

ECONOMIES OF SCOPE FROM SHARED INPUTS¹

Paul Koh¹ Devesh Raval²

¹Yonsei University

²Federal Trade Commission

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ECONOMIES OF SCOPE ARISE FROM SHARED INPUTS

Large, multi-product firms are everywhere

Economies of scope explain their existence (Panzar & Willig, 1981)

Economies of scope arise from having shared inputs across production lines

Question : How important are shared inputs to large, multi-product firms?

WE LEVERAGE UNIQUE MICRODATA ON SHARED INPUTS

FTC Line of Business Surveys

- ▶ Data from 1974–1977 on the largest US manufacturing firms
- ▶ Revenue and input expenditure by “line of business”
- ▶ Information on shared inputs (whether “line-of-business-specific” or “general purpose”)

WHAT'S NEW?

We generally lack data on how multi-product firms use their inputs

The literature has responded in two ways:

1. Specify input allocation rule

- Collard-Wexler and De Loecker (2015), De Loecker et al. (2016), Foster et al. (2008), Gong and Sickles (2021), Itoga (2019), Orr (2022), and Valmari (2023)

2. Estimate a transformation function

- Caselli et al. (2024), Dhyne et al. (2022, 2023), Diewert (1973), Grieco and McDevitt (2017), Lau (1976), Maican and Orth (2021), and Malikov and Lien (2021)

We bring direct evidence on how firms use private and common inputs

RESEARCH QUESTIONS

- ▶ What explains variation in shared inputs?
- ▶ Substitutability between private vs. shared inputs?
- ▶ Degree of economies of scope?
- ▶ Merger synergies from shared inputs?

HISTORY OF FTC LINE OF BUSINESS SURVEYS

- ▶ Pilot in 1973, Four Waves 1974-1977
- ▶ 180 corporations sued to stop data collection
- ▶ FTC won in DC District Court (1977) and Court of Appeals (1978)
- ▶ 1984: Commission voted 4-1 vote to discontinue future data collection

FTC LINE OF BUSINESS SURVEYS DATA

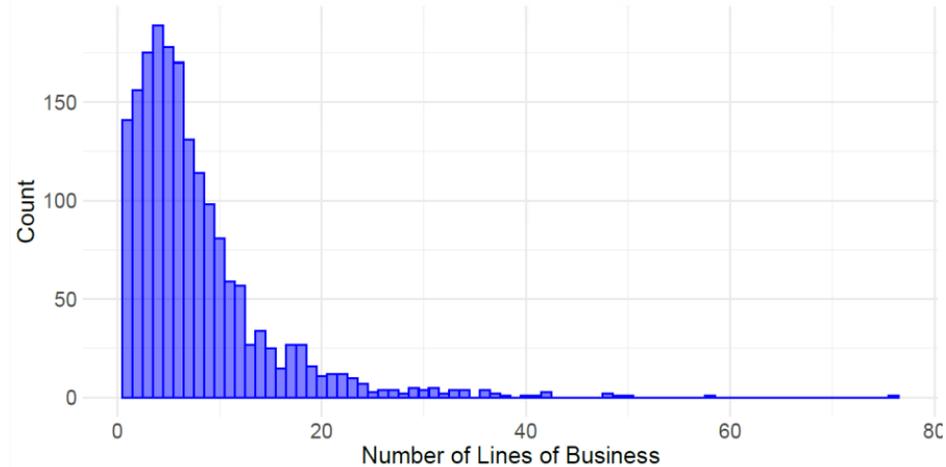
- ▶ FTC defined 289 “lines of business”
- ▶ Asked the firms to provide revenue/cost information for a “line of business”
- ▶ Data represent about 50% of manufacturing sector revenue

Year	Firms	Firm-LB	Firm-LB in Manufacturing
1974	436	4,291	3,383
1975	469	4,507	3,536
1976	466	4,572	3,598
1977	456	4,650	3,693

“LINE OF BUSINESS” IS COMPARABLE TO 3/4-DIGIT SIC

FTC Code	Description	Related 1977 SIC or Census Codes
<i>MANUFACTURING CATEGORIES:</i>		
<i>Food and Kindred Products</i>		
20.01	Meat packing, sausages and other prepared meat products	2011, 3
20.02	Poultry dressing, poultry and egg processing	2016, 7
20.03	Fluid Milk	2026
20.04	Dairy products exc. fluid Milk	202, x 2026
20.05	Canned specialties	2032
20.06	Frozen fruits, fruit juices, and vegetables	2037
20.07	Frozen specialties	2038
20.08	Canned, dried, dehydrated, and pickled fruits and vegetables including preserves, jams, jellies, dehydrated soup mixes, vegetable sauces and seasoning, and salad dressings	2033, 4, 5
20.09	Cereal breakfast foods	2043
20.10	Desserts and other sweet foods	2045

MOST FIRMS OPERATE MULTIPLE LINES OF BUSINESS



1. Large firms tend to operate multiple production lines
2. 8% of firms operate a single line of business
3. 5% of firms have more than 20 lines of business

SURVEY ASKED ABOUT COMMON VS. PRIVATE INPUTS

The survey asks the firm to distinguish “traceable” vs. “non-traceable” inputs

- ▶ “Traceable” = Directly attributable to a line of business
- ▶ “Non-Traceable” = Serving general corporate purpose

We examine two common inputs

- ▶ **Capital** (= Net Plant + Property + Equipment)
- ▶ **Management** (= General/Administrative + Advertising + Other Selling)

About 2/3 of the firms report using shared inputs in both categories

STYLIZED FACTS: SCALABILITY RATIO

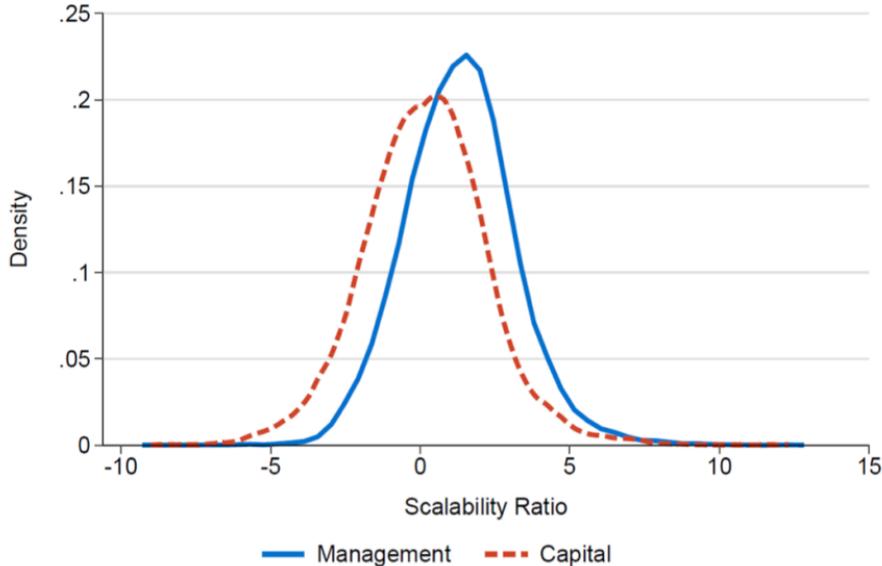
Question : What explains variation in shared inputs?

Scalability ratio of Argente, Moreira, Oberfield, and Venkateswaran (2024)

$$\text{scalability ratio of input} = \frac{\text{shareable portion of input}}{\text{private portion of input}}$$

- ▶ Sufficient statistic for how much an input can be applied across firm's products
- ▶ Should be positively correlated with size and scope

MANAGEMENT IS MORE SCALABLE THAN CAPITAL



For a median firm-line of business,

- ▶ Capital: Shared Input 20% higher than private input
- ▶ Management: Shared input 270% higher than private input

SCALABILITY RATIO CORRELATED WITH SIZE & SCOPE

We regress the scalability ratio on firm size and scope

Table. Relationship between the scalability ratio and firm size and scope

	Management				Capital			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Size	0.44 (0.06)		0.30 (0.07)	0.13 (0.07)	0.48 (0.08)		0.25 (0.09)	0.19 (0.09)
Scope		0.60 (0.11)	0.39 (0.12)	0.58 (0.11)		0.79 (0.12)	0.63 (0.14)	0.71 (0.14)
Controls	No	No	No	Yes	No	No	No	Yes
R^2	0.06	0.05	0.07	0.10	0.05	0.08	0.09	0.09

All coefficients are positive, consistent with Argente et al. (2024)'s prediction

NESTED CES PRODUCTION FUNCTION ESTIMATION

Question : How important are shared inputs for production?

We assume

$$Y_{jt} = A_{jt}(\alpha H_{jt}^\rho + (1 - \alpha)C_{jt}^\rho)^{\frac{\sigma}{\rho}}$$

where

$$H_{jt} = M_{jt}^{\beta_m} L_{jt}^{\beta_l} K_{jt}^{\beta_k} E_{jt}^{\beta_e} \quad (\text{Private inputs})$$

$$C_{jt} = \mathcal{K}_{jt}^\delta \mathcal{E}_{jt}^{1-\delta} \quad (\text{Shared inputs})$$

Key parameters of interest are

- ▶ distributional parameter α
- ▶ elasticity of substitution $\sigma = \frac{1}{1-\rho}$

WE ESTIMATE REVENUE PRODUCTION FUNCTION

We only observe revenue but not physical outputs

Assume a CES demand function

$$\frac{P_{jt}}{P_t} = \left(\frac{Y_{jt}}{Y_t} \right)^{\frac{1}{\eta}} e^{\chi_{jt}}$$

- ▶ $\eta > 0$ is the elasticity of demand
- ▶ χ_{jt} is the demand shock (observed by the firm)

We estimate the associated revenue production function

IDENTIFICATION AND ESTIMATION

WE FOLLOW GANDHI, NAVARRO, AND RIVERS (2020)

We apply Gandhi et al. (2020) to estimate production functions

- ▶ Firms are producers of multiple products
- ▶ But we observe input allocations at the product level

Generate moment conditions from two assumptions:

1. Static Profit Maximization with Flexible Inputs: Input Share Moments
2. First-Order Linear Markov Productivity Process: Dynamic Panel Moments

IDENTIFICATION AND ESTIMATION

INPUT SHARE MOMENTS

Firm maximizes profit w.r.t. flexible input X_{jt} (material and labor)

$$\max_{X_{jt}} \mathbb{E}[P_{jt} Y_{jt} | \mathcal{I}_{jt}] - X_{jt}$$

Rearranging the FOC gives

$$s_{jt}^X = \log \zeta + \log \xi_{jt}^X + \log \mathbb{E}[e^{\zeta \varepsilon_{jt}}] - \zeta \varepsilon_{jt},$$

- ▶ $s_{jt}^X \equiv \log \frac{X_{jt}}{R_{jt}}$ is the log of input share
- ▶ $\xi_{jt}^X \equiv \frac{\partial Y_{jt}}{\partial X_{jt}} \frac{X_{jt}}{Y_{jt}}$ is the output elasticity w.r.t. input X

The assumption on unexpected productivity shock ε_{jt} ensures

$$\mathbb{E}[\varepsilon_{jt} | \mathcal{I}_{jt}] = 0$$

IDENTIFICATION AND ESTIMATION

DYNAMIC PANEL MOMENTS

Taking the log of the revenue production function gives

$$r_{jt} = \zeta f_{jt} + \lambda_t + \nu_{jt} + \zeta \varepsilon_{jt}$$

- ▶ $\nu_{jt} = \zeta \omega_{jt} + \chi_{jt}$ is the persistence shock

We assume that ν_{jt} follows a linear first-order Markov stochastic process

$$\nu_{jt} = \mu_0 + \mu_1 \nu_{jt-1} + \eta_{jt},$$

- ▶ the error term η_{jt} satisfies $\mathbb{E}[\eta_{jt} | \mathcal{I}_{jt-1}] = 0$

We assume

$$\mathbb{E}[\eta_{jt}^* | \mathcal{I}_{jt-1}, P_t, Y_t] = 0$$

IDENTIFICATION AND ESTIMATION

COMBINED MOMENTS

Given the nested CES form of the production function, the input share equation and the dynamic panel equation become

$$s_{jt}^X = \log \psi + \log \beta_X + \log \left(\frac{\alpha \tilde{H}_{jt}^\rho}{\alpha \tilde{H}_{jt}^\rho + (1 - \alpha) \tilde{C}_{jt}^\rho} \right) + \log \mathbb{E}[e^{\zeta \varepsilon_{jt}^X}] - \zeta \varepsilon_{jt}^X,$$

$$r_{jt} = \frac{\psi}{\rho} \log \left(\alpha \tilde{H}_{jt}^\rho + (1 - \alpha) \tilde{C}_{jt}^\rho \right) + \mu_1 \left(r_{jt-1} - \frac{\psi}{\rho} \log \left(\alpha \tilde{H}_{jt-1}^\rho + (1 - \alpha) \tilde{C}_{jt-1}^\rho \right) \right) + \phi_t + \eta_{jt}^*$$

Unconditional moment equations are

$$\mathbb{E}[\zeta \varepsilon_{jt}^X \tilde{Z}_{jt}^1] = 0,$$

$$\mathbb{E}[\eta_{jt}^* \tilde{Z}_{jt}^2] = 0.$$

► \tilde{Z}_{jt}^1 includes functions of \mathcal{I}_{jt}

• log or (normalized) private and common inputs and their quadratic

PRODUCTION FUNCTION ESTIMATES

COBB-DOUGLAS PARAMETERS FOR PRIVATE AND SHARED INPUTS

	(1)	(2)	(3)
β_m	0.48 (0.05)	0.46 (0.11)	0.59 (0.03)
β_l	0.21 (0.02)	0.25 (0.06)	0.26 (0.01)
β_k	0.12 (0.03)	0.11 (0.03)	0.05 (0.03)
β_e	0.20 (0.05)	0.17 (0.05)	0.10 (0.04)
δ	0.21 (0.18)	0.03 (0.19)	0.32 (0.23)
Obs.	6,524	6,524	6,524
Flexible Function	{M, L} CES	{M} CES	{M, L} CD

PRODUCTION FUNCTION ESTIMATES

RETURNS TO SCALE, DISTRIBUTION WEIGHT, AND ELASTICITY OF SUBSTITUTION

	(1)	(2)	(3)
ψ	1.00 (0.09)	1.02 (0.14)	0.76 (0.05)
α	0.96 (0.01)	0.96 (0.02)	0.98 (0.01)
ρ	0.61 (0.23)	0.64 (0.18)	0.00 -
σ	2.58	2.81	1.00
Obs.	6,524	6,524	6,524
Flexible Function	{M, L} CES	{M} CES	{M, L} CD

- ▶ $\psi = 1$: constant returns to scale
- ▶ $\alpha < 1$: positive weight on shared inputs
- ▶ $\rho > 0$ ($\Leftrightarrow \sigma > 1$): private and shared inputs are substitutes

SMALL REVENUE ELASTICITIES: LB LEVEL

Question : How do revenues respond to common inputs?

Table. Distribution of Revenue Elasticities w.r.t. Inputs at the LB Level

Input	Count	Mean	Median
<i>Private Inputs</i>			
Materials	9,856	0.45	0.46
Labor	9,856	0.20	0.20
Capital	9,856	0.11	0.11
Management	9,856	0.18	0.19
<i>Common Inputs</i>			
Capital	9,856	0.01	0.01
Management	9,856	0.05	0.03

LARGER REVENUE ELASTICITIES: FIRM LEVEL

But common inputs affect all lines of business at the firm

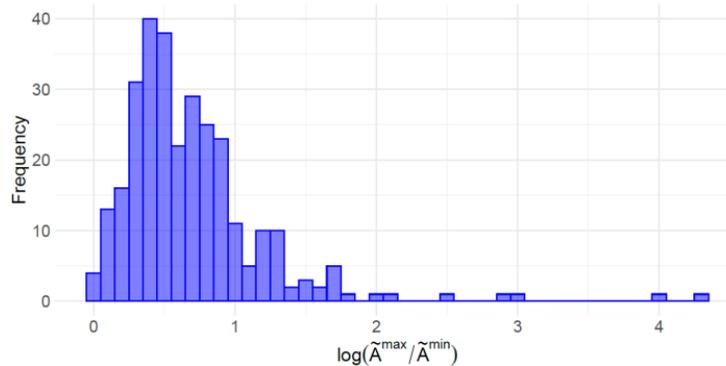
So we measure **aggregate (firm-level) elasticities**

Table. Distribution of Aggregate Revenue Elasticities of Common Inputs

Input	Count	Mean	Median
<i>Case 1: $\pi_j^P = s_j^{X,P}$, $\pi^C = s^{X,C}$</i>			
Capital	1,193	0.11	0.11
Management	1,193	0.21	0.21
<i>Case 2: $\pi_j^P = 0$, $\pi^C = 1$</i>			
Capital	1,193	0.20	0.10
Management	1,193	0.14	0.11
<i>Case 3: $\pi_j^P = s_j^{X,P}/(1 - s^{X,C})$, $\pi^C = 0$</i>			
Capital	1,193	0.15	0.11
Management	1,193	0.38	0.23

LARGE PRODUCTIVITY DIFFERENCES WITHIN FIRMS

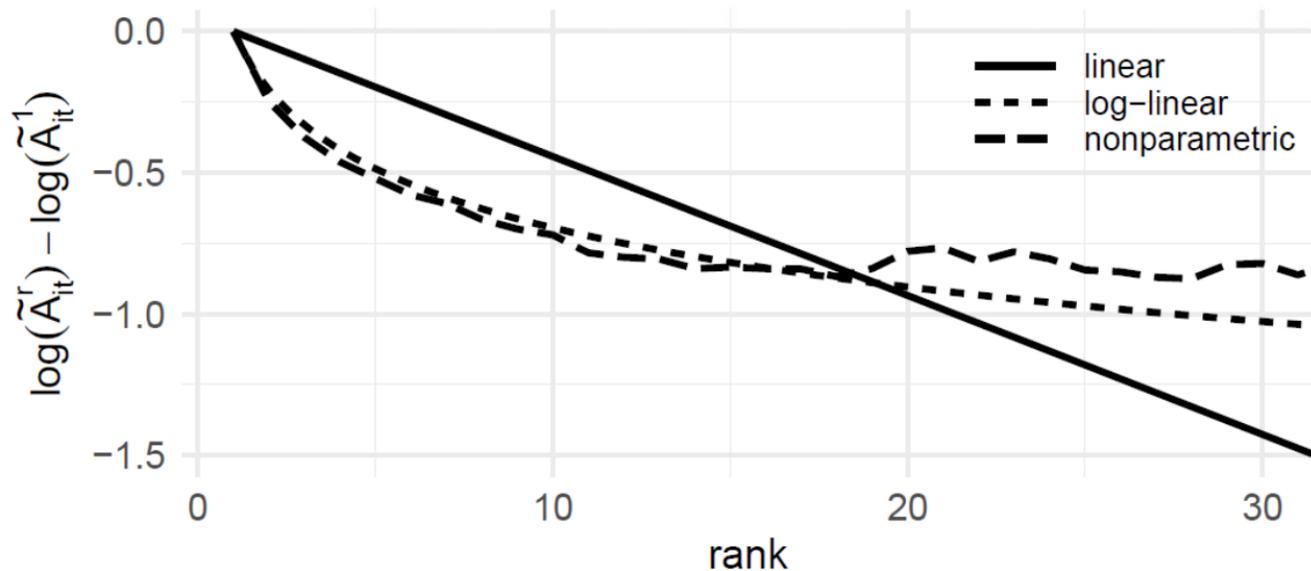
Question : How are productivities distributed within and across firms?



- ▶ Median firm: Best product 79% higher TFPR than worst
- ▶ 75% of variance of productivities within firm

PRODUCTIVITY & CORE COMPETENCIES

Question : How does productivity vary by number of products?



PRODUCTIVITY & CORE COMPETENCIES

Question : How does productivity vary by size and scope?

Table. Revenue Productivity Regression

	(1) \tilde{a}_{ijt}	(2) $\tilde{a}_{it}^{\text{mean}}$	(3) $\tilde{a}_{it}^{\text{max}}$	(4) $\tilde{a}_{it}^{\text{min}}$	(5) $\tilde{a}_{it}^{\text{max}} - \tilde{a}_{it}^{\text{min}}$
Log Size	0.028 (0.010)	0.079 (0.011)	0.112 (0.029)	0.003 (0.014)	0.109 (0.031)
Log Scope	-0.086 (0.014)	-0.099 (0.015)	0.063 (0.034)	-0.217 (0.024)	0.280 (0.040)
Obs.	9,856	1,193	1,193	1,193	1,193

REVENUE LOSSES FROM REDUCING COMMON INPUT

Table. Expected Revenue Loss by the Number of Lines of Business

LoB	Reduction in Common Input				
	10%	25%	50%	75%	90%
1	0.3%	0.9%	1.8%	3.0%	3.9%
2 – 3	0.4%	1.1%	2.3%	3.8%	5.0%
4 – 6	0.5%	1.3%	2.7%	4.4%	5.8%
7 – 9	0.5%	1.4%	3.0%	4.9%	6.4%
10+	0.7%	1.9%	4.0%	6.5%	8.6%
All	0.6%	1.6%	3.4%	5.6%	7.4%

Revenue loss increases with firm's scope

SMALL MERGER SYNERGIES FROM SCOPE ECONOMIES

We simulate mergers of firms with non-overlapping production lines

Table. Predicted Percentage Change in Total Revenue from Mergers

Common Input Aggregation	Count	Mean	Min	Median	Max
$\mathcal{X}^{\text{post}} = \max\{\mathcal{X}^A, \mathcal{X}^B\}$	33,018	1.5%	0.0%	0.9%	38.6%
$\mathcal{X}^{\text{post}} = \mathcal{X}^A + \mathcal{X}^B$	33,018	2.4%	0.1%	1.8%	39.0%

CONCLUSION

1. Shared inputs generate significant economies of scope
2. Shared inputs and private inputs are substitutes
3. Large productivity differences occur within firms
4. Merger synergies from scope economies are small

REFERENCES I

-  Argente, D., Moreira, S., Oberfield, E., & Venkateswaran, V. (2024). **Scalable expertise** [Available at https://conference.nber.org/conf_papers/f206568.pdf].
-  Caselli, M., Chatterjee, A., & Li, S. (2024). **Productivity and quality of multi-product firms.**
-  Collard-Wexler, A., & De Loecker, J. (2015). **Reallocation and technology: Evidence from the us steel industry.** *American Economic Review*, 105(1), 131–171.
-  De Loecker, J., Goldberg, P. K., Khandelwal, A. K., & Pavcnik, N. (2016). **Prices, markups, and trade reform.** *Econometrica*, 84(2), 445–510.
-  Dhyne, E., Petrin, A., Smeets, V., & Warzynski, F. (2022). **Theory for extending single-product production function estimation to multi-product settings (tech. rep.).** National Bureau of Economic Research.

REFERENCES II

-  Dhyne, E., Petrin, A., Smeets, V., & Warzynski, F. (2023). **Multi product firms, import competition, and the evolution of firm-product technical efficiencies (tech. rep.)**. National Bureau of Economic Research.
-  Diewert, W. E. (1973). **Functional forms for profit and transformation functions**. *Journal of Economic theory*, 6(3), 284–316.
-  Foster, L., Haltiwanger, J., & Syverson, C. (2008). **Reallocation, firm turnover, and efficiency: Selection on productivity or profitability?** *American Economic Review*, 98(1), 394–425.
-  Gandhi, A., Navarro, S., & Rivers, D. A. (2020). **On the identification of gross output production functions**. *Journal of Political Economy*, 128(8), 2973–3016.
-  Gong, B., & Sickles, R. C. (2021). **Resource allocation in multi-divisional multi-product firms**. *Journal of Productivity Analysis*, 55, 47–70.

REFERENCES III

-  Grieco, P. L., & McDevitt, R. C. (2017). **Productivity and quality in health care: Evidence from the dialysis industry.** *The Review of Economic Studies*, 84(3), 1071–1105.
-  Itoga, T. (2019). **Essays on multi-product firms.** The Pennsylvania State University.
-  Lau, L. J. (1976). **A characterization of the normalized restricted profit function.** In *The hamiltonian approach to dynamic economics* (pp. 131–163). Elsevier.
-  Maican, F., & Orth, M. (2021). **Determinants of economies of scope in retail.** *International Journal of Industrial Organization*, 75, 102710.
-  Malikov, E., & Lien, G. (2021). **Proxy variable estimation of multiproduct production functions.** *American Journal of Agricultural Economics*, 103(5), 1878–1902.
-  Orr, S. (2022). **Within-firm productivity dispersion: Estimates and implications.** *Journal of Political Economy*, 130(11), 2771–2828.

REFERENCES IV

-  Panzar, J. C., & Willig, R. D. (1981). **Economies of scope.** *The American Economic Review*, 71(2), 268–272.
-  Valmari, N. (2023). **Estimating production functions of multiproduct firms.** *Review of Economic Studies*, 90(6), 3315–3342.