Structural Analysis of the Agricultural Sector in Japan Using a Social Accounting Matrix for 2023: Evidence from a Disaggregation of 20 Agricultural Productions

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Structural Importance of Agriculture in Advanced Economies

- The declining share of agriculture in GDP and employment is a common feature of structural transformation in advanced economies (Hayami & Yamada, 1991; Honma & Hayami, 2009; Timmer, 2009).
- However, a small GDP share does not necessarily imply a small structural role, as agriculture maintains extensive production and income linkages with the rest of the economy (Hayami & Ruttan, 1985).
- Previous studies frequently evaluate agriculture based on output or value-added shares.
- Such measures may underestimate the broader economic role of agriculture.
- Moreover, most existing studies treat agriculture as a single aggregated sector, masking substantial heterogeneity among agricultural activities.

IO and SAM Approaches

- Input–Output (IO) studies have widely examined interindustry linkages, multipliers, and key sectors (Schultz, 1977; Miller & Blair, 2022).
- Social Accounting Matrices (SAMs) extend IO frameworks by incorporating factor incomes, households, institutions, and expenditure feedback effects (Stone, 1962; Cardenete & Sancho, 2003).
- SAM-based analyses therefore capture not only production effects but also income-distribution and consumption-induced effects.

Agricultural Structural Analysis

- Previous studies have applied IO and SAM frameworks to agriculture and agri-food systems in Ireland, Spain, the EU, and Japan (Miller et al., 2011; Cardenete et al., 2014, 2015; Cardenete et al, 2015; Costa & Mainar-Causapé, 2018; Garrido-Cruz et al., 2024; Ishikawa, 2023).

- Existing evidence suggests that agriculture may remain economically important despite its declining direct contribution to GDP and employment.

This study

- Construct a Japan SAM for 2023 by integrating FIGARO-SAM and the Japanese IO table.

- Disaggregate agriculture into 20 subsectors.

- Evaluate agricultural importance using:
  - Employment and Labor Income Multipliers
  - Backward and Forward Linkages
  - Hypothetical Extraction Method (HEM)
  - SAM Multiplier Decomposition

Research Question

1. Does agriculture generate significant employment and income effects?
2. Which agricultural subsectors occupy key positions in the Japanese economy?
3. How important is agriculture from a system-wide perspective?
4. What mechanisms explain its importance?

Structure of Social Accounting Matrix

- Benchmark database: The 2023 FIGARO-SAM
- Supplementary information to disaggregate an agricultural sector in the 2023 FIGARO-SAM: The 2022 Japanese Input–Output Table

	Account	Description	# of accounts
Endogenous	Production	Agriculture	**20**
		Non-agriculture	17
	Factors	Labor	1
		Capital	1
	Institution	Enterprise	1
		Household	1
Exogenous	Government		1
	Capital accumulation(FDC)		1
	Rest of the world		1

Disaggregating an Agricultural Sector into 20 ag sectors

S1	Rice and Rice Straw	S11	Seeds & Seedlings
S2	Wheat & Barley	S12	Flowers & Ornamental Plants
S3	Potatoes & Tubers	S13	Non-edible Crops
S4	Pulses & Beans	S14	Dairy Farming
S5	Vegetables	S15	Beef Cattle
S6	Fruits	S16	Pigs
S7	Sugar Crops	S17	Eggs
S8	Beverage Crops	S18	Broilers
S9	Other Edible Crops	S19	Other Livestock
S10	Feed Crops	S20	Agricultural Services

17 non-agricultural sectors.

S21	Forestry & Fisheries	S30	Rubber & Plastics
S22	Energy & Heavy Industry	S31	Non-Metallic Minerals
S23	Food Processing	S32	Construction
S24	Textiles & Apparel	S33	Trade & Postal Services
S25	Wood Products	S34	Accommodation & Food Services
S26	Paper Products	S35	Finance & Real Estate
S27	Information & Business Services	S36	Public, Education & Health
S28	Chemicals	S37	Membership Organizations
S29	Pharmaceuticals		

Employment

Unit: Persons

Trade & Postal Services	15,132,384	22.23%
Public, Education & Health	14,009,486	20.58%
Information & Business Services	10,501,044	15.42%
Accommodation & Food Services	7,295,756	10.72%
Energy & Heavy Industry	5,940,310	8.73%
Construction	5,128,662	7.53%
Finance & Real Estate	3,111,043	4.57%
Agriculture	**2,264,299**	**3.33%**
Wood Products	930,239	1.37%
Food Processing	824,817	1.21%
Rubber & Plastics	640,179	0.94%
Membership Organizations	614,888	0.90%
Textiles & Apparel	386,727	0.57%
Chemicals	345,446	0.51%
Non-Metallic Minerals	316,017	0.46%
Forestry & Fisheries	242,430	0.36%
Paper Products	236,951	0.35%
Pharmaceuticals	158,479	0.23%

Employment Multiplier

	Total	Own Sector	Other Sectors
Rice	117.53	83.56	33.97
Potatoes & Tubers	98.42	44.65	53.77
Fruits	75.94	42.12	33.82
Vegetables	74.00	38.59	35.41
Sugar Crops	72.70	32.92	39.78
Flowers & Ornamental Plants	62.51	24.67	37.84
Pulses & Beans	62.10	28.08	34.02
Other Livestock	55.42	19.53	35.89
Beef Cattle	55.00	10.53	44.47
Seeds & Seedlings	55.00	19.77	35.23
Agricultural Services	48.72	14.95	33.77
Beverage Crops	47.30	16.46	30.85
Feed Crops	46.87	12.87	34.00
Eggs	46.23	6.95	39.28
Wheat & Barley	45.20	11.48	33.72
Broilers	42.62	3.58	39.04
Dairy Farming	42.47	7.45	35.02
Pigs	42.01	4.45	37.56
Non-Edible Crops	25.14	4.06	21.08
Other Edible Crops	7.61	0.87	6.73

Unit: Persons Per 1Million Euro

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Unit: Persons Per 1Million Euro

Rice exhibits the largest employment-generating effect

- Rice has the highest employment multiplier among all agricultural subsectors.
- A one-million-euro increase in final demand for rice generates approximately 118 jobs throughout the Japanese economy
- Rice therefore represents the most employment-intensive agricultural activity in terms of economy-wide effects.

Livestock sectors are particularly dependent on economy-wide linkages

- The majority of employment effects occur in other sectors.
- Livestock production stimulates employment through extensive purchases of feed, transportation, trade, processing, business services, rather than through direct employment alone.

Unit: Persons Per 1Million Euro

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Crop sectors exhibit stronger direct employment effects

- These sectors generate a larger proportion of employment within their own production activities.

Unit: Persons Per 1Million Euro

Key findings

- Agricultural subsectors differ considerably in their employment-generating capacity.
- Rice, Potatoes & Tubers, Fruits, and Vegetables exhibit the strongest employment effects.
- Livestock-related sectors generate most of their employment impacts through other sectors of the economy.
- The results reveal substantial heterogeneity within agriculture and highlight the importance of intersectoral employment linkages.

Labor Income Multiplier

	Total	Own sector	Other sectors
Potatoes & Tubers	0.970	0.022	0.948
Vegetables	0.966	0.018	0.948
Sugar Crops	0.963	0.018	0.945
Agricultural Services	0.961	0.003	0.958
Rice	0.960	0.003	0.957
Seeds & Seedlings	0.959	0.002	0.958
Flowers & Ornamental Plants	0.959	0.020	0.939
Dairy Farming	0.954	0.005	0.949
Eggs	0.952	0.007	0.945
Broilers	0.952	0.003	0.949
Beef Cattle	0.951	0.003	0.948
Pigs	0.951	0.006	0.945
Feed Crops	0.944	0.003	0.941
Other Livestock	0.929	0.006	0.923
Fruits	0.921	0.025	0.897
Beverage Crops	0.870	0.007	0.863
Wheat & Barley	0.834	0.012	0.822
Pulses & Beans	0.804	0.013	0.791
Non-Edible Crops	0.587	0.007	0.581
Other Edible Crops	0.172	0.006	0.166

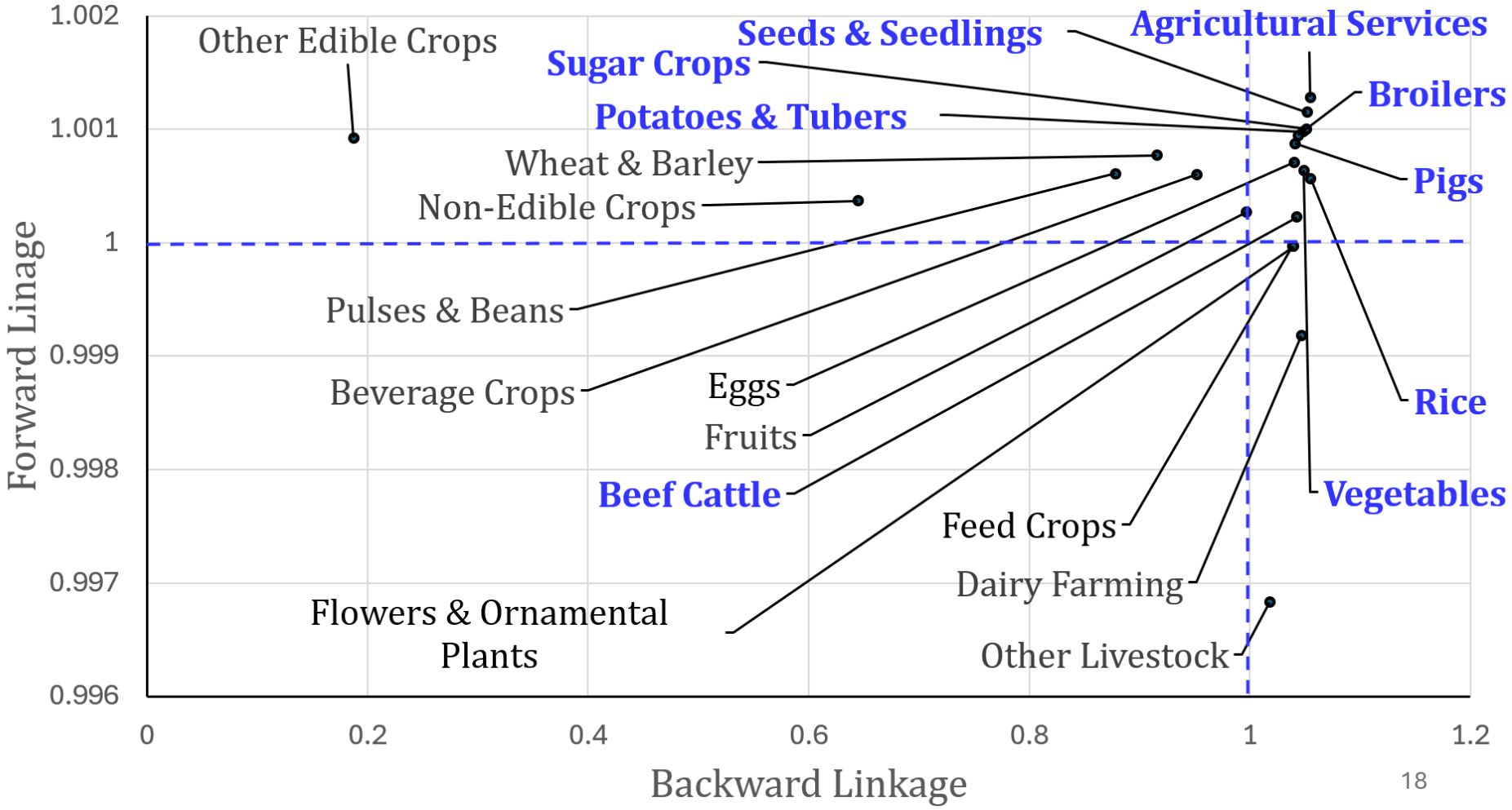
Unit:
Million Euro
Per
1Million Euro

Key findings

- Labor income multipliers are high across most agricultural subsectors, ranging from 0.80 to 0.97.
- For almost all subsectors, more than 95% of labor income effects occur outside the agricultural sector itself.
- This indicates that agriculture generates labor income primarily through economy-wide production and income linkages.
- (Later we will see)The results are consistent with the HEM analysis, which shows that the majority of economic losses occur in other sectors when agriculture is extracted.

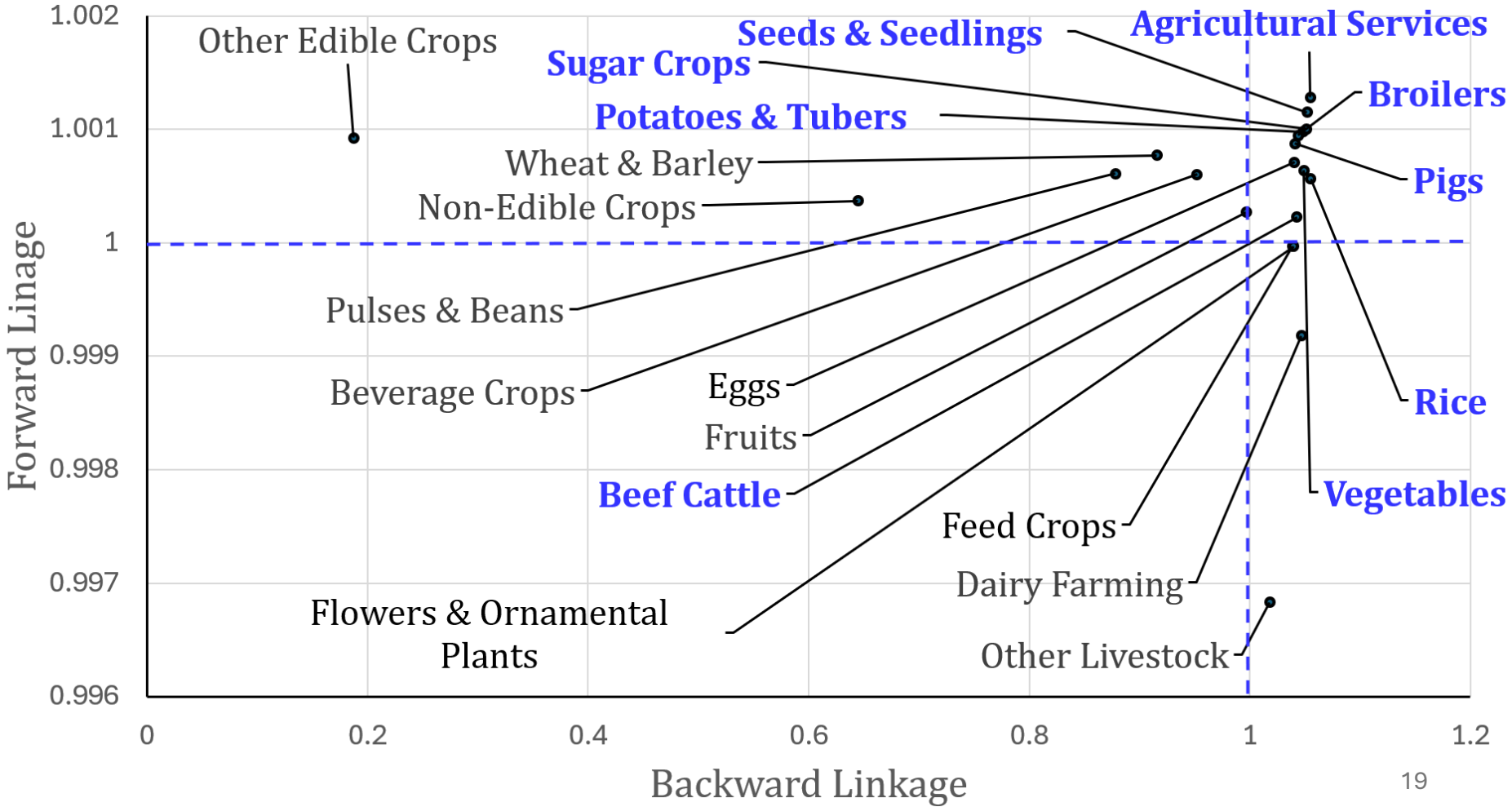
Structural Heterogeneity of Agricultural Subsectors

- $0.1873 \leq BL_i \leq 1.055,\ 0.994 \leq FL_i \leq 1.001$
- Agricultural subsectors exhibit **substantial variation in backward linkages** but relatively limited variation in forward linkages.



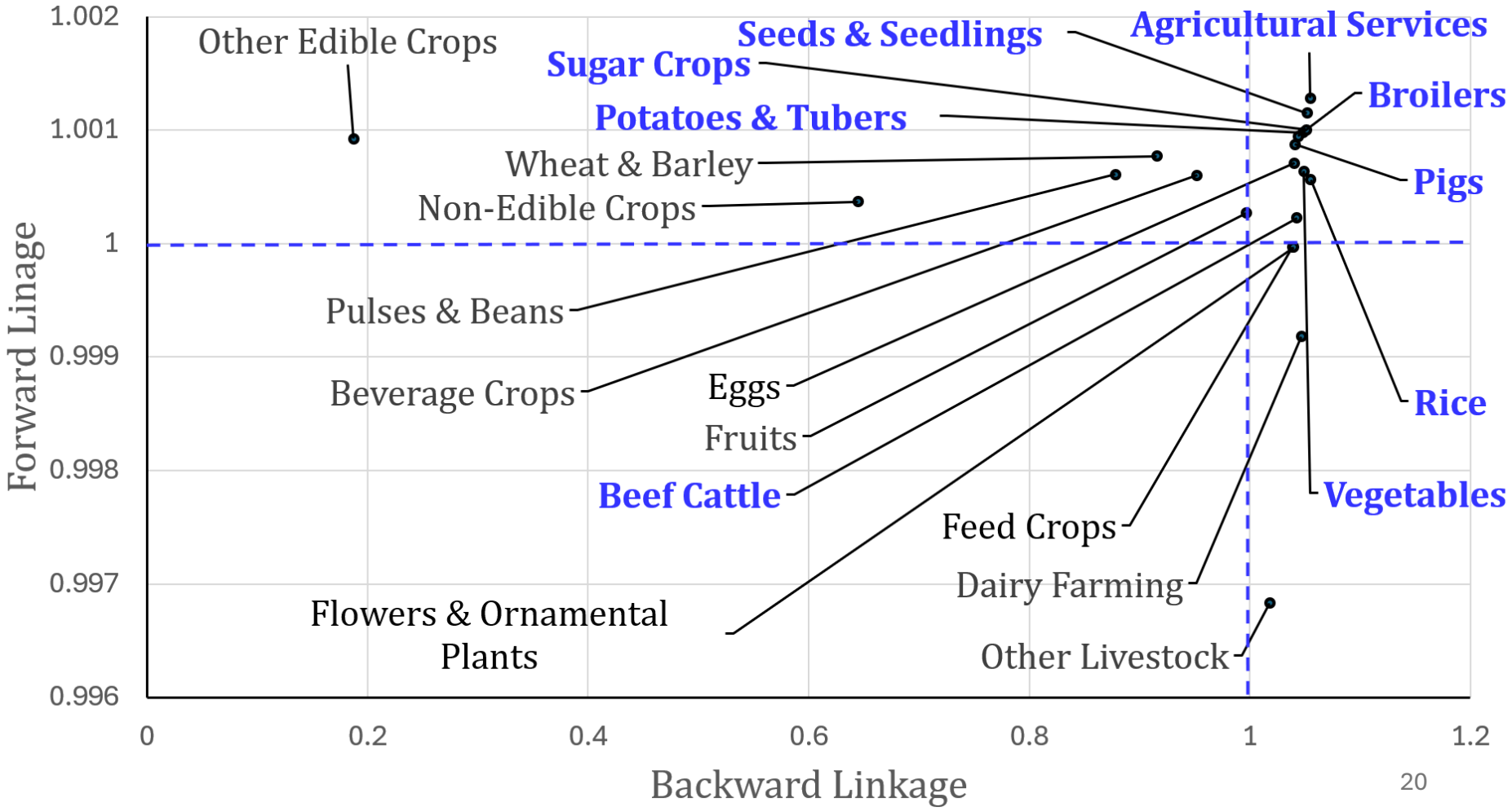
Structural Heterogeneity of Agricultural Subsectors

- Differences among ag subsectors arise mainly from their input-demand structures rather than their roles as suppliers to other industries.
- Ag subsectors occupy **heterogeneous positions on the demand side of the production network.**



Key Sectors: $BL_i > 1$ and $FL_i > 1$

- These sectors occupy relatively central positions in the Japanese production network, functioning both as major purchasers of inputs and as suppliers to downstream activities.



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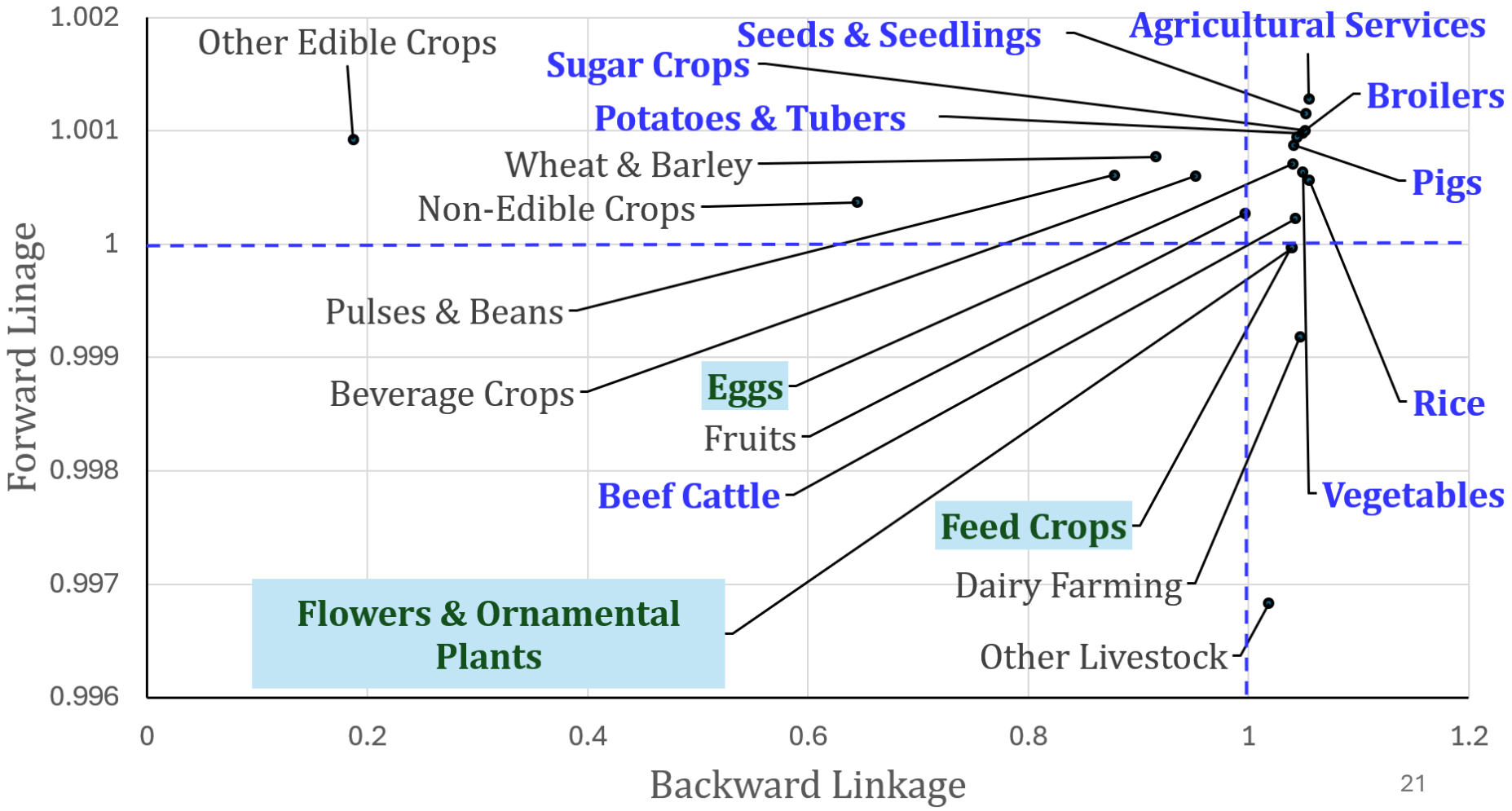
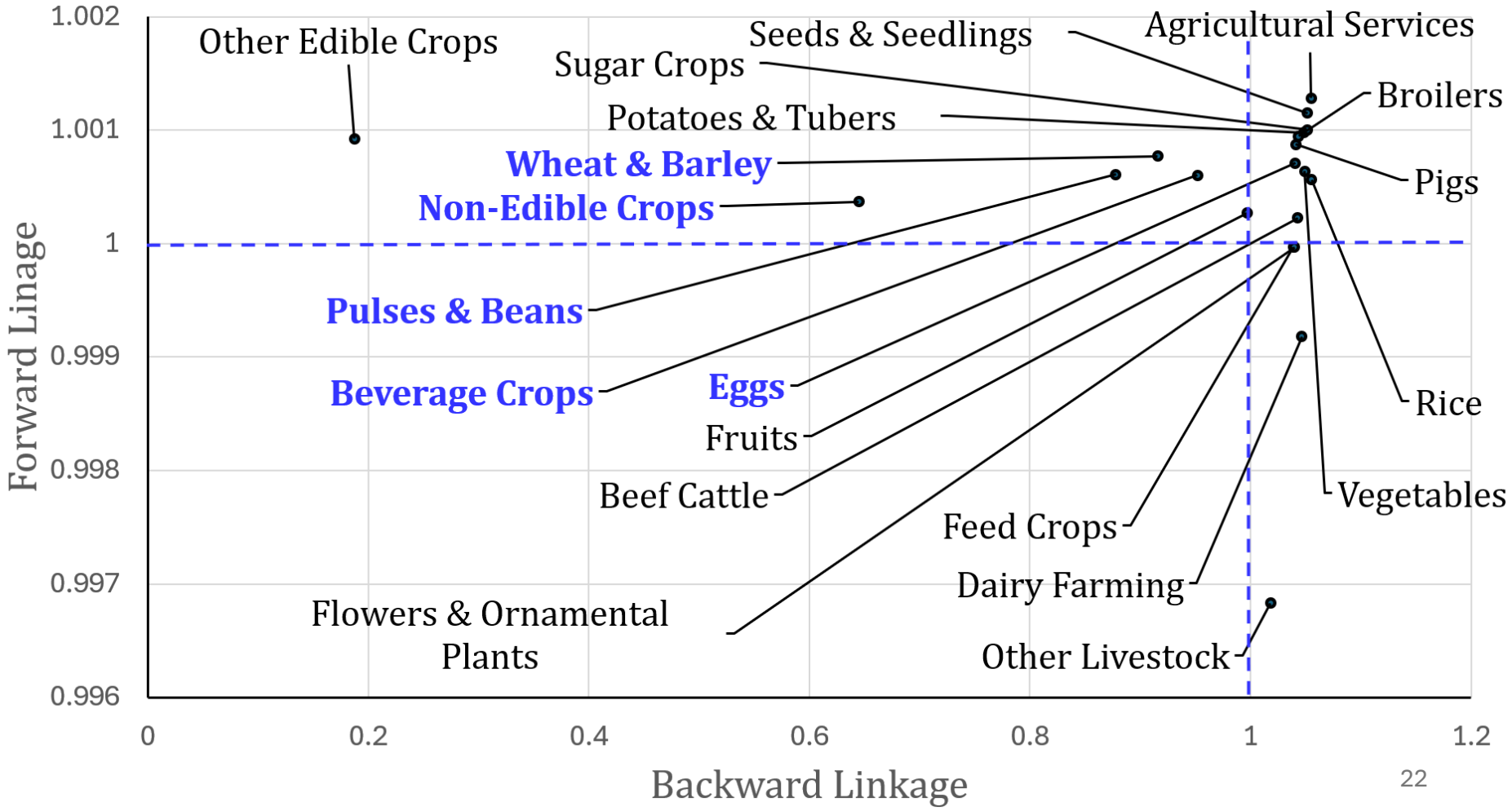


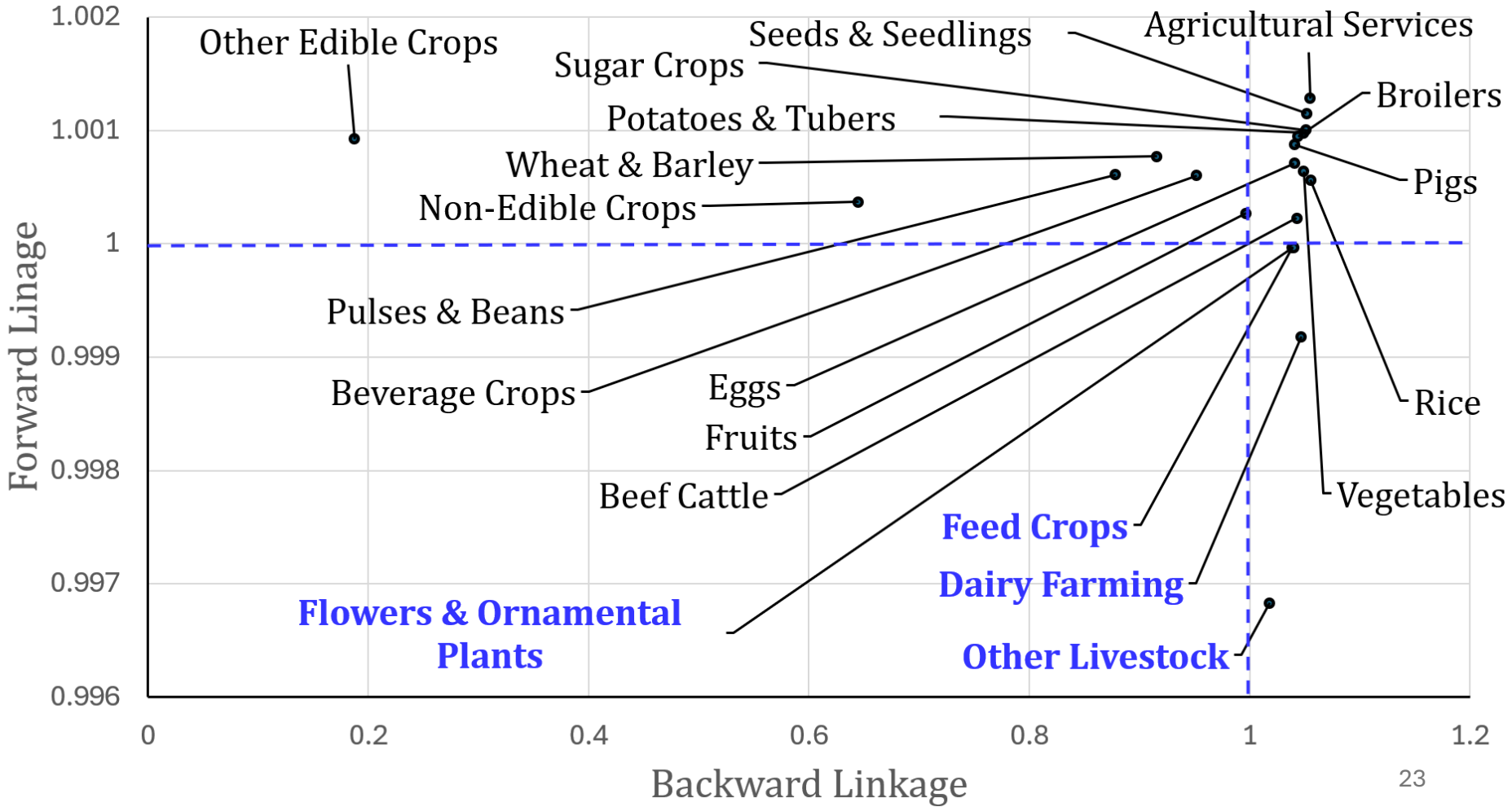
Supply Oriented Sectors: $BL_i < 1$ and $FL_i > 1$

- These sectors play a stronger role as suppliers than as stimulators of upstream production activities.



Demand Oriented Sectors: $BL_i > 1$ and $FL_i < 1$

- These sectors generate relatively strong upstream demand effects while exhibiting weaker supply-side linkages.



What We Found So Far

- The BL–FL analyses reveals that agricultural subsectors differ considerably in their positions within the Japanese production network.
- While forward linkages remain relatively homogeneous across subsectors, backward linkages vary substantially.
- This indicates that the economic importance of agricultural activities is driven primarily by differences in input-demand structures rather than supply-side relationships.

Why HEM?

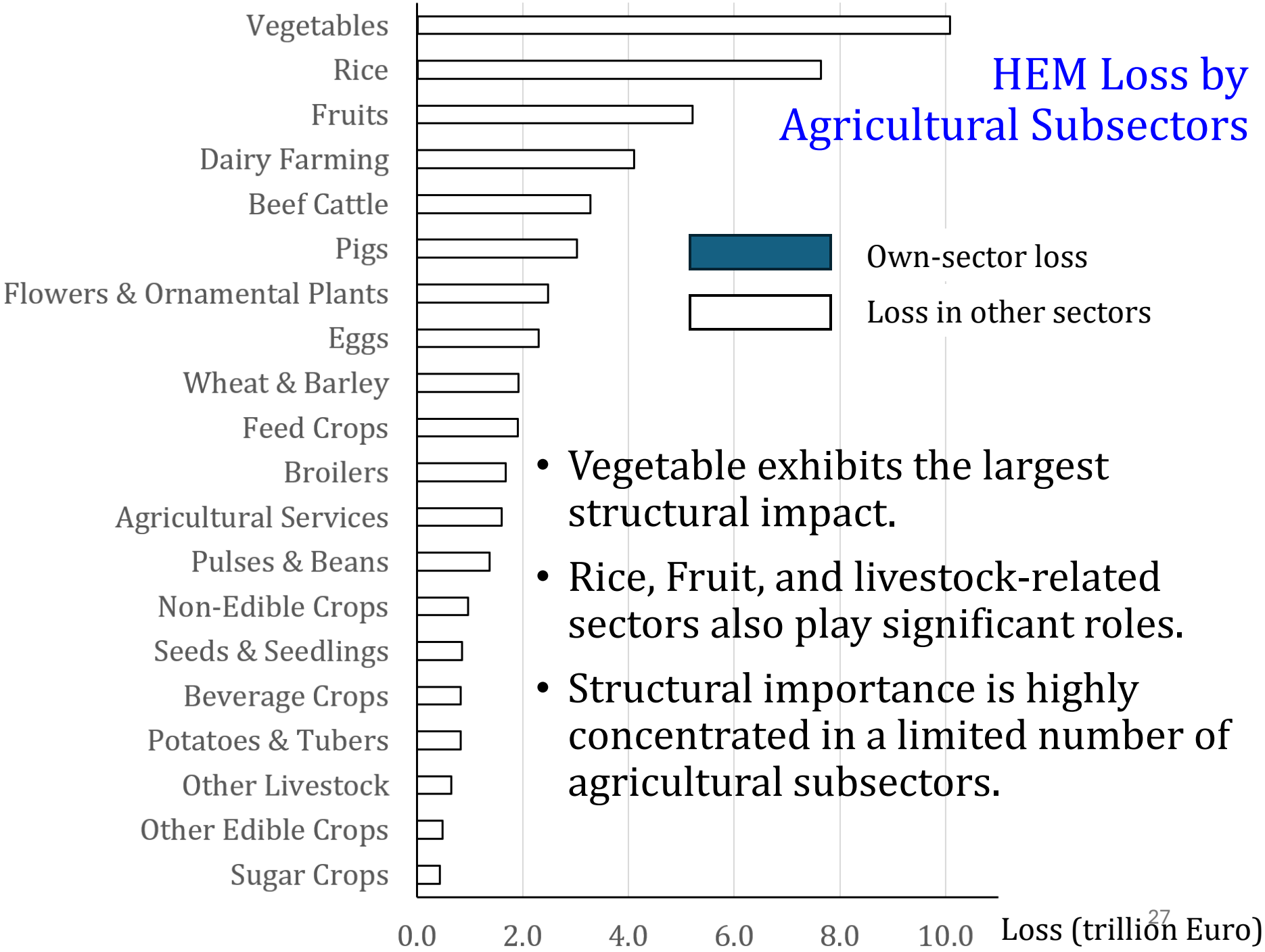
- Multiplier and Linkage Analysis
  - Measures expansion effects
  - Evaluates how strongly a sector stimulates other activities
  - Does not directly measure structural dependence
- Hypothetical Extraction Method(HEM)
  - Measures extraction effects
  - Evaluates the loss incurred when a sector is removed
  - Captures structural importance within the economic system

- How much would the Japanese economy lose if agriculture disappeared?

HEM Results: Why Does Agriculture Matter?

- **The extraction of all twenty** agricultural sectors results in a loss of 45.96 million euro, equivalent to **2.94%** of total economic activity.
- More than 99% of the total loss occurs outside the extracted sector rather than within the sector itself.
- This suggests that the importance of agriculture is driven primarily by its interactions with the rest of the economy.

HEM Loss by Agricultural Subsectors

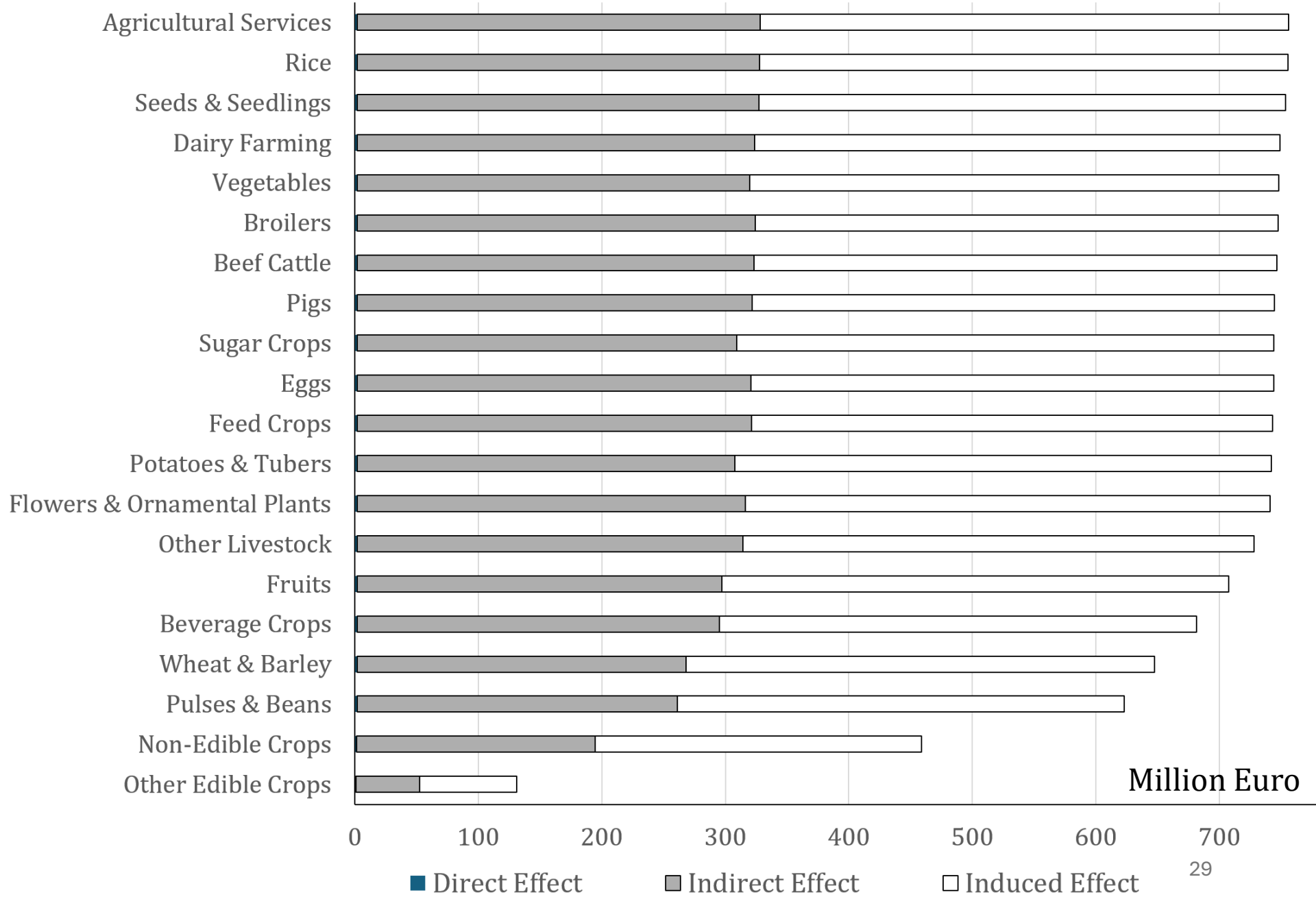


- Vegetable exhibits the largest structural impact.
- Rice, Fruit, and livestock-related sectors also play significant roles.
- Structural importance is highly concentrated in a limited number of agricultural subsectors.

SAM Multiplier Decomposition

- The total multiplier effect is decomposed into direct, indirect, and induced effects following the SAM multiplier decomposition framework proposed by Pyatt and Round (1979).
- Direct effect
  - Initial increase in production within the affected sector.
  - No interindustry transmission.
- Indirect effect
  - Effects transmitted through intermediate input transactions.
  - Captures interindustry linkages.
- Induced effect
  - Effects generated through household income and consumption feedback.
  - It arises because households receive income and spend part of that income on consumption.

Agricultural Subsectors Comparison



Direct, Indirect, and Induced Effects

- Induced effects constitute the largest component of total multiplier effects across almost all agricultural subsectors.
- Direct effects are negligible compared with indirect and induced effects.
- The economic importance of Japanese agricultural sectors is driven not only by production linkages but also by household-income feedback mechanisms.
- Agricultural Services, Rice, Dairy Farming, and Vegetables exhibit particularly large total effects.
- These findings help explain why HEM losses occur predominantly outside the extracted sector.

Conclusion: Agriculture remains structurally important despite its small GDP share.

- Agricultural subsectors exhibit substantial heterogeneity.
- Agriculture generates significant economy-wide employment and income effects.
- Extracting agriculture reduces total economic activity by 2.94%.
- Induced effects are the primary transmission mechanism.