Inter-industry Labor Reallocation in Türkiye

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*The views expressed in this presentation are solely those of the authors and do not represent the official views of the Central Bank of the Republic of Türkiye (CBRT).

Content

Introduction

- Structural changes require workers to move between sectors.
- Efficient reallocation of workers is essential for a well-functioning labor market.
- As employment shifts from industry to services, it is important to understand potential frictions in the labor market.
- To understand those frictions for Türkiye, we analyze two main components:
  - Task distance
  - Transaction index (Inter-industry connections)
- How does labor adapt to industrial transformation?
- How policy can support smoother reallocation?

Introduction

- Using a gravity model, we examine the effects of task differences and economic interrelatedness indices on transitions.
- In addition to these variables we also use indicators to represent sectoral performance:
  - Average sectoral wage
  - Number of employees in the sector
  - Sectoral job creation and destruction rates
- We find that while task distance reduces worker mobility, stronger inter-industry linkages increase it.

Literature Review

- Theoretical foundations on this field rely on human capital theory and job matching models that conceptualizes how investments in occupation or sector specific skills shape worker productivity and mobility.
  - Becker (1964), Mincer (1974) and Jovanovic (1979)
- Task differences affect inter-sectoral labor mobility and wages.
  - Poletaev and Robinson (2008) - greater task distance correlate with larger earning declines (US).
  - Neffke, Otto, and Weyh(2017) - transitions are more likely between sectors with similar human capital requirements (Germany).
- Gathmann and Schönberg (2010): "Task specific human capital" affects %52 of wage growth throughout an individual's career.
- Kondo and Naganuma (2015) : "Gravity model"

Data

- Period between 2014-2023.
- Administrative records on B2B transactions (Firm's Purchase and Sales Declarations):
  - Aggregated at the NACE-2 level. Each firm's invoice value is conditioned not to exceed the firm's net sales value reported in their balance sheets.
- Social Security Institution (SSI):
  - This study covers all full-time employees in the private sector.
- O*NET and Turkish Household Labor Force Survey:
  - Task score calculations follow Acemoglu and Autor (2011)
  - The task difference index follows Kondo and Naganuma (2015)

Data

To calculate task scores to create the task distance index, four main skill and work domain categories from the O*NET database were used:

- Work Context
- Work Activities
- Abilities
- Skills

Using questions from these four groups, 22 components in total were created through factor analysis. A transformation is then made from the SOC-10 classification to the ISCO-08 classification.

Data

- Using two digit ISCO-08 occupational codes, task scores are calculated for each sector and task component (1).

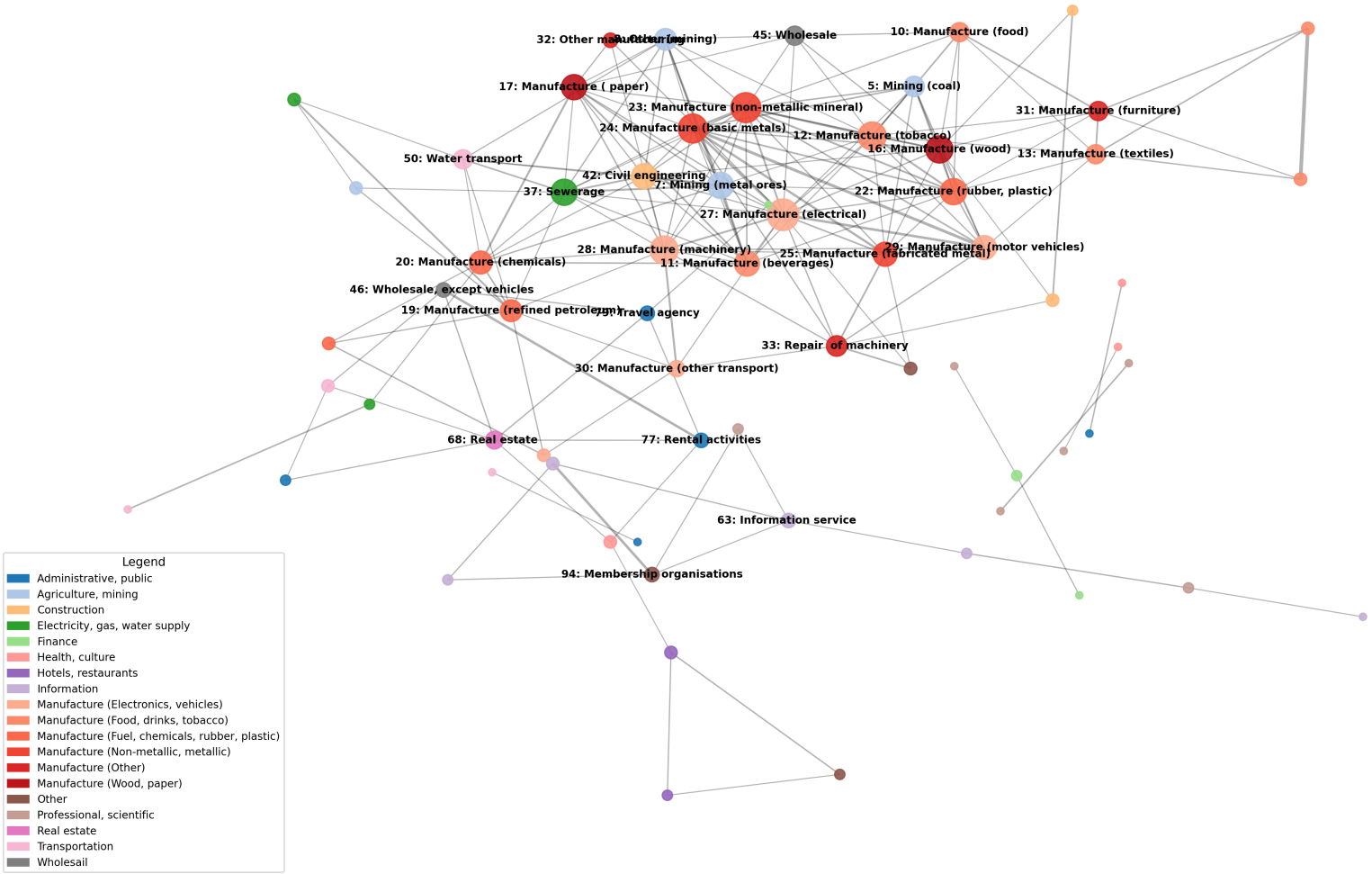
$$\widehat{s_{mjt}} = \sum_{o=1}^{40} \frac{E_{ojt}}{\sum_{o=1}^{40} E_{ojt}} s_{mo} \tag{1}$$

where o denotes occupation, m denotes the task component and j stands for the corresponding industry.

- Distances between sectors j and k are calculated (2).

$$S_{jkt} = \sqrt{\sum_{m=1}^{22} \left(\widehat{s_{mjt}} - \widehat{s_{mkt}}\right)^2} \tag{2}$$

Task Distance Cluster Graph



Data

Table: Descriptive Statistics (2014-2023)

Variables	Observations	Mean	Std. Dev.	Min	Max
Worker flow	74,476	63.43	324.23	0	14,409.18
Total employment of source industry	74,476	167,580.40	247,143.30	272.42	1,631,942
Total employment of destination industry	74,476	167,580.40	247,143.30	272.42	1,631,942
Task distance	74,476	6.12	2.55	0.43	16.55
Transaction index (Million TL)	74,476	1,930	26,200	1	3,140,000
Job creation rate in source industry	74,476	0.21	0.12	0.01	0.92
Job creation rate in destination industry	74,476	0.21	0.12	0.01	0.92
Job destruction rate in source industry	74,476	0.17	0.12	0.01	1.13
Job destruction rate in destination industry	74,476	0.17	0.12	0.01	1.13
Average earnings in source industry	74,476	142.11	104.07	35.42	950.97
Average earnings in destination industry	74,476	142.11	104.07	35.42	950.97

Methodology-Gravity Model

- Poisson Pseudo Maximum Likelihood (PPML) model is used. To control for factors that impact labor mobility across sectors, sector and year fixed effects are included.

$$W_{jkt} = \exp\Big(\log\alpha_0 + \alpha_1 \log E_{jt} + \alpha_2 \log E_{kt} + \alpha_3\beta_1 \log S_{jkt} + \alpha_3\beta_2 \log T_{jkt} + \gamma_1 p_{jt} + \delta_1 p_{kt} + \gamma_j + \delta_k + \lambda_t\Big) + \varepsilon_{jkt} \tag{3}$$

W_{jkt} represents worker flow from industry j to k at time t, E_j and E_k represent total employment in industries j and k, S_{jkt} represents task distance, T_{jkt} represents transaction index for economic interrelatedness, and p_{jt} and p_{kt} are sector specific control variables.

Results

Table: PPML Results for Inter-industry Worker Flow

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log total employment of source sector	0.41***	0.40***	0.41***	0.41***	0.46***	0.48***
	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)
Log total employment of destination sector	0.60***	0.58***	0.62***	0.57***	0.61***	0.58***
	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)
Log transaction index	0.21***	0.21***	0.21***	0.21***	0.21***	0.21***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log task distance	-0.64***	-0.64***	-0.64***	-0.64***	-0.64***	-0.64***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log average earnings of source industry (t-1)		-0.01		0.04		0.22
		(0.27)		(0.28)		(0.26)
Log average earnings of destination industry (t-1)		-0.35		-0.70***		-0.35
		(0.23)		(0.24)		(0.22)
Log job creation rate of source industry			-0.06	-0.06		
			(0.05)	(0.05)		
Log job creation rate of destination industry			0.37***	0.38***		
			(0.07)	(0.07)		
Log job destruction rate of source industry					0.31***	0.31***
					(0.07)	(0.07)
Log job destruction rate of destination industry					0.02	0.02
					(0.05)	(0.05)
Observations	74,476	74,476	74,476	74,476	74,476	74,476
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Source-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Results

- Transitions are more likely for sectors with high employment share. (Higher matching probability, labor demand/supply conditions)
- Task distance appears to be an important source of friction for worker mobility.
- Worker movements are more frequent between sectors that are more interrelated through input-output linkages (Transaction index).
- Job creation in the destination sector and job destruction in source sector are positively correlated with worker movements between sectors.

Robustness Checks

Table: PPML Estimates of Worker Flows Between Industries, Last 12 Months

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log total employment of source industry	0.40***	0.38***	0.40***	0.39***	0.45***	0.46***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Log total employment of destination industry	0.58***	0.56***	0.59***	0.55***	0.59***	0.57***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Log transaction index	0.20***	0.20***	0.20***	0.20***	0.20***	0.20***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log task distance	-0.64***	-0.64***	-0.64***	-0.64***	-0.64***	-0.64***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log of lagged average earnings of source industry		-0.16		-0.11		0.07
		(0.25)		(0.25)		(0.24)
Log of lagged average earnings of destination industry		-0.28		-0.58***		-0.27
		(0.22)		(0.23)		(0.21)
Log job creation of source industry			-0.06	-0.06		
			(0.04)	(0.04)		
Log job creation of destination industry			0.32***	0.32***		
			(0.06)	(0.06)		
Log job destruction of source industry					0.30***	0.30***
					(0.05)	(0.05)
Log job destruction of destination industry					0.04	0.03
					(0.04)	(0.04)
Observations	74,476	74,476	74,476	74,476	74,476	74,476
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Source-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Robustness Checks

Table: PPML Estimates of Worker Flows Between Industries, Skills and Transaction Index is 2023 Values

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log total employment of source industry	0.57***	0.57***	0.54***	0.457***	0.59***	0.64***
	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)
Log total employment of destination industry	0.73***	0.74***	0.75***	0.73***	0.73***	0.75***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Log transaction index	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log task distance	-0.62***	-0.62***	-0.62***	-0.62***	-0.62***	-0.62***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log of lagged average earnings of source industry		0.51*		0.53*		0.74***
		(0.27)		(0.28)		(0.26)
Log of lagged average earnings of destination industry		0.16		-0.21		0.16
		(0.23)		(0.24)		(0.22)
Log job creation of source industry			-0.04	-0.04		
			(0.05)	(0.05)		
Log job creation of destination industry			0.38***	0.38***		
			(0.07)	(0.07)		
Log job destruction of source industry					0.30***	0.31***
					(0.07)	(0.07)
Log job destruction of destination industry					0.01	0.01
					(0.05)	(0.05)
Observations	74,820	74,820	74,820	74,820	74,820	74,820
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Source-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Robustness Checks

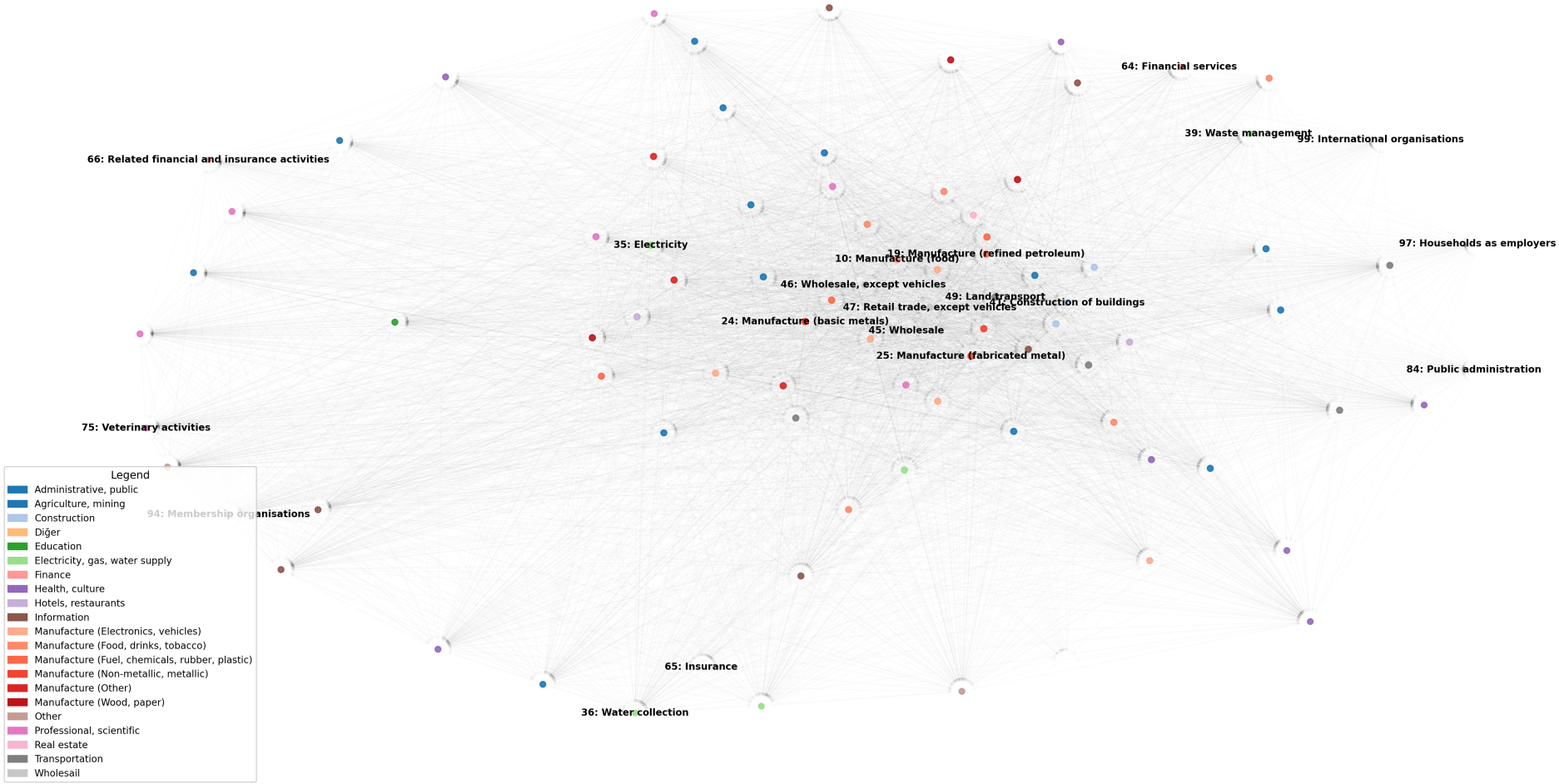
Table: PPML Estimates of Worker Flows Excluding 2020 and 2021

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log total employment of source industry	0.42***	0.40***	0.44***	0.42***	0.49***	0.57***
	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.08)
Log total employment of destination industry	0.70***	0.64***	0.68***	0.61***	0.72***	0.97***
	(0.07)	(0.06)	(0.07)	(0.06)	(0.06)	(0.01)
Log transaction index	0.20***	0.21***	0.20***	0.21***	0.20***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log task distance	-0.65***	-0.65***	-0.65***	-0.65***	-0.65***	-0.68***
	0.42***	0.40***	0.44***	0.42***	0.49***	0.57***
Observations	59,512	59,512	59,512	59,512	59,512	59,512
Controls	No	Wage	Job Creation	Job Creation-Wage	Job Destruction	Job Destruction-Wage
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Source-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-industry FE	Yes	Yes	Yes	Yes	Yes	Yes

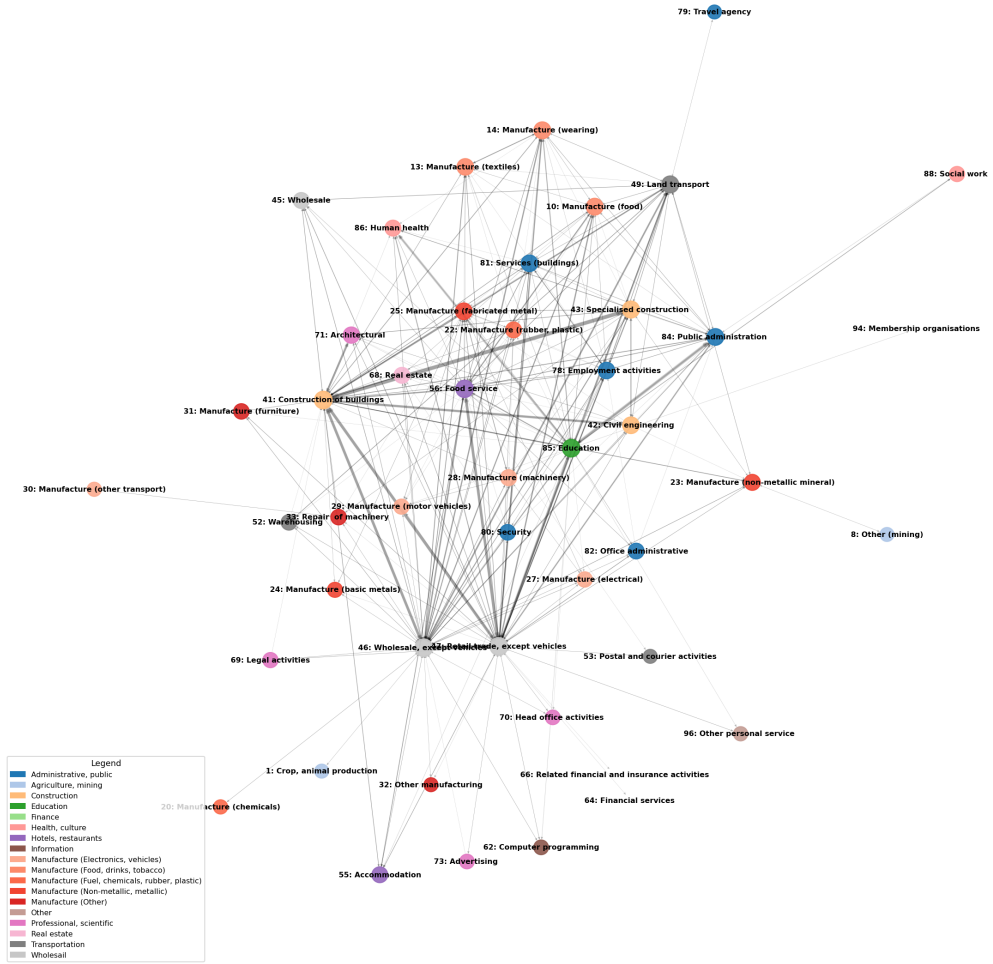
Conclusion

- The probability of workers transitioning to sectors where more similar tasks are performed and stronger trade linkages are higher.
- Sector-specific variables play a limited role.
- To improve labor market efficiency, policymakers must consider the structural frictions that shape worker movements across industries.
- Policy implication: When mobility barriers arise due to differences in required skills or task structures, targeted re-skilling and training programs can help reduce these frictions.

Transaction Index



Worker Flow Cluster Graph



Abilities

Variables	Physical Strength and Coordination	Sensory and Perceptual Abilities	Fine Motor Skills and Dexterity	Cognitive and Reasoning Abilities	Mathematical Abilities
Gross Body Coordination	0.9086	0.1242	0.009	0.0744	-0.0469
Stamina	0.9069	0.0708	0.0452	0.0327	-0.0613
Dynamic Strength	0.8279	0.0532	0.1353	-0.0412	-0.0227
Gross Body Equilibrium	0.8254	0.1954	0.033	0.1069	-0.0296
Night Vision	-0.0132	1.0268	-0.1149	-0.0797	0.0758
Peripheral Vision	0.0829	1.0172	-0.167	-0.0741	0.0758
Spatial Orientation	0.1282	0.9767	-0.1732	-0.0291	0.1061
Glare Sensitivity	0.0644	0.9397	-0.0643	-0.0622	0.0509
Finger Dexterity	0.1573	-0.2699	0.9348	-0.1686	-0.0808
Arm-Hand Steadiness	0.3183	-0.1096	0.7603	-0.1946	-0.1099
Visual Color Discrimination	0.1075	0.0284	0.7157	0.1438	0.12
Manual Dexterity	0.3192	-0.0818	0.7156	-0.2526	-0.1066
Problem Sensitivity	0.0757	0.12	0.0782	0.8615	0.0168
Deductive Reasoning	-0.0092	-0.0058	-0.1441	0.8341	0.2021
Inductive Reasoning	-0.0502	0.0033	-0.1164	0.8218	0.1583
Fluency of Ideas	0.1229	-0.2089	-0.1116	0.796	0.2299
Speed of Closure	-0.0172	0.127	0.2131	0.7782	0.056
Originality	0.1443	-0.2536	-0.0899	0.7698	0.1929
Mathematical Reasoning	-0.2015	0.1218	-0.0794	0.4056	0.6661
Number Facility	-0.1693	0.1409	-0.0718	0.3884	0.6509

Activities

Variables	Leadership and Human Development	Information Processing and Analytical	Customer Service and External	Technical and Physical Operations	Creative and Support Services Activities
Coaching and Developing Others	1.0369	-0.0727	-0.1447	-0.1136	-0.1471
Training and Teaching Others	0.9281	0.0664	-0.3097	-0.0723	-0.1606
Guiding, Directing, and Motivating Subordinates	0.9193	-0.0813	0.0274	0.086	0.0325
Coordinating the Work and Activities of Others	0.8335	-0.0412	0.0925	0.1284	-0.01
Processing Information	-0.1004	0.9182	-0.0909	-0.0992	0.0772
Documenting/Recording Information	-0.1308	0.864	0.183	0.0102	-0.2528
Analyzing Data or Information	0.0778	0.827	-0.1954	-0.2049	0.2338
Getting Information	-0.0386	0.8063	0.0578	-0.0814	-0.0249
Updating and Using Relevant Knowledge	0.0433	0.7549	0.1001	-0.1086	0.0577
Identifying Objects, Actions, and Events	0.0522	0.7505	-0.0786	0.3211	-0.0978
Performing for or Working Directly with the Public	-0.0822	-0.0854	0.8553	0.0087	-0.4132
Communicating with Persons Outside Organization	-0.0443	0.3011	0.6622	-0.1852	0.0708
Selling or Influencing Others	0.187	-0.2241	0.6356	-0.0448	0.1964
Inspecting Equipment, Structures, or Material	0.0294	0.0011	-0.0339	0.9307	-0.0058
Repairing and Maintaining Mechanical Equipment	-0.0627	-0.117	-0.0641	0.8734	0.1776
Controlling Machines and Processes	-0.0133	-0.0691	-0.1841	0.8324	0.0428
Handling and Moving Objects	0.0086	-0.3204	0.0365	0.8044	-0.1441
Operating Vehicles, Mechanized Devices, or Equipment	-0.0695	-0.1076	0.1189	0.7998	0.0162
Estimating the Quantifiable Characteristics of Products, Events, or Information	0.199	0.3246	-0.1415	0.4551	0.4663
Assisting and Caring for Others	0.2857	0.0346	0.3448	0.144	-0.6798

Context

Variables	Outdoor and Environmental Conditions	Physical Activity and Posture	External Communication and Equipment Pacing	Interpersonal Conflict and Difficult People	Health Hazards and Safety Risks	Leadership and Teamwork	Work Autonomy and Decision Authority	Routine Tasks and Precision Requirements
Outdoors, Exposed to Weather	1.0583	-0.1224	0.1269	0.1906	-0.076	-0.102	-0.0026	-0.1688
Outdoors, Under Cover	1.0039	-0.17	0.2345	0.0507	0.0134	-0.0366	-0.0526	-0.1919
In an Enclosed Vehicle or Equipment	0.9756	-0.2864	0.1124	0.2628	-0.0923	-0.1872	0.1541	-0.108
Extremely Bright or Inadequate Lighting	0.868	0.0196	0.0293	0.0592	0.074	-0.061	-0.0585	0.0675
Spend Time Standing	-0.0715	1.0223	-0.0408	0.0518	-0.0665	0.135	0.0228	-0.1252
Spend Time Sitting	0.0162	-0.9943	0.0375	-0.0313	0.0406	-0.1365	-0.0393	0.1831
Spend Time Bending or Twisting the Body	0.2064	0.8096	0.0586	0.0757	0.0607	-0.077	0.0067	0.103
Pace Determined by Speed of Equipment	0.1665	0.2261	-0.5038	-0.1004	-0.063	0.1554	-0.2306	0.2461
Telephone	0.1916	-0.4507	0.4675	0.2179	0.0458	0.0651	0.2122	0.1994
Deal With Unpleasant or Angry People	-0.0621	0.1393	0.0068	0.8778	0.0169	0.0493	-0.1181	0.1332
Deal With Physically Aggressive People	0.0685	0.0212	-0.0898	0.7553	0.259	-0.0017	-0.1097	-0.1783
Frequency of Conflict Situations	0.0338	-0.0172	-0.0027	0.6996	-0.0736	0.3411	0.043	0.0324
Exposed to Disease or Infections	-0.2562	0.0603	0.0324	0.4333	0.7316	-0.1264	0.1043	-0.0946
Exposed to Radiation	-0.0121	-0.1288	0.0403	0.0129	0.7142	0.01	-0.0502	0.0858
Consequence of Error	0.3392	-0.1811	-0.2622	0.2068	0.4361	0.0247	0.1063	0.2172
Coordinate or Lead Others	-0.0664	0.0304	-0.004	0.1673	-0.0348	0.8073	0.0643	-0.1147
Work With Work Group or Team	-0.0302	-0.0621	0.0342	0.2357	0.0497	0.7674	-0.2674	0.0428
Freedom to Make Decisions	-0.0371	-0.0779	0.0797	-0.0314	0.0453	-0.089	0.8097	-0.1848
Structured versus Unstructured Work	-0.1423	-0.1091	0.1113	-0.1078	-0.021	0.0437	0.7346	-0.1539
Impact of Decisions on Co-workers or Company Resu	0.1287	-0.0232	-0.0145	0.3643	0.0411	0.1543	0.5165	0.2465
Importance of Repeating Same Tasks	-0.0382	-0.1443	0.0657	0.2474	0.0015	0.0335	-0.2163	0.7714
Importance of Being Exact or Accurate	-0.2292	-0.1582	-0.0052	-0.0686	0.1577	-0.0125	0.1296	0.7148
Spend Time Making Repetitive Motions	-0.1041	0.5472	0.0229	0.0793	-0.1585	-0.1889	-0.1426	0.581

Skills

Variables	Analytical and Technical Skills	Interpersonal and Management Skills	Technical Operations and Maintenance Skills	Resource Management Skills
Science	0.884	-0.1206	0.1503	-0.1753
Complex Problem Solving	0.8148	0.2281	0.0947	0.0246
Critical Thinking	0.8103	0.2505	0.0163	-0.0336
Instructing	0.5141	0.5778	0.0849	-0.1383
Monitoring	0.4303	0.5967	0.252	-0.0384
Time Management	0.2206	0.5936	0.0517	0.2587
Equipment Maintenance	-0.0447	0.0106	0.9559	-0.1059
Repairing	-0.0224	0.017	0.9532	-0.0972
Troubleshooting	-0.001	-0.0065	0.9513	0.0176
Management of Financial Resources	-0.0031	0.1953	-0.1092	0.868
Management of Material Resources	-0.0245	0.2654	0.1085	0.8279