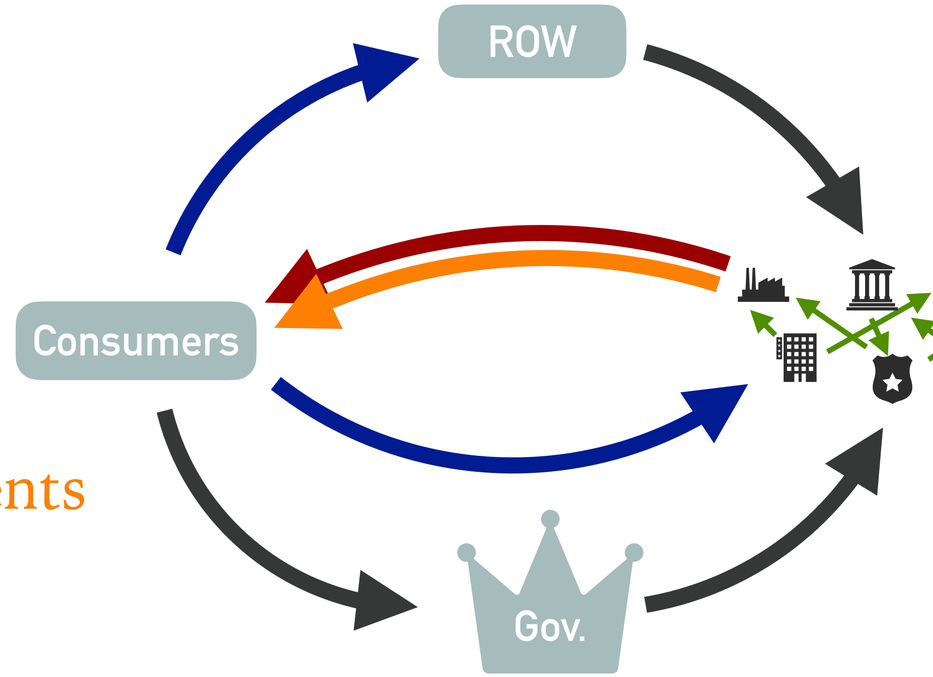
2) Set unit of disaggregation

3) Disaggregate into bilateral flows across cells using micro data

Choices are flexible, we implement one specific proof of concept in Denmark

STEP 1: DEFINE AGGREGATE CIRCULAR FLOW

- All 36 flows in 4 opening SNA in 2018: production, distribution, redistribution, use.
- Across 5 sectors: consumers, producers, government, rest of the world (ROW), capital accumulation
- Examples:
  - domestic & foreign consumer spending
  - intermediate input spending, exports, imports
  - labor compensation, mixed income, dividend payments
  - income taxes, VAT, government spending, etc.



CONSUMER T-TABLE

Outflows			Inflows		
Outflow	Outflow to	Value (bn DKK)	Inflow	Inflow from	Value (bn DKK)
Domestic consumer spending	Producers	771.9	Labor compensation paid by domestic producers	Producers	1132.9
Foreign consumer spending	Rest of the world	81.9	Mixed income from non-corporate producers	Producers	80.7
Consumer product taxes paid	Government	173.2	Surplus of corporate producers to consumers (dividends)	Producers	38.5
Consumer non-product taxes paid	Government	566.4	Surplus of owner-occupied housing to consumers	Producers	83.3
Consumer social contributions paid	Government	181.1	Consumer social benefits received	Government	422.2
Consumer interest paid	Capital accumulation	29.7	Consumer adjustment for pension entitlements received	Government	92.5
Consumer natural resource rents paid	Capital accumulation	3.4	Consumer interest received	Capital accumulation	5.3
Consumer other transfers paid	Capital accumulation	44.8	Consumer pension investment income	Capital accumulation	75.5
Consumer gross saving	Capital accumulation	130.1	Consumer natural resource rents received	Capital accumulation	3.4
			Consumer other transfers received	Capital accumulation	39.2
			Labor compensation paid by foreign producers	Rest of the world	8.9
Total value outflows		1982.4	**Total value inflows**		1982.4

0.15 USD = 1 DKK

STEP 2: UNIT OF DISAGGREGATION

- **2,700 region-by-industry cells** in Denmark
  - 98 municipalities
  - 17 consumer-facing industries: food away from home, groceries, etc.
  - 10 non-consumer facing industries: manufacturing, construction, etc.
  - 4 non-work: retired, students, not in workforce, long-term unemployed
- **Consumer cells:** adults, by region of residence x industry of main job (med. 650)
- **Producer cells:** establishments, by region x main production industry (med. 50)

- Other disaggregations possible

STEP 3: DISAGGREGATE

- Break down each aggregate into bilateral flows across cells
  - how much does a grocery worker from Billund spend on Copenhagen restaurants?
- Combine a range of micro data
  - geo-coded bank transactions; administrative registers on income, taxes and wealth; credit registry; car registrations; firm-to-firm trade; etc.
- 36 matrices with 2,700 rows and/or columns
- 40m data entries (long appendix), national accounts: 10k
- Here: focus on **consumer spending,** overview of rest

DISAGGREGATING CONSUMER SPENDING

- Main data: transactions from Danske Bank
  - 20% of Danish adults have main bank account at Danske
  - representative of population (see paper)
  - cards (45%), transfers and debits (45%), phone payments, cash withdrawals
- Observe consumer industry from salary payments, address from bank records
- Observe store address and MCC for most payments, foreign and abroad
- Cross-walk between MCC and industry codes
- Builds on recent work using cards, phone apps, websites, surveys
  E.g., Agarwal et al, Davis et al, Dunn & Gholizadeh, Flynn et al, Miyauchi et al, Ganong et al

DISAGGREGATING CONSUMER SPENDING

- Three categories not fully observed in bank data

1. Housing
   - Spending on owner-occupied housing: in tax registers
   - Spending on rentals: some rents paid in bank data and rent received in tax registers
2. Financial services
   - Observe financial advice payments in bank data
   - Distribute aggregate interest rate spread in prop. to interest paid in tax registers
3. Vehicles
   - Observe vehicle registrations and some purchases in bank data

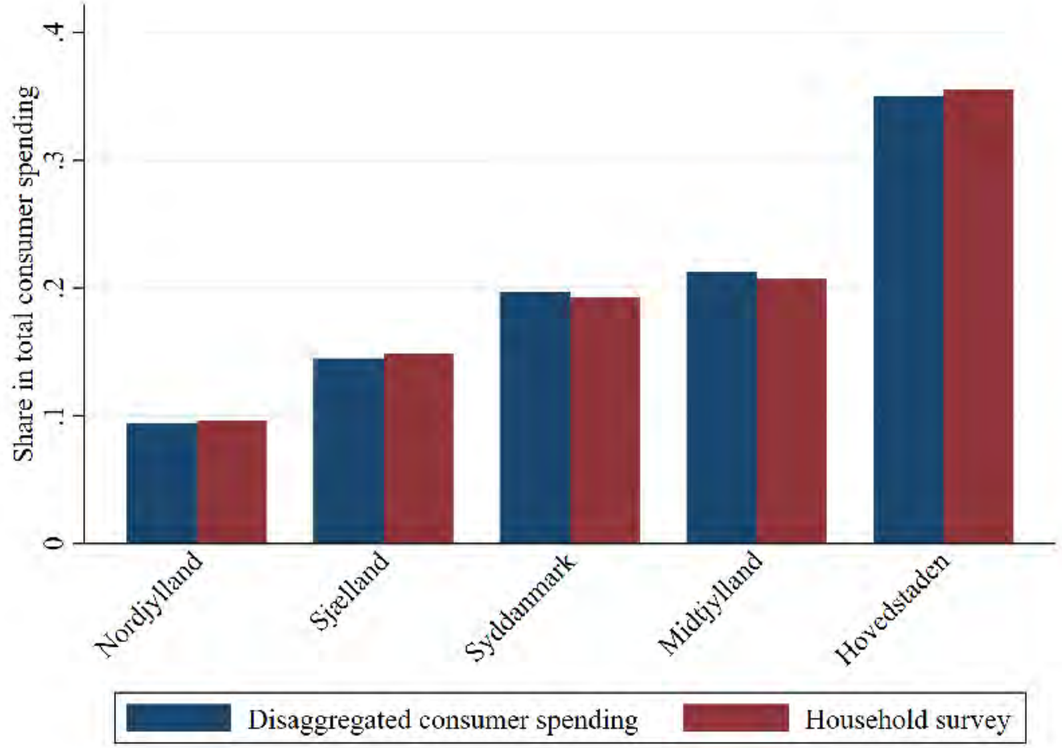
- Finally, scale by ratio of cell-level to observed population

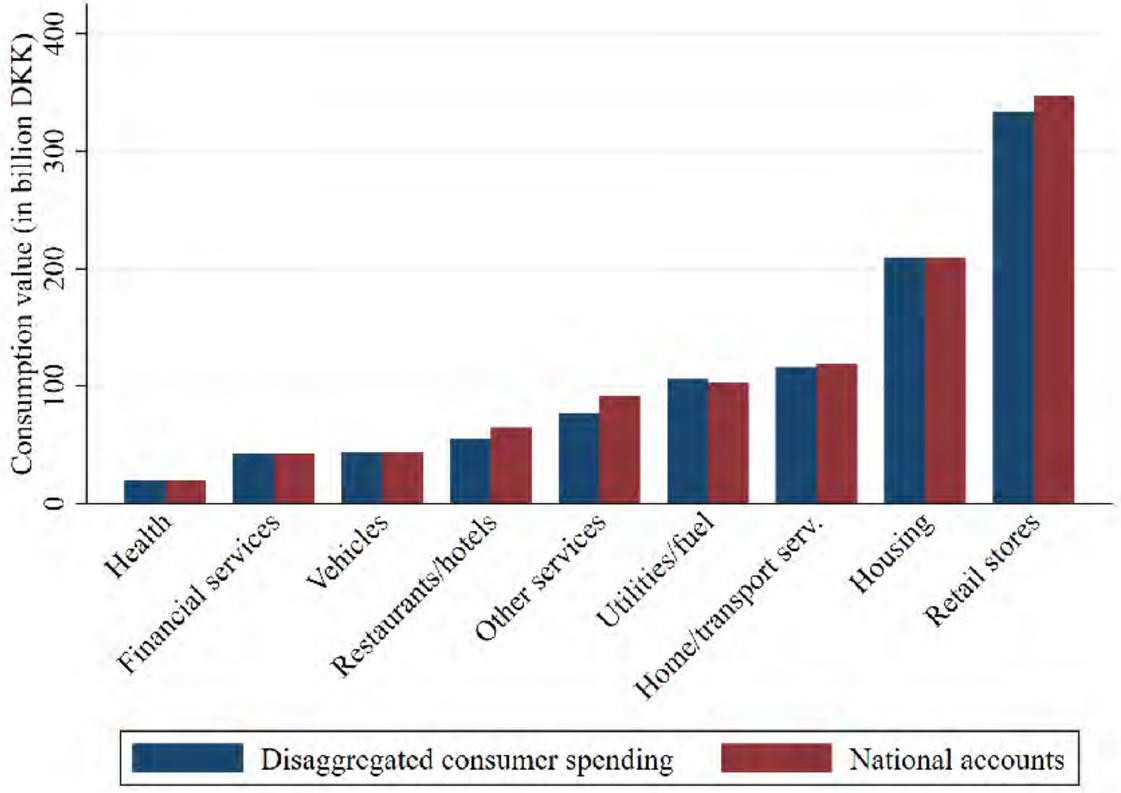
FREQUENTLY ASKED QUESTIONS

- **Cash:** 7% of spending. Observe ATM withdrawals, assume spent like other in-person spending.
- **Measurement of spending consistent with NA IO table**
  - We want the observed producer establishment to be the store providing final good or service.
  - Satisfied for in-store purchases. What about online?
  - Online purchases of **goods**: verified by hand that transactions go to store/distr. center shipping the good.
  - Online purchases of **services**: corrected online payments for in-person services (e.g., movie theaters, entertainment) to follow the geographical distribution of offline spending in the same category.
  - Confirm that for each industry, the regional distribution of consumer sales is close to that of labor income.
  - Similar facts and model results if we focus on in-store spending.
- **Individuals versus households**
  - Could in principle also measure transfers across individuals (e.g., within households)
  - Does not affect today's facts and model conclusions

COMPARISON WITH SURVEY AND NATIONAL ACCOUNTS

Disaggregated spending matches distribution across regions and industries

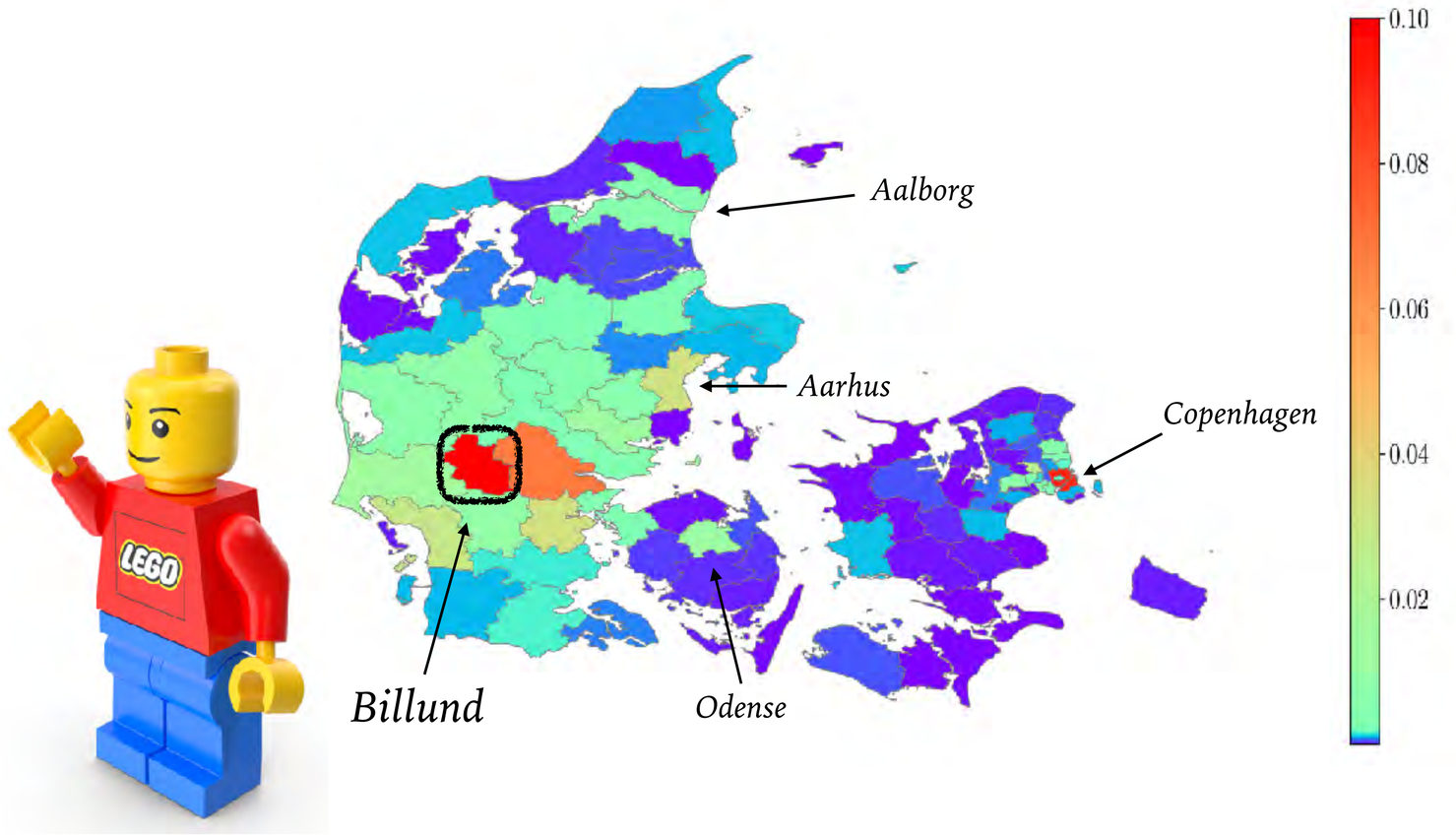




DISAGGREGATED SPENDING FLOWS

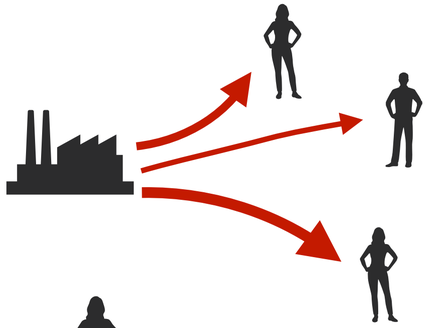
Geographic concentration resembles a gravity model, plus deviations (e.g., Vejle malls)

Spending of manufacturing workers in Billund

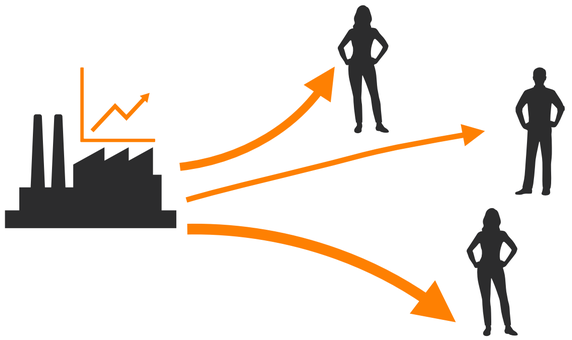


OTHER FLOWS

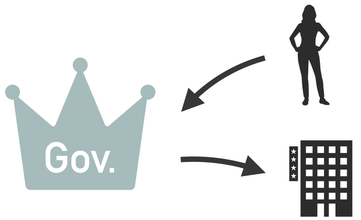
- **Labor compensation**
  - Government registers on locations of residence and work



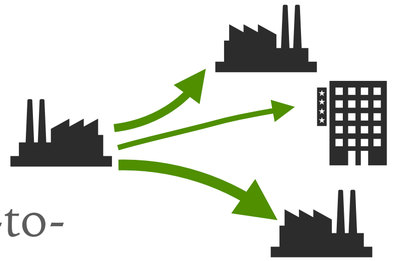
- **Mixed income and dividends**
  - Unincorporated businesses:
    - Mixed income from administrative registers
  - Corporations:
    - Dividends from tax registers



- **Government transactions**
  - Individual and firm registers on different types of taxes and subsidies

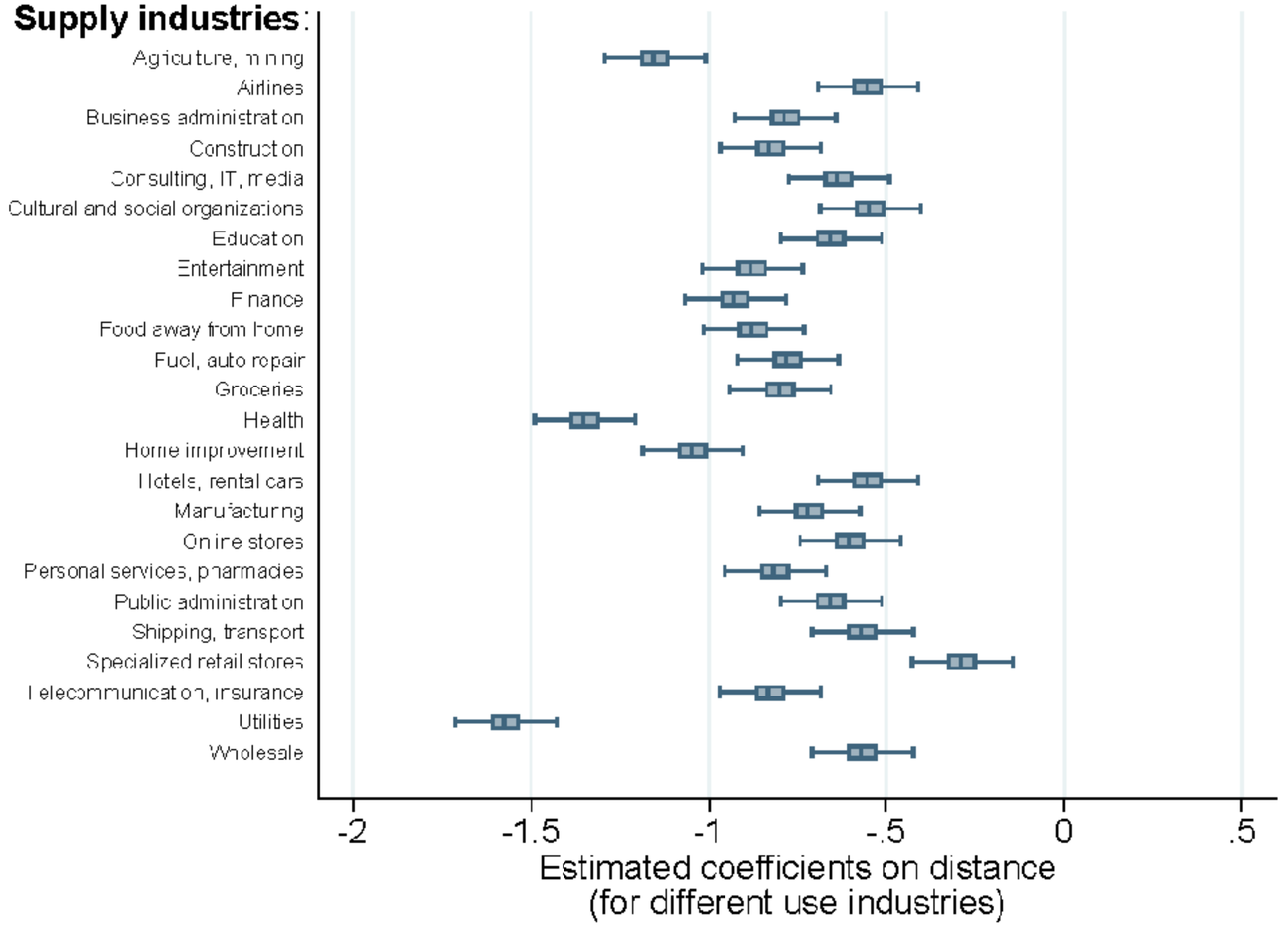


- **Intermediate input trade**
  - Start with national IO table (117 industries)
  - Impose gravity using regional output shares (e.g., Leontief & Strout) and industry-to-industry gravity coefficients from CrediWire trade data

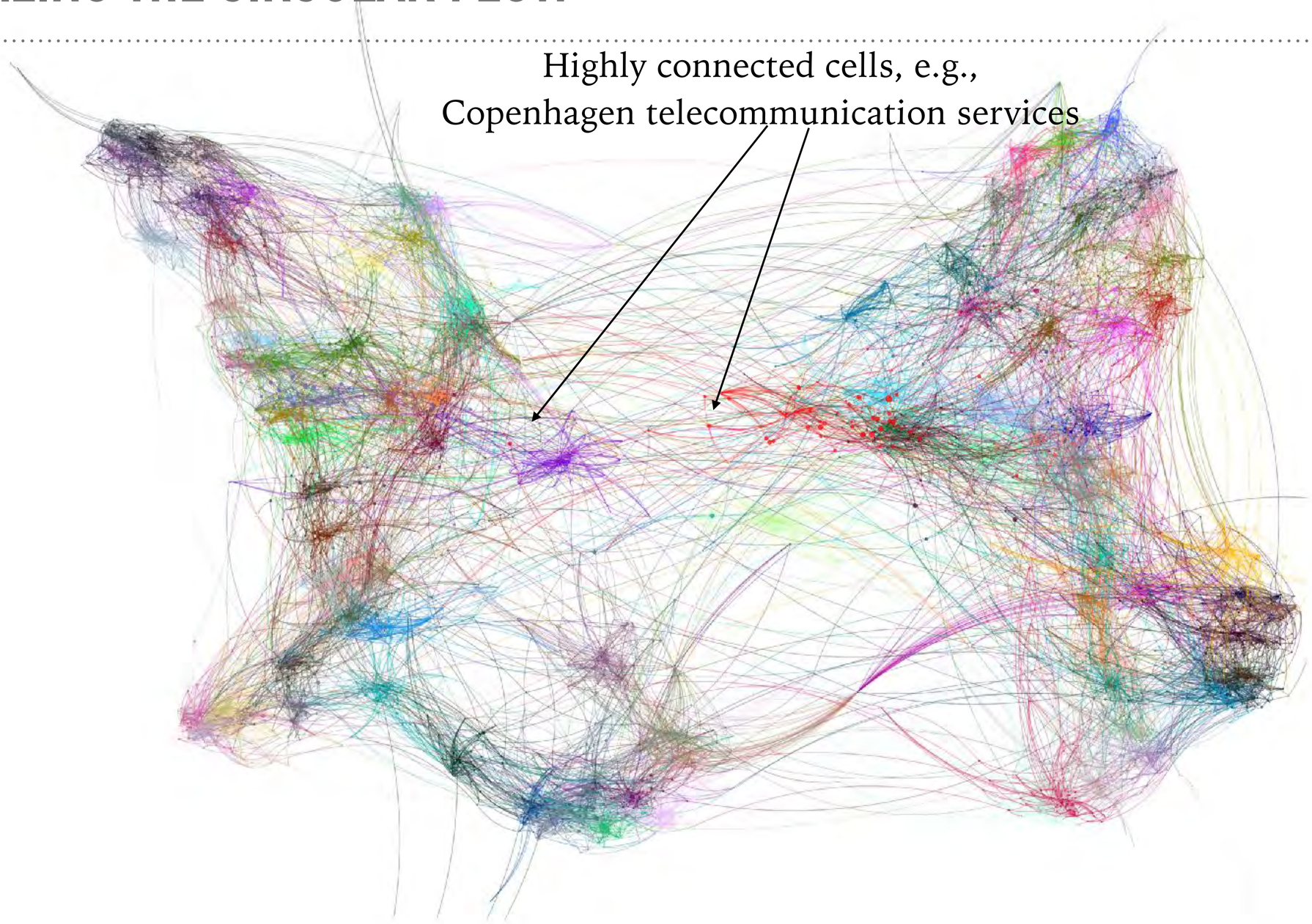


DISTANCE AND PRODUCER TRADE

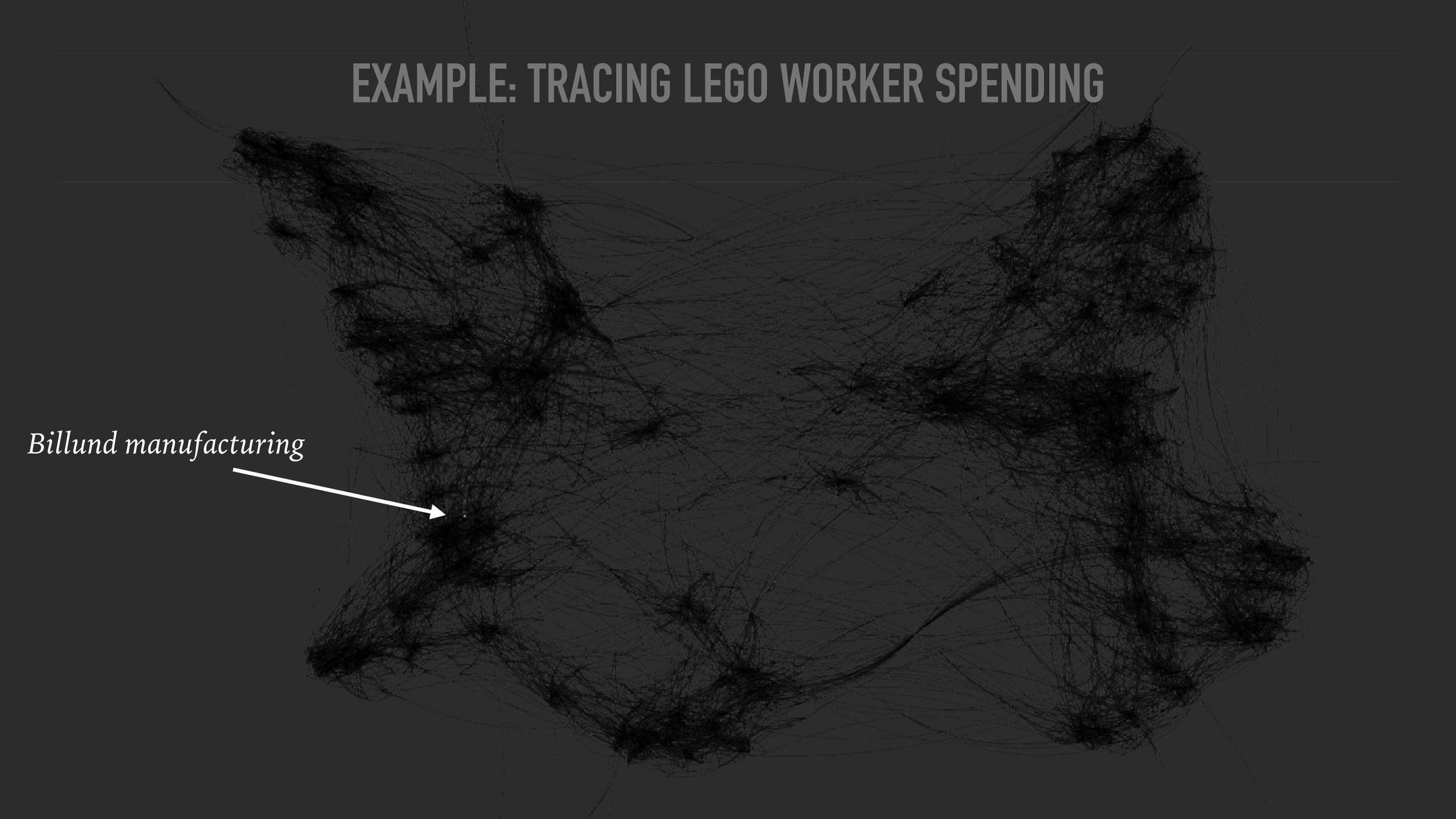
- Producers buy utilities, health services, home improvement from nearby
- Producers buy telecommunication and insurance from further



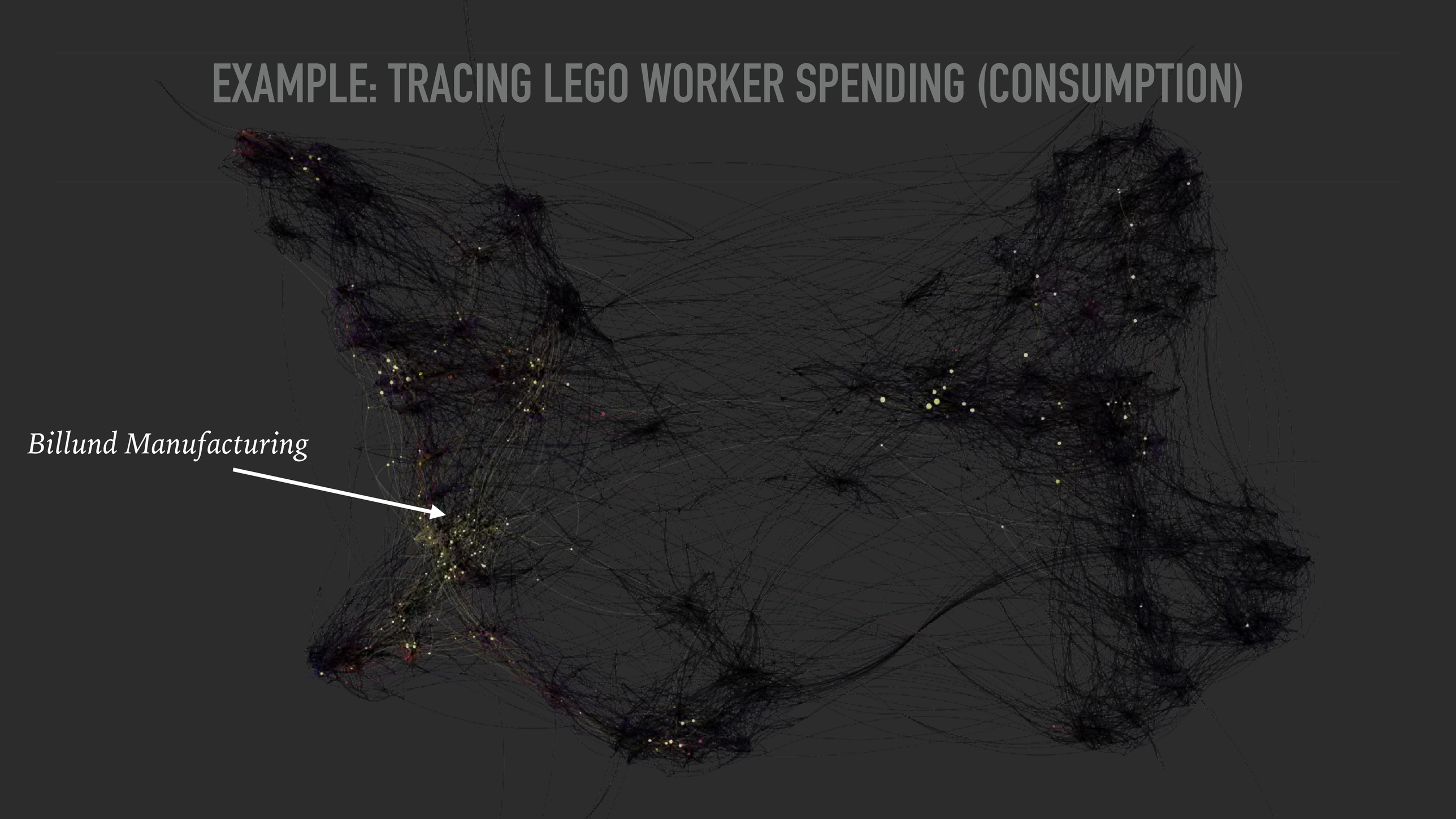
VISUALIZING THE CIRCULAR FLOW



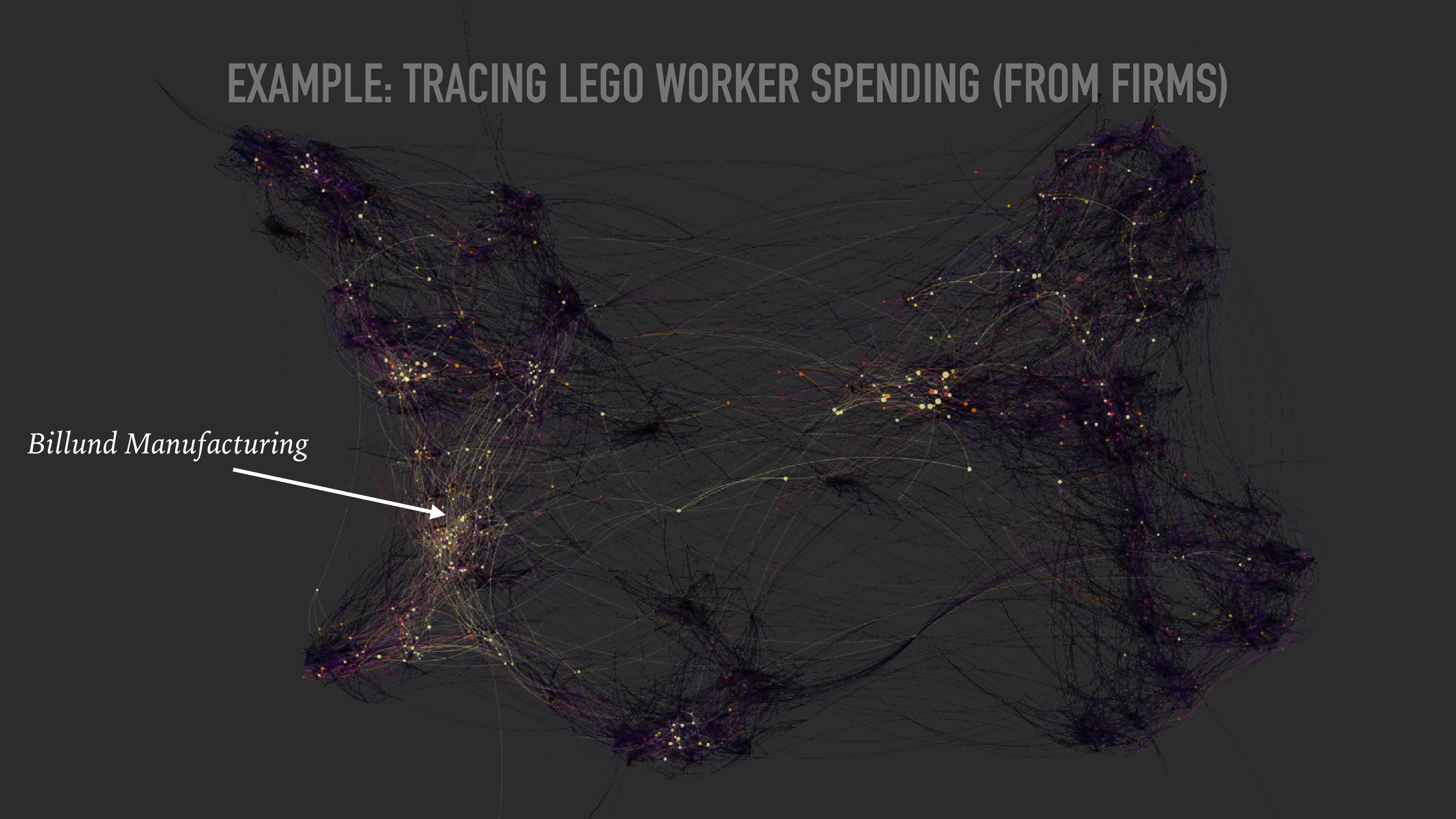
EXAMPLE: TRACING LEGO WORKER SPENDING



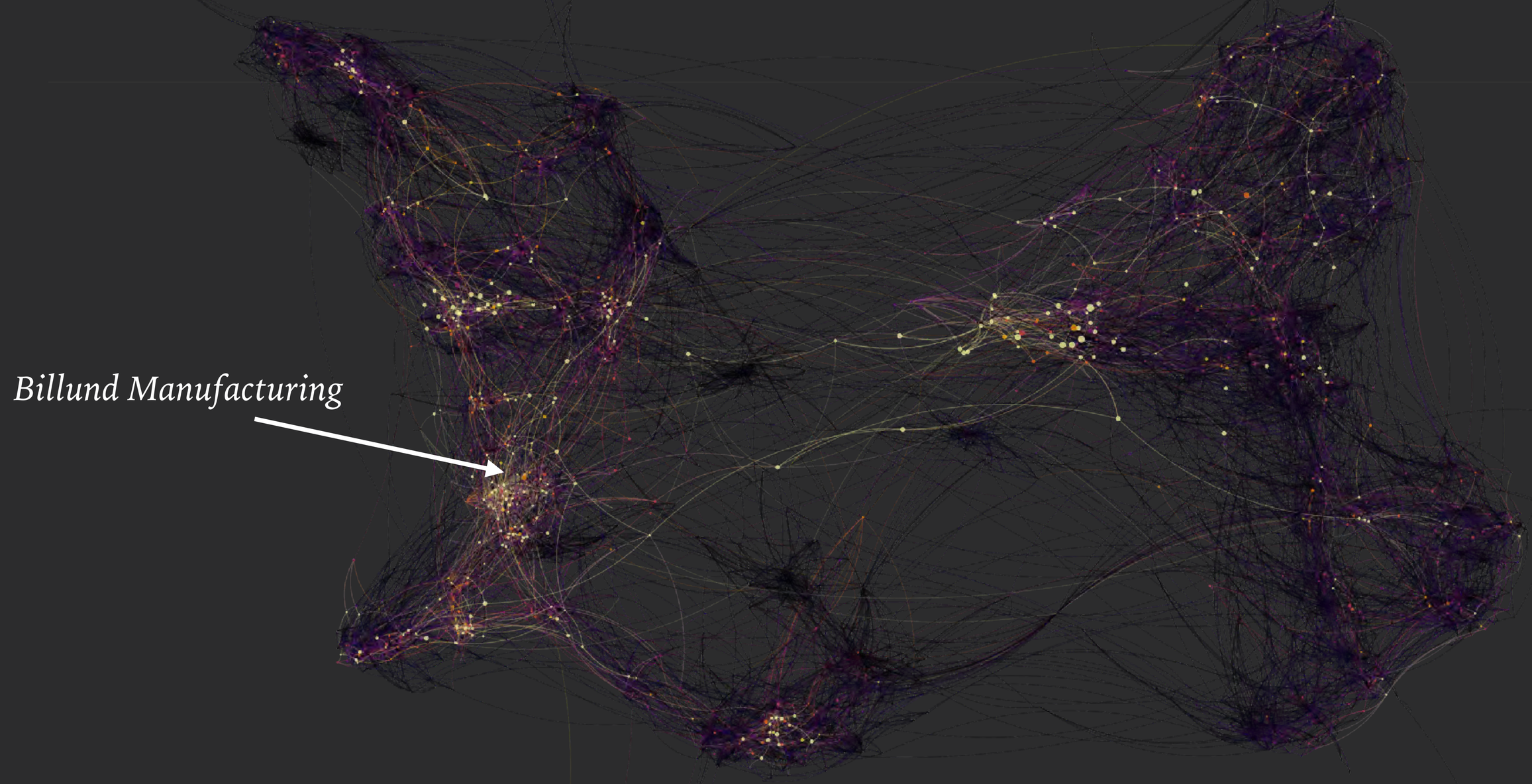
EXAMPLE: TRACING LEGO WORKER SPENDING (CONSUMPTION)



EXAMPLE: TRACING LEGO WORKER SPENDING (FROM FIRMS)



EXAMPLE: TRACING LEGO WORKER SPENDING (FIRMS AND CONSUMERS)



STYLIZED FACTS

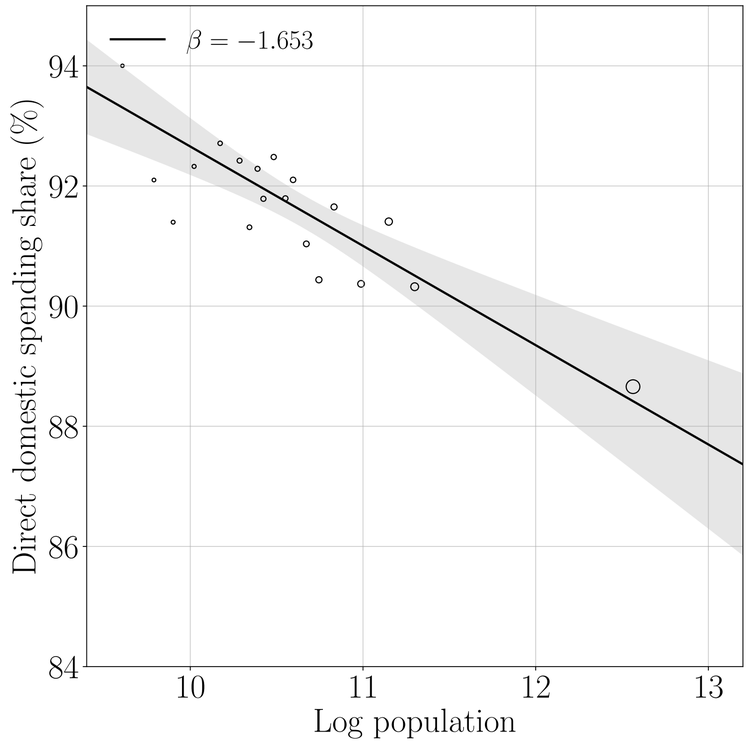
Move from case studies to systematic patterns

1. Direct domestic spending
2. Assortative spending
3. Urban bias
4. Triangular flows across regions
5. Spending intensity

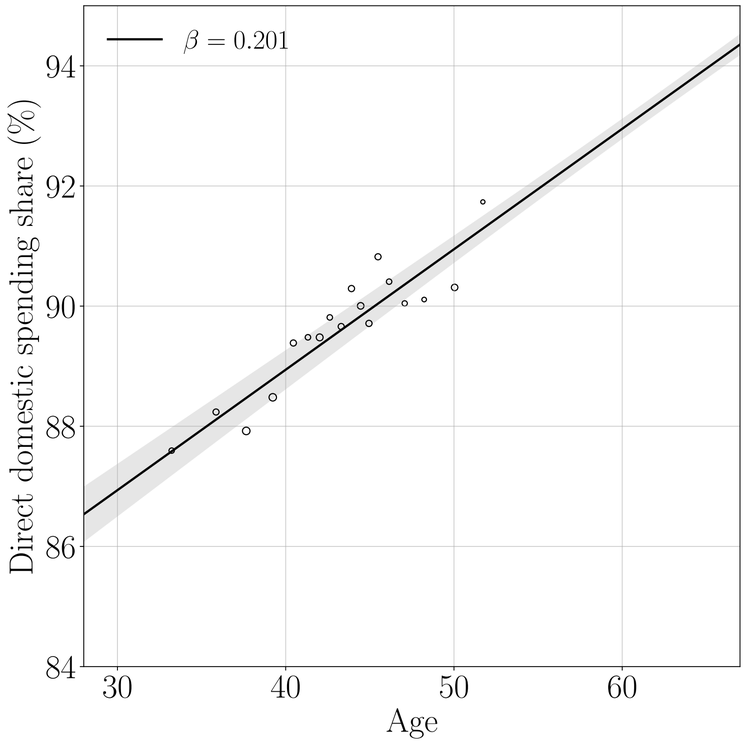
DIRECT DOMESTIC SPENDING

- Higher for rural/small, old, and non-college-educated consumers
- Goes to travel-related and specialized retailers
- Holds within industry/region and controlling for income/financials

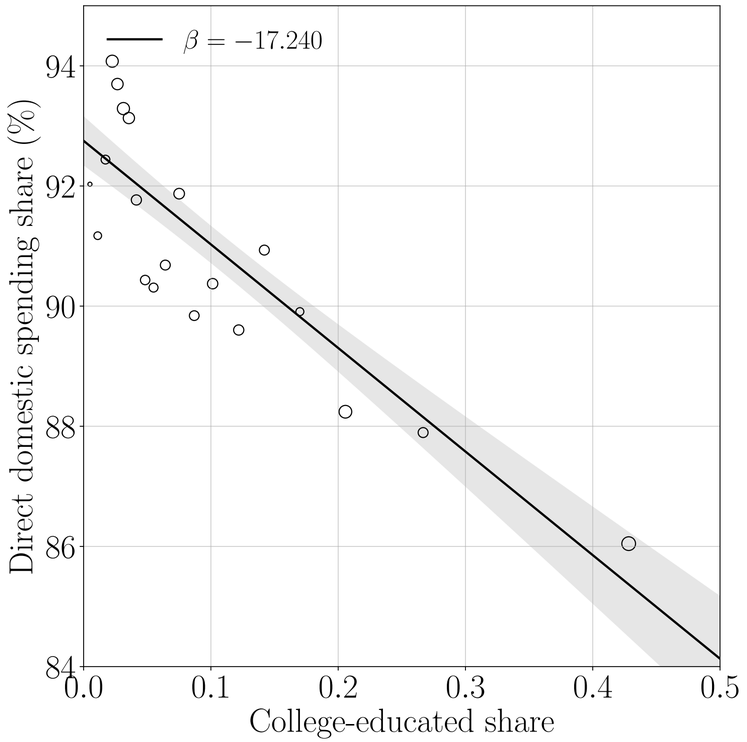
Region size



Age



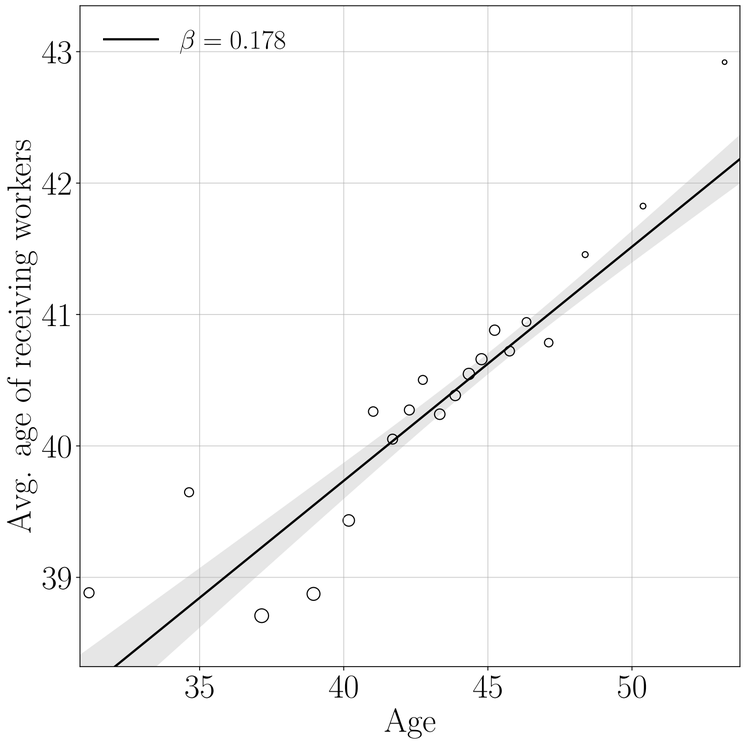
College-educated share



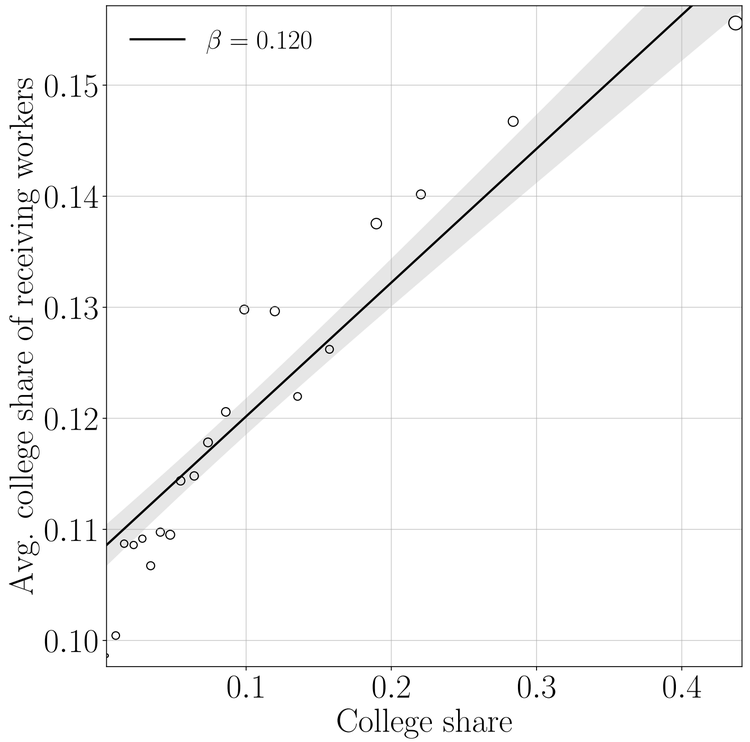
ASSORTATIVE SPENDING

- Characteristics of consumers and workers mildly correlated
- Higher-order connections reinforce direct patterns
- E.g., spending by old consumers contributes to income of old consumers

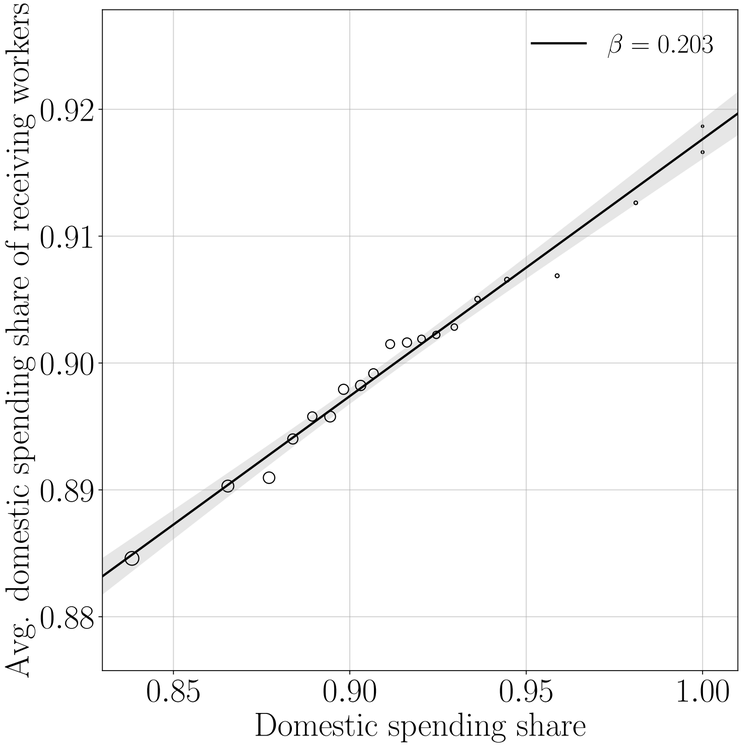
Age



College-educated share

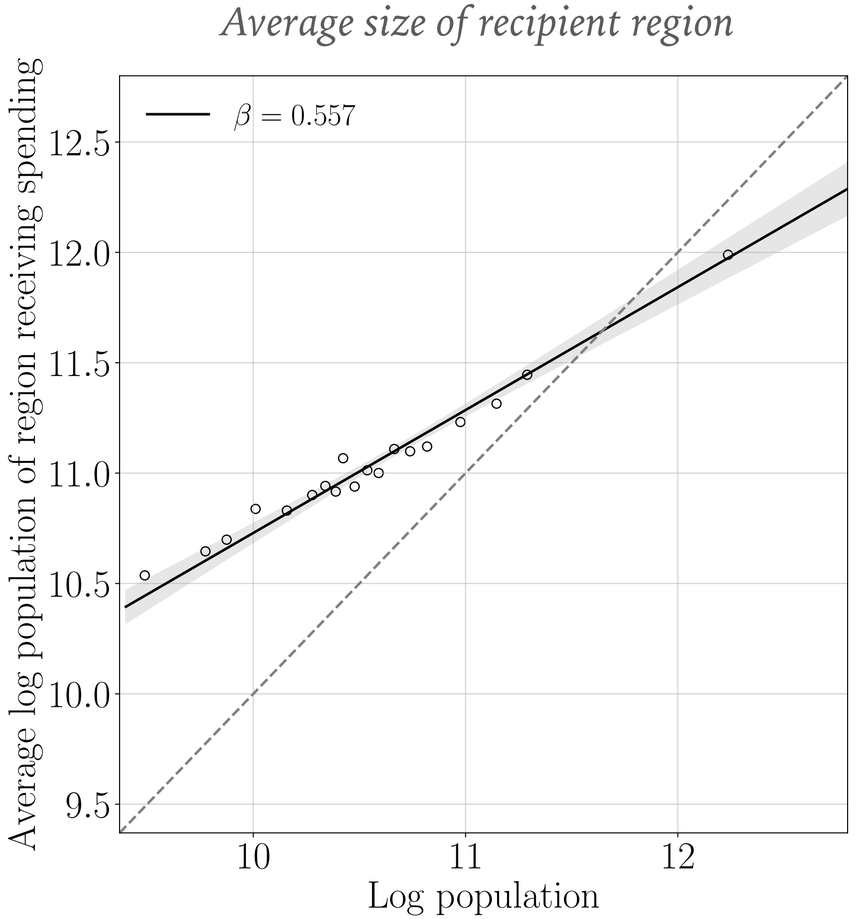


Domestic spending share



CONSUMERS SPEND IN MORE URBAN PLACES THAN THEY LIVE

- Driven by spending on services, retail stores, entertainment (Glaeser et al)
- Extended gravity model: distance matters less for large urban regions

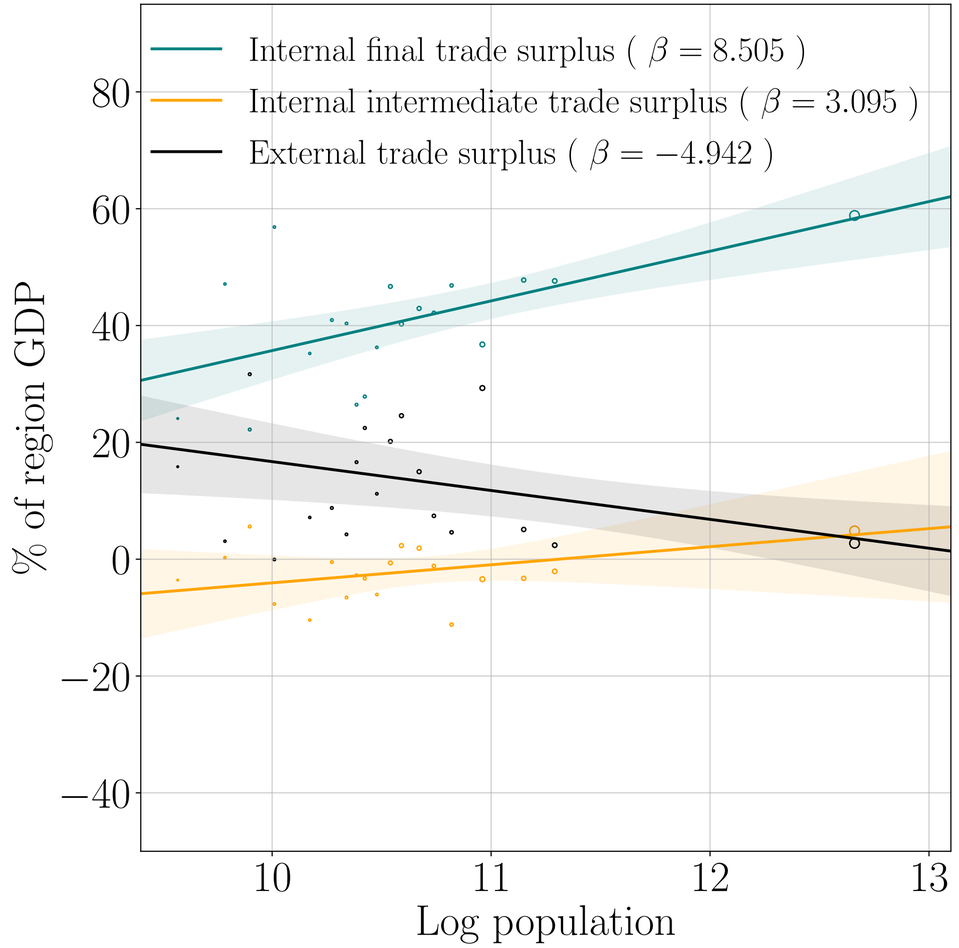


RURAL REGIONS EXPORT ABROAD, CITIES DOMESTICALLY

- Construct consistent balance of payments (net flows) for each region and cell

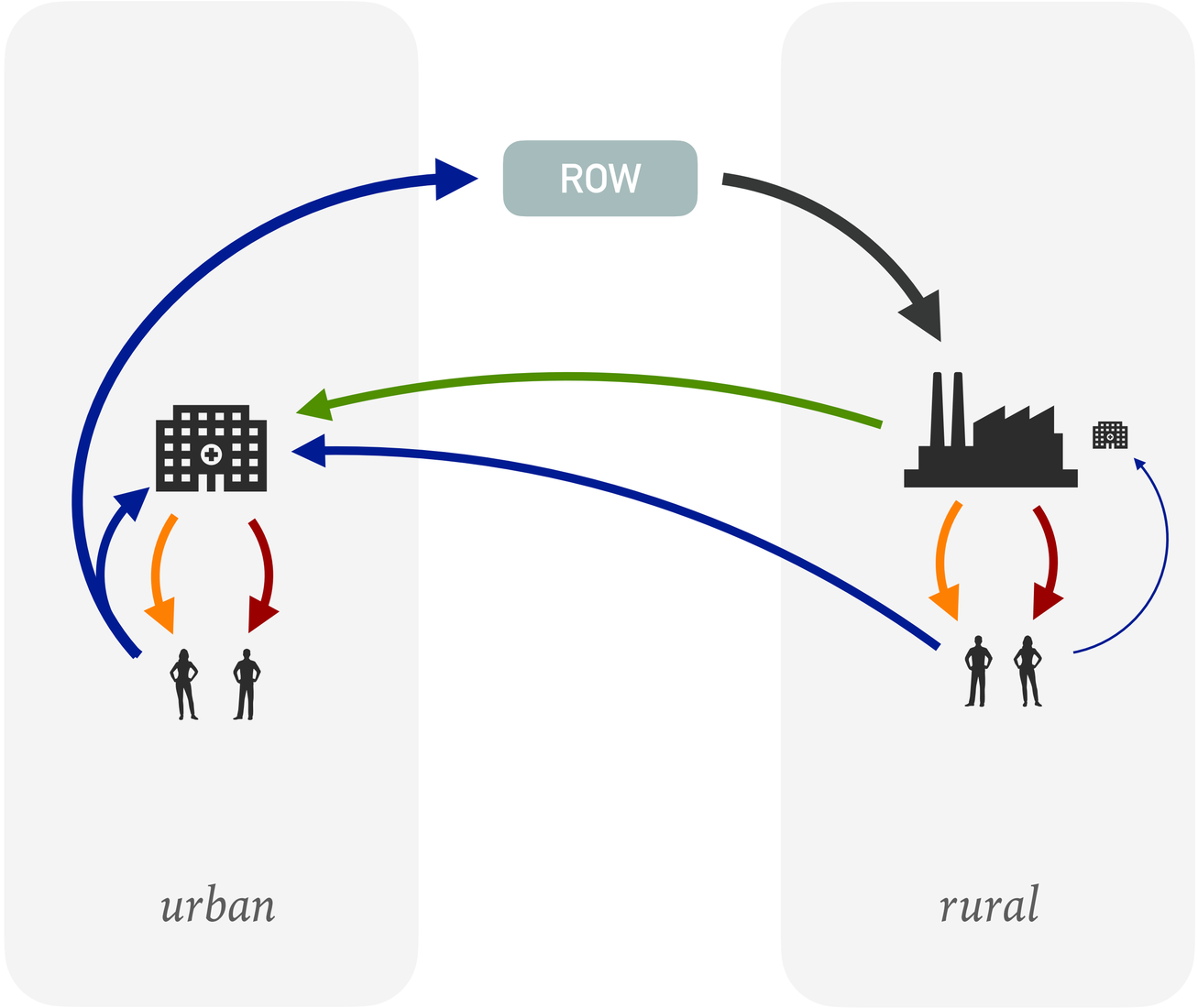
External surplus has negative slope: rural regions export to foreign countries (on net)

- *Vestas: Ringkøbing-Skjern and Ikast-Brande*
- *Novo Nordisk: Kalundborg*
- *Lego: Billund*



Internal surplus has positive slope: urban regions export to rural regions (on net)

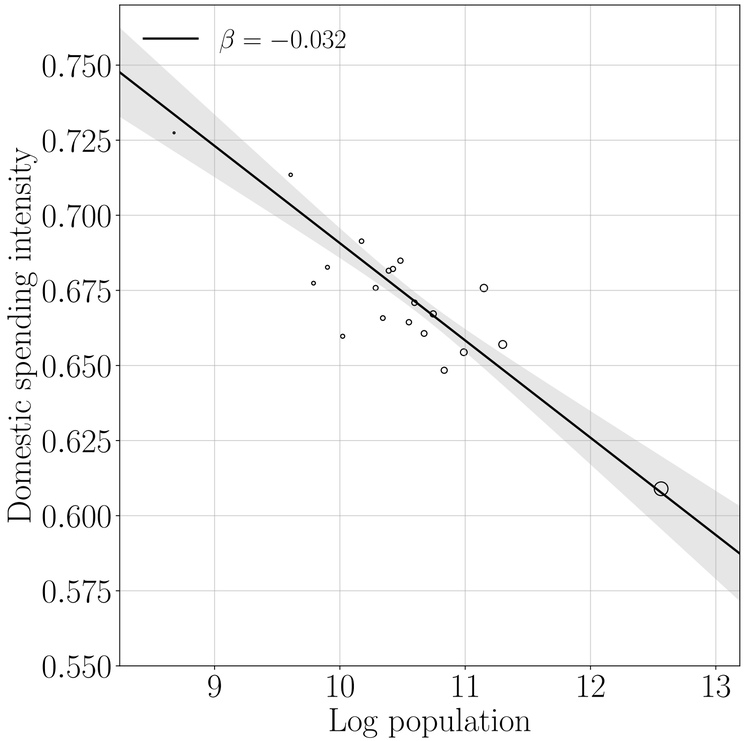
TRIANGULAR FLOWS ACROSS SPACE



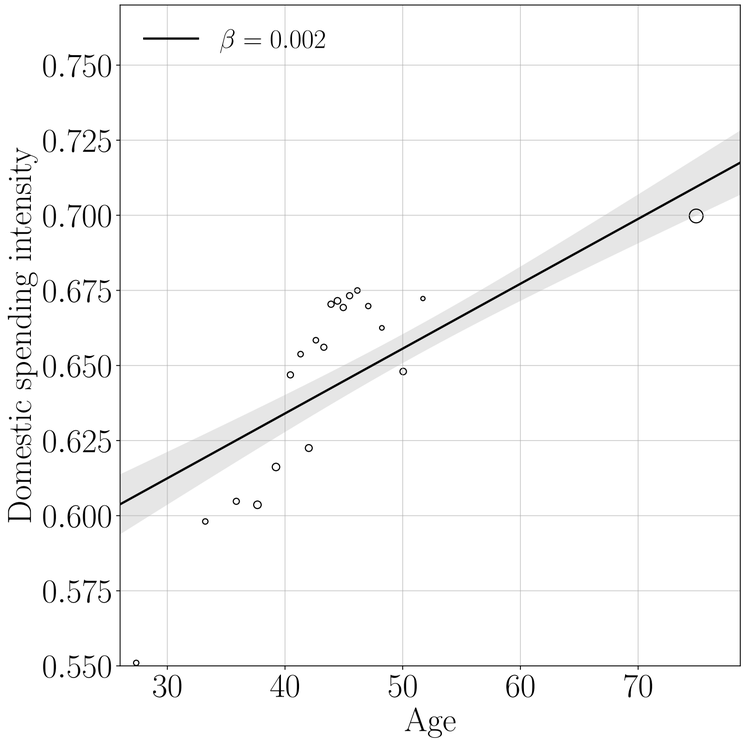
SUMMARY MEASURE: "DOMESTIC SPENDING INTENSITY"

- To what extent does a cell's spending contribute to domestic incomes?
- Captures direct and higher-order connections
- E.g., all consumers spend 50% domestically, only domestic labor as input, then: intensity = 1/2+1/4+1/8+… = 1 for all cells

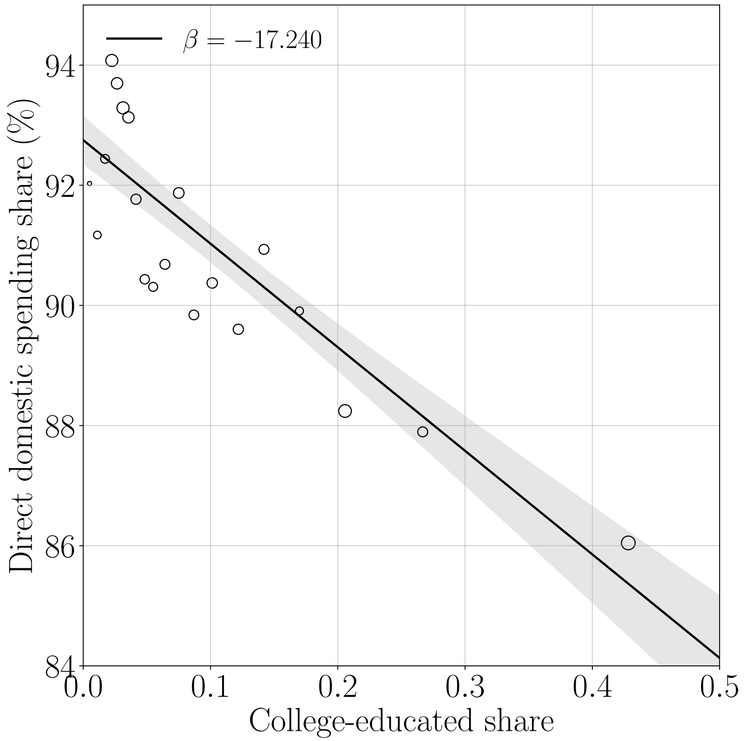
Region size



Age



College-educated share



MODEL AND POLICY APPLICATIONS

IMPLICATIONS FOR POLICY

- Can disaggregated economic accounts improve policy?
- Yes for policy aimed at individual cells
  - e.g., do place-based transfers leak?
- Less clear: aggregate benefits?
  - today: evaluate effects of financial transfers on GDP
  - other possible applications: trade policy, redistribution, etc.

MODEL

- Idea: simple model of fiscal policy with disaggregated structure
- Fixed exchange rate, downwardly rigid wages
- Disaggregated consumer cells, producer cells, government, ROW
  - Producer cells and ROW produce differentiated goods
  - Nested CES production over labor, capital, foreign and domestic intermediates
  - Consumer cells and ROW have nested CES preferences over goods
  - Government taxes, spends on producers, transfers to consumers
- Calibrate model using DEA
- First: elasticities=1, static; later: dynamic, calibrated elasticities & MPCs (Flynn et al)
- Inspired by Acemoglu et al, Baqaee-Farhi, Caliendo-Parro, Farhi & Werning, Liu, Redding & Turner, Rodríguez-Clare et al

FISCAL TRANSFERS IN AN ECONOMY-WIDE RECESSION

GDP MULTIPLIERS IF EVERY CELL FACES UNEMPLOYMENT

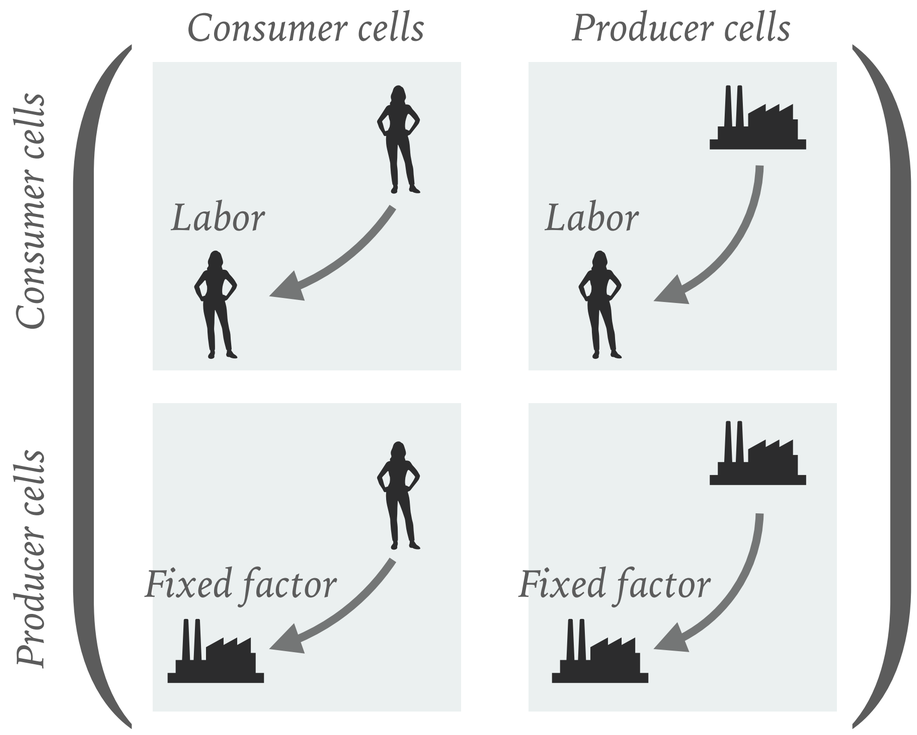
- What happens to GDP if government transfers \$1 to consumer cell i?
- Theory:

$$multiplier = \frac{d\,real\,GDP}{d\,transfer\,to\,i} = \frac{1}{\lambda_i}\begin{pmatrix}\boldsymbol{\phi}' & \mathbf{0}\end{pmatrix}(\mathbf{I}-\mathbf{M})^{-1}\mathbf{M}_i$$

- $\phi_i \in \{0,1\}$ indicator if wage rigidity binding for cell i
- λ_i = net cost of the policy, accounting for fiscal externality
- $\mathbf{M}$: factor demand matrix, captures all entries of DEA
  - $\mathbf{M}_i$ = ith column of $\mathbf{M}$ = how much spending of cell i ends up
    - as demand for labor of consumer i' ($M_{i'i}$)
    - as return to fixed factor of producer j (M_{ji})

FACTOR DEMAND MATRIX $\mathbf{M}$

$$\mathbf{M} =$$



Different from I-O matrix:

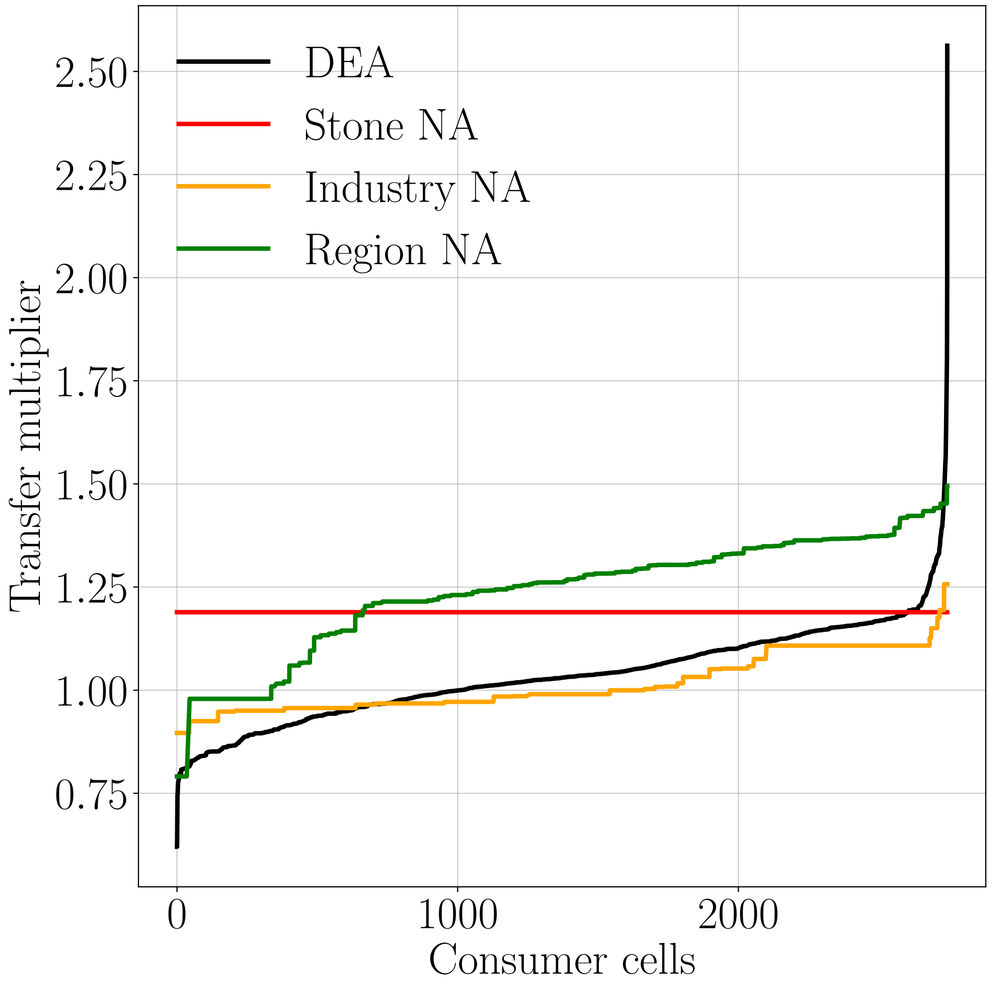
- *Tracks spending between consumers*
- *I-O matrix tracks goods between suppliers*

M *includes information from:*

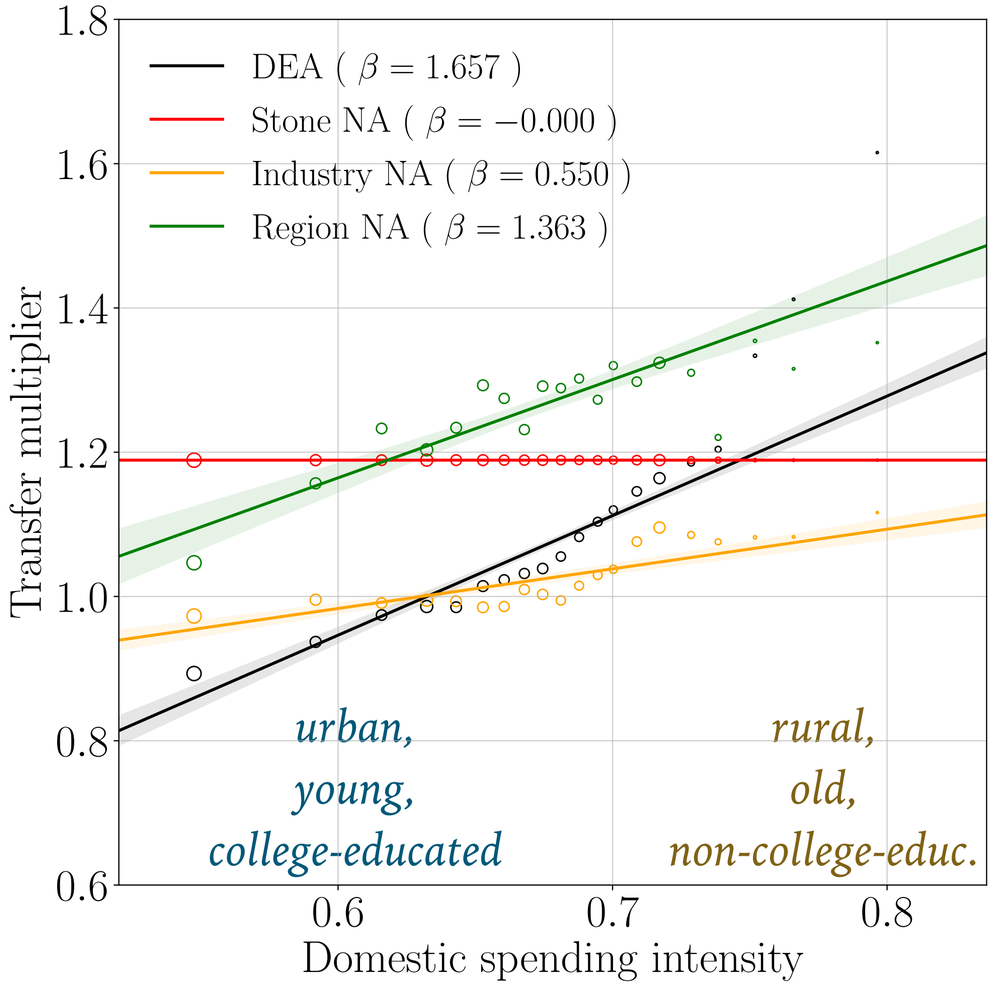
- *disaggregated consumers spending*
- *I-O matrix*
- *disaggregated labor and capital income*

MULTIPLIERS ARE HETEROGENEOUS AND DEPEND ON SPENDING INTENSITY

Distribution of multipliers



Multipliers by spending intensity



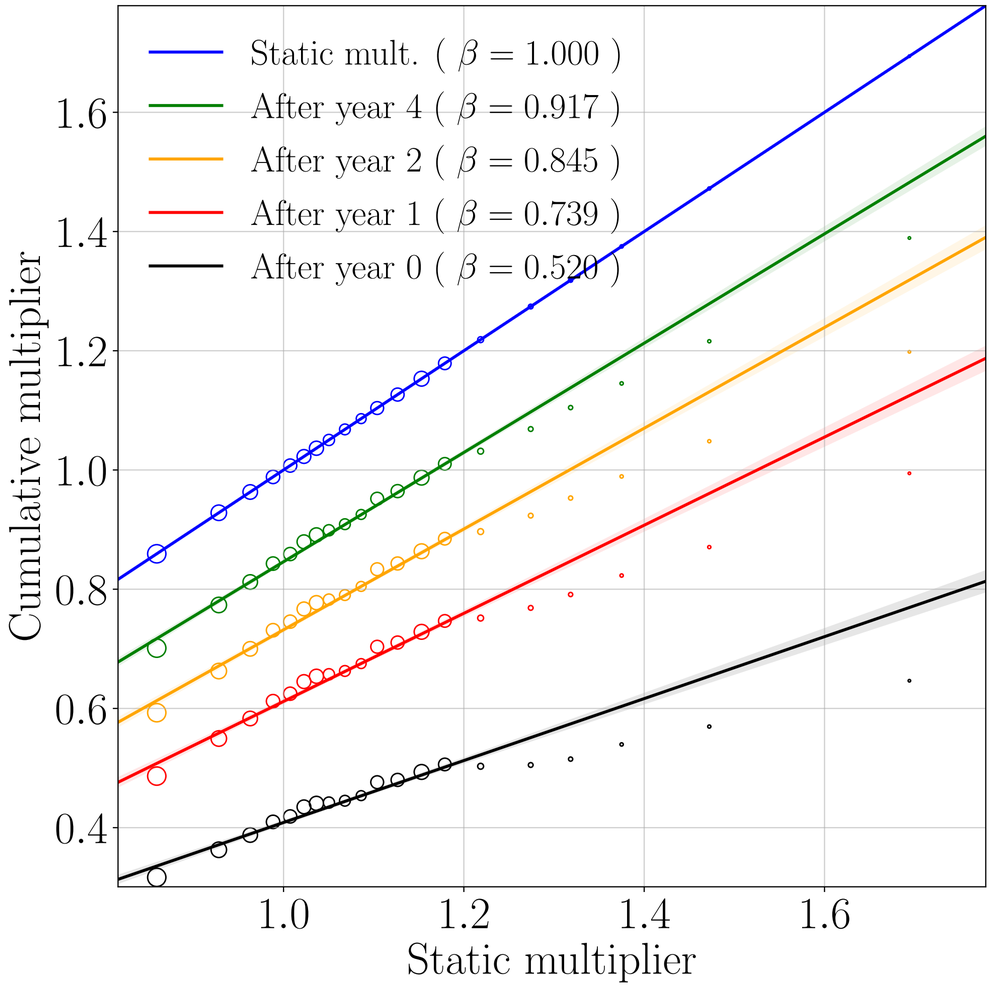
HOW MUCH DOES IT SAVE?

Targeting	Multiplier	Cost to raise GDP by 5% (in bn DKK)
Uniform	1.04	96
Top 10% spending intensity	1.21	82
2018 child tax credit	1.03	98
2022 inflation relief to elderly	1.19	88
2023 housing rent inflation support	0.96	96
Construction worker support	1.15	81
Consulting / IT worker support	1.05	105

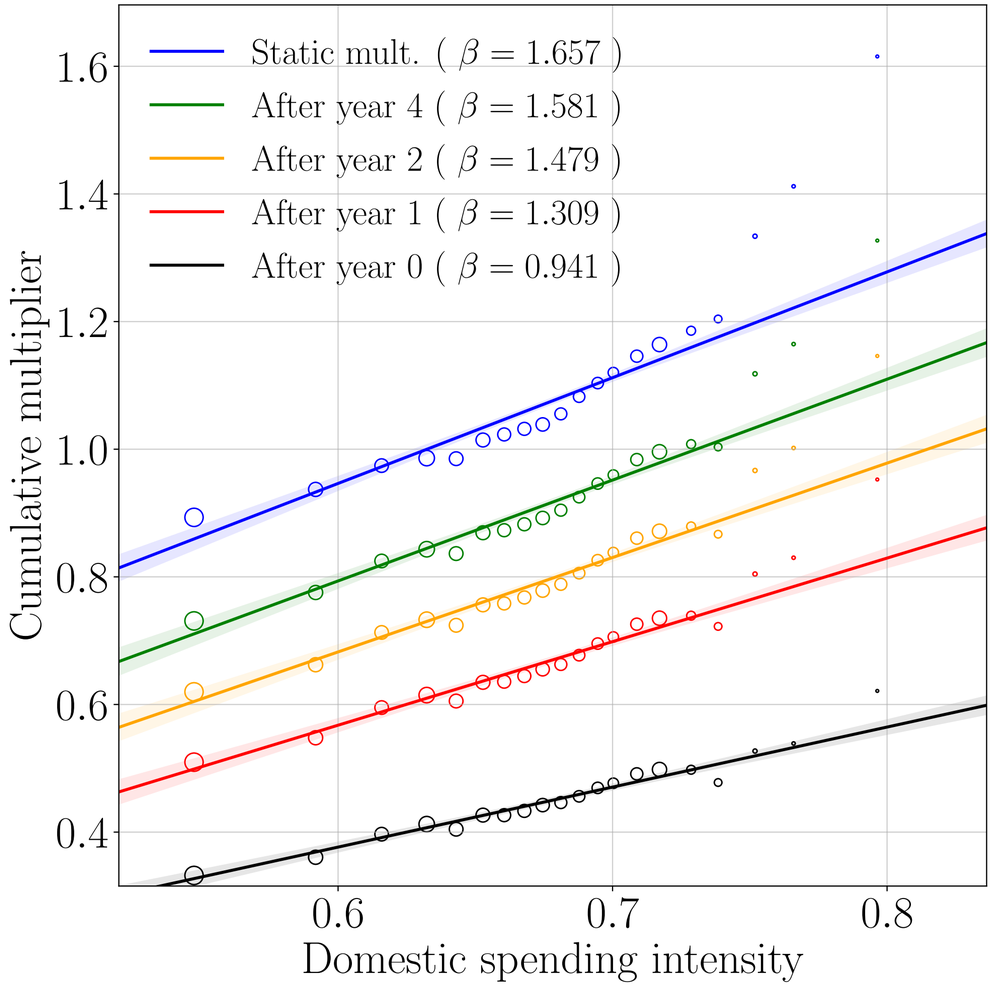
Save 0.4% of GDP for same gain

DYNAMIC MODEL WITH CALIBRATED ELASTICITIES & MPCS

Dynamic and static multipliers correlated



Spending intensity matters at all horizons



FISCAL TRANSFERS IN A HETEROGENEOUS RECESSION: EXAMPLE OF U.S. TARIFF SHOCK

HETEROGENEOUS RECESSION

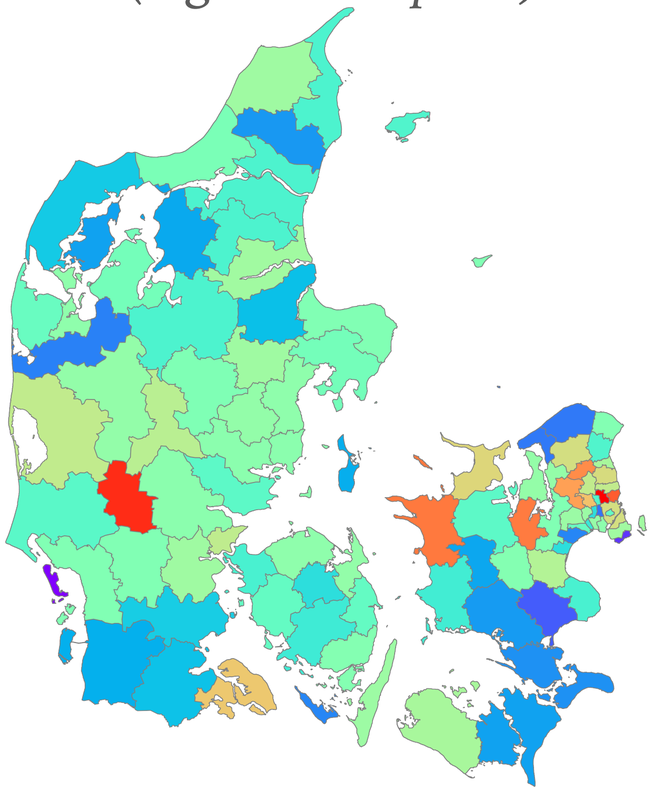
- Analyze recession where only some cells become unemployed
- Most real-world recessions are like that
- Illustrative example: hypothetical tariff increase on Danish exports to the U.S.

- Questions:
  - Which cells become unemployed?
  - Fiscal transfers to which cells have high multipliers?

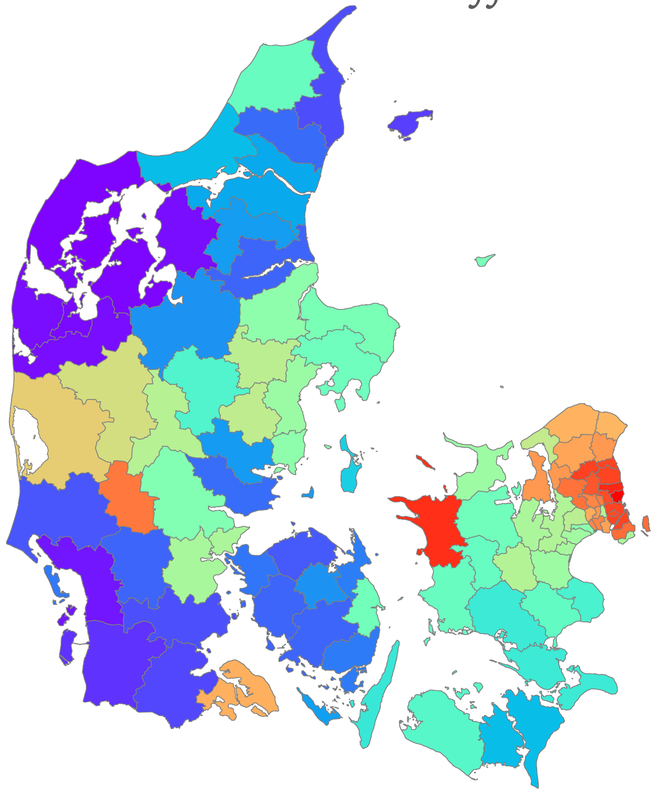
MULTIPLIERS AFTER U.S. TARIFFS

- Exporters directly affected, but unemployment spreads to other regions
- Multipliers largest for cells with high spending intensity, not unemployed cells

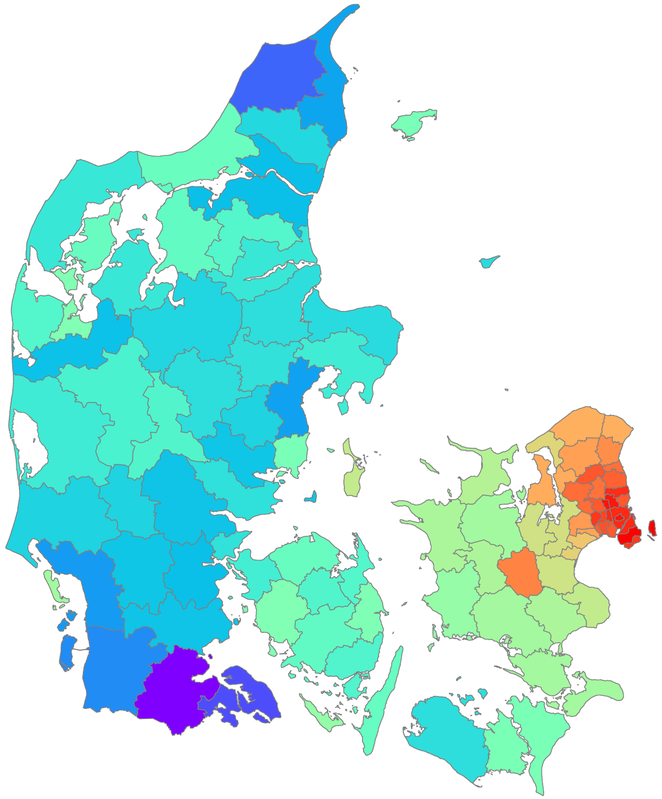
Direct exposure to U.S. tariffs (high U.S. exports)



Labor market unemployment due to U.S. tariffs



Transfer multipliers



SPENDING INTENSITY PREDICTS MULTIPLIERS

- Multipliers largest for cells with high spending intensity, not unemployed (slack) cells
- Need DEA to identify high-multiplier cells

	(1)	(2)	(3)	(4)
	Multiplier			
Consumer cell is slack	0.029***	0.003	-0.010**	-0.013***
	(0.007)	(0.006)	(0.005)	(0.003)
Spending share on directly exposed cells (%)		0.326***	-0.194***	-0.140***
		(0.028)	(0.029)	(0.022)
Spending share on slack cells (%)			0.029***	0.014***
			(0.001)	(0.001)
Spending intensity on slack cells				1.047***
				(0.082)
Observations	2,744	2,744	2,744	2,744
R^2	0.035	0.310	0.800	0.867

ADOPTED BY THE DANISH CENTRAL BANK TO ANALYZE OZEMPIC SHOCK

CHART 6

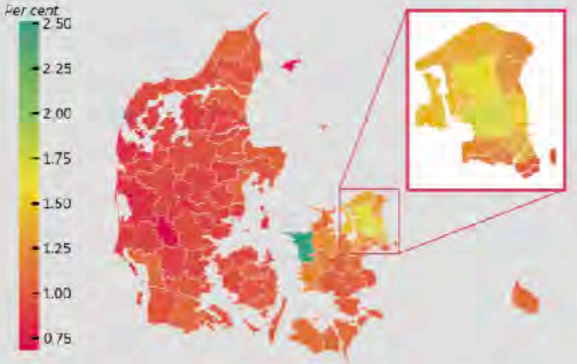
Consumption increases are widespread across the country following a general increase in manufacturing exports.

Percentage change in consumption for each municipality following an increase in demand for manufacturing exports.

CHART 7

Consumption increases are more concentrated on Zealand following an increase in pharmaceutical exports.

Percentage change in consumption for each municipality following an increase in demand for pharmaceutical exports.



https://www.nationalbanken.dk/media/zcfnipnx/increased-pharmaceutical-exports-have-both-aggregate-and-distributional-effects.pdf

CONCLUSION

- Measurement of disaggregated circular flow
- Stylized facts on spending intensities
- May improve “bang for the buck” of policies