Mapping Economic Shocks Through Financial Ties: A Network-Theoretic Framework for Disaggregated National Accounts

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Abstract

National accounts often treat the economy as a collection of averages. These accounts track total output, income, and consumption, but not how different parts of the economy are connected. In this paper, we present a network-based framework to capture the flow of money between firms, households, and the government. Using transaction-level data, we reconstruct economic networks and track how shocks spread through them. Our approach helps explain why some policies fail, why some recoveries stall, and why similar shocks lead to different outcomes across regions or sectors. We show that this method offers more precise insights than models that rely on representative agents or sectors. We also discuss how this framework can be built using real-world data from tax filings, digital payment logs, and bank transfers, and how it aligns with emerging efforts in national accounting reform.

1 Introduction

Standard macroeconomic models rely on averages. They measure total output or income but say little about who pays whom, who buys from whom, or how money moves across the economy. This limits our ability to see how shocks move through the system.

Recent access to transaction-level data allows a different view. Instead of treating households or firms as blocks, we can treat them as nodes in a network. Each transaction becomes a link. This approach lets us observe how money flows and how disruptions spread. It also makes it possible to identify who matters most in keeping the system stable.

This paper builds a general framework to do that.

2 Motivation and Background

2.1 The Limits of Aggregates

Aggregated national accounts mask variation. When a policy boosts "average consumption," we do not know which households increase spending or which firms benefit. During a shock, we cannot see which regions lose income first, or which sectors transmit distress.

2.2 Network Thinking in Economics

Network models have helped fields like epidemiology and power systems understand cascading effects. In economics, input-output models are a step in that direction, but they often stop at the industry level. We argue that modeling disaggregated transactions using network theory gives better visibility into systemic behavior.

3 Framework: Economic Flow as a Directed Network

3.1 Nodes and Edges

Each node is a unit such as a household, firm, government agency, or external sector. Edges represent monetary flows. The direction of an edge reflects the flow of funds from buyer to seller, from employer to worker, or from taxpayer to government.

3.2 Transaction Matrices

At the core of our framework is a dynamic transaction matrix T. Entry $T_{ij}(t)$ reflects the value of a transaction from unit i to unit j at time t. These matrices update over time and allow us to observe shifts in economic relationships.

3.3 Shock Propagation

We define a shock as a drop in outgoing flows from one or more nodes. The model tracks how this affects upstream and downstream nodes based on their direct and indirect dependencies. This can be simulated using standard tools from network diffusion models.

4 Application: Simulated Supply Shock

We use synthetic transaction-level data modeled after anonymized firm-consumer-government flows in a medium-sized economy. We simulate a sudden drop in production in one region due to a natural disaster.

4.1 Observation

Downstream, we see sharp drops in wages for workers tied to the affected firms. Upstream, suppliers face reduced orders. Some firms in other regions are insulated due to limited network exposure.

4.2 Comparison with Aggregate Models

Standard models predict a smoother decline in GDP. The network model shows sharp local drops and uneven recovery. Without seeing the network, policymakers would miss these distributional effects.

5 Policy Implications

5.1 Targeted Stabilization

Instead of broad fiscal transfers, the model helps identify high-centrality nodes whose stability affects many others. Supporting these actors can prevent broader declines.

5.2 Better Shock Forecasting

By observing which nodes are most exposed, we can predict which sectors or households are likely to face hardship before aggregate indicators show trouble.

5.3 Evaluation of Past Policies

Applying the network lens to past policy interventions allows us to understand whether aid reached the critical parts of the system.

6 Data Sources and Implementation Pathways

6.1 Building the Transaction Network

In many countries, government agencies already collect transaction-level data. Key sources include:

- Tax records such as employer filings, VAT submissions, and sales tax flows
- Bank transfer logs such as anonymized payments data across accounts
- Digital platforms such as mobile money records and platform economy transactions
- Household panels including matched employer-employee data and consumer expenditure logs

These can be merged using pseudonymized IDs to create the transaction matrix over time.

6.2 Ensuring Privacy and Access

To comply with privacy standards, data can be aggregated to preserve flow structure while masking identities. Agencies can release time-series edge-weighted networks or synthetic but statistically equivalent graphs.

6.3 Aligning with Existing Accounts

Efforts by Eurostat, the IMF, and the OECD have explored integrating granular data into the System of National Accounts. Our approach supports this by offering a method to reconcile transaction matrices with aggregate flows like GDP and national income.

7 Statistical Estimation and Calibration

7.1 Matrix Construction from Partial Data

When full transaction data is unavailable, we can estimate entries of the transaction matrix T using statistical matching. Input-output tables, sectoral sales distributions, and national survey data provide anchors. Regularization techniques such as ridge regression or entropy balancing can estimate missing flows.

7.2 Identifying Shocks and Centrality

To calibrate shock propagation, we identify nodes with high betweenness and eigenvector centrality. These nodes function as hubs for flow redistribution. Tracking variance in their outflows over time helps flag economic stress.

7.3 Model Validation

We propose back-testing this framework using historical transaction datasets, where available, such as those from COVID-era fiscal relief. We then compare observed propagation to simulated counterfactuals.

8 Comparison with Related Work

Model	**What It Captures**	**Limitations**
Input-Output Models	Industry flows	No intra-industry deta
Representative Agent Models	Aggregate behavior	Masks heterogeneity
Agent-Based Models	Simulated micro-dynamics	Often lack empirical g
Our Framework	Real transaction flows with dynamic propagation	Requires access to sens

This work builds on recent research using high-frequency data during COVID-19 and complements broader pushes for disaggregated national accounts.

9 Conclusion

Disaggregated transaction data, when structured as a network, provide a more realistic picture of how economic shocks and policies move through the economy. This approach allows for targeted, informed policy and better forecasts. As data access improves, we recommend that national statistical agencies begin integrating network-based tools into official economic monitoring and reporting.

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