Online Appendix to

Disaggregated Economic Accounts

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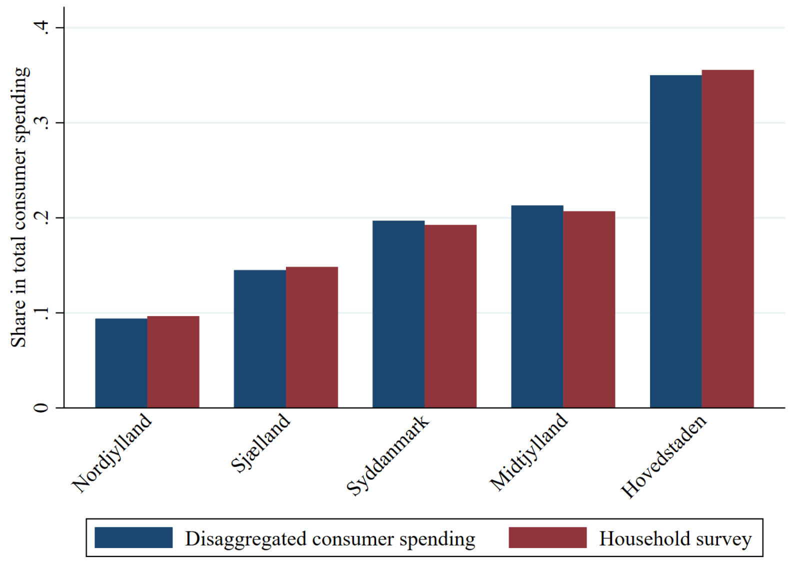
Appendix A Additional Figures and Tables

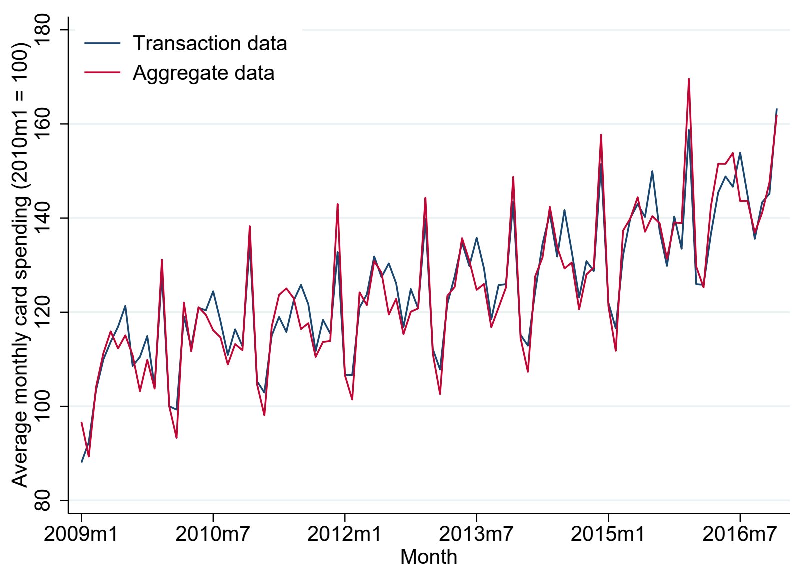
Appendix A.A Measurement

Figure A.I: Consumer spending shares in the disaggregated accounts and a household survey



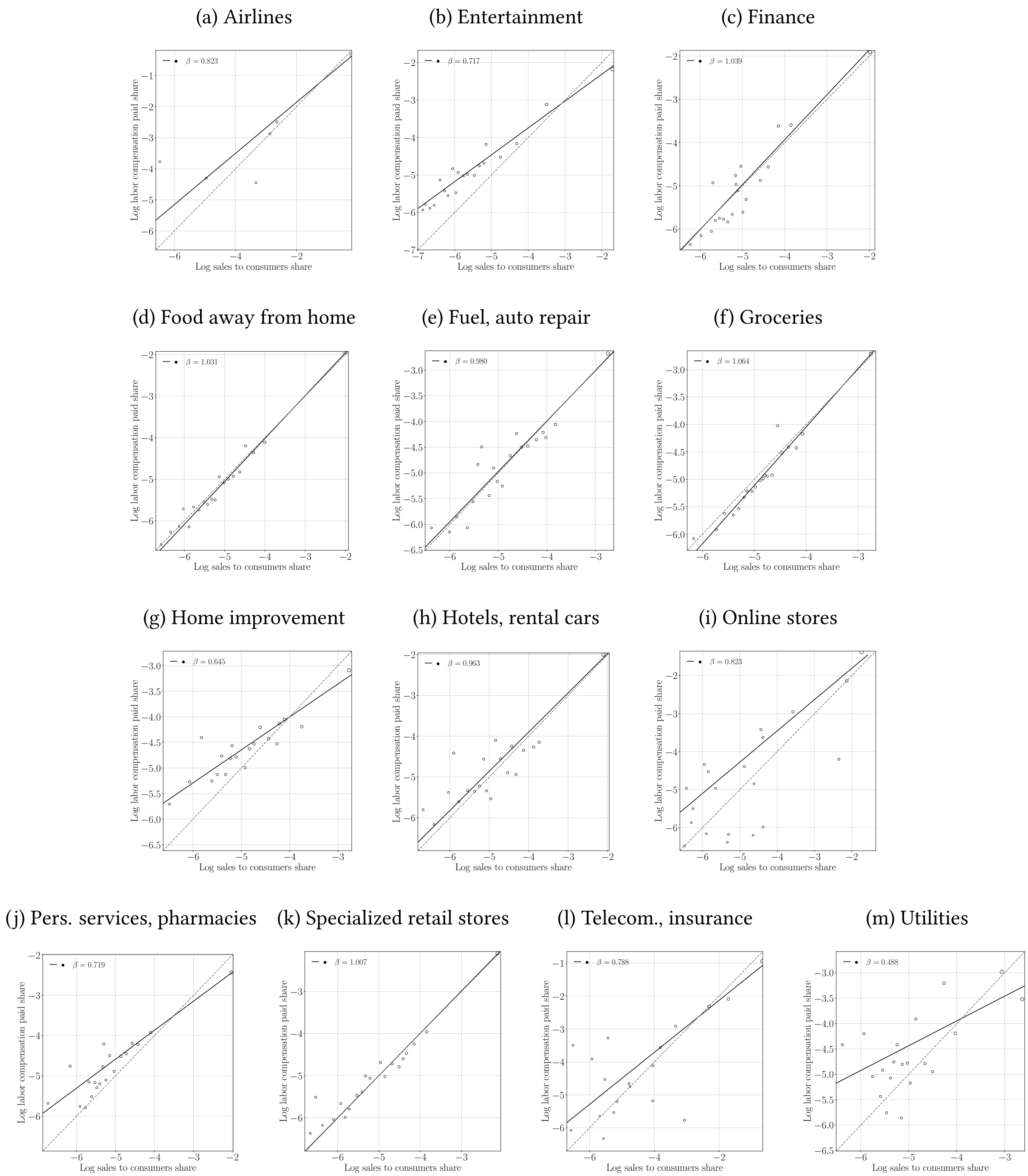
The figure compares consumer spending shares at the level of aggregated regions from the disaggregated consumer spending matrix to the Danish household budget survey.

Figure A.II: Consumer card spending over time



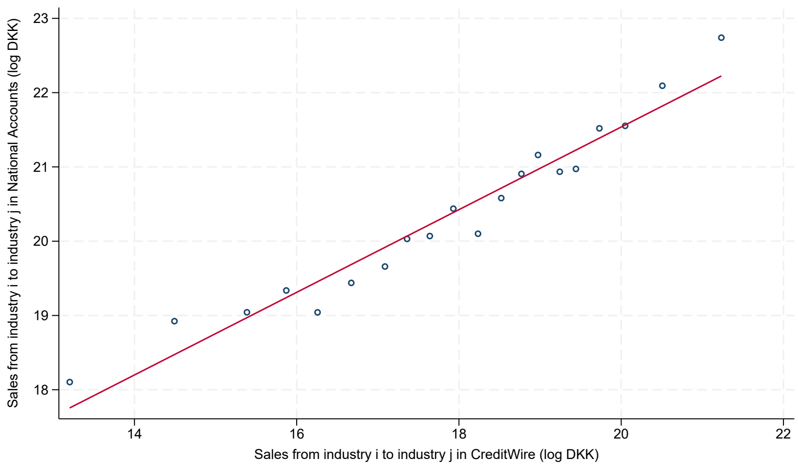
The figure compares aggregated consumer card spending over time in data from Danske Bank and Statistics Denmark (statistikbanken.dk/MPK60).

Figure A.III: Labor income shares and consumer spending shares across regions



The panels show binned scatter plots using data for one industry each. Each panel plots log labor compensation paid by producers in the region (as share of total labor compensation in an industry) against log consumer spending received by producers in the region (as share of total consumer spending in an industry). The solid lines are the lines of best fit, estimated using the cell-level data. Each circle contains the same number of regions. The size of a circle is proportional to the population size of cells in the region. The regressions are weighted by the within-industry spending share of each region. Standard errors are clustered by region.

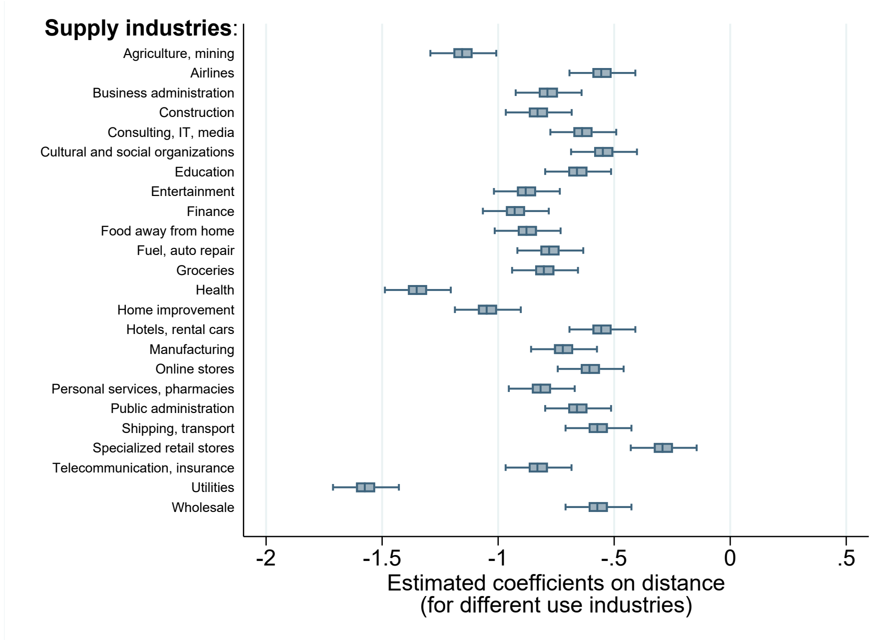
Figure A.IV: Industry-to-industry sales in CrediWire and national accounts



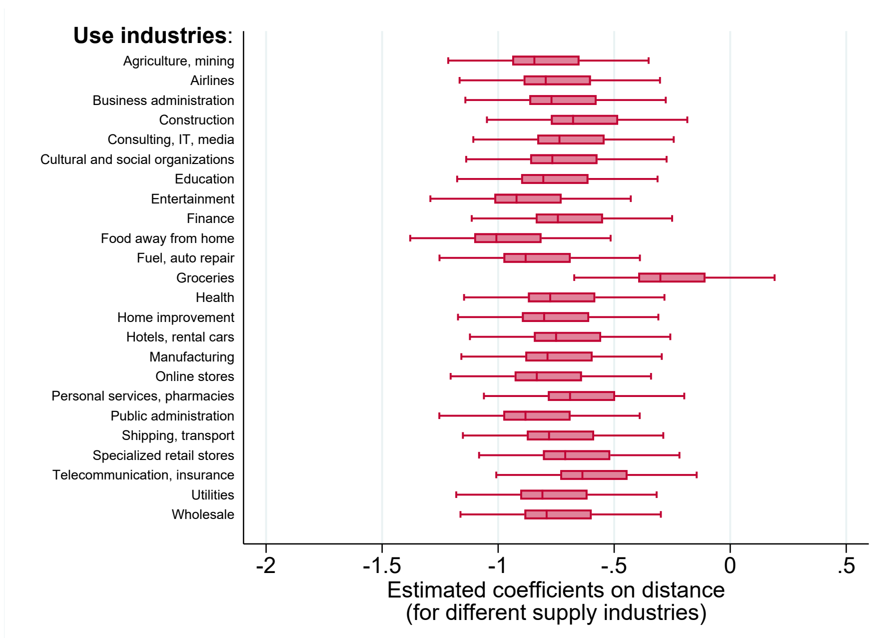
We construct a matrix of industry-to-industry intermediates transactions using the CrediWire data by aggregating transactions in CrediWire. We then plot a binned scatter plot of entries in the matrix using CrediWire data against the corresponding entries in the national accounts input-output table for intermediates trade. The high correlation suggests that the Crediwire data are broadly representative in terms of the distribution across supply and use industries.

Figure A.V: Distance coefficients for different industries

(a) By supply industry



(b) By use industry



The figure illustrates how the effect of distance on producer-to-producer trade varies across industries in the CrediWire data. We use a gravity specification to obtain estimates of the elasticity of trade with respect to distance for each combination of supply industry and use industry (576 estimates). Panel a shows the distribution of distance elasticity estimates for each supply industry separately (24 estimates in each case). Panel b shows the distribution of distance elasticity estimates for each use industry separately (24 estimates in each case). The box plots indicate the median elasticity estimate (the line inside the box), the quartiles (the edges of the box), and the upper and lower adjacent values (the whiskers).

Table A.I: Classification of industries

	Producer industry	Produces output	Sells directly to consumers	Pays labor compensation to consumers ("work industry")
1	Food away from home	Yes	Yes	Yes
2	Entertainment	Yes	Yes	Yes
3	Groceries	Yes	Yes	Yes
4	Personal services, pharmacies	Yes	Yes	Yes
5	Vehicles, fuel, vehicle repair, public transport	Yes	Yes	Yes
6	Hotels, rental cars	Yes	Yes	Yes
7	Airlines	Yes	Yes	Yes
8	Telecommunications, insurance	Yes	Yes	Yes
9	Online stores	Yes	Yes	Yes
10	Utilities	Yes	Yes	Yes
11	Specialized retail stores	Yes	Yes	Yes
12	Home improvement	Yes	Yes	Yes
13	Consulting, information technology, media	Yes	No	Yes
14	Business administration and janitorial services	Yes	No	Yes
15	Manufacturing	Yes	No	Yes
16	Wholesale	Yes	No	Yes
17	Finance, real estate	Yes	Yes	Yes
18	Cultural and social organizations	Yes	Yes	Yes
19	Agriculture, mining	Yes	No	Yes
20	Construction	Yes	No	Yes
21	Shipping, transport	Yes	No	Yes
22	Out of workforce and others	No	No	No
23	Retired	No	No	No
24	Health	Yes	No	Yes
25	Students	No	No	No
26	Education	Yes	No	Yes
27	Public administration	Yes	No	Yes
28	unemployed	No	No	No
29	Private landlords	Yes	Yes	No
30	Owner-occupied housing	Yes	Yes	No
31	Government-owned housing	Yes	Yes	No

The table lists the industry classification used throughout the paper. Specialized retail stores include shops selling a specialized set of goods not listed in another industry, e.g., books, computers, shoes, clothing.

Table A.II: Summary statistics on the population and Danske Bank sample

	Full population	Danske Bank sample
Number of adults	4,367,226	858,409
Mean age	48.56	49.97
Mean income (DKK)	298,834	281,039
Age distribution		
18-39	0.35	0.34
40-59	0.35	0.32
60+	0.30	0.34
Income distribution		
Quintile 1	0.20	0.22
Quintile 2	0.20	0.23
Quintile 3	0.20	0.21
Quintile 4	0.20	0.18
Quintile 5	0.20	0.17
Ratio of liquid assets to income distribution		
Quintile 1	0.20	0.20
Quintile 2	0.20	0.21
Quintile 3	0.20	0.19
Quintile 4	0.20	0.20
Quintile 5	0.20	0.20

The table compares summary statistics for the Danish population from administrative registers with our sample of Danske Bank customers.

Appendix A.B Stylized Facts

Table A.III: Determinants of domestic spending shares

	(1)	(2)	(3)	(4)	(5)	(6)
	Domestic spending share (%)					
Log population in region	-1.24***		-0.97***		-1.22***	-1.34***
	(0.19)		(0.20)		(0.15)	(0.19)
Age	0.19***	0.19***	0.22***	0.34***	0.18***	0.17***
	(0.029)	(0.029)	(0.044)	(0.053)	(0.021)	(0.036)
College-educated share	-9.36***	-7.59***	-12.91***	-5.42*	-8.82***	-7.39***
	(1.97)	(2.24)	(2.11)	(3.16)	(2.75)	(2.21)
Log density		-0.75***				
		(0.16)				
Distance to border					1.03***	1.07***
					(0.18)	(0.18)
Income (std.)					0.34	
					(0.45)	
Leverage (std.)						-0.26
						(0.36)
Liquid assets (std.)						-0.14
						(0.094)
Illiquid assets (std.)						0.028
						(0.35)
Observations	2,727	2,727	2,727	2,727	2,727	2,727
Industry FE	No	No	Yes	Yes	No	No
Region FE	No	No	No	Yes	No	No
R^2	0.44	0.42	0.63	0.71	0.48	0.48

The outcome is the share of spending going to domestic producer cells relative to total spending. Distance to border is the driving distance from the region center to the nearest of eight foreign addresses (Malmø, Helsingborg, Rostock, Puttgarden, and four large border shopping centers along the Jutland-Germany border) on Google Maps. Income, leverage, liquid assets, and illiquid assets are standardized to have a mean of 0 and standard deviation of 1. Income is average total post-tax income of consumers in the cell. Leverage is total debt divided by total assets (liquid plus illiquid assets). Liquid assets is the average value of total financial assets (including bank deposits, stocks, bonds, investment funds) owned by consumers in the cell. Illiquid assets is the average value of non-financial assets (including housing, cars, pensions) owned by consumers in the cell. Standard errors are clustered by consumer region and consumer industry. The regressions are weighted by population in the consumer cell. Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1.

Table A.IV: Consumer spending gravity regression for inflows into urban regions

	Log spending	
	(1)	*(2)*
Log distance	-1.33^{***}	-1.73^{***}
	(0.032)	(0.11)
Log distance × log dest. pop.		0.72^{***}
		(0.19)
Origin FE	Yes	Yes
Destination FE	Yes	Yes
Observations	2,561,036	2,561,036
R^2	0.324	0.325

Distance is measured as driving distance on Google Maps between region centers. For the interaction terms, we normalize log population to range from 0 to 1 across regions. The interaction coefficient therefore shows the change in the distance gradient when moving from lowest to highest population size. We include only spending to Danish producers in the regressions. Standard errors are clustered by consumer region and consumer industry. The regressions are weighted by population in the consumer cell. Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1.

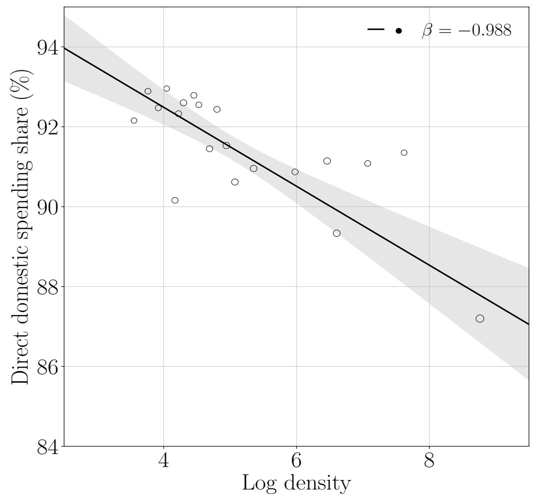
Table A.VI: External trade surplus across regions by region size

Regions	Adult population	External trade surplus	External trade surplus per adult
15 most populous regions	1,962,365	27.39 bn DKK	13,956 DKK
70 least populous regions	1,970',472	124.47 bn DKK	63,166 DKK

Table A.VII: Internal trade surplus across regions by region size

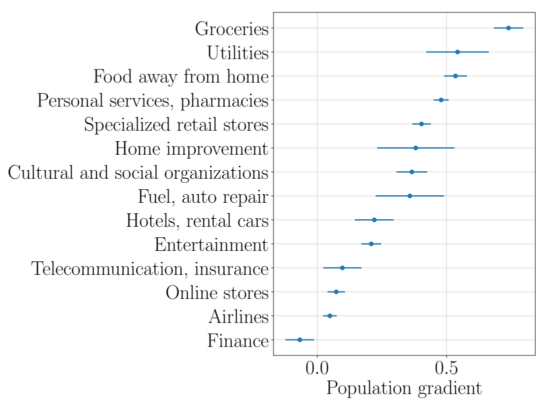
Regions	Adult population	Internal trade surplus	Internal trade surplus per adult
15 most populous regions	1,962,365	534.87 bn DKK	272,564 DKK
70 least populous regions	1,'970,472	297.00 bn DKK	150,724 DKK

Figure A.VI: Domestic spending share by log density



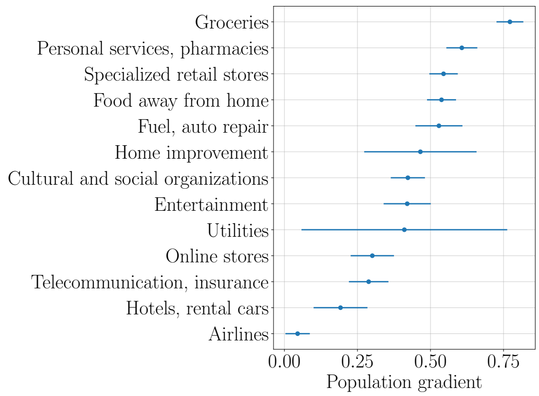
The figure replicates Figure III using log population density on the horizontal axis.

Figure A.VII: Population of home and receiving region: all spending



The figure shows coefficients from regressions of the average log population of regions receiving consumer spending from a consumer cell on the log population of the consumer cell's region. Each coefficient comes from a different regression using only data for one industry. The regressions are weighted by consumer cell population. Standard errors are clustered by region. The error bands are 95% confidence intervals.

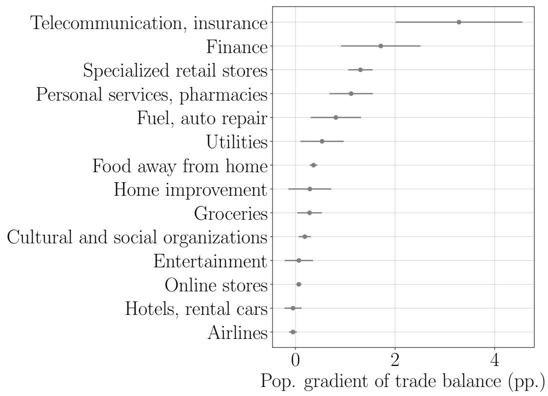
Figure A.VIII: Population of home and receiving region: only in-person spending



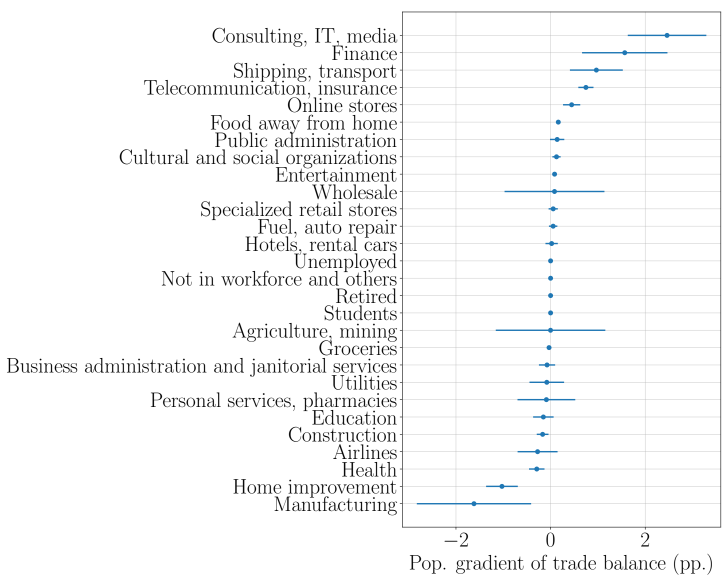
This plot replicates Figure A.VII using data for only spending carried out in person. We exclude finance since offline spending is rarely observed for the finance industry.

Figure A.IX: Internal trade surpluses and population size by industry

(a) Consumer spending

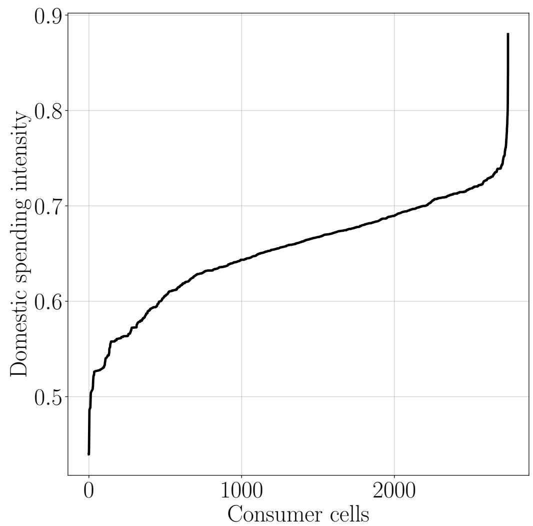


(b) Intermediates trade



This plot shows estimated coefficients of a regression of the internal trade surplus (sales to other domestic regions minus purchases by other domestic regions) on log population. Each coefficient comes from a different regression using only data for one industry. Panel a uses data on consumer spending and panel b on intermediates trade. The regressions are weighted by population in the region. Standard errors are clustered by region. The error bands are 95% confidence intervals.

Figure A.X: Distribution of domestic spending intensity



The figure plots the distribution of domestic spending intensity across consumer cells.

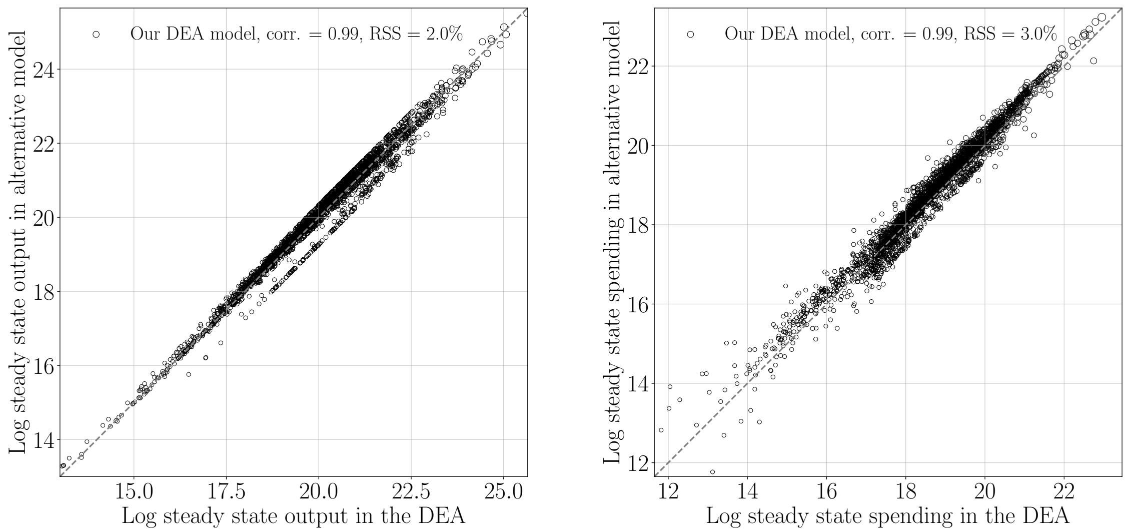
Appendix A.C Details on Calibration

Table A.VIII: Overview of baseline calibration

Parameter(s)	Symbol	Calibration target	Flow numbers from Table I
Spending shares	α_{ji}	Disaggregated consumer spending flows	1, 2
Consumer tax rate	τ_i	Consumer product taxes paid Consumer non-product taxes and social contributions	3, 4, 5
Corporate tax rate	τ_j	Dividends and surplus from gov. enterprises, taxes	22, 23, 24, 25
Labor compensation shares	λ_{ij}	Disaggregated labor comp. flows, incl. to foreign workers	10, 28
Profit income shares	κ_{ij}, γ_j	Mixed income, surplus to consumers	11, 12, 13
Intermediate input shares, imports	$\omega_{j'j}$	Trade flows in domestic intermediates, producer imports	21, 27
Gov. transfer share of gov. revenue	$\frac{T_i}{\sum_{i\in\mathcal{I}}\tau_i Y_i+\sum_{j\in\mathcal{J}}\tau_j\Pi_j}$	Consumer social benefits received, pension adjustment	14, 15
Gov. spending share of gov. revenue	$\frac{P_j G_j}{\sum_{i\in\mathcal{I}}\tau_i Y_i+\sum_{j\in\mathcal{J}}\tau_j\Pi_j}$	Domestic government spending	29
Relative distribution of exports	$\tilde{x}_j/\tilde{x}_{j'}$	Producer exports	31
Gov. import share of gov. revenue	$\tilde{g}$	Government imports	32
Aggregate export flows	$\tilde{x}_j$	Aggregate GDP	
Elasticity of export demand	$\tilde{\sigma}$	Cobb-Douglas (1) as baseline, higher in robustness	
Transfer from abroad	Δ	Zero absent any transfer shock	

Figure A.XI: Match between model economy and disaggregated accounts

(a) Sales by producer cell (b) Domestic consumer spending

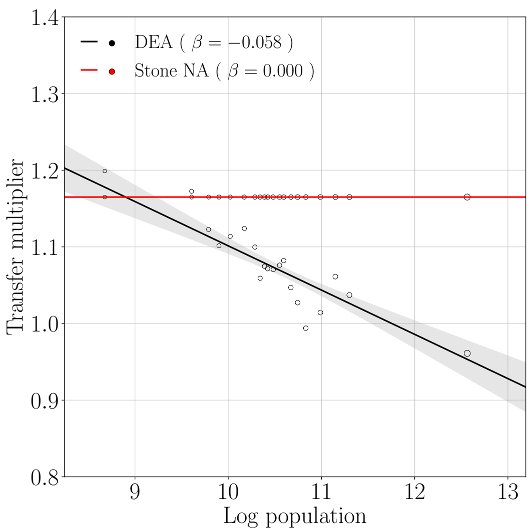


Panel a shows a scatter plot of log producer cell output in the model relative to the disaggregated accounts. Node size is proportional to producer cell output in the disaggregated accounts. Panel b shows a scatter plot of log consumer spending in the model relative to the disaggregated accounts. Node size is proportional to domestic spending in the disaggregated accounts. “corr” stands for correlation. “RSS” stands for the residual sum of squares. RSS captures the variance in the data not explained by the model, var$(y^{data} - y^{model})$, for any variable y, in percent of variance in the data var(y^{data}). RSS larger than 100% would imply that the variation in the model does not explain the data well.

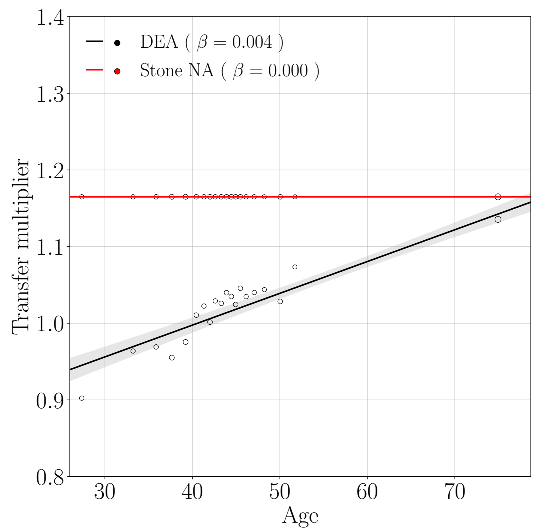
Appendix A.D Fiscal Transfer Multipliers

Figure A.XII: Multipliers and consumer characteristics

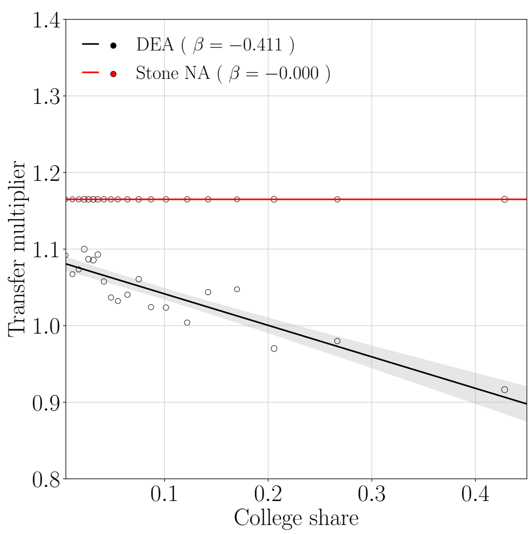
(a) By region size



(b) By age



(c) By college education



(d) By region density

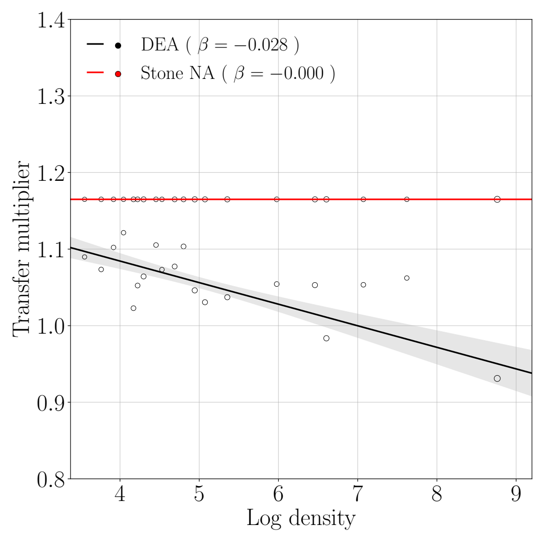
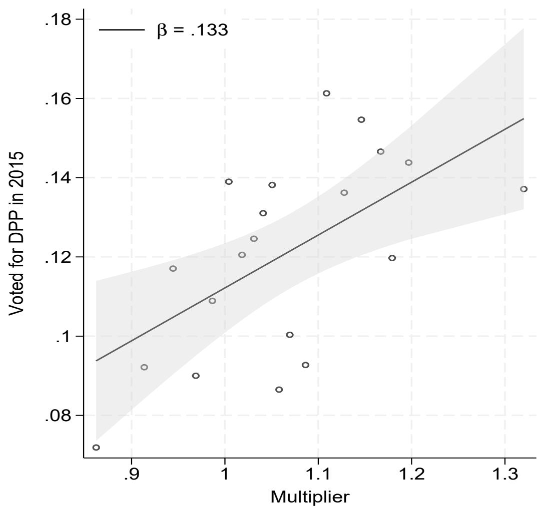
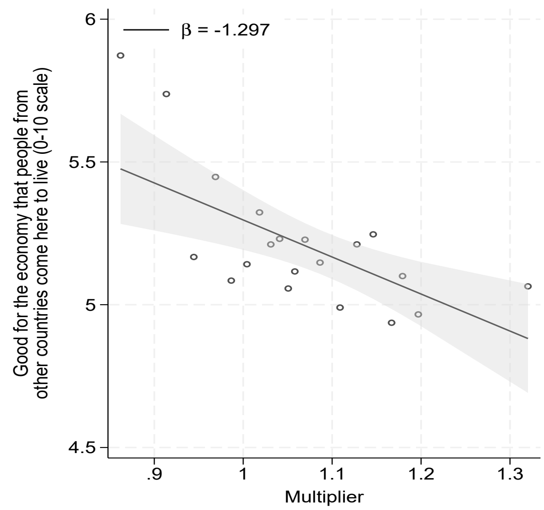


Figure A.XIII: Political and social preferences of high-multiplier cells

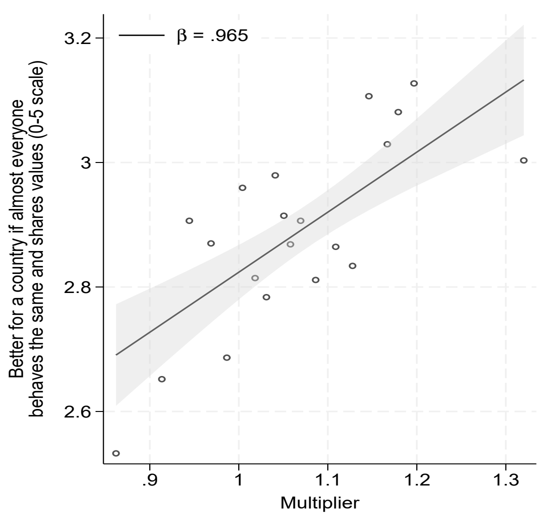
(a) Vote for right-wing populist party?



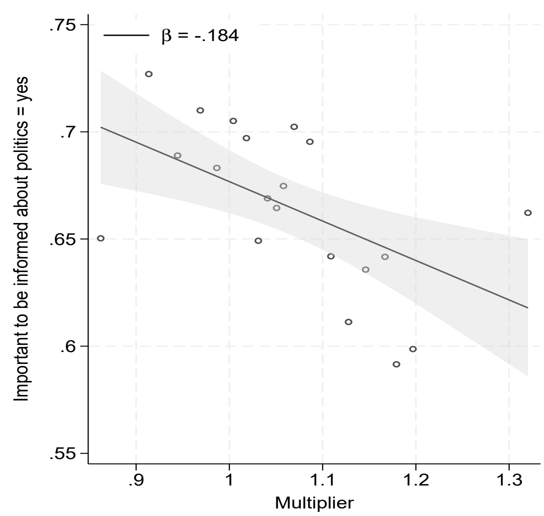
(b) Immigrants are bad for the economy?



(c) Better if everyone shares values?



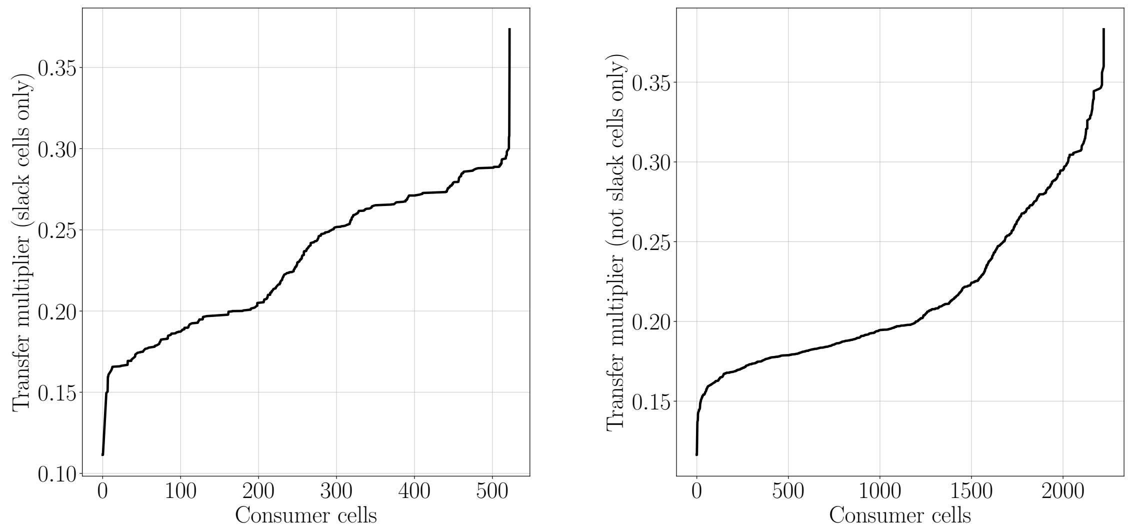
(d) Important to be informed about politics?



The panels report binned scatter plots of survey responses at the individual level against the multiplier of the individual's consumer cell. The relevant survey question is reported on the vertical axis. DPP is a right-wing populist party called Danish People's Party. The solid lines are the lines of best fit, estimated using the individual-level data. Each circle represents the same number of individuals. Standard errors are clustered by consumer cell. The error bands are 95% confidence intervals.

Figure A.XIV: Distribution of multipliers after U.S. tariff shock

(a) Multipliers among slack cells (b) Multipliers among non-slack cells



Panel a plots the distribution of the transfer multiplier in the static model for cells that are slack due to the U.S. tariff shock. Panel b plots the distribution of the transfer multiplier for cells that are not slack due to the U.S. tariff shock.

Figure A.XV: Dynamic multipliers by consumer cell characteristics

(a) By region size (b) By age (c) By college share

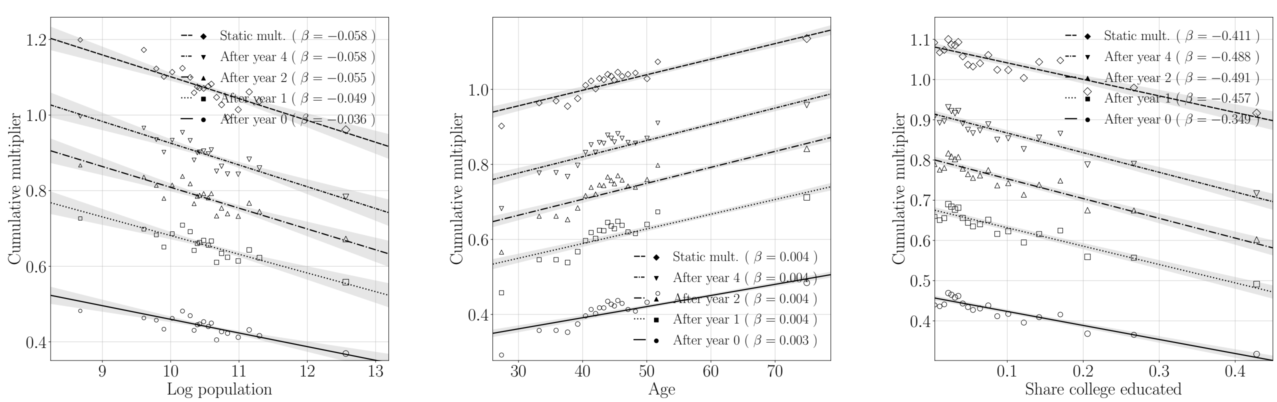
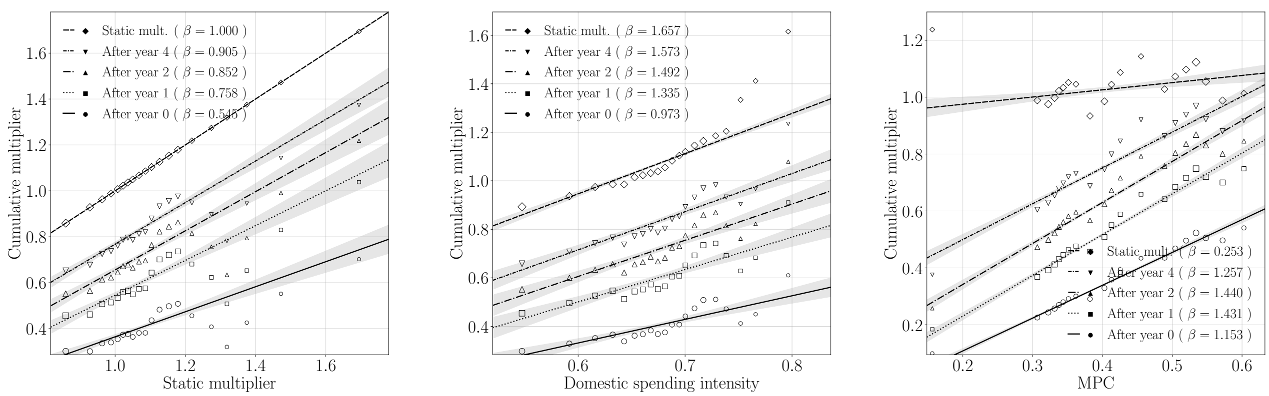


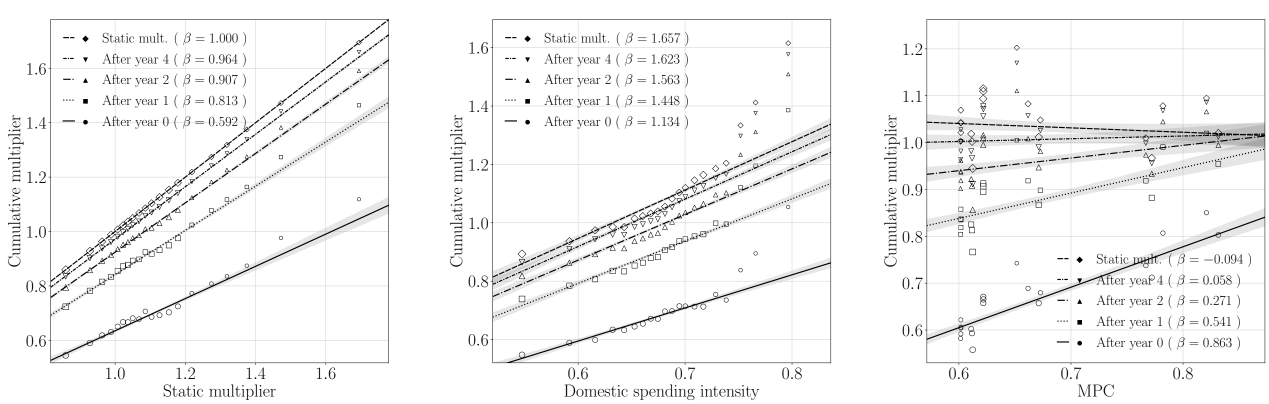
Figure A.XVI: Dynamic multipliers using MPCs from Lewis et al. (2025)



(a) Dynamic and static multipliers (b) Dynamic multipliers and domestic spending intensity (c) Dynamic multipliers and MPCs

The figure replicates Figure XIII but using the MPCs described in Appendix U.B.

Figure A.XVII: Dynamic multipliers using MPCs from Boehm et al. (2025)



(a) Dynamic and static multipliers (b) Dynamic multipliers and domestic spending intensity (c) Dynamic multipliers and MPCs

The figure replicates Figure XIII but using the MPCs described in Appendix U.C.

Table A.IX: Multipliers after U.S. tariff shock: Association with cell characteristics

	Multiplier			
	(1)	*(2)*	*(3)*	*(4)*
Avg log distance to slack cells	-0.048^{***}	-0.050^{***}	-0.049^{***}	-0.050^{***}
	(0.001)	(0.002)	(0.002)	(0.001)
Age	0.001^{***}			0.001^{***}
	(0.000)			(0.000)
Share college educated		-0.059^{***}		-0.020^{**}
		(0.010)		(0.010)
Log population			-0.007^{***}	-0.003^{**}
			(0.002)	(0.002)
Observations	2,744	2,744	2,744	2,744
R^2	0.846	0.807	0.807	0.854

The table reports regressions of the cell-level multiplier on cell characteristics after the U.S. tariff shock. The specifications compare consumer cells in a similar geographic position with respect to slack cells. We control for the distance to slack cells using the average distance to other regions, weighted by regional slackness and setting distance to the home region to 1 kilometer. The regressions are weighted by population in the consumer cell. Standard errors are clustered by consumer cell. Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1.

Appendix B Accounting Identities and T-Tables by Cell Type

Table A.XI: Aggregate consumer account

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	Household property insurance received	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

Table A.XII: Aggregate producer account

Outflows			**Inflows**		
Outflow	Outflow to	Value (bn DKK)	Inflow	Inflow from	Value (bn DKK)
Labor compensation paid to domestic employees	Consumers	1132.9	Domestic consumer spending	Consumers	771.9
Mixed income from non-corporate producers	Consumers	80.7	Domestic intermediates	Producers	1423.4
Surplus of corporate producers to consumers (dividends)	Consumers	38.5	Domestic government spending	Government	572.3
Surplus of owner-occupied housing to consumers	Consumers	83.3	Domestic capital accumulation spending	Capital accumulation	359.5
Domestic intermediates	Producers	1423.4	Producer exports	Rest of the world	1077.9
Dividends and surplus of government-owned/operated producers to government	Government	67.9			
Producer product and import taxes paid	Government	71.9			
Producer net production-related taxes	Government	20.9			
Producer taxes paid on income	Government	61.9			
Producer net interest, transfers, and saving	Capital accumulation	409.9			
Producer imports	Rest of the world	792.3			
Labor compensation paid to foreign workers	Rest of the world	21.4			
Total value outflows		4205	**Total value inflows**		4205

Table A.XIII: Aggregate government account

Outflows			Inflows		
Outflow	Outflow to	Value (bn DKK)	Inflow	Inflow from	Value (bn DKK)
Consumer social benefits received	Consumers	422.2	Consumer product taxes paid	Consumers	173.2
Consumer adjustment for pension entitlements received	Consumers	92.45	Consumer non-product taxes paid	Consumers	566.4
Domestic government spending	Producers	572.3	Consumer social contributions paid	Consumers	181.1
Government imports	Rest of the world	4.3	Dividends and surplus of government-owned/operated producers to government	Producers	67.9
Government net interest, transfers, and saving	Capital accumulation	52	Producer product and import taxes paid	Producers	71.9
			Producer net production-related taxes	Government	20.9
			Producer taxes paid on income	Government	61.9
Total value outflows		1143.2	**Total value inflows**		1143.2

Table A.XIV: Aggregate rest of the world account

Outflows			Inflows		
Outflow	Outflow to	Value (bn DKK)	Inflow	Inflow from	Value (bn DKK)
Producer exports	Producers	1077.9	Net national saving	Capital accumulation	88
Labor compensation paid by foreign producers	Consumers	8.9	Foreign consumer spending	Consumers	81.9
			Producer imports	Producers	792.3
			Labor compensation paid to foreign workers	Producers	21.4
			Government imports	Government	4.3
			Capital accumulation cell imports	Capital accumulation	98.9
Total value outflows		1086.9	**Total value inflows**		1086.9

Table A.XV: Aggregate capital accumulation account

Outflows			**Inflows**		
Outflow	Outflow to	Value (bn DKK)	Inflow	Inflow from	Value (bn DKK)
Consumer interest received	Consumers	5.3	Consumer interest paid	Consumers	29.7
Household property insurance received	Consumers	75.5	Consumer natural resource rents paid	Consumers	3.4
Consumer natural resource rents received	Consumers	3.4	Consumer other transfers paid	Consumers	44.8
Consumer other transfers received	Consumers	39.2	Consumer gross saving	Consumers	130.1
Domestic capital accumulation spending	Producers	359.5	Producer net interest, transfers, and saving	Producers	409.9
Capital accumulation cell imports	Rest of the world	98.9	Government net interest, transfers, and saving	Government	52
Net national saving	Rest of the world	88			
Total value outflows		670	**Total value inflows**		670

Appendix C Overview of Data Sources

We rely on several types of data to construct the disaggregated economic accounts. First, we use data from Danske Bank containing information about individual consumers and their transactions and producer-to-producer transaction data from CrediWire. Second, we use administrative data from government registers, such as the population, income, and employment registers. Third, we use publicly available aggregate statistics, such as housing, healthcare, and financial securities statistics.

In the following appendices, we provide details about the data sources and the disaggregated measurement. Table A.XVI lists all the data sources and the relevant Appendix containing details of the measurement.

We strive for consistency across all the disaggregated measurement by relying, whenever possible, on the same sample of individuals, the entire adult population in 2018, and a uniform assignment of individuals and firm establishments to cells based on government registers. The only instance where we need to deviate from these general rules is when we construct the disaggregated consumer spending flows. Here, we work with the sample of Danske Bank customers, roughly 20% of the national adult population, and we assign individuals and firm establishments to cells using the bank's internal data, as confidentiality concerns prevent us from merging the bank data and government registers.

The aggregates of our bottom-up calculations are typically slightly lower than the national accounts aggregate, mostly because our sample contains only adults, so we ultimately scale each cell-level observation by a common scaling factor to match the national aggregate exactly.

Table A.XVI: Overview of data sources

Disaggregated data type	Microdata from private sources	Microdata from the government	Aggregate statistics	Details
Region-by-industry cells	Danske Bank customer records and incoming transactions, customer records	Population register (BEF), labor market register (AKM), income register (IND), employment registers (BFL, IDAN)		Appendix D
Consumer spending	Danske Bank customer records and payment transactions	Income register (IND), credit register (URTE), auto register (DMR)	National housing statistics (BOL101)	Appendix E
Consumer and producer product taxes	Danske Bank payment transactions	Income register (IND), employment register (BFL)	Input-output table (NIO3)	Appendix F
Consumer and producer non-product taxes		Income register (IND), pension contribution register (INPI), population register (BEF)		Appendix G
Consumer interest, transfers, and saving (paid)		Population register (BEF), income register (IND)		Appendix H
Labor compensation		Income register (IND), pension contribution register (INPI), employment register (BFL)		Appendix I
Consumer dividend, mixed income, and surplus		Income register (IND), employment register (IDAN)	General firm statistics (GF5), registered securities statistics (DNVPDKS)	Appendix J
Government benefits to consumers		Income register (IND), pension contribution register (INPI), population register (BEF)		Appendix K
Consumer interest, transfers, and saving (received)		Population register (BEF), income register (IND)		Appendix L
Intermediates trade	customer records and transaction-level data on payments	Income register (IND)	Input-output tables (NIO1, NIO2, NIO3)	Appendix N
Exports and imports	Danske Bank payment transactions	Foreign trade registry (UHDI), firm sales and purchases registry (FIKS), income register (IND)	Input-output tables (NIO1, NIO2, NIO3), overnight stays by foreigners from VisitDenmark	Appendix O
Government dividend and surplus income		CVR register (hand-collected)		Appendix P
Consumption of government and NPISH output	Danske Bank customer records and incoming transactions	Population register (BEF), education register (UDD), income register (IND)	Public expenditure statistics (SYGU1), health statistics (INDAMP01), education statistics (UDDAKT20), child care statistics (BOERN4), culture and leisure statistics (BIB1)	Appendix S

Appendix D Defining Region-by-Industry Cells

The unit of our measurement is region-by-industry cells, the interaction of geographical regions and economic industries. Specifically, we define 99 regions (98 Danish municipalities and one foreign region) and 31 industries (Table A.I). We choose this definition of region and industries because we can observe it consistently across all underlying datasets and because it reveals a large degree of heterogeneity in disaggregated flows.

There are 24 industries that pay labor compensation to consumers. They include retail industries selling directly to consumers (e.g., food away from home, entertainment, grocery stores, drug stores), non-retail industries transacting mostly with firms (e.g., wholesale, agriculture, manufacturing, business services), and government-operated industries (e.g., public administration, health, education). We map six-digit NACE industry codes to the 24 industries that employ workers. Additionally, there are 4 separate industries for the non-working parts of the population (e.g., retired, students, long-term unemployed, out of workforce) and 3 industries providing housing without employees.

In the government registers, we assign all adults to a region based on their home address at the start of 2018, as observed in the administrative population register (BEF), and to an industry based on the NACE code of the firm establishment responsible for the largest part of their 2018 labor income, as observed in the labor market register (AKM). Individuals without labor income are assigned to an industry based on their age, observed in the administrative population register (BEF), and other income sources, observed in the income register (IND). Specifically, individuals without labor income are assigned to the industry "retired" if they are older than 65 years; to the industry "students" if they receive a government stipend (for which higher education students are almost universally eligible); to the industry "long-term unemployed" if they receive unemployment or cash benefits; and otherwise to the industry "out of workforce." The long-term unemployed cell captures only those individuals fully dependent on benefits without any labor income through the entire year. We assign firm establishments to producer region-by-industry cells using information from the employment registers (BFL and IDAN). To ensure anonymity, we censor information for the (very few) consumer cells containing fewer than 3 individuals or establishments in all datasets. In the Danske Bank, CrediWire, and firm export and import data, we follow similar procedures, as outlined below.

Appendix E Measuring Disaggregated Consumer Spending

Appendix E.A Data and Sample

To construct the disaggregated spending flows, we rely on data from Danske Bank for 2018 and 2019. We observe transaction-level information on consumers and merchants only for this period. Our sample consists of adult customers who conducted at least one transaction per month and registered their main bank account at Danske Bank throughout 2018 and 2019.[A1] For each customer, we observe all incoming and outgoing transactions. Card payments accounted for 47% of the total value of payment transactions. The most common card was Dankort (debit cards issued by Nets A/S), followed by MasterCard (debit and credit cards) and Visa (debit and credit cards). Cash withdrawals accounted for 7% of transaction value, whereas bill payments (direct debits and bank transfers to merchants) accounted for 45%. Mobile applications, such as Apple Pay or the Denmark-specific MobilePay, made up 1%.

Appendix E.B Identifying Consumer Region and Industry

We identify consumers' industry by extracting the name of the employer from incoming labor compensation payments and by identifying incoming government transfers (retired, students, government stipend, unemployment benefits). We use the banks' customer records to identify their region of residence. The address register in the bank is linked to the government's address registers and updated on a monthly basis. To ensure that moves across regions do not distort the spending patterns, we update an individual's region every month when constructing the disaggregated spending data. However, consistent with the assignment in the government registers, we define the industry of main employment on an annual basis as the industry paying the largest share of annual consumer income.

Appendix E.C Identifying the Merchant Region

We extract the address of the merchant establishment (i.e., the store) from the string that accompanies payment transactions in the bank's internal computer system. The information for card and mobile payments differs slightly by payment type.

- Dankort statements include a unique ID number for each merchant establishment for transactions in Denmark and the country name for transactions abroad. We match the Danish merchant IDs to the exact merchant address using a table issued by Nets A/S.
- MasterCard includes a detailed merchant address directly in the transaction string in the following format: merchant ID, shop name, street name, house number, postal code, country.
- Visa reports the merchant ID, shop name, and town for each transaction. The merchant IDs used by Visa and MasterCard generally coincide. Based on the MasterCard data, we can therefore construct a table matching merchant ID and detailed address. In very few cases, a merchant ID gets used twice for a Danish merchant and a foreign merchant. In these cases, we assume that the transaction was with the Danish merchant.

[A1] All adults register one "main" account with the Danish government, through which they conduct all financial interactions with the government.

- Some transactions in MobilePay and Apple Pay contain merchant addresses, but some do not.

For all card and mobile payments, we extract the merchant address and convert it to a consistent format using an API service provided by the government agency Styrelsen for Dataforsyning og Effektivisering (dawa.aws.dk/dok/api/adgangsadresse). This conversion identifies precise geocodes for each merchant while accounting for misspelled addresses and addresses that appear twice due to minor differences in formatting or spelling. The API compares the merchant address from a transaction with its database of official addresses. It iterates in a Levenshtein manner (i.e., it calculates the number of letters/digits that must be exchanged before one string is equal to another). We force the Levenshtein process to consider only addresses with exactly identical postcodes. Municipalities are combinations of several postcodes. By restricting to the same postcode, we ensure that the Levenshtein process cannot change the municipality information, the key information that we use to construct the disaggregated spending flows.

If the API cannot match the address unambiguously (so-called C-match), we remove the first line of the address, which often combines abbreviations of merchant and street name, making it difficult to recognize automatically. We also check whether the address contains the name of a shopping mall, rather than an official address. If so, we replace the name of the mall with the mall's address and rerun the API process. Finally, we manually research the official address of the 100 most common unmatched addresses.

Using this procedure, we identify the official shop address for 95% of card and mobile spending. We assume that the remaining 5% go proportionally to the same regions as other card and mobile spending. These remaining 5% also include cases where mobile applications (e.g., MobilePay) and online services (e.g., PayPal) do not directly send the purchase amount to a sales terminal, but transfer to a central account first before paying the merchant.

For bill payments, we use a slightly different approach. We directly observe the merchant's postal code for recurrent bill payments, which make up 67% of all payments. These observed postal codes allow us to infer the merchant region for the majority of remaining bill payments. Specifically, we split merchants into 48 industries. We calculate the number of transactions from each consumer region going to each of these 48 industries. To minimize noise, we keep industries where at least 50% of incoming bill payments contain postal code information and where we observe at least 200 incoming transactions from every consumer region. (Industries receiving 80% of total bill transaction value satisfy these two requirements.) For these industries, we then assume that bill payments flow to the same postal codes as bill payments with observed postal codes from the same consumer region to the same industry. For the remaining industries (covering 20% of bill transaction value), we assume that bill payments flow to the same postal codes as card payments from the same consumer region to the same industry.

We generally do not observe how cash withdrawals are spent, but we assign them to merchants in proportion to observed card spending in Denmark if the withdrawal was in Denmark and to observed card spending abroad otherwise. In a few cases, country information is missing, so we assume that withdrawals without decimal points (e.g., 100.00 DKK) are withdrawn and spent in Denmark and that other withdrawals (e.g., 100.76 DKK) are spent abroad.

Appendix E.D Identifying the Merchant Industry

We observe the merchant category code (MCC), a classification for the type of goods sold by a merchant, in the bank transaction data. To create disaggregated economic accounts with consistently defined producer cells, we need to map MCCs to the industry codes used in the employment and trade data. However, no such mapping exists so far. We therefore create a new cross-walk between MCCs and NACE industries.

First, we observe each merchant's Danish business identification number (CVR) and MCC in the bank's system. We link the CVR to the Danish Central Business Register where we can retrieve the merchant's industry (at the level of 741 NACE codes). Second, we manually assign MCCs to our 31 industries (only 14 of which are consumer-facing and are assigned MCCs). We then identify which of our industries appear most frequently among merchants in each of the 741 NACE codes. In very few cases, two industries appear equally often and we manually research the largest firms to identify the best match.

We create an alternative mapping between a merchant classification system called PCAT and our industries. The PCAT usually appears as part of the electronic transaction information for bill payments and can easily be mapped to our industries. MCC and PCAT are missing for some bill payments, amounting to 8% of total transaction value through bills. We assume that these payments go proportionally to the same industries as other bill payments by the same consumer cell.

We censor information for cell-to-cell flows based on fewer than 10 transactions in total, which overall is relevant for less than 0.1% of national spending. We instead impute these flows, setting them equal to the average per capita spending flows of all other cells in the same region.

Appendix E.E Online Spending

We identify whether card transactions took place in a physical store or online. Dankort transactions include a straightforward binary indicator for online transactions. MasterCard and Visa transactions contain ISO 8583 information, an internationally standardized message sent by a sales terminal in a transaction. If the POS7 code (input method) equals 1, 6, K, or L or if the POS5 (cardholder) code equals 5, the transaction is online. We treat payments using mobile applications (e.g., MobilePay) and online services (e.g., PayPal) that do not report a physical merchant ID and address as online transactions. For digital payment services, such as PayPal and DoorDash, we typically see the correct MCC of the establishment receiving the final sales.

In constructing the disaggregated spending flows, we generally treat online spending identically to spending in a physical store. That means that we identify the region-industry cell of the merchant and assign the incoming spending to this cell. However, we adjust the regional (but not the industrial) distribution of online spending for industries where we know that consumption of the final good takes place entirely in a physical location. In these cases, we assign all online spending using the regional distribution of spending on physical merchants. The online spending on these industries often goes to the central payment terminal of a parent company before being assigned to the physical merchant. For instance, online purchases of cinema tickets are often booked through a central company terminal in Copenhagen, even though consumption happens in local movie theaters. The full list of industries where we adjust the regional distribution is: food away from home; entertainment; medical and other specialized merchants; commuting; vehicle repair; hotels; rental cars; home improvement services. (These industries are sub-categories of our 31 final industries.)

We verify that the distribution of merchants receiving spending is in line with the distribution of where workers are employed in Figure A.III, which validates the disaggregated spending data. We make one final adjustment to the disaggregated spending flows: we adjust spending on airlines flowing into Copenhagen because we know that the airline establishments receiving the spending are actually located in the neighboring Tårnby region, which also contains the airport. Specifically, we reassign a share of each consumer cell's spending on airlines flowing into Copenhagen to airlines in Tårnby, so that Copenhagen's share in airline spending received equals its share in airline employment.

Appendix E.F Improving the Spending Flows with Government Data

Consumer spending on four types of goods is not captured comprehensively in bank transaction data: housing, financial services, vehicles, and water and waste services. We replace the transaction-based values from the bank data with adjusted values derived from combining Danske Bank data with government registers.

Appendix E.F.1 Consumption of Housing

We use separate methods to assign spending on owner-occupied housing and rented housing. First, owner-occupied rents are notoriously difficult to measure because they involve no financial transaction. However, the administrative income register (IND) contains the imputed rental value of owner-occupied housing for every individual. We thus allocate the national consumption of owner-occupied housing to consumer cells in proportion to the imputed rental value of their owner-occupied housing. Expenditure on owner-occupied housing flows to the producer cell for owner-occupied housing (our industry number 30) located in the same region as the home owners. The operating surplus of an owner-occupied housing producer cell in a region (SNA B.2G) then goes back to the consumer cells owning homes in that same region.

Second, we do not observe all rental payments in the bank transaction data. We instead distribute the national consumption of rented housing across consumer cells in proportion to their estimated rental costs. We observe some rental payments in the bank data, which we use to estimate

$$rental\ payment_p = \alpha + \vartheta\, region_p + \phi\, industry_p + \psi_1\, age_p + \psi_2\, age_p^2 + \varepsilon_p, \tag{A.1}$$

where p is an individual renter. Using the estimated fixed effects ϑ and ϕ, we predict the average rental cost in each consumer cell. We observe ownership of real estate in the administrative income register (IND) and assume that all consumers who do not own real estate are renters, which allows us to calculate the number of renters by consumer cell. Combining estimated rental payments with the number of renters allows us to estimate total rental costs by consumer cell, which we use to allocate national consumption of rented housing across cells.

Finally, we use aggregate statistics to assign rental payments to producer cells. In the National Housing Statistics (Table BOL101), we observe the number of rental housing units in each region owned by different owner types: individuals, non-profit building societies, limited liability companies, housing societies, and public authorities. The surplus of individual owners accrues to the "private landlord" industry (our industry number 29) and the surplus of corporate owners accrues to the "finance, real estate" industry (our industry number 17). As there is no information about the geographical location of the owners, we assume that the geographical distribution of individual owners of rental units in a given region follows the geographical distribution of mixed income in the region and that the geographical distribution of the individuals behind corporate owners of rental units in a given region follows the geographical distribution of dividend payments. The remaining owner types are public or non-profit organizations. The surplus of these owners goes to the "government-owned housing" industry (our industry number 31) in the same region where the housing is located.

Appendix E.F.2 Consumption of Financial Services

Consumption of financial services in the national accounts is composed of the value of financial advice provided by financial firms and the interest rate spreads accruing to financial firms. While we observe payments for financial advice in the bank transaction data, it is difficult to disentangle the interest rate spreads from the raw value of interest payments in transaction data. Instead, we allocate the national consumption of financial services across consumer cells in proportion to their interest expenses. The tax register (IND) contains interest expenses for every individual. We aggregate interest expenses at the level of each consumer cell.

Producer cells in our "finance, real estate" industry (number 17) receive consumers' expenditures on financial services. To identify which regional producer cells receive expenditures from which consumer cells, we use loan-level data from the administrative credit register (URTE). Specifically, for each bank loan and each interest payment, the credit register contains an identifier for the bank branch that has recorded the loan and the interest payment. There are around 3,000 bank branches in Denmark. We do not observe the region of branches directly, so we define the region of each branch as the most common region of consumers holding loans recorded at the branch. We then compute how the interest payments of each consumer cell are distributed across bank branches in different regions. Finally, we assume that a consumer cell's spending on financial services is distributed across producer cells in proportion to its distribution of interest payments.

Appendix E.F.3 Vehicle Purchases

We do not observe all vehicle purchases in the bank transaction data because many purchases do not flow directly to the vehicle producer but rather flow through financial firms. We therefore use a top-down approach to assign national vehicle purchases to consumer cells in proportion to each consumer cell's share of total spending on new cars. We estimate each consumer cell's total spending on new cars by combining bank transaction data on annual spending at vehicle dealers with information on vehicle registrations from the administrative auto register (DMR). We use data over the period 2014–2016, as this is the most recent period where we can combine transaction data from Danske Bank and administrative data from the auto register. We therefore assume that relative levels of vehicle spending are unchanged between 2014–2016 and 2018.

We first estimate the average price of purchased vehicles for each consumer cell. We use a sample of individuals where we observe just one new car registration in a given year and spending at vehicle dealers of at least 50,000 DKK in the bank transaction data in the same year. We then regress individual-level spending at vehicle merchants on industry-by-year and region-by-year fixed effects,

$$spending_{p,y}^{vehicle\_merchants} = \theta_{i(p),y} + \eta_{r(p),y} + \epsilon_p,$$

where p is an individual in industry $i(p)$ and region $r(p)$ and year is y. We predict the average price of new cars in each consumer cell using the estimated fixed effects. We can directly calculate the number of newly registered vehicles in the government vehicle registers. Combining the estimated price with the number gives an estimate of total spending on new cars by consumer cell for each year in 2014–2016. We compute each cell's share of total spending on new cars in each year and then average across years. We use these shares to allocate national vehicle purchases in 2018 across consumer cells.

Producer cells in our "cars, fuel, car repair, public transport" industry (number 5) receive consumers' expenditures on vehicles. To identify which regional producer cells receive spending from which consumer cells, we use Danske Bank data on vehicles purchased via cards, assuming that all consumers within the same region distribute their vehicle spending across regions in the same proportion.[A2]

[A2] If there are less than 50 vehicle car purchases in a region, we group that region with a neighboring region. This

Appendix E.F.4 Water and Waste Services

Rental payments often include consumption of water and waste services in Denmark, which implies that we cannot separately identify spending on water and waste in the transaction data. We therefore allocate the national consumption of water and waste services to consumer cells in proportion to their spending on other utilities. We assume that water and waste is produced locally, setting the region of the producer cell receiving the payments equal to region of the consumer cell.

Appendix F Measuring Disaggregated Product and Production-Related Taxes

Product taxes (SNA D.21) are paid by buyers upon the purchase of a good to the government. The most important product taxes are import taxes, product-specific taxes (e.g., on fuel, energy, cigarette, and alcohol), and value added taxes (VAT).

We first describe how we measure import and product-specific taxes paid by consumers. (We turn to VAT later.) We observe the aggregate of import and product-specific taxes in the Danish national accounts table NIO3. The table reports aggregate import and product-specific taxes paid by consumers on the products of 117 distinct industries. These 117 industries do not map directly into our 31 industries. We therefore break down the 117 industries into the most granular grouping in the Danish national accounts (741 industries), by assuming that taxes paid on each industry's products are proportional to industry employment shares, and subsequently aggregate to our 31 industries. We then calculate the implied product-specific tax rate and the implied import tax rate for each of our industries by combining information on total tax-inclusive consumer spending on each industry from the disaggregated consumer spending flows with the tax data. The implied import and product-specific tax rates range from 0% in exempt industries (e.g., personal services, pharmacies and cultural and social organizations) to 50% in utilities (due to Denmark's very high energy tax rates).

We next describe how we measure VAT paid by consumers. The standard VAT rate in Denmark is 25%. We set this tax rate for consumer spending on all industries except a few industries whose products are VAT-exempt: airlines, finance, health, education, public administration, and all housing. In addition, spending on two of our industries is partially exempt: insurance (part of our industry 8, telecommunications and insurance) and culture (part of our industry 18, cultural and social organizations). We use data from NIO3 on total VAT paid by consumers on products of each industry, following the method used for product-specific and import taxes described above, and calculate that the average VAT rate is 7% (for industry 8) and 5% (for industry 18).

We disaggregate product taxes paid by Danish producers, the government, and the capital accumulation cell using the Danish input-output table, as described in Appendix N. Note that

leads us to group Læsø with Frederikshavn; Langeland and Ærø with Svendborg; Fanø with Esbjerg; Ringkøbing-Skjern with Herning; Lemvig with Holstebro; Morsø with Thisted; and Samsø with Odder.

producers are reimbursed for VAT paid on intermediates.

We observe the net of production-related taxes (SNA D.29) and subsidies (SNA D.39) in the industry-level national accounts (summing positions in the national accounts of the financial, non-financial, and unincorporated household production sectors). Examples of such positions are a special payroll tax on firms in the financial industry, which compensates for the industry's VAT exemption; subsidies to agricultural producers; and housing property taxes. We take a top-down approach to allocating these industry-level flows to producer cells. For all industries except owner-occupied housing, we allocate the industry's net production-related taxes in proportion to labor compensation, which we compute from the employment register (BFL). For owner-occupied housing, we allocate net production-related taxes in proportion to their total rental value, which we compute from the income register (IND).

Appendix G Measuring Disaggregated Non-Product Taxes

Consumer non-product taxes are flows from consumer cells to the government. There are two types: current taxes on income, wealth, etc. (SNA D.5) and social contributions (SNA D.61).

First, current taxes on income, wealth, etc. include income taxes paid directly by consumers as well as a tax on pension wealth returns paid by pension funds on consumers' behalf. We disaggregate each part separately. In the income register (IND), we observe total annual income taxes paid, excluding pension returns taxes, for each individual in the population. We scale this measure by a factor of 1.09 to match the national accounts aggregate when summing the values at the level of consumer cells. For the pension returns taxes paid by pension funds, we have no direct individual-level measure. We therefore apply a top-down approach assuming that DKK pension wealth returns, and hence also returns taxes, are proportional to total accumulated pension contributions since 1995, which is the first year for which we have microdata on pension contributions in the pension contribution register (INPI).

Second, we use a bottom-up approach to disaggregate social contributions. In the income register (IND) and the pension contributions register (INPI), we observe total annual pension contributions, including contributions to a mandatory retirement savings program (ATP), as well as on membership fee payments to unemployment insurance funds. We aggregate these variables to the cell level and scale the cell totals by a factor of 1.2 to make the national total match the national accounts aggregate.

Producer non-product taxes (SNA D.5) are paid on income and flow from producer cells to the government. Since income taxes in Denmark are a fixed fraction of producer profits, we allocate the national aggregate in proportion to the accounting income of each producer cell (sales minus intermediates minus labor compensation).

Appendix H Measuring Disaggregated Consumer Interest and Transfers Paid

We disaggregate interest payments (SNA D.41) using a bottom-up approach. In the administrative income register (IND), we observe each individual's interest payments on all financial liabilities. The sum of these interest payments exceeds the value of position D.41 in the national accounts because the individual-level measure includes the full nominal amounts paid by consumers to lenders, whereas the national accounts value is net of Financial Services Indirectly Measured (FISIM). We therefore scale the individual-level variable so that its aggregate matches the national accounts. The implicit assumption is that the ratio of FISIM to total nominal interest payment is the same across consumer cells.

Since we have no individual-level data on payments related to renting of land and subsoil resources (SNA D.45), we use a top-down approach to disaggregate this flow. Each consumer cell is assigned a share of the aggregate value corresponding to its population share in the population register (BEF).

Other current transfers (SNA D.7) include non-life-insurance premium payments and miscellaneous current transfers. We also disaggregate these transfers top-down, assigning each cell a share of the national total equal to its population share.

Appendix I Measuring Disaggregated Labor Compensation

We use the income register (IND) and the pension contributions register (INPI) to measure total annual labor compensation, including employer contributions to pension schemes, paid to each individual consumer. We then aggregate these payments at the level of consumer and domestic producer cells. The aggregate of the raw disaggregated flows is slightly lower than in the national accounts, mostly because our sample contains only adults. We scale each value by a factor of 1.01 to match the national accounts flow compensation of employees, receivable (SNA D.1).

We also observe labor compensation received from foreign producers in the income register (IND). The aggregated value in the income register is below the aggregate in the national accounts, likely because our consumer cell definition implies that we do not capture individuals moving to Denmark during the year and because we do not observe foreign pension income perfectly in the income register. As a result, we scale each value by a factor of 1.47 to match the national accounts aggregate.

Finally, we record labor compensation paid by Danish producers to foreign employees. The employment register (BFL) contains all labor compensation payments by Danish producers and the unique personal identifier of the employee receiving the payment. We consider recipients not listed in the population register (BEF) as foreign employees. We scale the value of payments to foreign employees for each producer cell by a common factor of 1.14 to match the national accounts aggregate.

Appendix J Measuring Disaggregated Mixed Income, Dividends, and Surplus

We measure mixed income, dividends, and surplus flowing from each producer cell to each consumer cell.

Non-corporate firms pay mixed income to their owners. We determine how mixed income is distributed across consumer cells following the methodology for labor compensation discussed above. We link information about establishments operated by sole proprietorships from the employment register (IDAN), including the municipality where the establishments are located, to the mixed income of the individuals owning the establishment.

Corporate firms pay surplus to their owners in the form of dividends. To distribute dividend payouts across consumer cells, we rely on individual-level data on stock dividend income from the income register (IND). We disaggregate aggregate distributed income of corporations, receivable (SNA D.42) in proportion to the total dividend income of each consumer cell. We thereby implicitly assume that all consumer cells hold a diversified portfolio of Danish corporations. We measure dividends paid by each producer cell by distributing the aggregate dividends paid to Danish consumers in proportion to the accounting income of each producer cell, which are measured in the disaggregated accounts as: total sales − intermediates − labor compensation − mixed income − surplus − dividends and surplus paid to government − net taxes − imports.

Finally, the national accounting flow operating surplus, gross (SNA B.2G) corresponds to operating surplus from owner-occupied housing. We aggregate individual-level imputed rental values of owner-occupied housing as reported in the income register (IND), which produces the industry's total output. We scale this output by a factor 0.67 to match the national value for B.2G. The implicit assumption is that the ratio between gross operating surplus and output in the owner-occupied dwellings industry is constant across consumer cells.

Appendix K Measuring Disaggregated Government Benefits to Consumers

National accounts describe three types of transfers to consumers. First, we aggregate all government income transfers and private pension savings payouts from the income register (IND) to calculate the cell-level measure of social benefits other than social transfers in kind (SNA D.62). We scale by a factor of 1.03 to match the national accounts value. Second, other current transfers (SNA D.7) consist of miscellaneous current transfers, for example, disaster and accident relief. We disaggregate this position top-down using cell population shares obtained from the administrative population register (BEF). Third, adjustment for the change in pension entitlements (SNA D.8) represents an accounting adjustment in the national accounts to avoid double-counting changes in pension entitlements.[A3] We disaggregate it by combining data from the income register and the pension

[A3]In our system, all pension-related flows (SNA D.61, D.62, and D.8) originate and go to the government cell, which has the advantage that all double-counting of pension flows naturally nets out in the government cell. Aggregate contributions register (INPI) to construct an individual-level measure of pension contributions net of payouts. We then scale this measure to match the national accounts aggregate value.

Appendix L Measuring Disaggregated Consumer Interest and Transfers Received

First, we disaggregate interest, receivable (SNA D.41) bottom-up by using individual-level information on interest income from the income register (IND) and scaling so that the total across consumer cells matches the national accounts aggregate. Second, other investment income, receivable (SNA D.44) includes investment income from insurance policies and pension entitlements. We disaggregate this using a top-down approach where each consumer cell is assigned a share of the national accounts value proportional to its pension contributions accumulated since 1995. Third, rent, receivable (SNA D.45) consists of income from renting land and subsoil resources. We disaggregate it top-down using population shares.

Appendix M Measuring Consumer Characteristics

We use information from several government registers at the individual level for the full population. From the education register (UDDA), we extract each individual's highest level of education and use it to compute the share of individuals in each cell who have completed a university degree. Occupation codes are from the labor market register (AKM). We define an individual as doing manual labor if their main occupation is in manual trades work, operator and assembly work, transportation, other manual labor, or military service.

From the wealth register (FORMGELD), we obtain information about individual balance sheets. We compute cell-level averages of their: total debt, which includes both unsecured debt (e.g., consumer credit) and secured debt (e.g., mortgages and car loans); liquid financial assets, which consists of bank deposits and financial securities like stocks, bonds and investment fund shares; and illiquid assets like housing, cars, and retirement savings in tax-preferred pension saving accounts.

Appendix N Measuring Disaggregated Intermediates Trade

Disaggregated intermediates trade flows describe how producers in one cell are connected to producers in other cells through trade in intermediates. We start from the Danish input-output table at the most disaggregated level with 117 industries (Tables NIO1, NIO2, and NIO3 at statbank.dk). The input-output table illustrates how the output produced by one industry is used as intermediate input in other industries or in final use categories, such as government spending and capital

national accounts in different countries deal with pensions in different ways. In the Danish national accounts, pensions flow between consumers and government as well as between consumers and the financial corporation sector, which creates the double-counting issue.

formation. It also shows how output from a given industry is produced from intermediate inputs acquired from other industries.

To convert the standard input-output table to a format suitable for our purposes, we need to address three challenges. First, the 117 industries do not map directly onto the industry classification used in the disaggregated economic accounts (DEA). Second, the input-output table has no geographical dimension: it describes flows from firms in industry s to firms in industry t at the national level, but not from firms in industry s and region i to firms in region j and industry t. Third, the national accounting convention of measuring output of retail industries in the form of net trade margins is not compatible with the disaggregated consumer spending flows (which reports actual money flows). The following subsections describe how we overcome these challenges.

Appendix N.A Adapting the IO table to DEA Industry Classification

To address the first challenge, we disaggregate the input-output table based on the national accounts (NA) industry classification to a more granular subindustry grouping. Formally, let lower-case letters $\{a, b, c...\}$ denote the NA industries in the standard input-output table and let upper-case letters $\{A, B, C...\}$ denote the 27 output-producing DEA industries shown in Table A.I. Let j denote a granular industry at the level used in the microdata. Consider a particular NA industry $x \in \{a, b, c...\}$ and a particular DEA industry $Y \in \{A, B, C...\}$: we define subindustry x_Y as the set of granular-level industries that are subindustries of both x and Y, $x_Y = \{j | j \subset x, j \subset Y\}$. This approach produces 173 non-empty subindustries, which represent the highest level of industry aggregation compatible with both the NA classification and the DEA classification.

To carry out the disaggregation into subindustries, we compute a measure of output for each establishment by distributing the output of each firm across the establishments of the firm, using the within-firm labor compensation share of each establishment as weight. We then aggregate output to the level of each subindustry x_Y, compute the subindustry's output share within NA industry x, and disaggregate the flows for industry x reported in the original input-output table using these shares. For example, the original input-output table reports the value of flows from NA industry a to NA industry b. We assume that the flow stemming from subindustry a_Y is proportional to the share of output produced by NA industry a. Similarly, we assume that the flow to subindustry b_Z is proportional to its share of output in NA industry b. Concretely, we compute the flow from a_Y to b_Z as the total flow from a to b multiplied by the output shares of a_Y and b_Z within their respective NA industries.

The input-output table also reports flows from domestic final use categories (government spending, capital accumulation) to domestic producers and from domestic producers to the government in the form of VAT and product tax payments. We disaggregate these flows to the subindustry level on the producer side using subindustry output shares.

In sum, these steps produce a national table of trade flows at the level of 173 subindustries.

We will later re-aggregate the 173 subindustries to the 27 output-producing industries in the DEA. However, before doing so, we add a regional dimension, as described next.

Appendix N.B Estimating the Role of Distance

We incorporate the effect of distance on intermediates trade using transaction-level data on producer-to-producer sales. The dataset is from the business service provider CrediWire and covers more than 4,300 firms over the period 2018-2022. The dataset includes information about industry and region of supplying firms retrieved from CrediWire's records. This allows us to assign each of the selling firms to a producer cell. When the buying firm is an identifiable domestic firm, the dataset also includes information about the industry and the region of the buying firm retrieved from the national business register. This allows us to assign each of these buying firms to a producer cell.

The CrediWire data include around 5 million producer-to-producer transactions where both supplier and buyer can be assigned to producer cells, covering around 1% of aggregate domestic intermediates transactions. To compare the distribution of industry-to-industry sales in the CrediWire data to the national accounts, we construct a matrix of total industry-to-industry transactions by aggregating the raw transactions in CrediWire. We then plot a binned scatter plot of entries in the matrix using CrediWire data against the corresponding entries in the national accounts input-output table for intermediates trade. The high correlation in Figure A.IV suggests that the Crediwire data are broadly representative in terms of the distribution across supplier and buyer industries.

To construct our disaggregated matrix, we aggregate the transactions in CrediWire to the cell-level and estimate a gravity model, with the aim of estimating how producer-to-producer trade varies with distance. The dependent variable is sales from the selling (supplier) producer cell to the buying (user) producer cell and the key explanatory variable is geographical distance. The model also includes two sets of fixed effects. First, there are fixed effects for every producer cell, both on the supplier side and the user side, which control non-parametrically for the economic size of producer cells. Second, there are fixed effects for every pair of supplier industry and user industry, which ensures that identification comes exclusively from variation in geographical distance within industry pairs. We estimate the gravity model in its multiplicative form with the Poisson pseudo-maximum likelihood estimator (Silva and Tenreyro 2006).

The baseline model yields a statistically significant distance coefficient of around -0.74. This coefficient captures the average elasticity of domestic trade with respect to distance.[A4] Incidentally, it is close to analogous estimates for international trade (e.g., Silva and Tenreyro 2006 report an estimate of -0.78 in their Table 3, column 6). We next allow for heterogeneity in the distance

[A4] This average coefficient differs from the one reported in Figure V because there we use a more traditional log-log specification without the pairwise supplier-by-user fixed effects, without zero flow and zero distance observations in the dataset, and without relying on the Poisson estimator.

coefficient by interacting distance with indicators for supply industries and use industries. This allows us to obtain an estimated distance coefficient for every combination of supply industries and use industries (576 estimates) by adding the coefficients on the relevant supply industry interaction and the relevant use industry interaction. Figure A.V illustrates the results with two sets of box plots: Panels a and b show the distribution of distance coefficients (i.e., median, quartiles, and adjacent values) for each supply industry and for each use industry, respectively. The distance coefficients vary substantially across supply industries (and much less within) and within use industries (and much less across). This pattern is consistent with the notion that the structural elasticity is product-specific and that firms tend to use a large number of inputs to produce a small number of outputs.

Appendix N.C Combining Regional and Industry Variation

We determine the level of trade in each region-by-industry cell by assuming that regions send and receive intermediates in proportion to their shares of total labor compensation paid in each subindustry (except in the three zero-employment housing industries where we use regional spending shares from the disaggregated consumer spending flows, see Appendix E).

Combining this assumption on trade levels with the estimated distance coefficients, we can now disaggregate the flows between subindustries to a region-by-subindustry table. Formally, let a_Y and b_Z denote subindustries and let i and j denote regions. We assume that the flow from subindustry a_Y, region i to firms in subindustry b_Z, region j is

$$flow_{a_Y,b_Z,i,j} = flow_{a_Y,b_Z} * \theta_{a_Y,b_Z,i} * \eta_{a_Y,b_Z,j} * distance_{ij}^{-\beta^{IND(i)}-\beta^{IND(j)}}, \tag{A.2}$$

where $flow_{a_Y,b_Z}$is the intermediates flow from subindustry a_Y to subindustry b_Z at the national level and $distance_{ij}$ is the distance between region i and region j. The parameters $\theta_{a_Y,b_Z,i}$ and $\eta_{a_Y,b_Z,j}$ are origin and destination region fixed effects within the a_Y-b_Z subindustry pair. These are set so that 1) region i's total share of national a_Y-b_Z flows (i.e., $\sum_j flow_{a_Y,b_Z,i,j}/flow_{a_Y,b_Z}$) matches its share of labor compensation payouts in subindustry a_Z, and 2) region j's total share of industry a_Y-b_Z flows (i.e., $\sum_i flow_{a_Y,b_Z,i,j}/flow_{a_Y,b_Z}$) matches its share of total labor compensation payouts in subindustry b_Z.

We implement this assumption through an iterative numerical procedure. Starting from initial guesses for $\theta_{a_Y,b_Z,i}$ and $\eta_{a_Y,b_Z,j}$, we compute the implied value of each $flow_{a_Y,b_Z,i,j}$. We then adjust the guesses by a multiplicative constant that ensures that the flows add up to their national counterpart, $flow_{a_Y,b_Z}$. Next, we update the guesses by multiplying them with the ratios of the regions' labor compensation shares to the implied shares of national a_Y-b_Z flows. We repeat this procedure until the implied share of national a_Y-b_Z flows converges toward the relevant labor compensation share for each origin and destination region.

For flows from final use categories (non-profits, government spending, capital formation) to domestic subindustries, we add a geographic dimension on the destination side only. Here, we assign each region a share of the total national flow equal to its share in subindustry labor compensation. Conversely, for VAT and product taxes going from domestic subindustries to the government, we add a geographic dimension on the origin side only: each region is assigned a share of the national flow equal to its labor compensation share within the subindustry.

After disaggregating to the subindustry-region level, we aggregate to the industry-region cell level described in Appendix D by summing over subindustries belonging to the same DEA industry within each region.

Appendix N.D Redirecting Flows From Consumers Through Retailers

National accounts measure output in retail industries as trade margins (i.e., sales net of acquisition costs). Thus, if a retailer buys a product from a non-retail producer at price p_1 and sells it to a consumer at price p_2, the national accounts input-output table will display two flows: 1) a flow of $p_2 - p_1$ from consumers to retail, and 2) a flow of p_1 from consumers to the non-retail producer's industry. This makes the standard input-output table inconsistent with our disaggregate spending flows because the disaggregated spending flows show total sales values going from consumers to producers. A consistent system of disaggregated economic accounts therefore necessitates an adjustment to make the different disaggregated datasets compatible.

Since the disaggregated economic accounts are measured in total sales units, we leave the disaggregated consumer spending flows untouched and instead adjust the disaggregated intermediates trade flows. Specifically, we identify flows in the national accounts input-output table that go directly from consumers to producer industries that, in fact, do not sell directly to consumers (see Table A.I). We set the original flow equal to zero and instead add it in two places: first, to the flow going from consumers to the retail industry that sells the relevant goods; and second, to the flow going from the relevant retail industry to the industry producing the good. With that adjustment, the producing industry still receives the same amount of inflows, while consumers still spend the same amount. The only difference is that the relevant retail industry now has higher inflows (from consumers) and outflows (to the producing industry). We identify the relevant industry by manually assigning the 72 consumption categories reported in the input-output tables to the retail industry most likely to sell that category.[A5]

Note that this adjustment increases the total sum of flows in the input-output table. For retail

[A5] An example illustrates how the adjustment affects the final intermediates trade table. If the input-output table reports a flow of 1,000 from private consumers to manufacturers in region X as payment for cheese, the disaggregated intermediates trade flows replace this flow of 1,000 with 1) flows from grocery retailers in each of the 98 regions to manufacturers in region X, where the size of each flow is 1,000 multiplied by the origin region's share in total existing flows from grocery retailers to manufacturers in region X; and 2) flows from private consumers to grocery retailers in each of the 98 regions, where the size of each flow matches the corresponding retailer-to-manufacturer flow.

industries, the total sum of inflows thus no longer corresponds to the total value of output as defined in national accounts. The output of retailers is now defined as the full value of sales (excluding VAT and product taxes), while the retailer's acquisition cost is treated as an intermediate input from the non-retail producer of the traded product.

Appendix O Measuring Disaggregated Foreign Exports and Imports

Appendix O.A Foreign Exports and Imports of Manufacturing Firms

We follow different methods for manufacturing and non-manufacturing firms. For manufacturing firms, we observe imports and exports at the level of individual firms (CVR level) in two databases. Trade in goods is in the foreign trade registry (UHDI), while trade in services is in the firm sales and purchases registry (FIKS). We calculate each firm's total exports and imports as the sum of the values in the two registries.[A6] In some industries, the firm-level data and national accounts do not follow the same reporting guidelines for exports and imports. For instance, Danish national accounts report exports and imports of electricity traders by netting out short-run off-setting trades, while firm data report gross values. To ensure that we report values in line with national accounting guidelines, we scale total exports and imports in the firm-level data to match the industry aggregates in the national input-output table, at the level of 117 industries.

The vast majority of firms have only one establishment. We therefore assign these firms' exports and imports to their unique region-industry cell. For multi-establishment firms, we use information on the occupations of workers in each establishment to distribute firm exports and imports. We allocate exports of manufacturing firms to an establishment in proportion to the share of manufacturing workers' labor compensation paid by that establishment (relative to the firm's other establishments). We define manufacturing workers as those with occupation codes 13, 21, 31, 60--62, 70–75, 80–83, and 90–97. For instance, if a manufacturing firm has three establishments but one employs no manufacturing workers and two pay the same total labor compensation to manufacturing workers, we would assume that the exports of that firm come in even measure from the two establishments employing manufacturing workers. For imports, we allocate imports to an establishment in proportion to the share of firm-level non-retail store workers' labor compensation paid by that establishment.

Once we have allocated imports and exports of manufacturing firms to establishments, we assign each establishment to an industry-region cell, as described in Appendix D, and aggregate to the cell level.[A7]

[A6]For exports to non-EU countries, the FIKS registry shows only the sum of goods and services exports. We calculate services exports separately by assuming that the ratio of services to goods exports is the same for EU and non-EU exports at each firm.

[A7]To conform with anonymity guidelines, we censor exports and imports for cells with less than five firms and for cells where two firms represent more than 85% of total firm turnover. Within each industry, we compute total exports and imports associated with the censored cells and distribute it across the censored cells in proportion to their

Appendix O.B Foreign Exports and Imports of Non-Manufacturing Firms

We disaggregate exports and imports of non-manufacturing firms using labor compensation shares of regions within fine industries (based on the finest Danish classification at the level of 173 industries).

One industry (owner-occupied housing) has no firms, yet still has a small amount of imports according to the national accounts. We disaggregate this amount to the industry-region level using the geographic distribution of the imputed rental value of owner-occupied housing from the income register (IND).

Following the method applied to the disaggregated intermediates trade flows, we adjust the imports of retail industries to ensure consistency with the disaggregated consumer spending flows (see Appendix N.D).

Appendix O.C Exports to Foreign Visitors in Denmark

Firms can also export by selling goods to foreign consumers while they are in Denmark (e.g., sales to foreign tourists in Denmark). The national input-output table reports the total amount of consumer spending by foreign residents on Danish producers. We disaggregate this amount across Danish producer cells using two data sources.

First, we use the industry distribution of Danish residents' spending abroad from the disaggregated consumer spending flows to compute a proxy for each industry's share of foreign tourist spending, thus assuming that Danish tourists' spending behavior in foreign countries is indicative of foreign tourists' spending in Denmark. Second, to distribute across regions, we use data from visitdenmark.dk on foreigners' overnight stays at hotels to compute a proxy for each region's share of foreign tourist spending.

Appendix O.D Foreign Exports and Imports by Trading Partner

We measure foreign exports and imports by trading partner country using a combination of firm-level trade data from administrative registers, survey data, national accounts, and balance of payments (BoP) statistics. Total imports and exports, as measured above, are allocated across countries using cell-specific shares derived from micro data and aggregate BoP statistics. We conduct all steps separately for imports and exports.

For goods trade, we use detailed firm-by-product level data from the foreign trade register (UHDI) and use it to compute the share of goods trade relative to total trade for each cell, as well as individual country shares of total cell goods trade. As for total imports and exports, we disaggregate firm-level variables to the establishment level using labor compensation shares before aggregating to cell level. If information about the trading partner country is missing in a given firm-product

within-industry labor compensation shares.

entry, we impute it using the country distribution in uncensored entries for either (in order or priority) other products sold by the same firm, other firms selling the same product, or other firms belonging to the same cell.

For services trade, we rely on firm-level data from a survey conducted by Statistics Denmark. The survey covers the largest services trade firms in Denmark and a random sample of smaller firms. It is a key input in the compilation of BoP statistics. Since the number of firms in the survey is limited, inferring cell-level country distributions would introduce too much noise. Instead, we construct country distributions at the industry level and assume that these apply uniformly across all cells belonging to the same industry. In industries with limited survey coverage and in non-firm industries, we use the national-level country distributions for trade in services from aggregate BoP statistics.

Exports in the form of sales to foreigners visiting Denmark are treated separately. We use municipality-level data on the nationalities of overnight visitors to break down foreigners' spending in Denmark by visitor home country. For municipalities with missing data, we use the corresponding shares for the larger geographical unit ("landsdel") to which they belong. We apply the same country distribution across all industries, implicitly assuming that visitors from different countries visiting the same municipality spend their money on roughly the same products and services.

Finally, we compute overall country shares for total imports and exports in each cell as the value-weighted average of the corresponding shares for goods, services, and sales to foreign visitors. Due to anonymity requirements, we must censor all values in cells that contain only a few establishments or are dominated by one or two large firms. In those cases, we assume that the cell-level country shares correspond to the value-weighted average shares in the relevant industry.

Appendix P Measuring Disaggregated Government Dividend and Surplus Income

The government receives income from each producer cell that contains some government-owned establishments. We start with a list of firms that sell to consumers and producers at market prices and are (full or partly) owned by the government.[A8] We manually collect annual turnover for every firm from annual reports. We also collect information on establishment-level employment from the Danish business register (CVR). We combine these two datasets and split annual turnover regionally using each firm's distribution of employment across regions. We finally aggregate across industries (using the industry code of the parent firm) and regions to get to our level of producer cells. We assume that the share of surplus received by the government is equal to the share of turnover by government-owned establishments in each producer cell.

[A8] See fm.dk/arbejdsomraader/statens-selskaber/organisering.

Appendix Q Measuring Disaggregated Producer and Government Net Interest, Transfers, and Saving

The analog to producer net interest, transfers, and saving in the aggregate national accounts is the sum of the following SNA positions in the financial and non-financial corporate accounts: interest paid − received (net of D.41) + reinvested earnings on direct foreign investments other current transfers paid − received (net of D.43) + other investment income paid − received (net of D.44) + other current transfers paid − received (net of D.7) + natural resource rents paid (D.45) + gross saving (B.8g) + distributed income of corporations paid to rest of world (part of D.42) − distributed income of corporations received (D.42). This sum, based on the aggregate national accounts, differs slightly from "producer net interest, transfers, and saving" in our disaggregated accounts because the disaggregated spending flows imply a slightly higher value for consumer spending on foreign producers and thus slightly lower sales of domestic producers. An advantage of our approach is that we can directly observe foreign spending by Danish consumers in the Danske Bank data. In contrast, national accounts rely on balance of payments statistics, retail turnover, and consumer surveys to determine foreign spending (see also Footnote 15).

The analog to government net interest, transfers, and saving in the aggregate national accounts is the sum of the following government SNA positions: interest paid − received (net of D.41) + other current transfers paid − received (net of D.7) + gross saving (B.8g) − other investment income (D.44) − natural resource rents received (D.45). However, this sum based on the aggregate national accounts does not equal "net interest, transfers, and saving" in our disaggregated accounts because we do not disaggregate taxes, benefits, and subsidies received by institutional sectors other than producers and consumers (see Section III.B).

Appendix R Measuring Producer Balance Sheets

We use information on producer balance sheets from the firm financial accounts register (FIRE). The information in this register comes mainly from firms' financial statements, as reported to government agencies. It is collected by Statistics Denmark for economic analysis purposes and serves as key input into national accounts. The register covers private firms in most industries, except agriculture, fishing, finance, and government administration. Firms in FIRE make up around 93% of aggregate sales of Danish firms.

The data in the register are reported at the level of individual firms. For firms with establishments in multiple producer cells (e.g., in different regions), we assign a value to each establishment in proportion to its share of the firm's total labor compensation. We then compute average values at the cell level. Due to anonymity protection requirements, we censor values in cells that have only a few firms or are strongly dominated by one or two large firms.

On the assets side, we measure total, current, intangible non-current, tangible non-current, and financial non-current assets. On the liabilities side, we measure total debt, provisions for future obligations, short-term accounts payable, long-term accounts payable, other short-term debt, other long-term debt, and equity. Finally, from the firms' income statements, we measure the average turnover for the establishments in the cell.

Appendix S Measuring Disaggregated Consumption of Government and NPISH Output

We measure which consumer cells consume different types of government services. In the system of disaggregated economic accounts, the government purchases these services from government-operated establishments in each producer cell and provides them to consumers free of charge. We assume that the per capita consumption of collective public goods is uniform across the Danish population (including police, national defense, and public administration). We use individual-level data on actual uses of public services to allocate individual public consumption (including education, healthcare, and social protection), as detailed below.

Appendix S.A Education

We assign the aggregate consumption of education services observed in the national accounts to consumer cells according to the number of students in primary, secondary, and tertiary education in a cell. The education register (UDD) contains information about the education program in which each individual is currently enrolled (if any) as well as each individual's highest completed education. We categorize individuals as primary school students if they are currently enrolled in a program and have no completed education; as secondary school students if they are currently enrolled in a program and their highest completed education is primary school (10 years); as tertiary education students if they are currently enrolled in a program and their highest completed education is secondary school (13 years); and as non-students if they are currently not enrolled in a program.

We aggregate the number of students in primary, secondary, and tertiary education to the level of consumer cells. As the cells only include the adult population, we assign the education consumption of minors to adults in the same household before aggregating, drawing on the intra-household links in the population register (BEF). For instance, two parents with three children, two of whom are in primary school and one of whom is in secondary school, would each consume the equivalent of one year of primary education and half a year of secondary education.

Finally, we allocate aggregate government spending on education to cells in proportion to their share of students in primary, secondary, and tertiary education and total government expenditure on education at each of these levels. Specifically, the estimated consumption of education services in cell i is

$$C_i^{edu} = \sum_{q=p,s,t} \frac{\#students_{i,q}}{\#students_q} \times expenditure_q,$$

where q is the level of education (with p, s, and t indicating primary, secondary, and tertiary, respectively) and expenditure is government spending on education of level q.

Appendix S.B Healthcare

Government spending on healthcare falls into six categories: outpatient services; hospital services; medical products, appliances and equipment; public health services; research and development; and other. We allocate government healthcare consumption summed over all six categories, as reported in national accounts, to consumer cells using publicly available statistics for the first two categories, which make up around 85% of the total.

Outpatient services capture government spending flowing to primary healthcare providers, like general practitioners, specialist doctors, psychiatrists, and dentists. We obtain average primary healthcare expenditures by age, gender, and municipality (Table SYGU1 in the Public Expenditure Statistics). Based on a regression of average primary healthcare expenditure on a set of indicators for age, gender, and municipality, we predict primary healthcare expenses for each individual in the population. We then aggregate the predicted expenditures to the level of consumer cells. Since children account for a non-negligible part of healthcare spending, we include the full population by assigning minors to the same consumer cells as the adults cohabiting with the child. If parents live together but work in different industries, we split the child's predicted healthcare expenditure equally between the two cells.

Hospital services capture government expenditure related to hospital treatments, including emergency room and outpatient hospital treatments. Again, we obtain information on the average number of days spent in hospital by age, gender, and municipality (Table INDAMP01 in the Health Statistics). Regressing average hospital days on a set of indicators for age, gender, and municipality, we predict the number of hospital days for each individual in the population. We then aggregate the predicted hospital days to the consumer cell level, again allocating the hospital days of minors to their parents' cells.

Finally, we combine the two indicators of healthcare usage to disaggregate total consumption of healthcare services of consumer cell i as

$$C_i^{health} = \sum_{q=o,h} \left(\frac{usage_{i,q}}{\sum_i usage_{i,q}} \times \frac{exp_q}{exp_o + exp_h} \right) \times exp, \tag{A.3}$$

where q indexes the type of healthcare (with o and h indicating outpatient and hospital services, respectively), $usage_{i,q}$ denotes cell *i's* usage of type q (expenditure on primary care and the number of hospital days), exp_q is national government spending on healthcare of type q, and exp is national government spending on healthcare summed over all six categories.

Appendix S.C Social Protection

Government spending on social protection falls into five categories: sickness and disability; old age; family and children; unemployment; and other. We allocate social protection services to consumer cells based on government microdata. Specifically, we allocate the category "sickness and disability" to cells in proportion to the number of individuals on sick leave or disability pension as observed in the income register (IND); the category "old age" in proportion to the number of individuals aged 80 or older as observed in the population register (BEF); the category "family and children" in proportion to the number of preschool children as observed in the population register (BEF); the category "unemployment" in proportion to the number of long-term unemployed; and the category "other" by population shares. The estimated consumption of social protection services in consumer cell i is thus

$$C_i^{social} \quad = \sum_{q=s,o,d,u,z} \frac{usage_{i,q}}{\sum_i usage_{i,q}} \times exp_q, \tag{A.4}$$

where q indexes the type of social protection (with s, o, d, u, and z denoting sickness/disability, old age, family/children, unemployment, and other, respectively), $usage_{i,q}$ denotes the relevant indicator for cell i's usage of type q (see above), and exp_q is national government spending on social protection services of type q.

Appendix S.D Measuring Disaggregated Consumption of NPISH Output

We measure the consumption of output provided by non-profit organizations (NPISH) for different consumer cells. NPISH output falls into five categories: education; social work activities; libraries; museums and other cultural activities; sports activities (non-market); and activities of membership organizations.

We first disaggregate usage of the first four categories by consumer region. For education, we use regional data on the share of children attending private schools (Table "UDDAKT20" in the Education Statistics). For social work, we use regional data on the share of privately owned (as opposed to government-operated) daycare institutions (Table "BOERN4" in the Child Care Statistics). For libraries, we use regional data on library usage per capita (Table "BIB1" in the Culture and Leisure Statistics). For museums and other cultural activities, we use regional data on members of sports associations per capita.

To infer usage by industry of work, we rely on the Danske Bank data. For education, we proxy use of NPISH education with payments to private schools. For social work, we calculate payments to private child-care institutions. For libraries, we use payments to libraries. For sports activities, we use membership payments to sports associations. For all categories, we count the number of transactions relative to the number of bank customers in each industry. We thereby estimate how likely consumers in each industry are to consume a given type of NPISH output.

We combine the information on consumption shares of NPISH by consumer region and industry to calculate consumption of NPISH output by consumer cell:

$$npish^q_{r,i} = \sum_q \frac{npish_{q,r} \times npish_{q,i} \times pop_{r,i}}{\sum_{r,s} npish_{q,r} \times npish_{q,i} \times pop_{r,i}} \times expenditure_q,$$

where q is the NPISH category, r is region, i is industry, $pop_{r,i}$ is the cell's population, and expenditure is national NPISH output of type q.

For the final type of NPISH consumption, activities of membership organizations, we rely on Danske Bank data. This category consists mostly of trade unions and a small component of political or religious organizations. We disaggregate national consumption using as weights the share of individuals making payments to trade unions in each cell multiplied by the cell's population.

Appendix T Measuring Exposure to Fiscal Policy Transfer Programs

We measure the exposure of consumer cells to three transfer programs: the child tax credit as of 2018, the inflation relief to elderly in 2022, and the housing rent inflation support in 2023.

Appendix T.A Child Tax Credit as of 2018

The child tax credit is a refundable tax credit given to parents as a function of child age and parent income. In 2018, the highest annual rate of child tax credit amounted to around DKK 18,000 for children up to age 2, around DKK 14,000 for children age 3-6, and around DKK 11,000 for children age 7-17, with phase-out starting at a gross income around DKK 760,000. The total fiscal cost of the program was around DKK 12 billion in 2018.

Using detailed information about birth dates and parent-child links from the Population Register (BEF) combined with information about income from the Income Register (IND) and the parameters of the program, we determine the child tax credit received by each individual parent. We then aggregate across individuals to measure the exposure to the program of each consumer cell.

Appendix T.B Inflation Relief to Elderly in 2022

Following the surge in inflation in 2022, the Danish government decided to stimulate the economy and abate the living cost crisis by providing tax-free cash transfers to elderly individuals with low income and low liquidity (in addition to existing transfer programs). The inflation relief was targeted at around 290,000 individuals who were above the statutory retirement age (65 years), whose income was below DKK 91,000, and whose liquid assets were below DKK 95,000. There were three cash transfers: DKK 2,500 in September 2022, DKK 2,500 in January 2023, and DKK 5,000 in May 2023. The total fiscal cost was around DKK 3 billion.

Using detailed information from the Income Register (INC) about income and liquid assets in 2018 combined with the parameters of the program, we determine how much each individual would have received if an equivalent program had been in place in that year (deflating income and liquidity thresholds). We then aggregate across individuals to measure the exposure of each consumer cell.

Appendix T.C Housing Rent Inflation Support in 2023

To abate higher living cost due to the surge in inflation, the government decided in 2023 to pay a one-off cash transfer equal to one month's housing rent to people in social housing (in addition to other existing social programs). The transfer was targeted at individuals in social housing sections with special needs, including those with low median gross income, low median disposable income, receiving other social transfers, and single parents. The cash transfers were made in July 2024. In aggregate, the program transferred DKK 350 million.

We do not observe the payouts directly in the administrative registers and cannot measure all the specific criteria for special needs, so we allocate the aggregate transfers to consumer cells in proportion to the number of individuals living in social housing in 2018.

Appendix U Measuring Marginal Propensities to Consume (MPCs)

Appendix U.A MPCs Based on the Danish Release of Mandatory Savings in 2009

We estimate heterogeneous marginal propensities to consume using a Danish stimulus policy from 2009. The policy allowed individuals to convert savings held in an illiquid Special Pension (SP) account into immediately accessible funds (Kreiner et al. 2019). The SP funds stemmed from a government-mandated retirement saving program that was in place from 1998 to 2003. Originally, they were meant to be paid out in regular rates only after individuals turned 65. However, on March 1, 2009, the Danish government unexpectedly announced that all SP account holders would have free access to their SP funds from June 1, 2009. More than three million people—about three quarters of the adult population—were eligible. Of those, 94% chose to have their SP funds paid out, nearly all within the first two months.

Using individual-level monthly data on spending from Danske Bank matched with data on income, wealth, SP pay-outs and age from government administrative registers, we estimate the following equation for the period January 2009 to May 2010:

$$spend_{it} = \alpha_i + \delta \cdot post_t + \beta \cdot SP_i \cdot post_t + \boldsymbol{\gamma}' \boldsymbol{X}_i \cdot post_t + \epsilon_{it} \tag{A.5}$$

where $spend_{it}$ is individual i's spending in month t, α_i is an individual fixed effect, $post_t$ is an indicator taking the value one from June 2009 onward, and SP_i is the amount that individual i held in their SP account when it was released. $\boldsymbol{X}_i$ is a vector of categorical control variables, all measured at the beginning of 2009, capturing the individual's age, ex ante income, liquid assets, debt, DEA industry, and home region. Under the assumption that similar individuals with different SP funds would have remained on parallel spending trajectories in the absence of the policy, β identifies the effect of the stimulus program on spending, measured relative to the amount released and averaged over the first 12 months following this release. Because we annualize the monthly spending variable by multiplying it with 12, it can be interpreted as the one-year MPC for the average person in our sample.

To estimate heterogeneous MPCs, we extend the model by interacting $SP_i \cdot post_t$ with categorical variables representing key ex-ante characteristics: income, liquid assets, debt, and age. We find an average MPC of 0.43; lower MPCs for young adults and people with liquid assets; and no clear MPC heterogeneity by income and debt.

In a final step, we combine the coefficient estimates with individual-level data on age, income, liquid assets, and debt to compute predicted MPCs for each adult member of the population in 2018. We then average across individuals in each consumer cell to obtain cell-level MPC estimates.

Appendix U.B MPCs Based on Lewis et al. (2025)

The U.S. Economic Stimulus Act (ESA) of 2008 led to baseline transfers ranging from 300 USD to 600 USD per individual, with higher payments to individuals with children. The 2008 stimulus was originally studied by Parker et al. (2013) and re-analyzed with a focus on heterogeneity by Lewis et al. (2025). The average MPC reported in Section 4.1 of Lewis et al. (2025) is 0.42. Home-ownership, terciles of labor income, terciles of non-labor income, and the linear ratio of consumption to income are significantly associated with MPCs, as reported in their Table 3, column 5.

We predict the MPC of Danish consumer cells implied by the estimates in Lewis et al. (2025). We measure characteristics of Danish consumer cells that correspond to the characteristics in Table 3, column 5 of Lewis et al. (2025) that are statistically significantly associated with MPCs. Specifically, we measure: the share of homeowners in each cell; terciles of average labor income; terciles of non-labor income; and the ratio of total consumer spending to total income. The predicted MPC of a Danish consumer cell is given by a linear model of the cell-level characteristics multiplied with the relevant point estimates from Lewis et al. (2025). Finally, we ensure that the average predicted MPC matches the 0.42 average estimated by Lewis et al. (2025).

Appendix U.C MPCs Based on Boehm et al. (2025)

The French government paid a subset of households a one-off fiscal transfer of 300 Euro in May 2022. Boehm et al. (2025) in their Figure 2 report that the average household had spent 200 Euro by February 2023, implying a 9-month MPC of 0.67. Their results are consistent with an MPC of 1 after a few years. In their Figure 7, key dimensions of heterogeneity identified by a Lasso procedure include liquid wealth, age, and rural versus urban residence.

We predict the MPC of Danish consumer cells implied by the estimates in Boehm et al. (2025). Their Lasso specification uses quartiles of relevant consumer characteristics to analyze heterogeneity. We analogously calculate quartiles of characteristics for the Danish consumer cells. We then use the point estimates of heterogeneous MPCs according to the Lasso procedure at the 5-fold cross validation choice, as reported in their Figure 7. The predicted MPC of a Danish consumer cell is given by a linear model of the point estimates interacted with indicators for the bins with non-zero MPC heterogeneity. These bins with non-zero heterogeneity are: age Q3, age Q4, population size Q1 (for the most rural regions), population size Q4 (for the most urban regions), and liquidity rate Q3 (liquid assets over income). Finally, we ensure that the average predicted MPC matches the 0.67 average estimated by Boehm et al. (2025).

Appendix V Details on Model Derivations

Appendix V.A Proof of Proposition 1

To prove Proposition 1, we start from (20),

$$dGDP = \sum_{j \in \mathcal{J}} P_j dQ_j - \sum_{j \in \mathcal{J}} \sum_{j' \in \mathcal{J} \cup \{\mathcal{R}\}} P_{j'} dX_{j'j}. \tag{A.6}$$

Applying a total derivative to (10), we can express $P_j dQ_j$

$$P_j dQ_j = \sum_{i \in \mathcal{I}} Z_j P_j \frac{\partial F_j}{\partial N_{ji}} dN_{ji} + \sum_{j \in \mathcal{J} \cup \{\mathcal{R}\}} Z_j P_j \frac{\partial F_j}{\partial X_{jj'}} dX_{jj'}. \tag{A.7}$$

Next, observe that the first order condition for N_{ji} in the producer cell j's profit maximization problem is

$$Z_j P_j \frac{\partial F_j}{\partial N_{ji}} = W_i.$$

Similar, the first order condition for $X_{jj'}$ reads

$$Z_j P_j \frac{\partial F_j}{\partial X_{jj'}} = P_{j'}.$$

Substituting this into (A.7), we express $P_j dQ_j$ as

$$P_j dQ_j = \sum_{i \in \mathcal{I}} W_i dN_{ji} + \sum_{j \in \mathcal{J} \cup \{\mathcal{R}\}} P_{j'} dX_{jj'}. \tag{A.8}$$

This equation holds even if F_j is not using labor from some consumer cells i, that is, $\frac{\partial F_j}{\partial N_{ji}} = 0$ even if $N_{ji} = 0$, because in that case, $dN_{ji} = 0$, and similarly for the case where F_j is not using intermediates from some producer cell j'. Summing (A.8) across j and substituting into (A.6), this shows that the change in real GDP, $dGDP$, can be computed as the change in real labor payments,

$$dGDP = \sum_{j \in \mathcal{J}} \sum_{i \in \mathcal{I}} W_i dN_{ji}. \tag{A.9}$$

With all consumer cells having a fixed wage, as the economy is in a general recession, we have that $dGDP$ also equals the change in nominal labor payments, $\sum_{j \in \mathcal{J}} \sum_{i \in \mathcal{I}} d\left(W_i N_{ji}\right)$.

To compute how nominal labor payments change, we collect nominal equations from all consumer and producer cells.

Consumer cells. Due to their Cobb-Douglas preferences, nominal consumer spending across producer cells is simply a fraction of nominal income. Thus, in changes after a shock,

$$d\left(P_j c_{ij}\right) = \alpha_{ji} dY_i = \alpha_{ji} \left(1 - \tau_i\right) \left(\sum_{j \in \mathcal{J}} d\left(W_i N_{ji}\right) + \sum_{j \in \mathcal{J}} \kappa_{ij} \left(1 - \tau_j\right) d\Pi_j + dT_i \right) \tag{A.10}$$

for all $i \in \mathcal{I}$ and $j \in \mathcal{J} \cup \{\mathcal{R}\}$.

Producer cells. For firms, given their Cobb-Douglas production functions, nominal profits are simply a fraction of total nominal revenue,

$$d\Pi_j = \gamma_j d\left(P_j Q_j\right). \tag{A.11}$$

Similarly, labor demand is also a fixed fraction of total nominal revenue,

$$d\left(W_i N_{ji}\right) = \Lambda_{ij} \cdot d\left(P_j Q_j\right) \tag{A.12}$$

and so is the demand for intermediates,

$$d\left(P_{j'} X_{jj'}\right) = \Omega_{j'j} \cdot d\left(P_j Q_j\right). \tag{A.13}$$

Finally, from goods market clearing (17) we have that

$$d\left(P_j Q_j\right) = \sum_{j' \in \mathcal{J}} d\left(P_j X_{j'j}\right) + \sum_{i \in \mathcal{I}} P_j c_{ij}. \tag{A.14}$$

Putting things together. We define the vector $d\mathbf{v}$ as the change in *factor income* in the economy: the change in labor income received in the economy stacked with total profit income,

$$d\mathbf{v} \equiv \begin{pmatrix} \left\{ \sum_{j \in \mathcal{J}} d\left(W_i N_{ji}\right) \right\}_{i \in \mathcal{I}} \\ \left\{ d\Pi_j \right\}_{j \in \mathcal{J}} \end{pmatrix}.$$

Stacked pre-tax consumer income $d\mathbf{Y} = \{dY_i\}_{i\in\mathcal{I}}$ is then

$$d\mathbf{Y} = \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \cdot d\mathbf{v} + d\mathbf{T}, \tag{A.15}$$

which follows directly from (A.10). $d\mathbf{T} = \{dT_i\}_{i\in\mathcal{I}}$ is the vector of transfer shocks across consumer cells.

Next, stacked consumer spending $d\mathbf{c} \equiv \left\{\sum_{i\in\mathcal{I}} d\left(P_j c_{ij}\right)\right\}_{j\in\mathcal{J}}$ is

$$d\mathbf{c} = \mathbf{A} d\mathbf{Y}, \tag{A.16}$$

which is simply the matrix version of the first equality in (A.10). Combining (A.13) with (A.14), we have

$$d\left(P_j Q_j\right) = \sum_{j'\in\mathcal{J}} \Omega_{jj'} \cdot d\left(P_{j'} Q_{j'}\right) + \sum_{i\in\mathcal{I}} P_j c_{ij}.$$

Thus, denoting the change in nominal revenue by $d\mathbf{q}$, we have

$$d\mathbf{q} = \Omega d\mathbf{q} + d\mathbf{c}$$

or in other words,

$$d\mathbf{q} = \left(\mathbf{I} - \Omega\right)^{-1} d\mathbf{c}. \tag{A.17}$$

Finally, observe that from (A.11) and (A.12) it directly follows that the change in factor income $d\mathbf{v}$ is

$$d\mathbf{v} = \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} d\mathbf{q}. \tag{A.18}$$

Recall that $D(z_j)$ is our notation for a diagonal matrix with elements z_j along the diagonal, for any z_j. Putting together (A.15)–(A.18), we find that $d\mathbf{v}$ is determined as the solution to the fixed point

$$d\mathbf{v} = \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} \left(\mathbf{I} - \Omega\right)^{-1} \mathbf{A} \left(\begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} d\mathbf{v} + d\mathbf{T}\right).$$

Using the definition of $\mathbf{M}$ in (18), we rewrite this as

$$d\mathbf{v} = \mathbf{M} d\mathbf{v} + \mathbf{M} \begin{pmatrix} d\mathbf{T} \\ 0 \end{pmatrix}, \tag{A.19}$$

where $\begin{pmatrix} d\mathbf{T} \\ 0 \end{pmatrix}$ is a vector with $|\mathcal{I}|$ entries dT_i at the top and otherwise zeros.

Unique solution $d\mathbf{v}$. Next, we show that there is a unique solution $d\mathbf{v}$ to (A.19). To do so, observe that, because $\alpha_{\mathcal{R}i} > 0$ for all consumer cells and spending shares sum to 1, $\sum_{j\in\mathcal{J}\cup\{\mathcal{R}\}} \alpha_{ji} = 1$, $\mathbf{A}$ has column sums strictly below 1. Moreover, the matrices $\mathbf{A}$, $\begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix}$ have non-negative entries and column sums at least weakly below 1. Thus, their product

$$\mathbf{A}\begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix}$$

has non-negative entries and columns sums strictly below 1.

Next, observe that

$$\begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I} - \Omega)^{-1}$$

also has non-negative entries and column sums at least weakly below 1.

To prove this, note first that, rearranging (11), we have

$$d\Pi_j + \sum_{i\in\mathcal{I}} d\left(W_i N_{ji}\right) + \sum_{j'\in\mathcal{J}} d\left(P_{j'} X_{jj'}\right) = d\left(P_j Q_j\right) - \sum_{j'\in\mathcal{J}\cup\{\mathcal{R}\}} d\left(P_{\mathcal{R}} X_{j\mathcal{R}}\right).$$

Combining this with (A.11)–(A.13) and noting that $\sum_{j'\in\mathcal{J}\cup\{\mathcal{R}\}} d\left(P_{\mathcal{R}} X_{j\mathcal{R}}\right) \geq 0$, we find

$$\mathbf{1}' D(\gamma_j) + \mathbf{1}'\Lambda + \mathbf{1}'\Omega \leq \mathbf{1}'. \tag{A.20}$$

Since Λ, $D(\gamma_j)$, Ω have non-negative entries, and, by assumption, either Λ or $D(\gamma_j)$ have at least one entry in each column that is positive, Ω must have column sums strictly below 1. Therefore, Ω has a maximum eigenvalue below 1 and

$$(\mathbf{I} - \Omega)^{-1} = \mathbf{I} + \Omega + \Omega^2 + \ldots$$

exists and has non-negative entries. Moreover, the column sums of $\begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I} - \Omega)^{-1}$ are

$$\mathbf{1}' \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I} - \Omega)^{-1} = \mathbf{1}'\Lambda\left(\mathbf{I} - \Omega\right)^{-1} + \mathbf{1}' D(\gamma_j)\left(\mathbf{I} - \Omega\right)^{-1}. \tag{A.21}$$

From (A.20), we see that

$$\mathbf{1}' D(\gamma_j) + \mathbf{1}'\Lambda \leq \mathbf{1}' - \mathbf{1}'\Omega$$

and so that

$$\mathbf{1}' D(\gamma_j) + \mathbf{1}'\Lambda \leq \mathbf{1}'\left(\mathbf{I} - \Omega\right). \tag{A.22}$$

Using (A.22) we can bound (A.21) above,

$$\mathbf{1}'\begin{pmatrix}\Lambda\\ D(\gamma_j)\end{pmatrix}(\mathbf{I}-\Omega)^{-1}\leq\mathbf{1}'.$$

Thus, to sum up, $\mathbf{M}$, as defined in (18), consists of the product of two matrices

$$\begin{pmatrix}\Lambda\\ D(\gamma_j)\end{pmatrix}(\mathbf{I}-\Omega)^{-1}\qquad\text{and}\qquad\mathbf{A}\begin{pmatrix}\mathbf{I} & \mathbf{K}\end{pmatrix}$$

with non-negative entries and column sums strictly below 1. $\mathbf{M}$ therefore has all eigenvalues strictly inside the unit circle and $\mathbf{I}-\mathbf{M}$ is invertible. The unique solution to factor income $d\mathbf{v}$ in (A.19) is

$$d\mathbf{v}=(\mathbf{I}-\mathbf{M})^{-1}\mathbf{M}\begin{pmatrix}d\mathbf{T}\\ 0\end{pmatrix}. \tag{A.23}$$

With the expression in (A.9), we can write $dGDP$ as

$$dGDP=\begin{pmatrix}\mathbf{1}' & 0\end{pmatrix}d\mathbf{v}=\begin{pmatrix}\mathbf{1}' & 0\end{pmatrix}(\mathbf{I}-\mathbf{M})^{-1}\mathbf{M}\begin{pmatrix}d\mathbf{T}\\ 0\end{pmatrix}.$$

This proves (21) once the multiplier μ_i on a transfer to consumer cell i is defined as in (19) with fiscal externality $\overline{\tau}_i$.

Fiscal externality. Next, we derive the equation for the fiscal externalities $\overline{\tau}_i$ in (22). To do so, we totally differentiate the right hand side of the government budget constraint (14) to obtain the increase in tax revenue due to greater economic activity. Defining

$$\text{tax}\equiv\sum_{i\in\mathcal{I}}\tau_iY_i+\sum_{j\in\mathcal{J}}\tau_j\Pi_j,$$

we have

$$d\text{tax}=\sum_{i\in\mathcal{I}}\tau_i dY_i+\sum_{j\in\mathcal{J}}\tau_j d\Pi_j.$$

We rewrite this in vector form as

$$d\text{tax}=\mathbf{1}'D(\tau_i)d\mathbf{Y}+\mathbf{1}'D(\tau_j)d\Pi.$$

Substituting in $d\mathbf{v}$, this becomes

$$d\text{tax}=\mathbf{1}'D(\tau_i)\begin{pmatrix}\mathbf{I} & \mathbf{K}\end{pmatrix}\cdot d\mathbf{v}+\mathbf{1}'D(\tau_i)d\mathbf{T}+\mathbf{1}'D(\tau_j)\begin{pmatrix}0 & \mathbf{I}\end{pmatrix}d\mathbf{v}. \tag{A.24}$$

Next, define effective tax rates $\boldsymbol{\mathcal{T}}$ as $\mathcal{T}_i \equiv \tau_i$ and $\mathcal{T}_j \equiv \tau_j + \sum_i \tau_i \kappa_{ij} (1-\tau_j)$. Then:

$$d\text{tax} = \boldsymbol{\mathcal{T}}' \cdot (\mathbf{I} - \mathbf{M})^{-1} \mathbf{M} \begin{pmatrix} d\mathbf{T} \\ 0 \end{pmatrix} + (\tau_i)' \, d\mathbf{T},$$

which simplifies to

$$d\text{tax} = \boldsymbol{\mathcal{T}}' \cdot (\mathbf{I} - \mathbf{M})^{-1} \begin{pmatrix} d\mathbf{T} \\ 0 \end{pmatrix}.$$

Thus, the fiscal externalities are given by

$$\overline{\boldsymbol{\tau}} = \boldsymbol{\mathcal{T}}' \cdot (\mathbf{I} - \mathbf{M})^{-1} \begin{pmatrix} \mathbf{I} \\ 0 \end{pmatrix},$$

which is (22).

Price normalizations. Note that this entire proof of Proposition Appendix V.A does not rely on any of the price normalizations that we made for convenience in the calibration section.

Appendix V.B Formula for Domestic Spending Intensity

We define domestic spending intensity in (5) and (6). Denoting the intensity by z_i for consumer cells and z_j for producer cells, these equations are

$$z_i = \sum_{j \in \mathcal{J}} \alpha_{ji} z_j$$

and

$$z_j = \sum_{i \in \mathcal{I}} \Lambda_{ij} (1 + z_i (1 - \tau_i)) + \sum_{i \in \mathcal{I}} \gamma_j \kappa_{ij} (1 - \tau_j) (1 + z_i (1 - \tau_i)) + \sum_{j' \in \mathcal{J}} \omega_{j'j} z_{j'}.$$

To simplify the notation, we define $\tilde{z}_i \equiv (1 - \tau_i) z_i$. We summarize these equations in vector notation,

$$(\tilde{z}_i)' = (z_j)' \, \mathbf{A} \tag{A.25}$$

and

$$(z_j)' = \mathbf{1}'\Lambda + (\tilde{z}_i)' \Lambda + \left(\mathbf{1}' + (\tilde{z}_i)'\right) \mathbf{K} D(\gamma_j) + (z_j)' \, \Omega \tag{A.26}$$

where $(\tilde{z}_i)$ and (z_j) are vectors of that stack the intensities of consumer cells and producer cells, respectively. Rearranging (A.26), we express (z_j) as

$$(z_j)' = \left(\mathbf{1}' + (\tilde{z}_i)'\right) \Lambda \, (\mathbf{I} - \Omega)^{-1} + \left(\mathbf{1}' + (\tilde{z}_i)'\right) \mathbf{K} D(\gamma_j) \, (\mathbf{I} - \Omega)^{-1}.$$

We further rewrite this as

$$(z_j)' = \left(\mathbf{1}' + (\tilde{z}_i)'\right) \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I} - \Omega)^{-1}$$

and

$$(z_j)' = (\tilde{z}_i)' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I} - \Omega)^{-1} + \mathbf{1}' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I} - \Omega)^{-1}.$$

Combining this with (A.25), we have

$$(\tilde{z}_i)' = (\tilde{z}_i)' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I} - \Omega)^{-1} \mathbf{A} + \mathbf{1}' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I} - \Omega)^{-1} \mathbf{A}.$$

Multiplying from the left with $\begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix}$, we have

$$(\tilde{z}_i)' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} = (\tilde{z}_i)' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \mathbf{M} + \mathbf{1}' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \mathbf{M}$$

and thus

$$(\tilde{z}_i)' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} = \mathbf{1}' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} (\mathbf{I} - \mathbf{M})^{-1} \mathbf{M}.$$

Multiplying from the left with $\begin{pmatrix} \mathbf{I} \\ 0 \end{pmatrix}$ we then obtain

$$(\tilde{z}_i)' = \mathbf{1}' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} (\mathbf{I} - \mathbf{M})^{-1} \mathbf{M} \begin{pmatrix} \mathbf{I} \\ 0 \end{pmatrix}.$$

In terms of z_i, this means

$$(z_i)' = \mathbf{1}' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} (\mathbf{I} - \mathbf{M})^{-1} \mathbf{M} \begin{pmatrix} D\left((1-\tau_i)^{-1}\right) \\ 0 \end{pmatrix}.$$

Appendix V.C Proof of Proposition 2

To prove Proposition 2, we start from our expression for GDP in (A.9) from the proof of Proposition 1,

$$dGDP = \sum_{j \in \mathcal{J}} \sum_{i \in \mathcal{I}} W_i dN_{ji}.$$

Denoting by ϕ_i an indicator variable whether consumer cell i's labor supply is slack ($\phi_i = 1$) or not ($\phi_i = 0$), we can write the GDP response as

$$dGDP = \sum_{j \in \mathcal{J}} \sum_{i \in \mathcal{I}} \phi_i d\left(W_i N_{ji}\right). \tag{A.27}$$

For all slack consumer cells, the wage is rigid, as it is up against a binding lower bound. Thus, for those i, $W_i dN_{ji} = d\left(W_i N_{ji}\right)$. For all other cells i, $dN_{ji} = 0$, as the wage is free to adjust. This explains (A.27). Following the exact footsteps of the proof of Proposition 1, we see that the same equation for $d\mathbf{v}$ holds, (A.23). Combining (A.23) with (A.27) immediately implies

$$dGDP = \begin{pmatrix} \boldsymbol{\phi}' & 0 \end{pmatrix} \left(\mathbf{I} - \mathbf{M}\right)^{-1} \mathbf{M} \begin{pmatrix} d\mathbf{T} \\ 0 \end{pmatrix}.$$

The fiscal externality is identical to that in Proposition 1. This proves Proposition 2.

Appendix V.D Dynamic Model Setup

Time is discrete and we interpret each period as a year. Each consumer cell i consists of a continuum of consumers with overlapping generations. Consumers are born young without any assets. They earn labor income in the first period, enjoy log utility from consumption, and save for the future by holding assets. When saving, they earn an annuity premium, as in Blanchard (1985). Thus, they do not leave behind any bequests. For simplicity, we assume unitary elasticities, that is, Cobb-Douglas preferences and production functions.

Consumer cells. Consumer $\ell \in [0, 1]$ in consumer cell i born at time t_0 maximizes

$$\max_{\{C_{it}(\ell), A_{it}(\ell)\}} \sum_{t=t_0}^{\infty} \left(\beta \phi_i\right)^{t-t_0} \log C_{it}(\ell), \tag{A.28}$$

subject to

$$P_{it} C_{it}(\ell) + A_{it}(\ell) = \phi_i^{-1} \left(1 + r^*\right) A_{it-1}(\ell) + 1_{\{t=t_0\}} \frac{\left(1 - \tau_i\right) Y_{it}}{1 - \phi_i}. \tag{A.29}$$

Within each period, we that all consumers ℓ within cell i have exactly the same preferences, given by (7), that are Cobb-Douglas across goods with expenditure shares α_{ji}. ϕ_i is a cell-specific survival probability. We do not interpret it literally as physical survival probability, but instead, in the spirit of Farhi and Werning (2019), as analogous to the probability of avoiding a borrowing constraint in a richer model. A low ϕ_i therefore serves to effectively restrict the planning horizon of the consumers. We later calibrate ϕ_i to match MPC estimates across consumers.

$A_{it}(\ell)$ is the consumer's end-of-period t asset position. The consumer is earning the world interest rate $1 + r^*$ on the asset position, multiplied by the inverse of the survival probability ϕ_i^{-1} to capture the annuity premium.

A mass $1 - \phi_i$ of consumers is born each period t. These consumers all earn the income of the cell, giving an income of $\frac{(1-\tau_i)Y_{it}}{1-\phi_i}$ per newborn. Here, τ_i is the same tax rate as that introduced in Section V. Y_{it} is pre-tax income of cell i,

$$Y_{it} = N_{it}W_{it} + \sum_{j\in\mathcal{J}} \kappa_{ij} \left(1 - \tau_j\right) \Pi_{jt} + T_{it}, \tag{A.30}$$

where all objects are simply the time-varying counterparts of those in (8). The assumption that all income is earned in the first period of a perpetual youth model follows Caballero et al. (2008), and helps to keep the dynamics tractable. It avoids consumers changing consumption plans in anticipation of future income changes, for which there is only limited evidence in the data (see, e.g., Broda and Parker 2014, Auclert et al. 2020).

Aggregating across consumers within a consumer cell, overall cell consumption and cell asset accumulation

$$C_{it} = \int_0^1 C_{it}(\ell)d\ell \qquad \text{and} \qquad A_{it} = \int_0^1 A_{it}(\ell)d\ell$$

follow the following system of equations

$$P_{it}C_{it} = \left(1 - \phi_i\beta\right)\left(\left(1 + r^*\right) A_{it-1} + \left(1 - \tau_i\right) Y_{it}\right) \tag{A.31}$$

and

$$P_{it}C_{it} + A_{it} = \left(1 + r^*\right) A_{it-1} + \left(1 - \tau_i\right) Y_{it}. \tag{A.32}$$

This is a direct application of Proposition 5 in Appendix B.7 of Aggarwal et al. (2023).

Producer cells. Producer cells are an exact replica of the producer cells in the static model. Each cell j is occupied by a representative firm producing a quantity Q_{jt} of good j with technology

$$Q_{jt} = Z_jF_j\left(\{N_{jit}\}_{i\in\mathcal{I}}, \{X_{jj't}\}_{j'\in\mathcal{J}\cup\{\mathcal{R}\}}\right),$$

where F_j and Z_j are as before. N_{jit} and $X_{jj't}$ are now time-varying. Pre-tax profits are time-varying, too,

$$\Pi_{jt} = P_{jt}Q_{jt} - \sum_{i\in\mathcal{I}} W_{it}N_{jit} - \sum_{j'\in\mathcal{J}\cup\{\mathcal{R}\}} P_{j't}X_{jj't}. \tag{A.33}$$

Wage rigidity. We keep the assumption that wages are downwardly rigid,

$$W_{it} \geq \left(1 - \delta\right) W_{it-1}, \tag{A.34}$$

though for our analysis of cumulative multipliers below, we study the impact of fiscal stimulus during a recession which pushes wages down against the constraint (A.34) until some period H capturing the horizon of the recession.

Rest of the world. The economy still operates a fixed nominal exchange rate, $\mathcal{E}_t = 1$, with an exogenous constant foreign price $P_{\mathcal{R}}$ and stable export demand

$$x_{jt} = \tilde{x}_j \cdot \left(P_{jt}/P_{\mathcal{R}}\right)^{-\tilde{\sigma}} . \tag{A.35}$$

Government. The government budget constraint is given by

$$\sum_{j \in \mathcal{J} \cup \{\mathcal{R}\}} P_{jt} G_j + \sum_{i \in \mathcal{I}} T_{it} + (1 + r^*) B_t = B_{t-1} + \sum_{i \in \mathcal{I}} \tau_i Y_{it} + \sum_{j \in \mathcal{J}} \tau_j \Pi_{jt} + \Delta_t, \tag{A.36}$$

where now transfers T_{it}, pre-tax income Y_{it}, profits Π_{jt} and transfers from abroad Δ_t are time-varying. B_t is government debt issued at the end of period t.

Balance of payments. The balance of payments for our small open economy is now given by

$$\sum_{j \in \mathcal{J}} P_{jt} x_{jt} \ + \ \Delta_t \ + \ (1 + r^*) \, \text{nfa}_{t-1} \ = \ \text{nfa}_t \ + \sum_{i \in \mathcal{I}} P_{\mathcal{R}} c_{i\mathcal{R}t} \ + \ P_{\mathcal{R}} G_{\mathcal{R}} \ + \sum_{j \in \mathcal{J}} P_{\mathcal{R}} X_{j\mathcal{R}t}, \tag{A.37}$$

where the net foreign asset position is

$$\text{nfa}_t = \sum_{i \in \mathcal{I}} A_{it} - B_t.$$

Equilibrium. A *competitive equilibrium* in the dynamic economy consists of paths for prices and wages $\{P_{jt}, W_{it}\}$ and a dynamic allocation $\{Q_{jt}, N_{jit}, X_{jj't}, \Pi_{jt}, T_{it}, G_j, Y_{it}, C_{ijt}, x_{jt}, B_t, A_{it}\}$ such that (a) income is given by (A.30); (b) all consumer cells maximize utility (A.28) subject to (A.29); (c) all producer cells maximize profits (A.33); (d) the downward nominal wage rigidity (A.34) holds; (e) the government's budget constraint (A.36) is balanced with bounded B_t; (f) exports are given by (A.35); (g) labor markets clear for each consumer cell,

$$N_{it} = \sum_{j \in \mathcal{J}} N_{jit}; \tag{A.38}$$

(h) the goods market clears for each producer cell,

$$Q_{jt} = \sum_{j' \in \mathcal{J}} X_{j'jt} + x_{jt} + \sum_{i \in \mathcal{I}} C_{ijt} + G_j; \tag{A.39}$$

and (i) the balance of payments hold in (A.37).

Calibration. We calibrate the model exactly as we calibrated the static model in Section V.C. The only parameters we have to determine in addition are the survival probability ϕ_i for each consumer cell i, the discount factor β, and the world interest rate r^*. Since consumer cell i's consumption and saving behavior is summarized by equations (A.31) and (A.32), and only the product $\phi_i\beta$ appears there, we only have to choose $\phi_i\beta$ for each cell i. Independently, β does not matter for the behavior of the dynamic model. Furthermore, $1-\phi_i\beta$ is exactly consumer cell i's marginal propensity to consume (MPC) out of post-tax income. In our baseline, we calibrate this object using the MPC evidence from Denmark described in Appendix U.A. Finally, we set $r^*=0$ as in Aggarwal et al. (2023). In an economy that explicitly modeled growth, this would correspond to the common "$r=g$" assumption, which has not been far from the truth for Denmark. This assumption ensures that the flows in any steady state of the dynamic model are identical to those in the static model of Section V.

Appendix V.E Dynamic Model Analysis

We now analyze the response of the dynamic economy to a surprise transfer shock (dT_{it}), raising transfers to consumer cell i at date t by dT_{it}, all financed by transfers Δ_t from abroad, $\Delta_t = \sum_{i\in\mathcal{I}} dT_{it}$. We denote the change in assets by consumer cell i by dA_{it}. We convert all asset changes to be pre-tax, $d\tilde{A}_{it} \equiv \frac{dA_{it}}{1-\tau_i}$, which turns out to be convenient further down, and collect them in vector $d\tilde{\mathbf{A}}_t$. The law of motion of $d\tilde{A}_{it}$ is then obtained by linearizing (A.32)

$$\frac{1}{1-\tau_i} d\left(P_{it}C_{it}\right) + d\tilde{A}_{it} = \left(1+r^*\right) d\tilde{A}_{it-1} + dY_{it}. \tag{A.40}$$

Here, the change in nominal consumption across consumer cells $d\left(P_{it}C_{it}\right)$ is then

$$\frac{1}{1-\tau_i} d\left(P_{it}C_{it}\right) = m_i\left(1+r^*\right) d\tilde{A}_{it-1} + m_i dY_{it}, \tag{A.41}$$

where we abbreviate the MPC by $m_i \equiv 1-\phi_i\beta$ to simplify the notation. Nominal income dY_{it} changes according to

$$dY_{it} = \underbrace{\sum_{j\in\mathcal{J}} \lambda_{ij} d\left(P_{jt}Q_{jt}\right)}_{\equiv dv_{it}} + \sum_{j\in\mathcal{J}} \kappa_{ij}\left(1-\tau_j\right) \underbrace{\gamma_j d\left(P_{jt}Q_{jt}\right)}_{\equiv dv_{jt}} + dT_{it}. \tag{A.42}$$

In words, consumer i spends a fraction m_i of the additional assets $(1+r)\,dA_{it-1}$ with which it entered period t, as well as a fraction m_i out of income dY_{it}, including any transfers received dT_{it}. As before, dv_{it} is the factor income of consumer cell i's labor, dv_{jt} is the factor income of producer cell j's fixed factor. We stack transfers and factor income into $|\mathcal{I}| + |\mathcal{J}|$-dimensional vectors $d\mathbf{T}_t = ((dT_{it})_i, \mathbf{0})'$ and $d\mathbf{v}_t$. Equation (A.42) then becomes

$$d\mathbf{Y}_t = \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} d\mathbf{v}_t + d\mathbf{T}_t.$$

A crucial object in the dynamic model is the *dynamic factor demand matrix* $\mathbf{M}^{dyn}$, defined as

$$\mathbf{M}^{dyn} = \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I} - \Omega)^{-1} \mathbf{A} D(m_i) \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix}, \tag{A.43}$$

which includes a diagonal matrix of MPCs, $D(m_i)$. This matrix will guide the Keynesian amplification happening within each period. The full dynamics of our model are then described by two equations.

Proposition 3. *The response of the dynamic model to a transfer shock $(d\mathbf{T}_t)$ is governed by two equations. First, the vector of pre-tax asset positions $d\tilde{\mathbf{A}}_t = (d\tilde{A}_{it})$ evolves according to*

$$d\tilde{\mathbf{A}}_t = D(1 - m_i)(1 + r^*) \, d\tilde{\mathbf{A}}_{t-1} + D(1 - m_i) \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} (d\mathbf{T}_t + d\mathbf{v}_t), \tag{A.44}$$

where factor income $d\mathbf{v}_t$ is determined by

$$d\mathbf{v}_t = \mathbf{M}^{dyn} (d\mathbf{T}_t + d\mathbf{v}_t) + \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I} - \Omega)^{-1} \mathbf{A} D(m_i) (1 + r^*) \, d\tilde{\mathbf{A}}_{t-1}. \tag{A.45}$$

GDP is given by

$$dGDP_t = \begin{pmatrix} \mathbf{1}' & 0 \end{pmatrix} d\mathbf{v}_t \tag{A.46}$$

and tax revenue is given by

$$dtax_t = \boldsymbol{\mathcal{T}}' (d\mathbf{T}_t + d\mathbf{v}_t). \tag{A.47}$$

Proof. Equation (A.44) is a simple combination of (A.40) and (A.41). To derive (A.45), we follow the steps in Appendix V.A, but instead of (A.10), we use

$$d(P_{it} c_{ijt}) = \alpha_{ji} m_i (1 - \tau_i) \left((1 + r^*) \, d\tilde{A}_{it-1} + dY_{it} \right).$$

Stacked consumer spending (A.16) is now given by

$$d\mathbf{c}_t = \mathbf{A} D(m_i) d\mathbf{Y}_t + \mathbf{A} D(m_i)(1 + r^*) \, d\tilde{\mathbf{A}}_{t-1},$$

giving us the within period fixed point

$$d\mathbf{v}_t = \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I}-\Omega)^{-1} \mathbf{A} D(m_i) \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} (d\mathbf{v}_t + d\mathbf{T}_t) + \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I}-\Omega)^{-1} \mathbf{A} D(m_i) (1+r^*) d\tilde{\mathbf{A}}_{t-1}.$$

With the definition of $\mathbf{M}^{dyn}$ in (A.43), this simplifies to

$$d\mathbf{v}_t = \mathbf{M}^{dyn} (d\mathbf{v}_t + d\mathbf{T}_t) + \begin{pmatrix} \Lambda \\ D(\gamma_j) \end{pmatrix} (\mathbf{I}-\Omega)^{-1} \mathbf{A} D(m_i) (1+r^*) d\tilde{\mathbf{A}}_{t-1},$$

which is identical to (A.45). The GDP equation (A.46) follows from (A.9).

To solve for the response of tax revenue, we start with the dynamic analog of (A.24),

$$d\text{tax}_t = \mathbf{1}' D(\tau_i) \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \cdot d\mathbf{v}_t + \mathbf{1}' D(\tau_i) \begin{pmatrix} \mathbf{I} & 0 \end{pmatrix} d\mathbf{T}_t + \mathbf{1}' D(\tau_j) \begin{pmatrix} 0 & \mathbf{I} \end{pmatrix} d\mathbf{v}_t.$$

Using effective tax rates $\boldsymbol{\mathcal{T}}$ as before, this becomes

$$d\text{tax}_t = \boldsymbol{\mathcal{T}}' \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \cdot (d\mathbf{T}_t + d\mathbf{v}_t),$$

which is identical to (A.47). □

Appendix V.F Dynamic vs. Static Multipliers

We define the H-horizon cumulative multiplier of the dynamic model as

$$\mu_i^{pv}(H) = \frac{\sum_{t=0}^{H} (1+r^*)^{-t} \frac{dGDP_t}{dT_{i0}}}{1 - \sum_{t=0}^{H} (1+r^*)^{-t} \frac{d\text{tax}_t}{dT_{i0}}}$$

for a small transfer to consumer cell i. Stacking them into a vector, we denote them by $\boldsymbol{\mu}^{pv}(H)$. We next prove that the ∞-horizon cumulative multiplier equals the static multiplier.

Proposition 4. *The ∞-horizon cumulative multipliers in the dynamic model, $\boldsymbol{\mu}^{pv}(\infty)$, defined in (25), are equal to the multipliers in the static model, defined in (21).*

Proof. To prove this result, we take present values of the equations in Proposition 3. To simplify the math, we define $q \equiv \frac{1}{1+r^*}$. We begin with (A.44),

$$\sum_{t=0}^{\infty} q^t d\tilde{\mathbf{A}}_t = D(1-m_i) \sum_{t=1}^{\infty} q^{t-1} d\tilde{\mathbf{A}}_{t-1} + D(1-m_i) \begin{pmatrix} \mathbf{I} & \mathbf{K} \end{pmatrix} \left(\sum_{t=0}^{\infty} q^t d\mathbf{T}_t + \sum_{t=0}^{\infty} q^t d\mathbf{v}_t \right),$$

which simplifies to

$$D(m_i)\sum_{t=0}^{\infty}q^t d\tilde{\mathbf{A}}_t = D(1-m_i)\begin{pmatrix}\mathbf{I} & \mathbf{K}\end{pmatrix}\left(\sum_{t=0}^{\infty}q^t d\mathbf{T}_t + \sum_{t=0}^{\infty}q^t d\mathbf{v}_t\right).$$

Multiplying this on the left with $\begin{pmatrix}\Lambda \\ D(\gamma_j)\end{pmatrix}(\mathbf{I}-\Omega)^{-1}\mathbf{A}$, we get

$$\begin{aligned}\begin{pmatrix}\Lambda \\ D(\gamma_j)\end{pmatrix}&(\mathbf{I}-\Omega)^{-1}\mathbf{A}D(m_i)\sum_{t=0}^{\infty}q^t d\tilde{\mathbf{A}}_t \\ &= \begin{pmatrix}\Lambda \\ D(\gamma_j)\end{pmatrix}(\mathbf{I}-\Omega)^{-1}\mathbf{A}D(1-m_i)\begin{pmatrix}\mathbf{I} & \mathbf{K}\end{pmatrix}\left(\sum_{t=0}^{\infty}q^t d\mathbf{T}_t + \sum_{t=0}^{\infty}q^t d\mathbf{v}_t\right)\end{aligned}$$

where the big matrix on the left is simply $\mathbf{M}-\mathbf{M}^{dyn}$. Therefore,

$$\begin{pmatrix}\Lambda \\ D(\gamma_j)\end{pmatrix}(\mathbf{I}-\Omega)^{-1}\mathbf{A}D(m_i)\sum_{t=0}^{\infty}q^t d\tilde{\mathbf{A}}_t = \left(\mathbf{M}-\mathbf{M}^{dyn}\right)\left(\sum_{t=0}^{\infty}q^t d\mathbf{T}_t + \sum_{t=0}^{\infty}q^t d\mathbf{v}_t\right). \quad \text{(A.48)}$$

Next, taking present values of (A.45), we find

$$\sum_{t=0}^{\infty}q^t d\mathbf{v}_t = \mathbf{M}^{dyn}\left(\sum_{t=0}^{\infty}q^t d\mathbf{T}_t + \sum_{t=0}^{\infty}q^t d\mathbf{v}_t\right) + \begin{pmatrix}\Lambda \\ D(\gamma_j)\end{pmatrix}(\mathbf{I}-\Omega)^{-1}\mathbf{A}D(m_i)\sum_{t=0}^{\infty}q^t d\tilde{\mathbf{A}}_t.$$

Substituting (A.48) on the right hand side, this becomes

$$\sum_{t=0}^{\infty}q^t d\mathbf{v}_t = \mathbf{M}\left(\sum_{t=0}^{\infty}q^t d\mathbf{T}_t + \sum_{t=0}^{\infty}q^t d\mathbf{v}_t\right).$$

Thus, the present value of factor income $\sum_{t=0}^{\infty}q^t d\mathbf{v}_t$ responds "as if" we had a static economy with $\mathbf{M}$ (instead of $\mathbf{M}^{dyn}$) and a static transfer shock of $\sum_{t=0}^{\infty}q^t d\mathbf{T}_t$. Solving the fixed point,

$$\sum_{t=0}^{\infty}q^t d\mathbf{v}_t = (\mathbf{I}-\mathbf{M})^{-1}\mathbf{M}\sum_{t=0}^{\infty}q^t d\mathbf{T}_t.$$

The present value of GDP (A.46) therefore moves according to

$$\sum_{t=0}^{\infty}q^t dGDP_t = \begin{pmatrix}\mathbf{1}' & 0\end{pmatrix}(\mathbf{I}-\mathbf{M})^{-1}\mathbf{M}\sum_{t=0}^{\infty}q^t d\mathbf{T}_t.$$

Comparing this to (21), we see that

$$\sum_{t=0}^{\infty} q^t \frac{dGDP_t}{dT_{i0}} = \mu_i \cdot (1 - \overline{\tau}_i)\,, \tag{A.49}$$

where μ_i is the static multiplier.

The present value of tax revenue changes (A.47) is

$$\sum_{t=0}^{\infty} q^t d\text{tax}_t = \boldsymbol{\mathcal{T}}' \left(\sum_{t=0}^{\infty} q^t d\mathbf{T}_t + \sum_{t=0}^{\infty} q^t d\mathbf{v}_t \right) = \boldsymbol{\mathcal{T}}' \left(\mathbf{I} - \mathbf{M}\right)^{-1} \left(\sum_{t=0}^{\infty} q^t d\mathbf{T}_t \right).$$

Thus,

$$\sum_{t=0}^{\infty} q^t \frac{d\text{tax}_t}{dT_{i0}} = \overline{\tau}_i, \tag{A.50}$$

with the fiscal externality $\overline{\tau}_i$ exactly as defined in Proposition 22.

Putting together (A.49) and (A.50) we confirm that the infinite-horizon cumulative multiplier equals the static multiplier,

$$\mu_i^{pv}(\infty) = \frac{\sum_{t=0}^{\infty} \left(1+r^*\right)^{-t} \frac{dGDP_t}{dT_{i0}}}{1 - \sum_{t=0}^{\infty} \left(1+r^*\right)^{-t} \frac{d\text{tax}_t}{dT_{i0}}} = \frac{\mu_i \cdot (1 - \overline{\tau}_i)}{1 - \overline{\tau}_i} = \mu_i.$$

□

Appendix W Detailed Discussion of Alternative Accounts and Elasticities

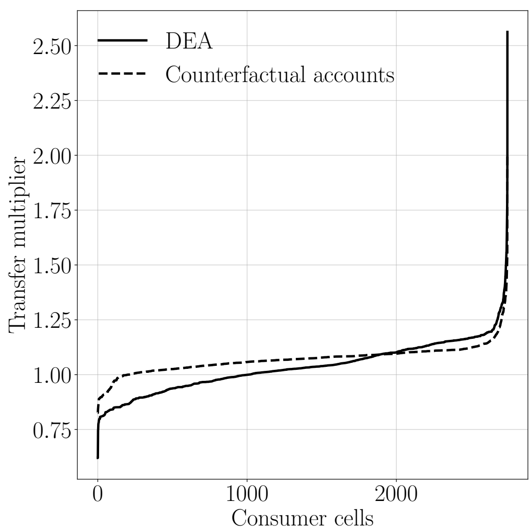
We present a more elaborate analysis of the points summarized in Section IX.

Appendix W.A Multipliers Under Counterfactual Accounts

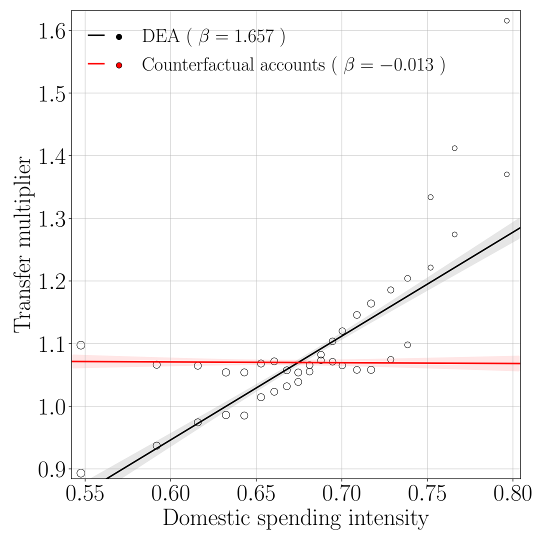
We show that the multipliers depend on the specific patterns observed in the disaggregated economic accounts (DEA), as opposed to being generic outcomes of a disaggregated model. We construct alternative, counterfactual accounts that differ from the true DEA in three ways. First, the domestic spending shares of rural consumer cells are low and those of urban cells are high in the counterfactual accounts, exactly opposite to the true pattern documented in Section IV.B. Second, urban consumer cells disproportionately spend in rural regions, so there is "rural bias" in consumption, contrasting the true urban bias established in Section IV.E. Finally, foreign exports of rural manufacturing firms are low and those of urban service firms are high in the counterfactual accounts. The three changes ensure that all accounting identities remain satisfied.

Using the counterfactual accounts, we re-calibrate the model of Section V and re-estimate the

Figure A.XVIII: Multipliers under counterfactual accounts



(a) Multipliers under counterfactual accounts and DEA

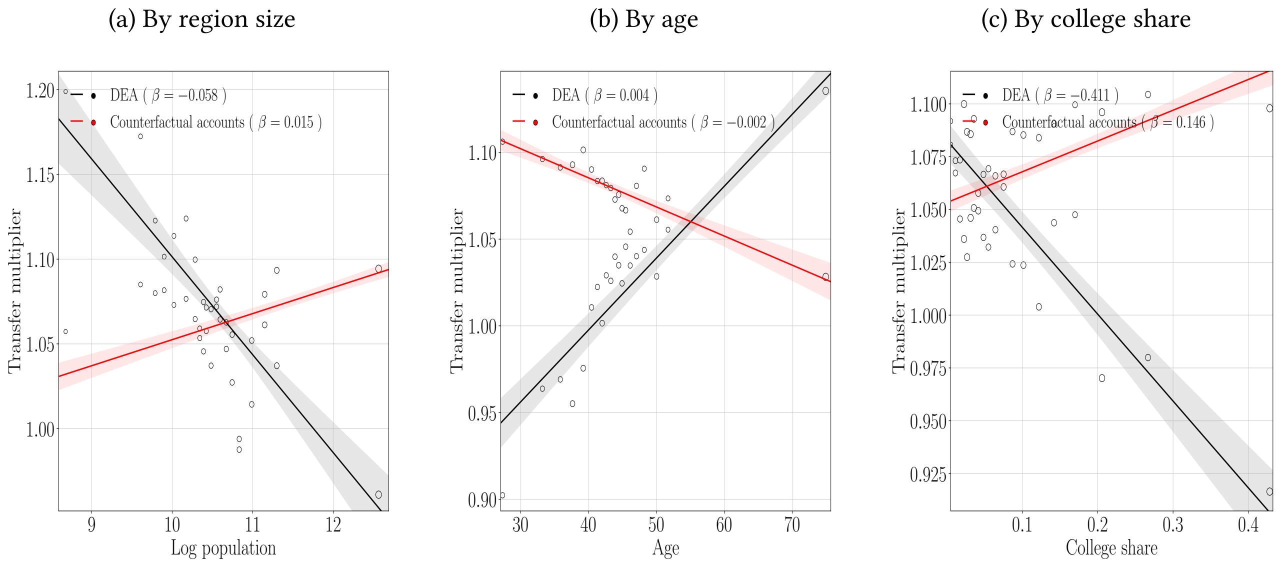


(b) Multipliers and domestic spending intensity

Panel a shows a binned scatter plot of the multiplier under alternative, counterfactual accounts described in Appendix W.A against the multiplier in the true disaggregated economic accounts (DEA). Panel b shows a binned scatter plot of the two multipliers against the DEA domestic spending intensity (calculated using the true DEA data). The solid lines are the lines of best fit, estimated using the cell-level data. Each circle contains the same number of cells. The size of a circle is proportional to the population size of cells in the circle. The regressions are weighted by population in the consumer cell. Standard errors are clustered by consumer cell. The error bands are 95% confidence intervals.

multipliers. The resulting multipliers differ from the baseline DEA multipliers, as shown in Figure A.XVIIIa, and are weakly associated with the domestic spending intensity calculated under the true DEA data, as shown in Figure A.XVIIIb. Moreover, rural, older, and less college-educated cells have lower multipliers under the counterfactual accounts, in contrast to the conclusions based on the true data, as shown in Figure A.XIX.

Figure A.XIX: Multipliers under counterfactual accounts and consumer characteristics



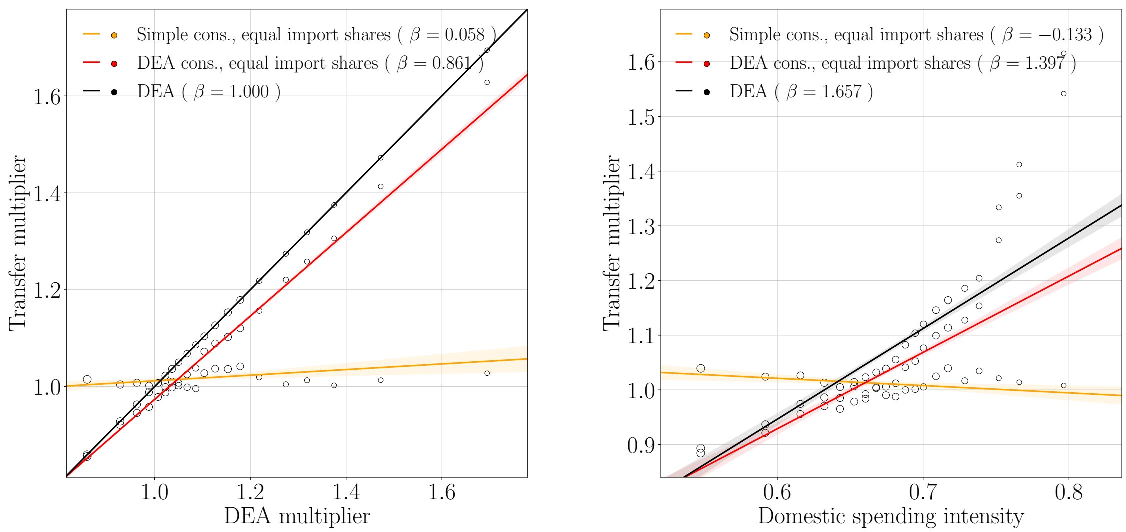
Panel a shows a binned scatter plot of the multiplier under alternative, counterfactual accounts against log population of the home region. Panel b shows a binned scatter plot of the multiplier under alternative, counterfactual accounts against the average age in the cell. Panel c shows a binned scatter plot of the multiplier under alternative, counterfactual accounts against the share of college-educated consumers in the cell. The solid lines are the lines of best fit, estimated using the cell-level data. Each circle contains the same number of cells. The size of a circle is proportional to the population size of cells in the circle. The regressions are weighted by population in the consumer cell. Standard errors are clustered by consumer cell. The error bands are 95% confidence intervals.

The analysis shows that changing the patterns in the disaggregated accounts changes the distribution of multipliers. Policymakers in economies with different structures may therefore benefit from measuring the disaggregated accounts in their specific context.

Appendix W.B Multipliers Under Simplified Accounts

Disaggregated data on foreign imports and consumer spending are not always available at the industry-by-region level. Some previous measurement systems have made simplifying assumptions to analyze the propagation of shocks in multi-region and multi-industry economies. While these assumptions are useful for some questions, they may lead to different conclusions about cell-level variation in transfer multipliers compared to the full DEA. We analyze whether the conclusions on multipliers change when we impose commonly used simplifying assumptions about foreign imports and consumer spending.

Figure A.XX: Multipliers under simplified accounts



(a) Multipliers under simplified accounts and DEA (b) Multipliers and domestic spending intensity

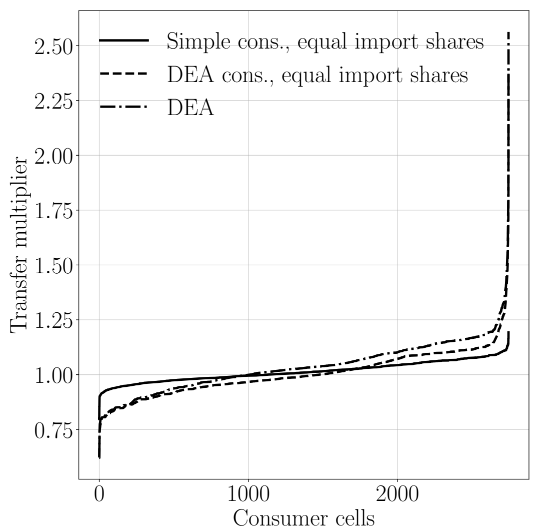
Panel a shows a binned scatter plot of the multiplier under two simplified accounts described in Appendix W.B against the multiplier in the true disaggregated economic accounts (DEA). Panel b shows a binned scatter plot of the multipliers against the DEA domestic spending intensity (calculated using the true data). The solid lines are the lines of best fit, estimated using the cell-level data. Each circle contains the same number of cells. The size of a circle is proportional to the population size of cells in the circle. The regressions are weighted by population in the consumer cell. Standard errors are clustered by consumer cell. The error bands are 95% confidence intervals.

In the absence of cell-level foreign trade data, a typical assumption is that every producer cell within an industry imports the same share of its intermediates from abroad. We adopt this simplified import pattern, but keep all other parts of the DEA unchanged. The resulting multiplier in the simplified accounts is positively associated with the multiplier based on the true data, but the slope is below 1, as shown in Figure A.XXa. In the same vein, the association between the multiplier and domestic spending intensity (calculated under the true data) is slightly lower in the simplified accounts, as shown in Figure A.XXb. Overall, the multipliers change somewhat but not strongly when we assume identical within-industry import shares.

In the absence of disaggregated consumer spending data, a common assumption is that consumers spend only on local producers and that local producers purchase final consumer goods from other regions in proportion to their purchases of intermediates from other regions. This approach is equivalent to assuming that the share of final goods purchased by region i consumers from region-by-industry producer cell j (out of the total consumer spending of region i consumers) equals the share of intermediates purchased by region i producers from producer cell j (out of the total intermediates spending of region i producers). In practice, this assumption is often implemented using expenditure shares calculated from cross-region shipments (e.g., the U.S. Commodity Flow Survey).

When we impose this simplified consumer spending matrix, the conclusions on multipliers change strongly, as shown by the low slopes in Figure A.XX. The distribution of multipliers is also more compressed than in the true data, as shown in Figure A.XXI, suggesting that simplifying assumptions would lead us to underestimate the potential gains from targeting high-multiplier groups.

Figure A.XXI: Distribution of multipliers under simplified accounts



The figure shows the distribution of multipliers under two simplified accounts described in Appendix W.B.

Another common simplifying assumption about consumer spending is that the share of consumer cell i's spending going to producer cell j (out of cell i's total spending) is identical across consumer cells. This assumption mirrors the representative consumer structure of Stone's SNA. Since there is no heterogeneity in consumer spending, the transfer multiplier is identical across cells, as shown in Figure XI.

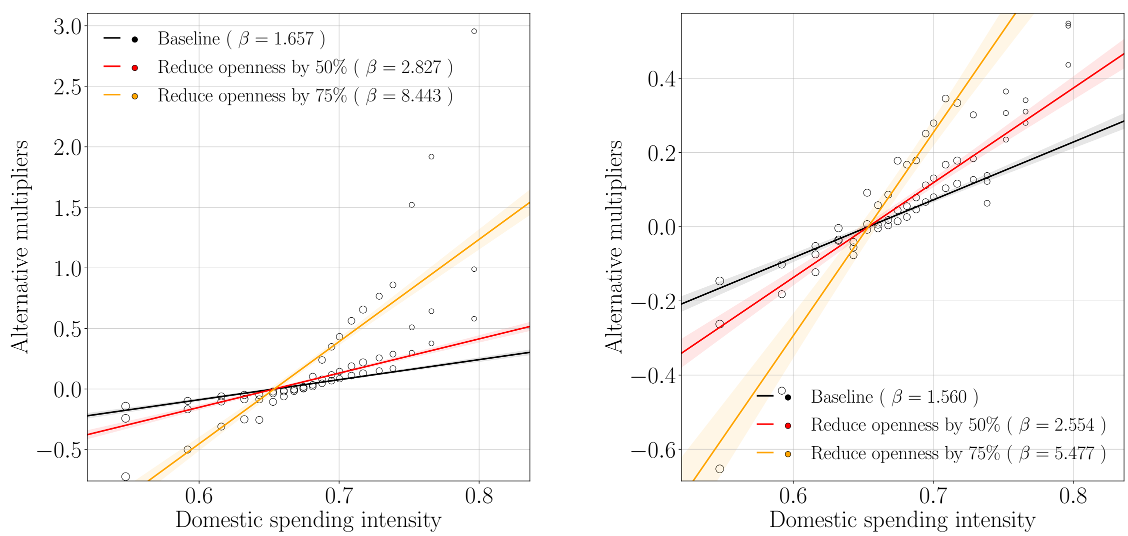
Taken together, the findings show that the variation in transfer multipliers cannot be replicated under simplifying assumptions in the absence of disaggregated data.

Appendix W.C Multipliers in Less Open Economies

We show that a cell's domestic spending intensity is associated with the relative size of its multiplier in economies less open to foreign trade than Denmark. The ratio of aggregate imports to GDP in Denmark was roughly 52% in 2018, slightly below the median European Union country. In contrast, the ratio was around three-quarters lower in the United States, which at 15% was the least open OECD country in the world.

We analyze two less open versions of the Danish economy by proportionally scaling down every cell's imports and exports by 50% and 75%, respectively. In the less open economies, domestic cells that import from abroad in the true data now purchase more from other domestic cells that export in the true data. As a result, each cell's foreign imports and exports are lower in the less open economies, relative to the true DEA, but each cell's total outflows and inflows remain unchanged.

Figure A.XXII: Multipliers in less open economies



(a) Static multipliers

(b) Dynamic multipliers after year 4

The panels show binned scatter plots of the multiplier in two less open economies against the DEA domestic spending intensity (calculated using the true data). The multipliers are de-meaned relative to other cells in the economy, which eases visual comparisons. Panel a shows multipliers from the static model. Panel b shows multipliers from the dynamic model after year 4. The solid lines are the lines of best fit, estimated using the cell-level data. Each circle contains the same number of cells. The size of a circle is proportional to the population size of cells in the circle. The regressions are weighted by population in the consumer cell. Standard errors are clustered by consumer cell. The error bands are 95% confidence intervals.

Using the less open economies, we re-calibrate the model of Section V and re-estimate the multipliers in an economy-wide recession in the static model. For each version of openness, we report de-meaned multipliers, since this eases visual comparisons and we do not want to focus on the well-known finding (going back to the textbook Mundell-Fleming model) that average multipliers are higher in less open economies. The de-meaned multipliers are equal to the multipliers of transfers that are funded internally through equal taxes on each consumer cell.

We plot the de-meaned multipliers for economies with different openness against the domestic spending intensity measured in the true DEA data in Figure A.XXIIa. Two findings stand out. First, domestic spending intensity continues to be strongly associated with the multiplier in less open economies. As before, the intuition is that cells with high domestic spending intensity contribute more to domestic incomes, implying that their spending leads to greater GDP gains. Second, the higher slopes in the less open economies reveal that the relation between domestic spending intensity and the multiplier is stronger in less open economies. Intuitively, each dollar spent in a less open economy reaches a multiple more domestic cells, so that an initial difference in domestic spending intensity is disproportionately amplified in a less open economy.

We repeat the analysis of less open economies using the dynamic model of Section VIII. Figure A.XXIIb plots multipliers from the dynamic model after year 4 against domestic spending intensity measured in the true data. The difference between the true DEA and the less open economies is less pronounced in the dynamic model relative to the static model. The reason is that in the dynamic model after finite horizons, consumers have not spent the initial transfer in full, so that the multiplicatively greater impact of domestic spending intensity has not yet fully played out.

Taken together, our key point is not to analyze whether spending intensities matter more or less in less open economies. Instead, we wish to emphasize that knowledge of the full DEA can provide policy-relevant insights in less open economies.

Appendix W.D Alternative Elasticities of Substitution

The baseline analysis assumes Cobb-Douglas elasticities equal to 1 because they may be appropriate for the analysis over a 4-year horizon and because of their analytical tractability, as explained in Section V.C. We explore variation in transfer multipliers using alternative elasticities.

Throughout this section, we assume that, for each consumer cell i, $C_i(\cdot)$ is of the form

$$C_i(\cdot) = c_{i\mathcal{R}}^{\alpha_{i\mathcal{R}}} \mathcal{C}_i(\{c_{ij}\}_{j\in\mathcal{J}})^{1-\alpha_{i\mathcal{R}}}.$$

$\mathcal{C}_i$ is a nested CES utility function with an outer elasticity of substitution between industries, $\overline{\sigma}$, and an inner elasticity of substitution σ between producer cells within an industry. We write the production function $F_j(\cdot)$ as

$$Q_j = Z_j F_j \left(K_j, \{N_{ji}\}_{i\in\mathcal{I}}, \{X_{jj'}\}_{j'\in\mathcal{J}}, X_{j\mathcal{R}}\right). \tag{A.51}$$

Here, we explicitly model the fixed factor K_j, and we separate the domestic labor bundle $\{N_{ji}\}_{i\in\mathcal{I}}$, domestic intermediates $\{X_{jj'}\}_{j'\in\mathcal{J}}$ and imported intermediates $X_{j\mathcal{R}}$. Given that we explicitly model the fixed factor K_j, F_j is constant returns to scale.[A9]

We assume F_j is nested CES, too, with an outer elasticity of substitution ϑ across the four types of inputs in (A.51), as well as an inner elasticity of substitution between domestic consumer cells (within industry) of ζ, and for domestic intermediates an outer cross-industry elasticity of

[A9] This formulation nests (10) by normalizing $K_j = 1$, as it is in fixed supply, and assuming that F_j is Cobb-Douglas over K_j and all the other inputs.

substitution of $\overline{\upsilon}$ as well as a within-industry elasticity of substitution υ. Irrespective of the choice of elasticities, our pre-shock economy is always calibrated to match the same flows as those described in Section V.C. Different elasticities only govern the response of the economy to shocks, such as transfers to consumer cells.

We study the robustness of our results on transfers multipliers with respect to two alternative calibrations of elasticities, one designed to capture short-run elasticities, and one designed to capture long-run elasticities. We summarize these calibrations in Table A.XVII.

Elasticity	**Symbol**	**Our baseline**	**Short-run**	**Long-run**
Consumption, across industries	$\overline{\sigma}$	1	0.9	1
Consumption, within industries	σ	1	1	2.11
Exports	$\tilde{\sigma}$	1	4	4
Production, across value added and inputs	ϑ	1	0.5	1
Intermediates, across industries	$\overline{\upsilon}$	1	0.2	1
Intermediates, within industries	υ	1	4	4
Labor, within industries	ζ	1	1	2.10

Table A.XVII: Alternative elasticities

Short-run elasticities. Here, we follow the calibrations suggested in Atalay (2017) and Baqaee and Farhi (2024). As in these papers, we let the elasticity of substitution in consumption across industries be $\overline{\sigma} = 0.9$, while the elasticity within industries is still $\sigma = 1$. The elasticity in the production function between value added and other types of inputs is $\vartheta = 0.5$. The elasticity of substitution between intermediate inputs from different industries is $\overline{\upsilon} = 0.2$, while it is $\upsilon = 4$ within industries, consistent with the within-industry estimates from Caliendo and Parro (2015). We assume that the export demand elasticity is also equal to $\tilde{\sigma} = 4$ following Simonovska and Waugh (2014) and Head and Mayer (2014). Labor demand within industries keeps a unit elasticity, $\zeta = 1$.[A10]

Long-run elasticities. To analyze the higher elasticities employed in trade, which are more relevant for long-run analyses, we set the consumption elasticity of substitution within domestic industries to $\sigma = 2.11$ as in Adão et al. (2022). We keep the export demand elasticity at $\tilde{\sigma} = 4$, as

[A10]Note that there is almost no labor demand across industries given that we index consumer cells by their main work industry.

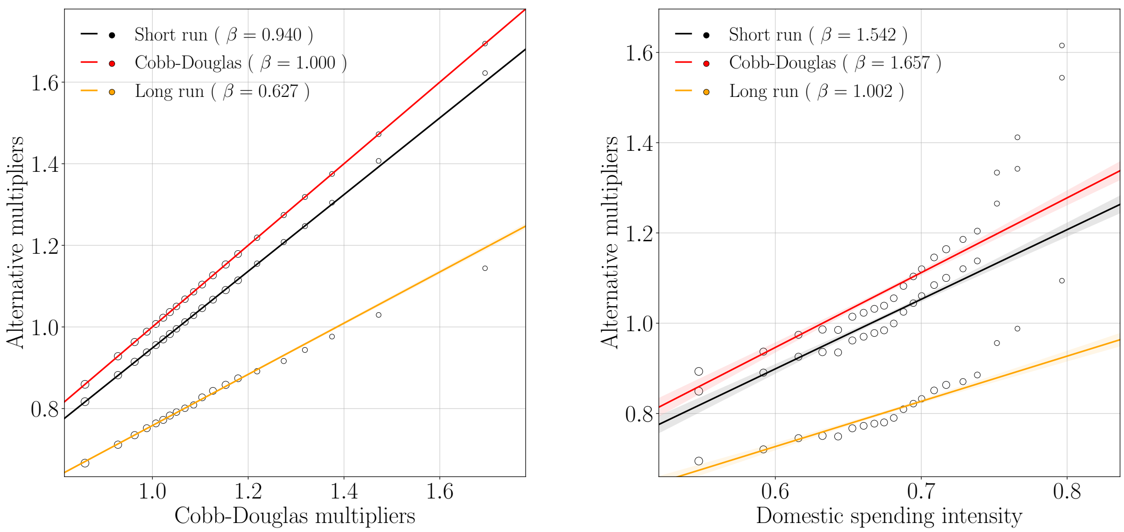
well as the elasticity between domestic intermediates within the same industry, $\upsilon = 4$. Finally, we assume that labor demand has an elasticity of 2.10 as in Adão et al. (2022) and close to Monte et al. (2018).

Results. We repeat the analysis of Section VI to calculate transfer multipliers during an economy-wide recession. We assume that at the initial equilibrium, the downward wage rigidity is binding for all consumer cells and then study small, first-order transfers. In principle, the economy with short-run elasticities could have multiple equilibria (globally) as some elasticities are below 1. We have not found any other equilibria and simply focus on the first-order effects of transfers around the calibrated initial equilibrium.

Figure A.XXIII shows that the multipliers based on the lower elasticities are higher on average. However, the focus of our paper lies not on the level of multipliers, but on the variation in multipliers and the relative effectiveness of targeted policies. The multipliers with lower elasticities are positively and linearly related to those from the baseline calibration. This finding implies that the conclusions related to variation in multipliers are similar with lower elasticities.

Figure A.XXIII also shows that the multipliers based on the long-run elasticities are lower, but positively correlated with the baseline multipliers, with little deviation from the linear line of best fit. This implies that the conclusions related to variation in multipliers, the focus of our analysis, are similar using long-run elasticities.

Figure A.XXIII: Multipliers using alternative elasticities



(a) Multipliers using alternative elasticities (b) Multipliers and domestic spending intensity

Panel a shows a binned scatter plot of the multiplier under alternative elasticities described in Appendix W.D against the multiplier using the baseline Cobb-Douglas elasticities. Panel b shows a binned scatter plot of the multipliers against the DEA domestic spending intensity. The solid lines are the lines of best fit, estimated using the cell-level data. Each circle contains the same number of cells. The size of a circle is proportional to the population size of cells in the circle. The regressions are weighted by population in the consumer cell. Standard errors are clustered by consumer cell. The error bands are 95% confidence intervals.