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How Agri-food Value Chain Employment and Compensation Evolve with Structural Transformation

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Notices

ABSTRACT

The traditional structural transformation narrative emphasizes inter-sectoral labor reallocation out of agriculture, ignoring whether workers exit agri-food value chains or merely migrate within them, from primary agricultural production to downstream food industries. We introduce a method to decompose multi-regional input-output table data into industry-andcountry-specific annual labor value added estimates by final consumer market segment – domestic food at home, domestic food away from home, or exports – and match with industryspecific employment data to estimate average worker compensation. Using data covering most of the global economy, 1993-2021, we report ten stylized facts that sharpen the traditional narrative about labor reallocation amid structural transformation. As incomes grow, labor exits primary production for downstream agri-food value chain segments that maintain a steady economywide employment share while offering jobs that pay better than farm work. Women disproportionately move from primary production to downstream, consumer-facing retail and food service, while men migrate to better-paying midstream jobs, increasing gender pay inequality within the value chain. Employment shifts are strongly associated with changes in national per capita income, but not with agricultural total factor productivity growth.

Keywords: economic development, food systems, gender gap, input-output tables, labor value added.

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Low-income countries are not simply economically smaller versions of high-income countries. Rather, the structures of their respective economies differ fundamentally. The traditional narrative about the "structural transformation" associated with economic development emphasizes labor reallocation from agriculture toward manufacturing and services. Theorists have explained this phenomenon using models of economic development that include two or three distinct sectors: agriculture, manufacturing, and perhaps services. In such models, technological change in agriculture combines with consumer preferences that cause the budget share spent on food to fall as incomes rise (i.e., Engel's Law) to drive labor reallocation out of rural agriculture and into urban manufacturing and/or services (Lewis, 1954; Chenery, 1960; Johnston and Mellor, 1961; Kuznets, 1973; Reynolds, 1983; Timmer, 1988, 2009). Empirical analyses confirm these patterns persist today (Herrendorf, Rogerson and Valentinyi, 2014; Gollin, Lagakos and Waugh, 2014; Lagakos and Waugh, 2013; Tombe, 2015).

This traditional structural transformation narrative, however, falsely equates agriculture - a production activity - with the food people consume, most of which undergoes post-harvest value addition. The narrative thus ignores the central role played by post-farmgate agri-food value chain (AVC) manufacturing and service industries that intermediate between rural agricultural producers and predominantly-urban food consumers (Barrett et al., 2022). These post-farmgate AVC segments are central to the story of structural transformation because they transform agricultural commodities into convenient, diverse, safe foods available to consumers no matter how far they live from farms. Indeed, because demand for these non-caloric food attributes rises as incomes grow, post-farmgate value addition accounts for a steadily rising share of consumer food expenditures (Reardon, 2015; Barrett et al., 2022), more than 70% on average globally (Yi et al., 2021). This also suggests that income growth originating from outside the agricultural sector may have demand-side effects on AVC transformation that are at least as profound as any effects arising due to upstream, supply-side changes such as advances in agricultural technologies.

We use multi-regional input-output tables generated from national accounts data to decompose (money-metric) value addition by AVC industry, factor of production, and final consumer market - i.e., domestic food at home, domestic food and accommodations away from home, or exports - and combine those decompositions with International Labor Organization (ILO) employment data to document ten stylized facts about how employment and compensation evolve within AVCs amid structural transformation. Together, these stylized facts sharpen the traditional narrative about structural transformation. Since nearly half the world's population lives in households employed in agrifood systems (Davis et al., 2023), getting this narrative right matters.

The data highlight how intermediary AVC segments absorb almost all of the inter-sectoral shift of labor out of primary production, and in a gender-differentiated way that aggravates male-female earnings gaps. Furthermore, midstream food processors/manufacturers, transporters, and wholesalers and consumer-facing retailers and food service outlets downstream are more labor intensive than primary production. So the labor share of total value-added in the food consumers purchase rises steadily as economies develop. Midstream and downstream jobs offer compensation greater than primary production workers earn, and that largely rises at the same rate as national income growth, even as the real inter-industry compensation gap narrows because of above-average growth in compensation to workers in primary production. Because women tend to migrate more from primary production to the downstream retail and food service sectors, while men disproportionately move to the best-paid midstream jobs, AVC labor transitions aggravate average gender pay inequality even while raising all AVC workers' average incomes. Finally, we show that within-AVC labor reallocation is strongly associated with real income growth, but only weakly associated with agricultural total factor productivity growth, suggesting that these transitions are more demand- than supply-driven, contrary to the dominant narrative in the structural transformation literature.

The main contributions of this paper are three. First, we advance the 'food dollar series' methodology, originally developed by the United States Department of Agriculture's Economic Research Service (Canning, 2011; Canning, Weersink and Kelly, 2016) and recently expanded to the global food dollar series (Yi et al., 2021). Specifically, we incorporate exports, and, relative to the global food dollar (Yi et al., 2021; Santeramo, Jelliffe and Hoekman, 2024), disaggregate value addition among five post-farmgate industries, and directly estimate average compensation (i.e., payments and benefits) to workers. This enhanced granularity provides a more nuanced understanding of value distribution along the food supply chain and its implications for labor.

Second, we generate an open access data set with far broader coverage than either Yi et al. (2021) or its FAOSTAT Food Value Chain data series offspring. We source input-output data from the EORA Global Supply Chain database (Lenzen et al., 2012, 2013), which provides annual data from 1993 to 2021 at the country and sector levels (Moran and Wood, 2014). We process over 80 billion EORA observations, approximately 3 billion data points annually for each of the 29 years for 189 different countries. These data cover 99% of the global economy. Further, by merging the AVC industry-specific value added and worker compensation estimates we generate with ILO employment data (ILO, 2024*b*), we generate unprecedented country-, industry- and year-specific employment and compensation estimates along the entire AVC. Because the ILO employment data are incomplete, the balanced panel of EORA-based value addition estimates become an unbalanced panel of 1,327 country-year-specific employment and compensation estimates, causing uneven coverage across national income levels. Figure SI.1 illustrates the data coverage by country-year real per capita income. Panel A shows the distribution of country-year pairs in the EORA data. Most observations fall in either the lower-middle-income country (LMIC) or upper-middle-income country (UMIC) categories, per World Bank definitions. Panel B depicts the narrower set of country-year pairs in the merged EORA-ILO data, covering 112 countries, which skew toward the high-income country (HIC) category. The merged EORA-ILO data cover 59% of the global economy and 31% of the global working age (15-64 years old) population, mainly reflecting China's omission from the ILO data. We then disaggregate the employment data by gender. In doing so we loseone year-specific observations from the 1,328 in the unbalanced panel, but we lose no countries.

Third, we summarize the central findings of our analysis of these new data in the form of ten stylized facts. These observations shed new light on the process of structural transformation and, in particular, on the evolution of AVCs and the labor employed therein, including gendered patterns of labor transition.

Results

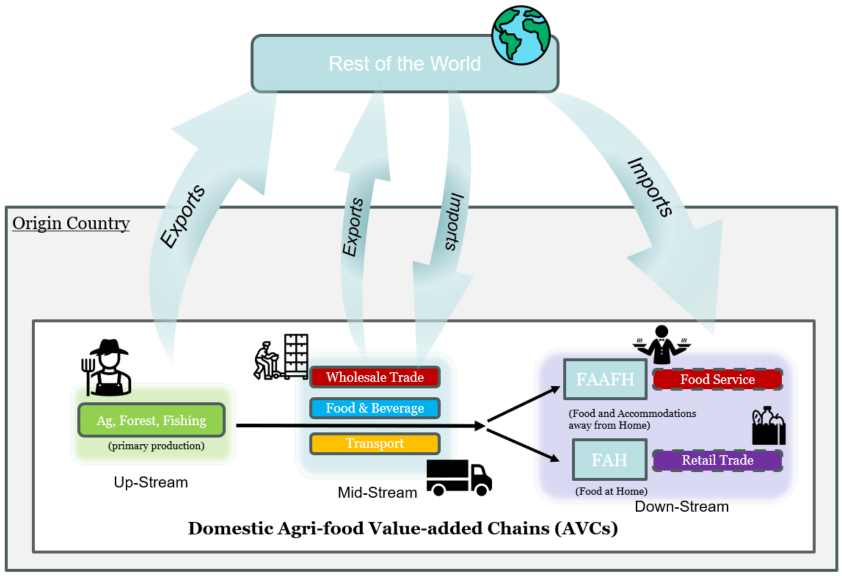
We disaggregate AVCs along two primary dimensions. First, we divide the AVC into six distinct industries: (i) agriculture, forestry, and fishing (AFF, i.e., primary production), three midstream sectors – (ii) food and beverage manufacturing and processing, (iii) transport, and (iv) wholesale trade – and two consumer-facing, downstream segments: (v) hotels and restaurants (i.e., food service), (vi) retail trade. Figure 1 illustrates the globally-integrated AVC framework featuring these six industries. Second, we differentiate based on final consumer market destination: (i) domestic food at home (FAH), (ii) domestic food and accommodations away from home (FAAFH), the vast majority of which is food away from home (FAFH),[1] and (iii) exports to accommodate food consumers in other countries. We estimate $10.18 trillion in 2021 nominal value addition embodied in global food purchases.

1. The share of total AVC value added attributable to primary production (AFF) falls as income grows, while the share of total value added tied to food service (FAFH) rises. The first part of this stylized fact is well-known, simply a reflection of Engel's Law, the empirical regularity that the budget share spent on food falls as real incomes rise. The second part – that FAFH rises as a share of total consumer food expenditures as real incomes increase – is widely asserted but surprisingly poorly documented. Figure SI.2 shows that these patterns appear in the global data and Figure SI.3 shows how the farm share of total consumer food expenditures varies across countries. These empirical regularities merely reflect that food is a normal good with an income elasticity of demand well below one, that consumers demand more convenience, quality, and diversity in diets as food expenditures increase, and that these non-caloric attributes entail added costs. Midstream and downstream (post-harvest) value addition therefore rises as a share of food expenditures.

Panel A of Figure 2 shows how the industry share of total AVC value added changes as real income per capita rises. The three dashed vertical lines in each figure represent the breaks

[1] FAFH expenditures consistently represent 71-95% of FAAFH expenditures across a range of countries, 2010-2016 (Yi et al., 2021). For example, food services accounted for 84 - 89% of FAAFH spending in the United States in constant 2012 dollars between 2002 – 2021 (see U.S. Bureau of Economic Analysis, table 2.4.6u at `www.bea.gov`). Thus, FAAFH offers a modest overstatement of true FAFH that is fairly consistent over space and time.

FIGURE 1: Globally-Integrated Agri-Food Value Chains



Notes: Authors' stylized illustration of a globally-integrated agri-food value chain.

between the low-income country (LIC), lower-middle-income country (LMIC), upper-middle-income country (UMIC) and high-income country (HIC) real income levels. We observe important heterogeneity based on the market destination: from left to right, FAH, FAAFH, exports, and then the total of all three. The 2021 primary production share of total global food expenditures was 28.4%. At low incomes, AFF dominates (i.e., greater than 60% of AVC value addition) in export markets and is comparable to retail in value addition in FAH, resulting in primary production accounting for a plurality of value addition over the LIC range. But AFF's share of AVC exports value addition falls sharply as incomes rise, as it does over the UMIC/HIC range for FAH markets. The end result is that in HICs, primary production accounts for a small share of total AVC value addition, comparable to that of the transport sector.

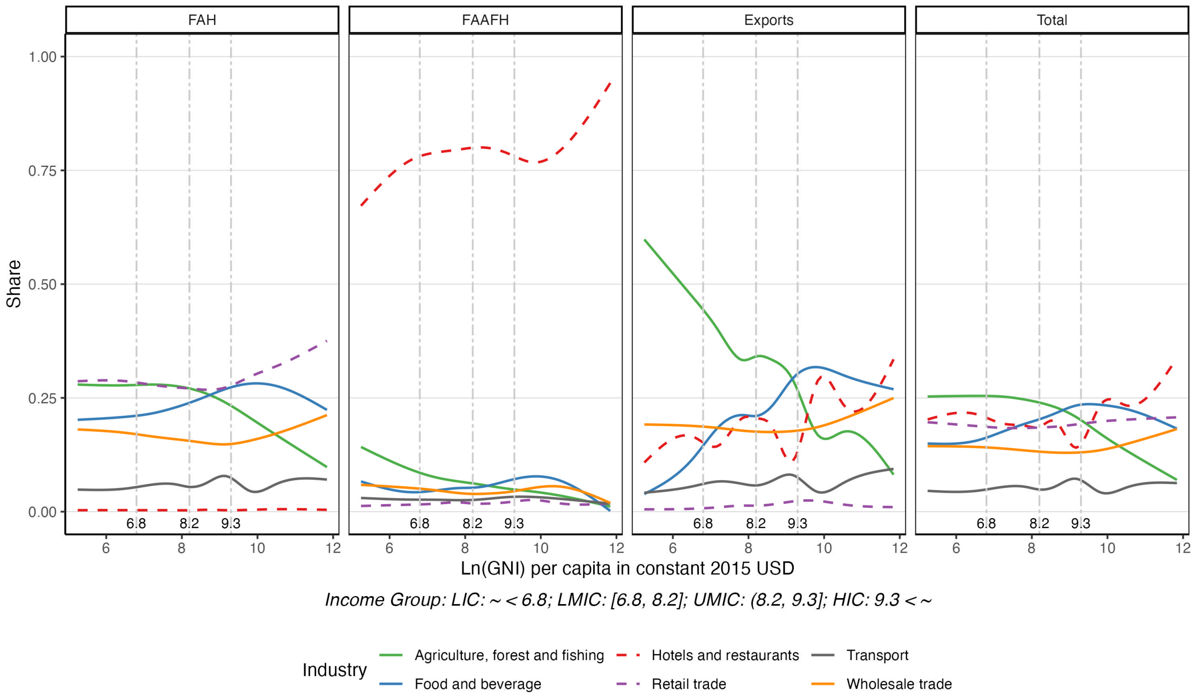
By contrast, food service (i.e., hotels and restaurants) dominates FAAFH over all income ranges, and as food consumed away from home rises as a share of total food expenditures, and as food service features more prominently in exports (i.e., sales to tourists) as incomes rise, food service becomes the single largest AVC sector by value addition among the highest income countries. The retail sector accounts for a plurality of FAH market AVC value addition across all income ranges, while food and beverage manufacturing and wholesale trade becomes far more important as countries move out of the LIC range, especially for exports.[2]

2. Downstream AVC segments are more labor-intensive than primary production at all national income levels. Panel B of Figure 2 depicts the labor share of total AVC industry value

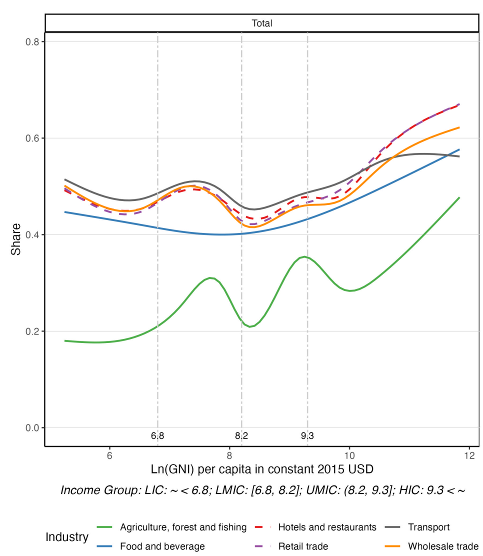
[2]Panel A of Figure SI.4 shows similar patterns in the industry share of labor value added.

FIGURE 2: Value Added by National Income Level

(A) Industry Share of Total AVC Value Added by Final Market



(B) Labor Share by Industry



Notes: Panel A pools estimates from 3,217 country-year pairs to show the industry shares of total value added $\frac{\text{Total VA}_{ict}}{\sum_{i=1}^{6}(\text{Total VA}_{ict})}$ by AVC industry, with log GNI per capita values (constant 2015 USD) on the x-axis. Panel B shows the labor share of value added by industry $\frac{\text{Labor VA}_{ict}}{\text{Total VA}_{ict}}$ across all market destinations(i.e., domestic FAH + domestic FAAFH + Exports).

added against national income per capita. Two key findings stand out. First, the highest labor shares are concentrated in the downstream AVC segments – hotels and restaurants, transport, retail trade, and wholesale trade – while primary production accounts for the lowest labor share of total industry value added across all national income levels. Second, the labor share of total value added generally rises across all industries as national income per capita grows. This presumably reflects growing inter-industry labor market integration and the impacts of resulting competition on labor productivity and compensation amid the process of structural transformation.[3]

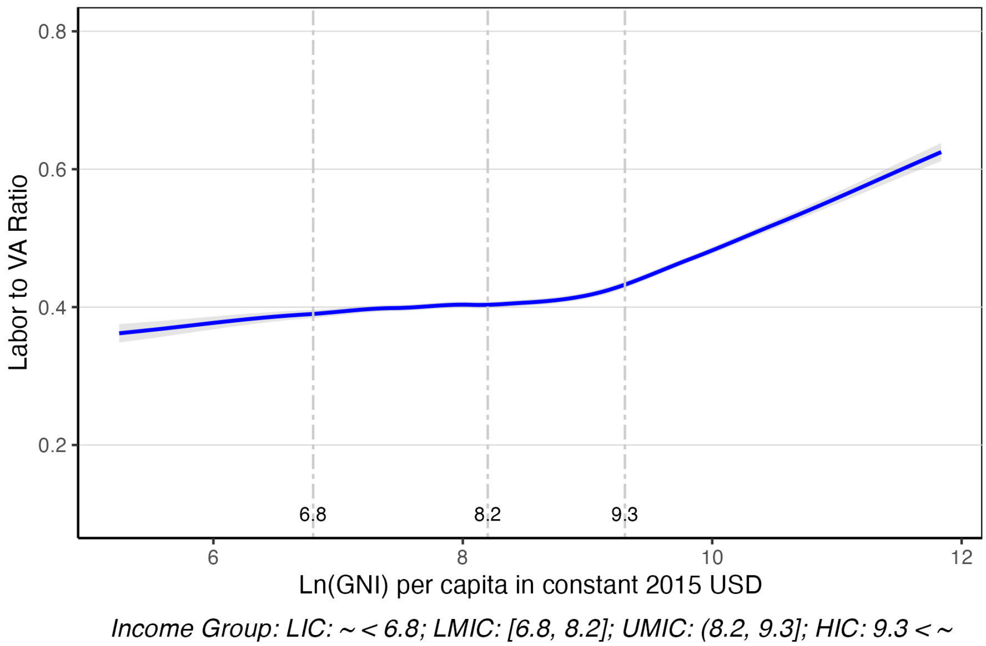
3. The labor share of total AVC value addition rises steadily with per capita incomes. Globally, the labor share of total food expenditures consistently ranged between 48-52% each year in our time series. The two prior stylized facts show that the rising FAAFH share of consumer food expenditures, combined with inter-industry differences in the labor intensity of production, imply that the labor share of the value addition in total food purchases rises with economic development. Consumers demand more preparation, processing and service, all of which requires labor. Per Figure 3, the labor share of total food expenditures averages less than 40% in LICs, growing to over 60% in the wealthiest countries. Across the full span of our data, the labor share of total value addition in consumer food expenditures rises by 3.5% for every doubling for real per capita income ($p=0.0000$, see Table SI.12). This underscores the close connection between wage rates and food prices, a relationship that grows stronger as incomes rise.

4. The share of employment in primary production falls as incomes rise, but the employment share of other AVC segments remains stable over the course of structural transformation. Panel A in Figure 4 shows how the economywide share of AVC employment in primary production and in the other five post-farmgate AVC segments combined evolve with real per capita income. Note that this uses the smaller, merged EORA-ILO sample, disproportionately reducing observations from LICs and LMICs. As the traditional structural transformation narrative holds, the economywide workforce share employed in primary AVC production falls as national income per capita increases. The novel finding is that the economywide employment share in the other AVC segments remains relatively stable as national income per capita rises from the LIC range to middle or HIC, ultimately matching or surpassing the AFF workforce in each destination market.

5. The best compensated AVC jobs are in off-farm, post-harvest segments. Workers migrate within AVCs, from low-paid farm work to post-farmgate industry jobs that pay better. Figure 5 shows how compensation per worker in each AVC industry varies as national income rises. Compensation per worker increases in all AVC industries as national income per capita grows, especially quickly in primary production, resulting in shrinking inter-industry AVC compensation differentials. Presumably, this reflects steady improvements in labor market integration across

[3] Panel B of Figure SI.4 shows similar trends in the labor share of total value added by final market destination.

FIGURE 3: Labor Share of Total AVC Value Added



Notes: The vertical axis shows the economywide ratio of labor value addition to total value addition in the AVC, summing across destination markets and industries. The line reflects a LOESS regression with 0.7 as the smoothing parameter, with a 95% confidence interval in grey shade.

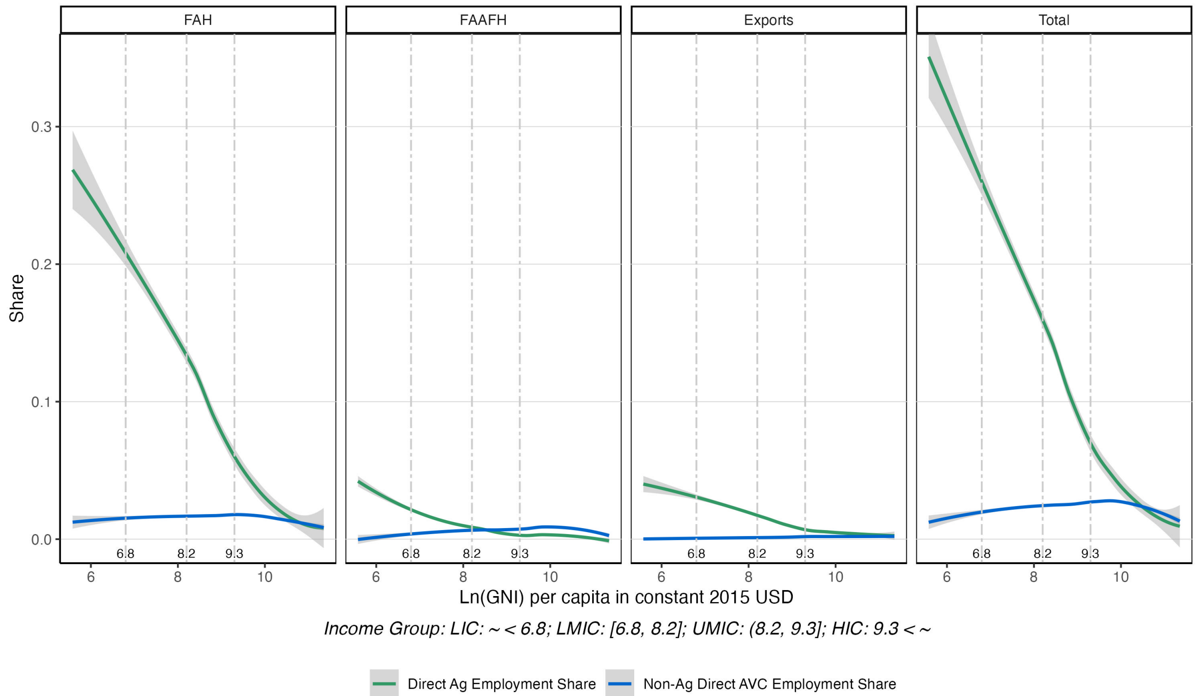
industries, perhaps partly due to improved communications and transportation that reduce inter-industry and rural-urban labor migration frictions.

6. AVC employment growth is concentrated in midstream and downstream segments. The clear implication of Panel B of Figure 4 is that job creation in AVCs occurs overwhelmingly in the mid-stream and downstream industries, not in primary production. This is an important empirical regularity to keep in mind as policymakers often talk of trying to encourage more young people to 'return to the farm.' Panel B of Figure 4 focuses within the AVC, reflecting essentially the product of panels A and B of Figure 2 and Figure 5. While primary production remains the dominant employer for AVC exports throughout the LIC, LMIC and UMIC range, food service and retail become the dominant AVC employment segments by the time countries reach the LMIC and UMIC ranges in FAAFH and FAH markets, respectively. The end result is that in HICs, the consumer-facing retail and food service sectors are the dominant AVC employers.

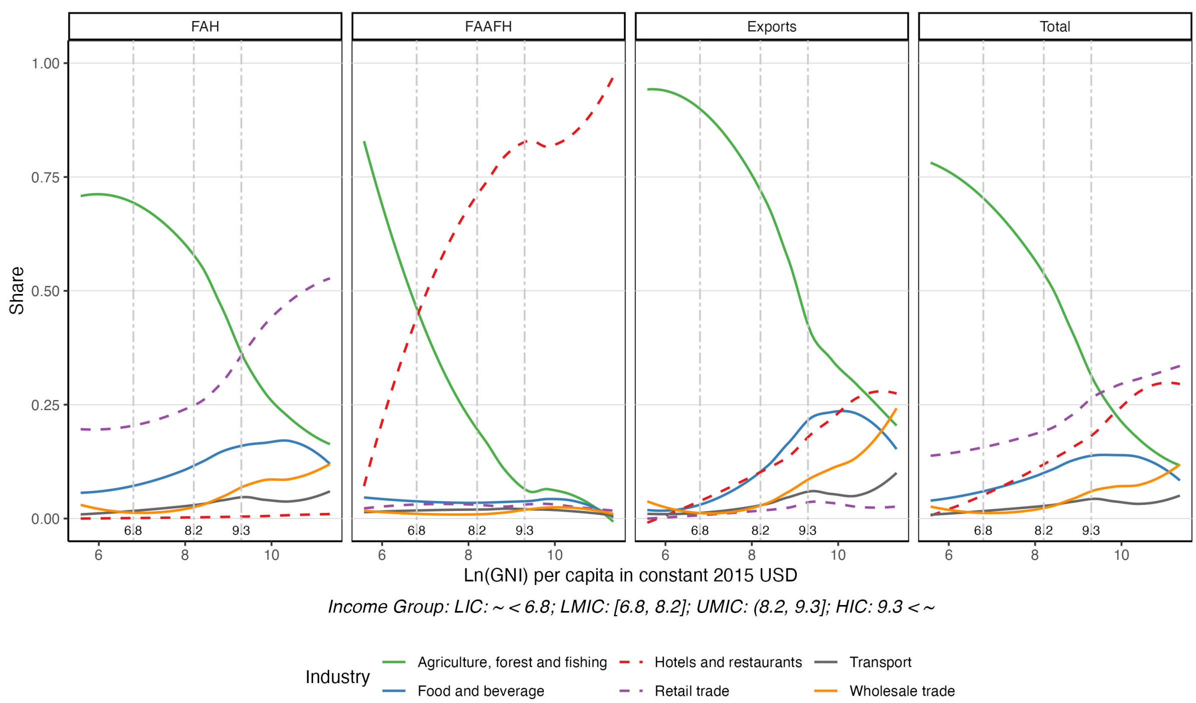
7. Subcontracting rises sharply with gross national income per capita. In all analyses discussed so far, we focus on employment within AVC industries and abstract away from subcontracted or outsourced employment (e.g., a farm or firm that hires an independent accountant or an external service provider to maintain its equipment). Panel A in Figure 6 shows the share of both own and subcontracted employment (in yellow and blue, respectively) within AVC industries.

FIGURE 4: Total Economywide Employment Shares by National Income Level

(A) Employment Share of Labor Force

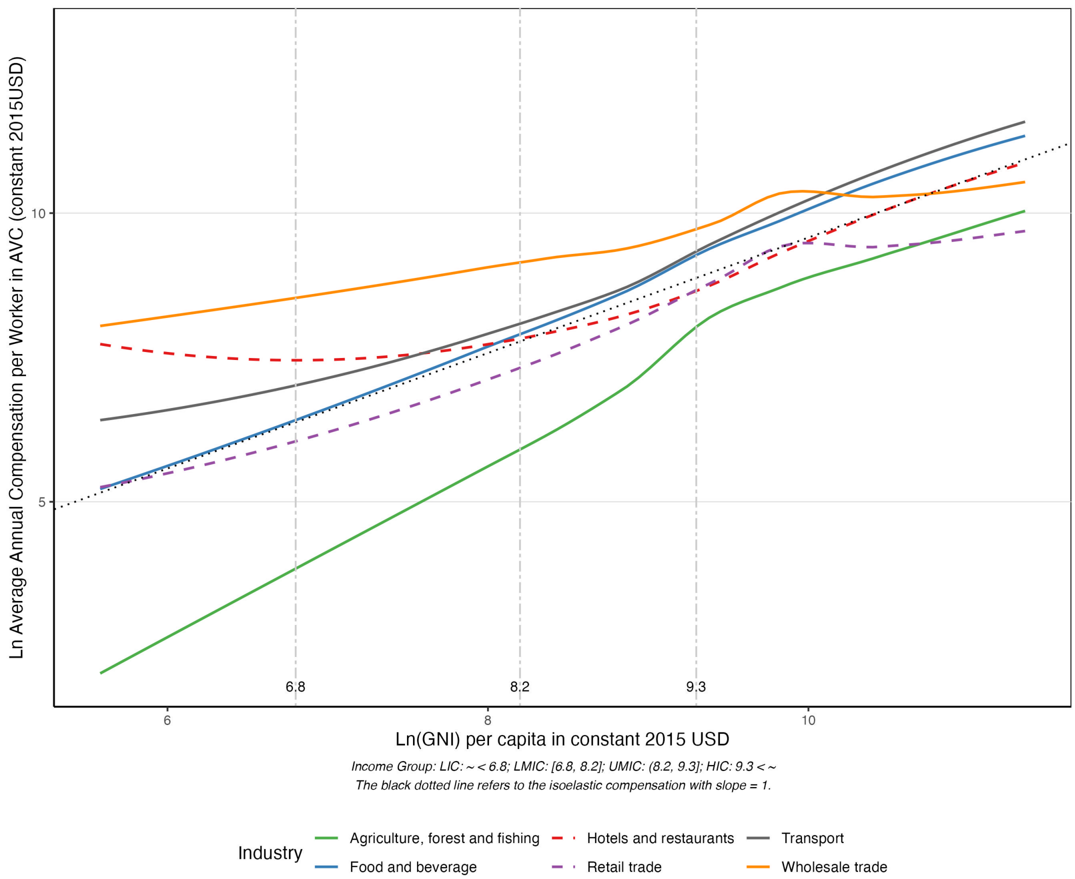


(B) Industry Share of AVC Employment



Notes: Panel A pools estimates from 1,328 country-year pairs in the matched Eora-ILO data, showing AFF employment (green line) and employment in all other AVC sectors (blue line) as a share of the economywide labor force, with log GNI per capita values (constant 2015 USD) on the x-axis. Grey shading reflects 95% confidence bands. Panel B shows the industry shares of total AVC employment (excluding subcontractors), $\frac{\text{Employment}_{ict}}{\sum_{i=1}^{6}(\text{Employment}_{ict})}$ by final market destination.

FIGURE 5: Average Compensation per AVC Worker

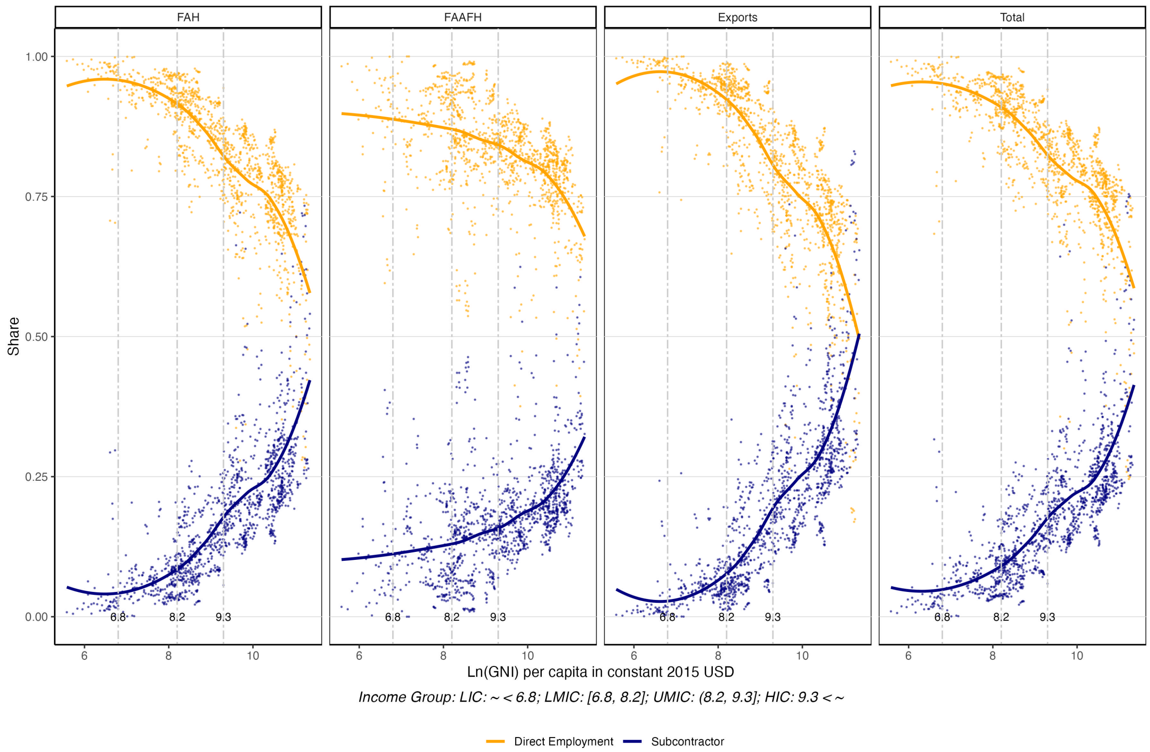


Notes: This figure shows the logarithmic average compensation per AVC worker (exclude subcontractors) calculated using a total of 1,328 country-year pairs in the matched Eora-ILO data, with logarithmic GNI per capita values (constant in 2015 U.S Dollars) on the x-axis. The average compensation estimates have been winsorized and normalized to constant 2015 U.S. Dollars.

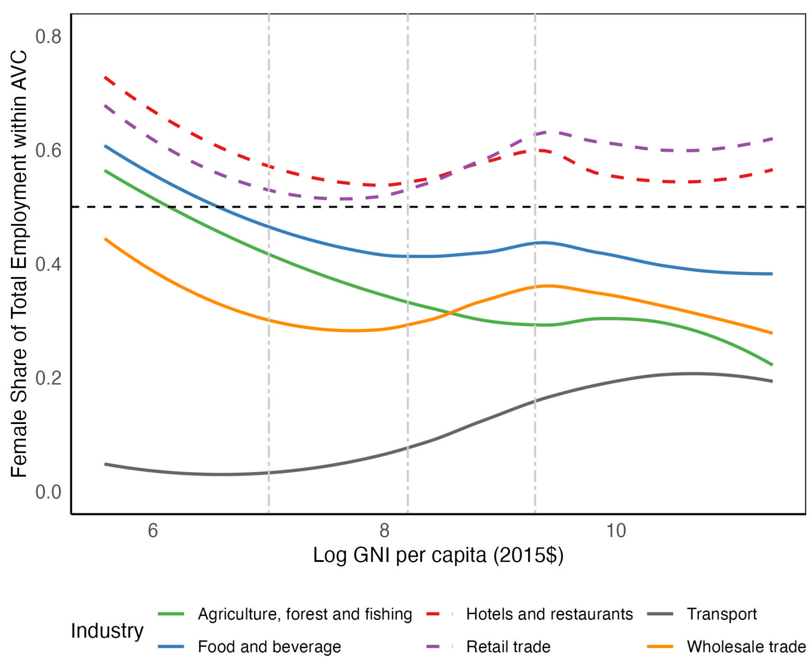
While own employment dominates subcontracted employment for each destination market and over the full income range, we see a striking empirical regularity that income growth is strongly associated within increased subcontracting. Outsourcing can boost productivity through any of several mechanisms, including increased specialization according to comparative advantage or through the emergence of rental and services markets to overcome scale barriers to the purchase of lumpy new technologies (Reardon et al., 2024). Consistent with the idea that greater subcontracting signals increased productivity, Figure SI.6 shows that compensation per worker is higher among subcontractors within all but one agri-food value chain industry (wholesale trade). And since subcontractors (e.g., accountants, vehicle mechanics) often serve clients across multiple AVC industries, we naturally see far less inter-industry variation in subcontractor compensation than in payments to direct employees.

FIGURE 6: Unpacking AVC Employment: Subcontracting and Gender

(A) Direct Employment and Subcontractor Shares



(B) Gender Ratio by Industry



Notes: Panel A shows the shares of AVC employment and subcontractors calculating from 1,328 country-year pairs, with log GNI per capita values (constant 2015 USD) on the x-axis. Panel B displays the share of female employment by AVC industry, per ILO data. The black, dashed horizontal line reflects gender equality (0.5) in industry labor force. Log GNI values of 7, 8.2, 9.3 are deflated 2023 World Bank cutoffs for LIC, LMIC, UMIC, and HIC income classes.

8. Women migrate relatively more from primary production to downstream retail and food service employment, while men migrate disproportionately from farming to midstream AVC jobs. Some industries predominantly employ men, others women. Over all income ranges, most AVC workers in transport and wholesale trade are men while most retail and food service employees are women (Figure 6, Panel B). Women outnumber men in primary production and food and beverage manufacturing only in the lowest-income economies. As incomes rise, women exit the AVC entirely faster than men do (Figure SI.7), thus manufacturing and farming become predominantly male by the time economies reach the middle-income range. The net result of these gendered industry patterns is that men and women's intersectoral labor transitions differ as economies develop. Women migrate mainly into service sectors while men are more likely to move into manufacturing and transport, reflecting economywide gendered employment patterns (Ngai and Petrongolo, 2017; Chiplunkar and Kleineberg, 2023; Ngai, Olivetti and Petrongolo, 2024).

9. Given inter-industry compensation differences, gendered occupational sorting translates into increasing within-AVC gender pay gaps as incomes rise. Compensation in female-heavy sectors is generally less than in primarily male industries (Killingsworth, 1990; Macpherson and Hirsch, 1995). Inter-industry pay differentials and gendered labor transitions thereby result in a 7% decrease in the female/male average AVC worker compensation ratio, from 1.03 to 0.94, as economies move from low to high income (Figure SI.8). Note that this purely reflects inter-industry differentials, abstracting away from gender pay gaps for the same job in the same industry or due to gendered occupational sorting within industries, for which our data cannot control. Structural transformation does not naturally ameliorate gender pay gaps; it may aggravate them.

10. Labor reallocation within AVCs is far more strongly associated with demand-side forces linked to income growth than with supply-side factors related to agricultural total factor productivity growth. A longstanding structural transformation narrative holds that agricultural technological change frees labor and capital from relatively less productive primary production, supplies increasingly affordable raw materials for industrial workers, and contributes to demand for more productive, non-farm products from farmers (Johnston and Mellor, 1961; Timmer, 1988, 2009; Barrett, Carter and Timmer, 2010). Especially in open economies, however, factors originating elsewhere in the economy might stimulate AVC transformation mainly through shifting consumer demand patterns (Matsuyama, 1992; Gollin, 2014; Dercon and Gollin, 2014; Santeramo, Jelliffe and Hoekman, 2024). We make a coarse attempt to explore these competing hypotheses descriptively using multivariate regression analysis. Specifically, we regress the labor share and average worker compensation of each AVC industry on real per capita income and on agricultural total factor productivity (AgTFP), plus controls (see the Multivariate Regression Analysis sub-section of the Methods section).

As Figure 7 shows, rising real per capita incomes are strongly associated with a declining share

FIGURE 7: Estimated marginal expected changes by AVC industry

	Industry Share of Total Work Force		Ln Ave Compensation per Worker (2015USD)	
	LnGNI	AgTFP	LnGNI	AgTFP
Ag, forest and fishing	-0.066	-0.039	1.376*	0.195
Food and Beverage	-0.006	0.002	1.069	-0.459
Hotels and restaurants	-0.002	0.016	0.768	0.013
Retail trade	-0.009	-0.007	0.805	0.073
Transport	-0.007	0.008	1.016	0.196
Wholesale trade	-0.003	0.006	0.390**	0.156

Negative:	***p < 0.01	**p < 0.05	*p < 0.10	insignificant
Positive:	***p < 0.01	**p < 0.05	*p < 0.10	insignificant

Notes: Cell entries represent the estimated net effect of a doubling of real per capita GNI (LnGNI columns) or of a one percent increase in agricultural total factor productivity (AgTFP columns) by AVC industry. Darker blue (red) shades indicate greater statistically significant positive (negative) estimated associations. Unshaded cells reflect estimates statistically insignificantly different from zero. Ln Ave Compensation estimates omit subcontractors. Asterisks in the LnGNI column of the Ln Average Compensation per Worker variable indicate the significance levels for testing the null hypothesis that the coefficient estimates equal one, implying that compensation grows at the same rate as per capita incomes in the broader economy. All estimates in this table reflect the regression results in Tables SI.13 and SI.14.

of workforce in primary production (AFF) - a decline of 6.6% for every doubling of real GNI per capita, an order of magnitude larger effect than we see in any midstream or downstream AVC industry, with no statistically significant association between real income growth and the food service or wholesale food share of the economy-wide workforce. Note that this correlation is independent of agricultural productivity growth - reflected in the AgTFP variable - which is far more weakly (or not significantly) correlated with labor reallocation within AVCs. Rising AgTFP generates income growth as well, so the estimated association of the AgTFP variable captures just the supply side effects mooted to generate backward and forward linkages that propagate gains in agricultural productivity into the non-farm economy, separate from the demand-side effects coming from increased farmer incomes (Lewis, 1954; Johnston and Mellor, 1961; Chenery and Syrquin, 1975; Timmer, 1988, 2009; Barrett, Carter and Timmer, 2010). The real per capita income variable captures income growth arising from gains anywhere in the economy (i.e., agricultural or non-agricultural sectors) independent of AgTFP growth. AVC labor reallocation seems far more strongly associated with demand-side phenomena than supply-side ones.

We also see in Figure 7 that in every AVC industry except for wholesale, average labor compensation grows at least as fast as average incomes, with the faster growth in labor income occurring in primary production, consistent with the inter-sectoral compensation convergence shown in Figure 5. Together, these results imply that income growth-driven changes in consumer food demand stimulate post-farmgate job creation and wage growth throughout AVC industries.

Discussion

These ten stylized facts can be summarized as follows. As real incomes rise, consumers demand more convenience, quality, safety, and variety in their diets, leading to a shift in consumer food expenditure shares away from primary production toward midstream and downstream value addition. This leads labor to exit primary production while employment grows in post-farmgate AVC intermediary segments where food is processed, transported, marketed, and served at higher values. These more labor-intensive midstream and downstream AVC industries largely maintain a steady economy-wide employment share throughout the structural transformation process. The midstream and downstream jobs also pay better than primary production, and mostly increase equi-proportionately – or better – with national income growth. Structural transformation also leads to increased specialization, manifest in a rising share of indirect employment (i.e., subcontracting) within AVCs that is likewise associated with greater worker compensation. Both male and female workers benefit from the transition from lower-paid farmwork to higher-paid off-farm jobs. But because women disproportionately move into customer-facing jobs in the retail and food service industries that pay less than the midstream manufacturing, transport and wholesale jobs to which men more commonly move, gender-differentiated occupational segregation results in a widening gender pay gap within AVCs.

These results are purely descriptive and cannot directly answer causal questions about what drives these empirical regularities of the structural transformation process. But stylized facts about labor reallocation away from agricultural production and toward manufacturing and services sectors associated with national income growth motivated seminal theoretical and empirical research on agricultural and economic development processes. We conjecture that these more nuanced findings can likewise motivate future research on the role AVCs more broadly play in the structural transformation process. This would include topics such as identifying factors that promote or constrain quality upgrading within AVCs (Macchiavello and Miquel-Florensa, 2019; Verhoogen, 2023), how consumer and farmgate food prices fluctuate amid the structural transformation process (Dalheimer, Bellemare and Lim, 2023), and how labor reallocation within AVCs advances or impedes equity goals within workforces (Arslan et al., 2021; Dolislager et al., 2021; Quisumbing et al., 2021; Chiplunkar and Kleineberg, 2023; Ngai, Olivetti and Petrongolo, 2024).

Our analysis is, of course, not without limitations. The primary limitation is the lack of quality and internationally comparable data that allow for disaggregation of industries across the entire AVC. Although our data cover most of the global economy, employment data gaps make coverage thinner among LICs. This is a distinct challenge for describing the structural transformation process. The literature on AVCs systematically suffers from this limitation (Barrett et al., 2022; Bellemare, Bloem and Lim, 2022). Indeed a key objective of this research is to make available an unprecedentedly large, detailed data set over an extended period and to inspire the generation and collection of higher quality and internationally comparable data that allows for more detailed, rigorous work probing the stylized facts presented here.

A second important limitation concerns how one handles mixed income, the net surplus accruing to unincorporated household enterprises. Mixed income reflects both implicit compensation to non-wage family workers and enterprise profits. As Figure SI.5 shows, the mixed income share of total AVC value addition falls steadily as real per capita incomes rise, from around 15-20% in LICs to well below 5% in HICs. We opt to omit mixed income, which implies we underestimate worker compensation, especially over the lowest income ranges. Since the mixed income shares are consistent across industries and decline similarly as real incomes rise, this should have no effect on our qualitative points. One could alternatively include mixed income and thereby overstate worker compensation instead.

References

Arslan, Aslihan, David L Tschirley, Constanza Di Nucci, and Paul Winters. 2021. "Youth inclusion in rural transformation." *Journal of Development Studies*, 57(4): 537–543.

Barrett, Christopher B, Michael R Carter, and C Peter Timmer. 2010. "A century-long perspective on agricultural development." *American Journal of Agricultural Economics*, 92(2): 447–468.

Barrett, Christopher B, Thomas Reardon, Johan Swinnen, and David Zilberman. 2022. "Agri-food value chain revolutions in low-and middle-income countries." *Journal of Economic Literature*, 60(4): 1316–1377.

Bellemare, Marc F, Jeffrey R Bloem, and Sunghun Lim. 2022. "Producers, consumers, and value chains in low-and middle-income countries." In *Handbook of Agricultural Economics*. Vol. 6, 4933–4996. Elsevier.

Canning, Patrick. 2011. "A revised and expanded food dollar series: a better understanding of our food costs." *ERR-144, U.S. Department of Agriculture, Economic Research Service*.

Canning, Patrick, Alfons Weersink, and Jessica Kelly. 2016. "Farm share of the food dollar: an IO approach for the United States and Canada." *Agricultural Economics*, 47(5): 505–512.

Chenery, Hollis B. 1960. "Patterns of industrial growth." *American Economic Review*, 50(4): 624–654.

Chenery, Hollis Burnley, and Moises Syrquin. 1975. *Patterns of development, 1950-1970.* Oxford University Press.

Chiplunkar, Gaurav, and Tatjana Kleineberg. 2023. "Gender Barriers, Structural Transformation, and Economic Development." *The World Bank*, Accessed: 2023-03-25.

Dalheimer, Bernhard, Marc F Bellemare, and Sunghun Lim. 2023. "Global Agricultural Value Chains and Food Prices." *Working paper*.

Davis, B, E Mane, L Yonca Gurbuzer, G Caivano, N Piedrahita, K Schneider, N Azhar, M Benali, N Chaudhary, R Rivera, et al. 2023. *Estimating global and country-level employment in agrifood systems.* Food & Agriculture Org.

Dercon, Stefan, and Douglas Gollin. 2014. "Agriculture in African development: theories and strategies." *Annual Review of Resource Economics*, 6(1): 471–492.

Dolislager, Michael, Thomas Reardon, Aslihan Arslan, Louise Fox, Saweda Liverpool-Tasie, Christine Sauer, and David L Tschirley. 2021. "Youth and adult agrifood system employment in developing regions: Rural (peri-urban to hinterland) vs. urban." *Journal of Development Studies*, 57(4): 571–593.

Gollin, Douglas. 2014. "The Lewis model: A 60-year retrospective." *Journal of Economic Perspectives*, 28(3): 71–88.

Gollin, Douglas, David Lagakos, and Michael E Waugh. 2014. "The agricultural productivity gap." *Quarterly Journal of Economics*, 129(2): 939–993.

Herrendorf, Berthold, Richard Rogerson, and Akos Valentinyi. 2014. "Growth and structural transformation." *Handbook of Economic Growth*, 2: 855–941.

ILO. 2024*a*. "ILOSTAT database description Labour Force Statistics (LFS, STLFS, RURBAN databases)." *Available from https://ilostat.ilo.org/methods/concepts-and-definitions/description-labour-force-statistics/, accessed 3-01-2024*.

ILO. 2024*b*. "International Labor Organization modelled estimates database, ILOSTAT [database]." *Available from https://ilostat.ilo.org/data/, accessed 3-01-2024*.

Johnston, Bruce F, and John W Mellor. 1961. "The role of agriculture in economic development." *American Economic Review*, 51(4): 566–593.

Killingsworth, Mark R. 1990. *The Economics of Comparable Worth.* Kalamazoo, MI:W.E. Upjohn Institute for Employment Research.

Kuznets, Simon. 1973. "Modern economic growth: findings and reflections." *American Economic Review*, 63(3): 247–258.

Lagakos, David, and Michael E Waugh. 2013. "Selection, agriculture, and cross-country productivity differences." *American Economic Review*, 103(2): 948–980.

Lenzen, Manfred, Daniel Moran, Keiichiro Kanemoto, and Arne Geschke. 2013. "Building Eora: a global multi-region input–output database at high country and sector resolution." *Economic Systems Research*, 25(1): 20–49.

Lenzen, Manfred, Keiichiro Kanemoto, Daniel Moran, and Arne Geschke. 2012. "Mapping the structure of the world economy." *Environmental Science & Technology*, 46(15): 8374–8381.

Leontief, Wassily. 1967. "An alternative to aggregation in input-output analysis and national accounts." *Review of Economics and Statistics*, 412–419.

Lewis, W. Arthur. 1954. "Economic development with unlimited supplies of labour." *Manchester School of Social and Economic Studies*, 22: 139–191.

Macchiavello, Rocco, and Josepa Miquel-Florensa. 2019. "Buyer-Driven Upgrading in GBCS: The Sustainable Quality Program in Colombia." Centre for Economic Policy Research (CEPR) CEPR Discussion Paper DP13935.

Macpherson, David A., and Barry T. Hirsch. 1995. "Wages and Gender Composition: Why do Women's Jobs Pay Less?" *Journal of Labor Economics*, 13(3): 426–471.

Matsuyama, Kiminori. 1992. "Agricultural productivity, comparative advantage, and economic growth." *Journal of Economic Theory*, 58(2): 317–334.

Miller, Ronald E, and Peter D Blair. 2022. *Input-output analysis: foundations and extensions. Third edition.* Cambridge University Press.

Moran, Daniel, and Richard Wood. 2014. "Convergence between the Eora, WIOD, EXIOBASE, and OpenEU's consumption-based carbon accounts." *Economic Systems Research*, 26(3): 245–261.

Ngai, L. Rachel, and Barbara Petrongolo. 2017. "Gender Gaps and the Rise of the Service Economy." *American Economic Journal: Macroeconomics*, 9(4): 1–44.

Ngai, L. Rachel, Claudia Olivetti, and Barbara Petrongolo. 2024. "Gendered Change: 150 Years of Transformation in US Hours." National Bureau of Economic Research Working Paper 32475.

Quisumbing, Agnes, Jessica Heckert, Simone Faas, Gayathri Ramani, Kalyani Raghunathan, Hazel Malapit, and pro-WEAI for Market Inclusion Study Team Hazel Malapit Jessica Heckert Sarah Eissler Simone Faas Elena Martinez Emily Myers Audrey Pereira Agnes Quisumbing Catherine Ragasa Kalyani Raghunathan Deborah Rubin Greg Seymour. 2021. "Women's empowerment and gender equality in agricultural value chains: evidence from four countries in Asia and Africa." *Food Security*, 13: 1101–1124.

Reardon, Thomas. 2015. "The hidden middle: the quiet revolution in the midstream of agrifood value chains in developing countries." *Oxford Review of Economic Policy*, 31(1): 45–63.

Reardon, Thomas, Titus Awokuse, Ben Belton, Lenis Saweda O Liverpool-Tasie, Bart Minten, Genevieve Nguyen, Sara Qanti, Johan Swinnen, Rob Vos, and David Zilberman. 2024. "Emerging outsource agricultural services enable farmer adaptation in agrifood value chains: A product cycle perspective." *Food Policy*, 127: 102711.

Reynolds, Lloyd G. 1983. "The spread of economic growth to the Third World: 1850-1980." *Journal of Economic Literature*, 21(3): 941–980.

Santeramo, Fabio Gaetano, Jeremy Jelliffe, and Bernard Hoekman. 2024. "Agri-food value chains and the global food dollar: The role of trade and services." *Food Policy*, 127: 102706.

Statistics Division, Department of Economic, and United Nations Social Affairs. 2008. *International Standard Industrial Classification of all Economic Activities, Revision 4.* UN.

Timmer, C Peter. 1988. "The agricultural transformation." *Handbook of Development Economics*, 1: 275–331.

Timmer, C Peter. 2009. *A world without agriculture: The structural transformation in historical perspective.* AEI Press Washington, DC.

Tombe, Trevor. 2015. "The missing food problem: Trade, agriculture, and international productivity differences." *American Economic Journal: Macroeconomics*, 7(3): 226–258.

Verhoogen, Eric. 2023. "Firm-level upgrading in developing countries." *Journal of Economic Literature*, 61(4): 1410–1464.

Yi, Jing, Eva-Marie Meemken, Veronica Mazariegos-Anastassiou, Jiali Liu, Ejin Kim, Miguel I Gómez, Patrick Canning, and Christopher B Barrett. 2021. "Post-farmgate food value chains make up most of consumer food expenditures globally." *Nature Food*, 2(6): 417–425.

Supplementary Information for

How Agri-food Value Chain Employment and Compensation Evolve with Structural Transformation

Data and Methods

This section documents the methods and data for decomposing value added, employment, and compensation of each industry serving global agri-food systems. Given the study's focus on agri-food value chains, final demand for the 'food at home' (fah) marketing channel encompasses purchases by or for households from the agriculture (A01), fishing (A02), and food and beverages (A04) sectors, collectively referred to as agri-food (AF) sectors (see sector codes in Table SI.1). A second marketing channel reflects final demand for 'food and accommodations away from home' ($faafh$), in which households outsource the purchase and preparation of AF sector outputs to the hotels and restaurants (A18) sectors. To facilitate all intermediate sales throughout both marketing channels and all final market sales for the fah marketing channel, including domestic and international sales, marketing services are provided by wholesalers (A16), retailers (A17), and by the transport sector (A19). Sectors A16 to A19 are collectively referred to as marketing services (MS). All remaining sectors may indirectly serve these two domestic and international marketing channels through some or all six supply chain ($SC = AF \cup MS$) sectors. These other sectors serving the SC sectors are collectively referred to as non-supply chain (*NSC*) sectors and are alternatively referred to as subcontractors.

Data

The primary data sources from EORA for this study are the EORA26, EORA full tables, and the EORA transportation margin tables. The EORA26 is a global MRIO (Multi-Regional Input-Output) table featuring a harmonized classification with 26 sectors. These 26 sectors are derived from the more detailed sectors present in the EORA full tables and are referred to as 'EORA sectors' throughout this study. A comprehensive list of these 26 sectors can be found in Table SI.2. The aggregation of these sectors from the detailed sectors available in the EORA full tables is documented in a concordance table provided by EORA. In addition to the two major data sources, the EORA transportation margin tables are also applied in the study. The EORA tables are annual country industry or commodity level data. The EORA dataset offers a comprehensive and annually updated compilation of economic activity data at the country and sector levels. The quality and reliability of the EORA dataset have been thoroughly examined and discussed in Moran and Wood (2014).

ILO Employment Data

Gender-specific labor data are sourced from the International Labor Organization (ILO).[4] The ILO obtains national-level employment data from nationally reported sources and modeled estimates, primarily collected from Labor Force Surveys and Population Censuses, supplemented by data

[4]Data source: ILOSTAT: Employment by sex and economic activity – ISIC level 2 (thousand) – Annual. (Accessed on 03-08-2024)

gathered from household surveys (ILO, 2024*a*). ILO employment data include both paid and self-employed working age persons, defined as age 15 and above (ILO, 2024*a*).

Total employment data are disaggregated into Female and Male gender categories. The reported total does not always equal the sum of the male and female categories. We used the following decision rules to balance the labor data: (1) if a country reports labor data for females and males separately, we define total labor as the sum of the two; (2) if a country reports only one gender and total labor, we use the residual method to estimate the employment volume for the missing gender category;[5] (3) if neither gender category is reported for any of the six AVC industries, we drop the country-year pairs from the gender analysis since we cannot disaggregate the workforce by gender, although we retain it for the prior employment and compensation analysis that is not gender disaggregated.

Ultimately, 1,636 total country-year pairs covering 154 countries from 1993 to 2021 are available for further data matching with industry-specific labor value-added estimates. The Eora data map to the ILO employment data with the codes used by ILO - ISIC revision 3.1 (see Table SI.9) or revision 4 (see Table SI.10).[6] We built a concordance table for this purpose (SI.11) and drop country-year pairs with missing values for any AVC industries.

Methods

Topics in this section include derivation of income and employment multipliers, supply chain decomposition analysis, and the numerous steps that collectively facilitate construction of a structural model of the global agri-food economy. We also outline our approach to addressing data outliers, and our multivariate regression analysis. Table SI.3 provides a summary of the variables and symbols used throughout this study.

Development of Multipliers

Income and employment multipliers (see Chapter 6 in Miller and Blair (2022), and supply chain decomposition analysis in Leontief (1967) or Canning (2011)) are employed to estimate the total value addition, employment, and labor compensations across each supply chain sector within the agri-food value chains. Additionally, these measures are estimated not only for the supply chain sectors but also for their subcontractors. These measures are applied by marketing channels - domestic and international *fah* and *faafh*.

The MRIO account is specified in equation 1 [7]

[5] The residual method used here refers to: Female + Male = Total.

[6] The International Standard Industrial Classification of All Economic Activities (ISIC) and revisions are detailed in Statistics Division and Social Affairs (2008).

[7] We represent matrices (vectors) with bold upper-case (lower-case) letters, and sets (subsets) with italicized upper-case (lower-case) letters. Letters may be of the Roman or Greek alphabet. A prime (') denotes the transpose of a vector or matrix, a double-prime (") denotes a diagonalized vector, and $\{matrix\}^{-1}$ indicates a matrix inversion. The use of subscripts with matrices and vectors ($\mathbf{M}_{\text{row,column}}$) indicates row and column locations of a sub-matrix or sub-vector, while a (*) subscript indicates all rows or columns. We denote $\mathbf{j}$ as a unit summation vector, which is assumed to have

$$\mathbf{E26}^t = \begin{bmatrix} \mathbf{M}^t & \mathbf{Y}^t \\ \mathbf{V}^t & 0 \end{bmatrix} \quad (1)$$

Here, $\mathbf{E26}^t$ is the balanced Eora26 MRIO account for year $t \in T$, as discussed below. $\mathbf{M}$ is the inter-industry transaction matrix of dimension $\mathbf{M}_{R\times I,R\times I}$. Countries ($R$) are listed in Table SI.7, and sectors (I) are listed in Table SI.2. $\mathbf{V}$ denotes the value-added matrix of dimension $\mathbf{V}_{PF,R\times I}$. Primary factors ($PF$) are listed in Table SI.5. $\mathbf{Y}$ represents the final demand matrix of dimension $\mathbf{Y}_{R\times I,R\times F}$. Final demand categories (F) are listed in Table SI.6.

For any country/sector pair, $r \times i \in R \times I$, total intermediate plus final market sales are measured as (suppressing the year superscript) $\mathbf{E26}_{r\times i,*} \times \mathbf{j}$, and represents global demand (or use) of $r \times i$. For the same country/sector pair, $r \times i \in R \times I$, global supply is measured as $\mathbf{j}' \times \mathbf{E26}_{*,r\times I}$, and represents global supply of $r \times i$. In a balanced MRIO account supply equals use for all country/sector pairs:

$$\mathbf{E26}_{R\times I,*} \times \mathbf{j} = \mathbf{M} \times \mathbf{j} + \mathbf{Y} \times \mathbf{j} = \mathbf{x}_{R\times I} = (\mathbf{j}' \times \mathbf{M} + \mathbf{j}' \times \mathbf{V})' = (\mathbf{j}' \times \mathbf{E26}_{*,R\times I})' \quad (2)$$

Equation 2 introduces the gross output vector, $\mathbf{x}_{R\times I}$, representing both annual supply and use of all country/sector pairs. Minor imbalances throughout our version of Eora26 are addressed by distributing any row/column pair imbalances between a 'rest-of-world' exogenous row and column account in proportion to their corresponding supply and use totals. The rest-of-world exogenous accounts are included in the source Eora26 database and were created as a mechanism to balance the source accounts. Our use of this account extends this balancing mechanism to the residual imbalances in our source data.

The inter-industry transaction matrix is converted to a direct requirement matrix (A) by dividing all elements through by their corresponding country/sector gross output, $\mathbf{A} = \mathbf{M} \times \{\mathbf{x}''\}^{-1}$, which can be manipulated to show that $\mathbf{A} \times \mathbf{x} = \mathbf{M} \times \mathbf{j}$. By substituting this expression for M into the expression between the first and third equality in equation 2 and noting that $\mathbf{y} = \mathbf{Y} \times \mathbf{j}$, it is routine to derive the MRIO multiplier model as follows:

$$\mathbf{A} \times \mathbf{x} + \mathbf{y} = \mathbf{x} \leftrightarrow \mathbf{y} = \{\mathbf{j}'' - \mathbf{A}\} \times \mathbf{x} \leftrightarrow \mathbf{L} \times \mathbf{y} = \mathbf{x} \quad (3)$$

where $\mathbf{L} = \{\mathbf{j}'' - \mathbf{A}\}^{-1}$ is the total requirement matrix, describing the linear homogeneous technologies among intermediate inputs across all country/sector pairs. An important property of this linear homogeneous technology among intermediate inputs, as embodied in the total requirement matrix ($\mathbf{L}$) derived in equation 3, is the ability to extract any subset of the final demand vector such as $\mathbf{y}^{fah}$ and $\mathbf{y}^{faafh}$ and determine the global gross industry output requirements ($\mathbf{x}^{fah}$ and $\mathbf{x}^{faafh}$) to facilitate this final demand:

the same number of rows (or columns) as the matrix or vector when pre- (or post-) multiplied. Superscripts are reserved to specify year (T) and marketing channel (C), such as $\mathbf{M}^{2021,\text{fah}}$.

$$\mathbf{L} \times \mathbf{y}^{fah} = \mathbf{x}^{fah} \tag{4a}$$
$$\mathbf{L} \times \mathbf{y}^{faafh} = \mathbf{x}^{faafh} \tag{4b}$$

Next, several employment and income multipliers are constructed as extensions of the gross output multiplier. These are total employment, total labor compensation, and total gross domestic product (GDP). For these multipliers we first convert country/sector employment (**emp**), labor compensation ($\mathbf{V}_{l,*}$), and gdp ($\mathbf{v} = \mathbf{j}' \times \mathbf{V}$) to number of workers, wages, and income per quantum of gross output:

$$\mathbf{e} = \{\mathbf{x}''\}^{-1} \times \mathbf{emp} \tag{5a}$$
$$\mathbf{w} = \{\mathbf{x}''\}^{-1} \times \mathbf{V}'_{l,*} \tag{5b}$$
$$\mathbf{g} = \{\mathbf{x}''\}^{-1} \times \mathbf{v} \tag{5c}$$

In this equation, elements in vector e, w, and g represents employment, wage, and value-added requirements per quantum of gross output by country/sector pair. Estimation of total requirement multipliers across these three metrics are measured for each supply chain (SC) sector as follows:

$$\mathbf{et}^{t,c}_{SC} = \mathbf{e}^{t\prime\prime}_{SC} \times \mathbf{x}^{t,c}_{SC} = \mathbf{e}^{t\prime\prime}_{SC} \times \mathbf{L}^{t}_{SC,*} \times \mathbf{y}^{t,c}, \quad \forall\, t \in T,\ c \in \{fah, faafh\} \tag{6a}$$
$$\mathbf{wt}^{t,c}_{SC} = \mathbf{w}^{t\prime\prime}_{SC} \times \mathbf{x}^{t,c}_{SC} = \mathbf{w}^{t\prime\prime}_{SC} \times \mathbf{L}^{t}_{SC,*} \times \mathbf{y}^{t,c}, \quad \forall\, t \in T,\ c \in \{fah, faafh\} \tag{6b}$$
$$\mathbf{gt}^{t,c}_{SC} = \mathbf{g}^{t\prime\prime}_{SC} \times \mathbf{x}^{t,c}_{SC} = \mathbf{g}^{t\prime\prime}_{SC} \times \mathbf{L}^{t}_{SC,*} \times \mathbf{y}^{t,c}, \quad \forall\, t \in T,\ c \in \{fah, faafh\} \tag{6c}$$

Not accounted for in these measures are the employment, wages, and value-added contributions of non-supply chain sectors (NSC) that indirectly contribute these metrics to the various marketing channels in their role as subcontractors to the various supply chain sectors.

A supply chain multiplier analysis precisely attributes the subcontractor contributions to the various supply chain sectors, and is facilitated through a matrix reduction procedure achieved through a double inversion method developed byLeontief (1967) for a study of the U.S. steel supply chain and adapted by Canning (2011) to study agri-food value chains. Restating the last equality in equation (3) with deference to our SC/NSC partition of the 26 sectors:

$$\underbrace{\left(\begin{bmatrix} (\mathbf{j}'' - \mathbf{A}_{SC,SC}) & -\mathbf{A}_{SC,NSC} \\ -\mathbf{A}_{NSC,SC} & (\mathbf{j}'' - \mathbf{A}_{NSC,NSC}) \end{bmatrix}\right)^{-1}}_{(\mathbf{j}''-\mathbf{A})^{-1}(=\mathbf{L})} \times \underbrace{\begin{bmatrix} \mathbf{y}^{c}_{SC} \\ \mathbf{0}^{c}_{NSC} \end{bmatrix}}_{\mathbf{y}^{c}} = \underbrace{\begin{bmatrix} \mathbf{x}^{c}_{SC} \\ \mathbf{x}^{c}_{NSC} \end{bmatrix}}_{\mathbf{x}^{c}}, \forall c \in \{\text{fah}, \text{faafh}\} \tag{7}$$

To restate total requirement multipliers in equations 6a to 6c for our six SC sectors in a way that reflects all indirect contributions to each SC sector by all subcontracting (NSC) sectors, we refer to the partitioned MRIO account in equation 7:

$$\mathbf{ets}_{SC}^{t,c} = \left[\mathbf{e}_{SC}^{t} + \left\{\left(\mathbf{L}_{SC,SC}^{t}\right)'\right\}^{-1} \times \left(\left(\mathbf{L}_{NSC,SC}^{t}\right)' \times \mathbf{et}_{NSC}^{t}\right)\right] \times \mathbf{x}_{SC}^{t,c}, \quad \forall t \in T,\ c \in \{\text{fah}, \text{faafh}\} \tag{8a}$$

$$\mathbf{wts}_{SC}^{t,c} = \left[\mathbf{w}_{SC}^{t} + \left\{\left(\mathbf{L}_{SC,SC}^{t}\right)'\right\}^{-1} \times \left(\left(\mathbf{L}_{NSC,SC}^{t}\right)' \times \mathbf{wt}_{NSC}^{t}\right)\right] \times \mathbf{x}_{SC}^{t,c}, \quad \forall t \in T,\ c \in \{\text{fah}, \text{faafh}\} \tag{8b}$$

$$\mathbf{gts}_{SC}^{t,c} = \left[\mathbf{g}_{SC}^{t} + \left\{\left(\mathbf{L}_{SC,SC}^{t}\right)'\right\}^{-1} \times \left(\left(\mathbf{L}_{NSC,SC}^{t}\right)' \times \mathbf{gt}_{NSC}^{t}\right)\right] \times \mathbf{x}_{SC}^{t,c}, \quad \forall t \in T,\ c \in \{\text{fah}, \text{faafh}\} \tag{8c}$$

The product of the first term in the squared brackets and the final term in equations 8a to 8c is a repeat of equations 6a to 6c. The product of the second term in squared brackets (itself a product of three terms) and the final term translates the gross output of supply chain sectors to accommodate global demand by marketing channel into total employment, wages, and gdp by subcontracting sectors. Specifically, within the expression in squared brackets that is the product of three terms, the product of the second and third terms translates the total requirements of subcontracting sectors to accommodate gross outputs of the *SC* sectors into total employment, wages, and gdp produced by the subcontractors. The first term of the product of three terms allocates these measures to the specific *SC* sectors by their precise contributions to these sectors. A routine test to validate these calculations is to verify that $\mathbf{j}' \times \mathbf{gts}_{SC}^{t,c} = \mathbf{y}^{t,c}, \quad \forall\, t \in T,\ c \in \{\text{fah}, \text{faafh}\}$. In words, total gdp by supply chain stage equals the market value of final demand by marketing channel. In this study we report employment, labor compensation, and gdp results by country/year/*SC*-sector both with (equations 8a to 8c) and without (equations 6a to 6c) subcontractor contributions. For gender analysis, equations 5a, 6a, and 7 can be further partitioned by gender, and assuming equal wages by gender within each sector facilitates analysis of total labor compensation by gender.

Estimation of non-tobacco share in household demand

The EORA26 tables were compiled by EORA through the aggregation of commodities and industries into the EORA26 sectors, which groups tobacco and its derivative products within . the Agriculture (A01 sector) and/or Food & Beverage (A04 sector) sectors. We employed both the EORA full tables and EORA26 tables to measure final demand for A01 and A04 sectors net of demand for tobacco products. Because EORA does not break down household consumption by commodity, we had to employ natural language processing techniques, and compile country/year specific concordances among tobacco, agriculture, food, and beverage sectors to separate out tobacco, as did (Yi et al., 2021). The benefit of these steps is to produce a global accounting of the food economy that does not include the global tobacco economy.

The matrix **B** measures non-tobacco shares of final household demand over all country/sector pairs independent of marketing channel ($\mathbf{YH}^{t,c}$). For all non-farm and non-food sectors this share is always 0. Our measure of final demand by marketing channel net of tobacco is calculated as:

$$\mathbf{YF}^{t,c} = \mathbf{B}^{t,c} \otimes \mathbf{YH}^{t,c}, \quad \forall\, t \in T,\ c \in \{\text{fah}, \text{faafh}\} \tag{9}$$

where $\otimes$ indicates element-wise multiplication, and **YF** is the final household demand net of tobacco.

Estimation of margins

Values at basic prices from the EORA26 and full tables are used in this analysis. To track the value additions from the mid- and down-stream of the value chain, this study estimates the value added by the wholesale, retail trade, and transportation sectors corresponding to final demand for A01 (agriculture), A02 (fishing), and A04 (food & beverages). In addition, this analysis not only estimates the value added by these margin sectors but also tracks the contribution of the primary agricultural production sector to these margin industries. The estimation of these margin values is discussed in this section. These margins are calculated using the estimated margin ratio and the fah demand at basic prices [8]:

$$\mathbf{YM}^{t,c,\pi} = \mathbf{\Omega}^{t,c,\pi} \otimes \mathbf{YF}^{t,c}, \quad \forall\, t \in T,\ c \in \{\text{fah}\}, \pi \in [\text{A16, A17, and A19}] \tag{10}$$

where π refers to different margin industries: A16 represents wholesale trade, A17 retail trade, and A19 transportation services. The dimension of $\mathbf{YM}^{t,c,\pi}$ is $(R \times I, R)$ for each margin industry. $\mathbf{\Omega}^{t,c,\pi}$ measures the margin ratio across country/sector pairs.

Estimation of transportation margin ratios

The margin ratio for the transportation industry group ($\mathbf{\Omega}^{t,c,\pi=A19}$ in equation. 10) is estimated using data from the EORA transportation margin tables and the concordance table between EORA26 and EORA full tables. As transportation margin tables only reflect the margins associated with industries, not final demand, we estimate the ratio based on the restaurant and hotel industries (A18) to each of the agrifood sectors. More specifically, the transportation margin ratios are estimated by:

$$\mathbf{\Omega}^{t,c,\pi=\text{A19}} = Tr^{t,c} \oslash M^{t,c} \tag{11}$$

where $\mathbf{\Omega}^{t,c,\pi=\text{A19}}$ represents the matrix of transportation margin ratios with dimensions $(R \times I, R)$, and Tr denotes the transportation margin matrix for the hotel and restaurant industry, which is a subset of the full transportation margin matrix, also with dimensions $(R \times I, R)$. The operator $\oslash$ indicates element-wise division. $\mathbf{\Omega}^{t,c=\text{fah},\pi=\text{A19}}$ is a subset of $\mathbf{\Omega}^{t,\pi=\text{A19}}$ where the columns correspond to the hotel and restaurant industry. Similarly, M is a subset of **M** where the columns correspond to the hotel and restaurant industry.

The transportation margin matrix **Tr** is derived from detailed industry-level data, which is consistent with the EORA full tables but not with the aggregated EORA26 sectors. To align the

[8] We do not estimate the margin values for faafh because the basic prices of faafh consumed at food service places (such as restaurants) and hotels already include margin values.

detailed transportation margin data with the EORA26 framework, we use the EORA concordance to aggregate the detailed industries into the 26 harmonized sectors. This process ensures that *Tr* reflects the transportation margins at the EORA26 sector level, allowing for consistent analysis and comparisons within the EORA26 system.

Estimation of wholesale and retail trade margin ratios

To address the data limitation that the EORA trade margin tables do not distinguish between the wholesale and retail sectors, we derived the wholesale and retail trade margins by utilizing the EORA26 tables, instead of using the trade margin tables. This approach also enables us to estimate trade margins for both the origin and destination countries when it comes to imported food. The domestic trade margins are estimated by:

$$\boldsymbol{D\Omega}^{t,\pi=\text{A16}} = YW^{t,\pi=\text{A16}} \times \{\mathbf{YA}''\}^{-1} \tag{12a}$$

$$\boldsymbol{D\Omega}^{t,\pi=\text{A17}} = YW^{t,\pi=\text{A17}} \times \{\mathbf{YA}''\}^{-1} \tag{12b}$$

where $\boldsymbol{D\Omega}$ represents the domestic trade margins with dimensions $(1 \times R)$, capturing the services provided by domestic margin industries. The terms $YW^{t,\pi=\text{A16}}$ ($YW^{t,\pi=\text{A17}}$) denote the domestic wholesale margin (retail margin), with the dimension $(1 \times R)$. The matrix $\mathbf{YA}$ is the total household demand for industries and commodities A01, A02, ..., A12, with dimensions $(1 \times R)$. The diagonal values in $\boldsymbol{\Omega}$ are $\{\boldsymbol{D\Omega}\}''$, while the off-diagonal elements of $\boldsymbol{\Omega}$ are constructed based on the trade margin ratios of the importing and exporting countries.

The application of margin ratios

After estimating the transportation and trade margin ratios, potential data quality issues are addressed by screening and adjusting for outliers in the transportation and trade ratios using the interquartile range (IQR) method.

$$\begin{aligned} \text{IQR}^{t,c,\pi} &= Q_3(\Omega^{t,c,\pi}) - Q_1(\Omega^{t,c,\pi}) \\ \text{LowerBound}t,c,\pi &= Q_1(\Omega^{t,c,\pi}) - 1.5 \times \text{IQR}^{t,c,\pi} \\ \text{UpperBound}^{t,c,\pi} &= Q_3(\Omega^{t,c,\pi}) + 1.5 \times \text{IQR}^{t,c,\pi} \\ \forall\, t \in T,\ c &\in \{\text{fah}\},\ \pi \in [\text{A16, A17, and A19}] \end{aligned} \tag{13}$$

The equations define the interquartile range (IQR) and the thresholds for identifying lower and upper outliers for the margin ratios $\Omega^{t,c,\pi}$. The IQR is calculated as the difference between the third quartile Q_3 and the first quartile Q_1. The lower outliers are values below $Q_1 - 1.5 \times \text{IQR}$ and are replaced by this threshold. The upper outliers are values above $Q_3 + 1.5 \times \text{IQR}$ and are replaced by this threshold.

Estimation adjustment

The estimated labor compensation for each SC sector is examined for potential data issues each year by identifying and scaling outliers beyond three standard deviations. These outliers are then adjusted using a screening process based on this threshold, which can be formulated as follows:

$$\begin{aligned} \text{LowerBound}_{va^{l,I\in AF}_{GNIgroup}} &= \mu_{va^{l,I\in AF}_{GNIgroup}} - 3\sigma_{va^{l,I\in AF}_{GNIgroup}} \\ \text{UpperBound}_{va^{l,I\in AF}} &= \mu_{va^{l,I\in AF}_{GNIgroup}} + 3\sigma_{va^{l,I\in AF}_{GNIgroup}} \end{aligned} \tag{14}$$

where $\mu_{va^{l,I\in AF}_{GNIgroup}}$ and $\sigma_{va^{l,I\in AF}_{GNIgroup}}$ represents the mean and standard deviation of labor compensation $va^{l,I\in AF}$ within the income group categorized by GNI per capita (low, lower-middle, upper-middle, high income). Outliers are replaced by the lower or upper bounds [9].

Multivariate Regression Analysis

We conduct multivariate regression analysis to explore the stylized facts in a bit more detail. While these regression results are purely descriptive and do not estimate causal effects, we control for several possible confounding factors (i.e., population, urban migration, time trends, etc.). Specifically, we estimate variations of the following regression specification:

$$\begin{aligned} \text{Y}_{int} = \beta_0 + \beta_1 \ln \text{GNI}_{nt} + \sum_{i=1}^{6} \gamma_i (\ln \text{GNI}_{nt} \cdot \text{I}_i) + \beta_2 \text{AgTFP}_{nt} + \sum_{i=1}^{6} \delta_i (\text{AgTFP}_{nt} \cdot \text{I}_i) \\ + \alpha_1 (\ln \text{Urban}_{nt}) + \alpha_2 (\ln \text{POP}_{nt}) + \beta_3 \text{I}_i + \lambda_n + \tau_t + \epsilon_{itn} \end{aligned} \tag{15}$$

where I_i is a vector of binary variables each representing AVC industries, with Agriculture, Forestry, and Fishing the omitted reference industry. $Urban_{nt}$ is the urban population (in millions of persons) in country n in year t, and POP_{nt} is the total population (in millions) of country n in year t. λ_n is a country fixed effect, capturing time-invariant features such as location, colonial ties, dominant language, etc. τ_t is a year fixed effect that captures all interannual changes common to all countries - e.g., global recession, global commodity market price shocks, etc. ϵ_{itn} is the mean zero, iid error term, with all standard errors clustered at the country level. Table SI.1 reports the variable name, description, and sources for each of the explanatory variables. The multivariate regressions follow this general specification with different dependent variables Y_{int}, respectively in Table SI.13 the industry share of total economywide workforce by destination market and industry; and in Table SI.14 the logarithm of the average compensation per worker and per subcontractor in each AVC industry in constant 2015 USD.

[9] This study observed only the upper bound outliers for compensations.

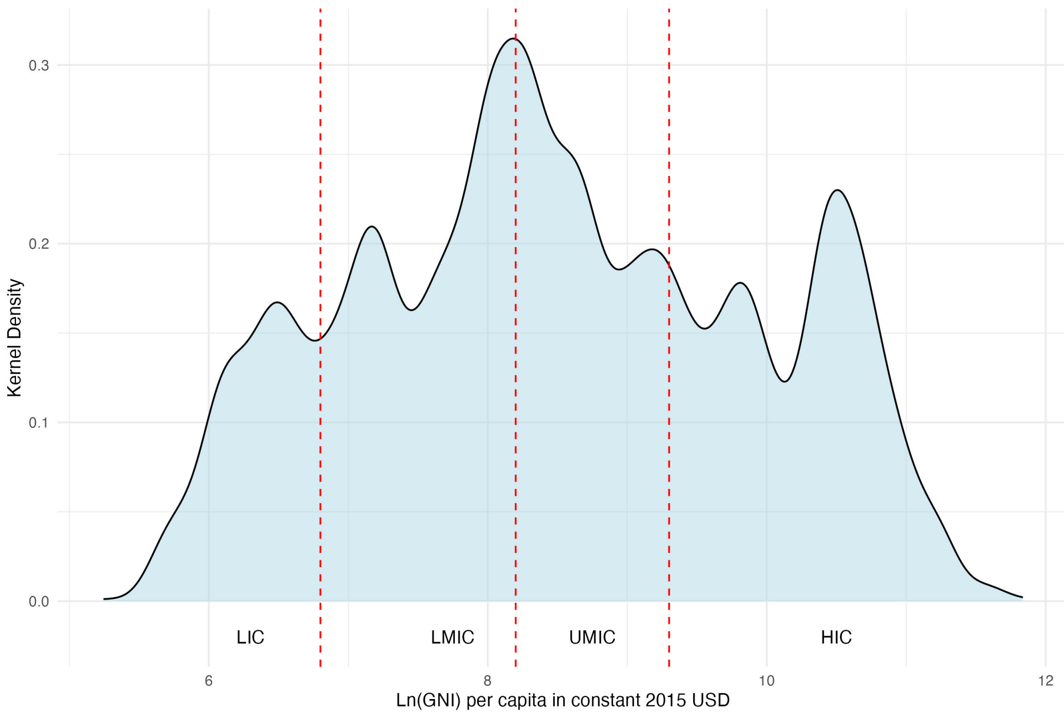
TABLE SI.1: Regression explanatory variables

Variable	**Description**	**Source**
$lnGNI$	Logarithm GNI per capita (constant 2015 USD)	World Bank (updated on 03/08/24)
$AgTFP$	Agricultural Total Factor Productivity (2015=100)	USDA ERS (updated on 09/29/23)
$lnUrban$	Urban population (millions)	World Bank (updated on 03/08/24)
POP	Total population (millions)	World Bank (updated on 03/08/24)

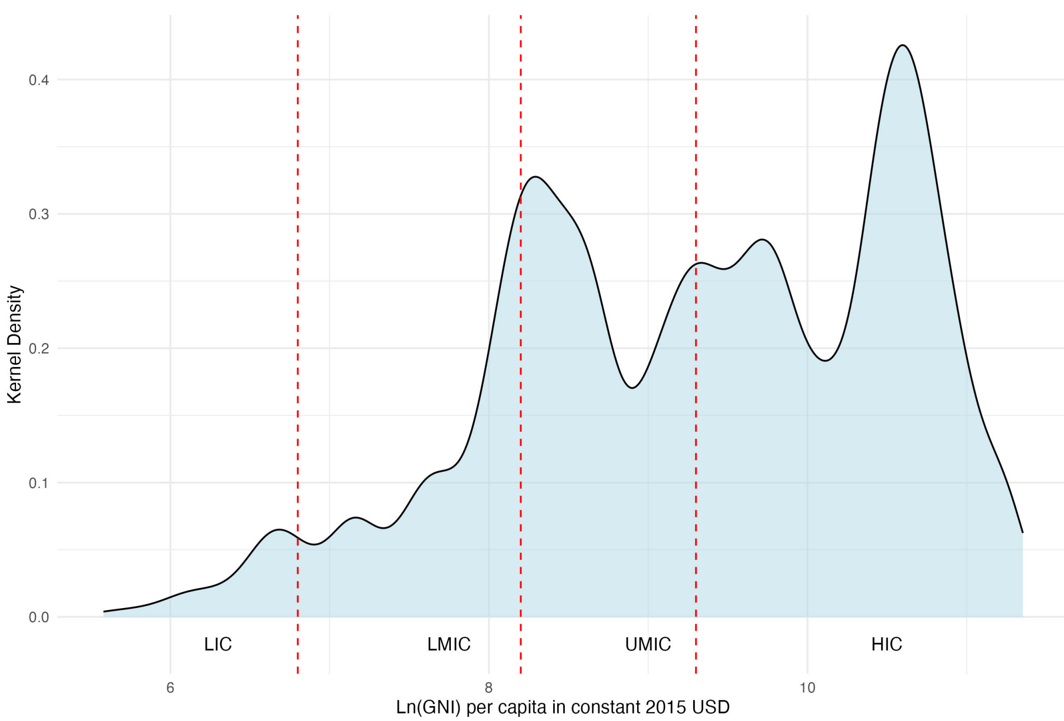
Additional Figures

FIGURE SI.1: Data Coverage

(A) EORA Data Coverage Across National Income Levels

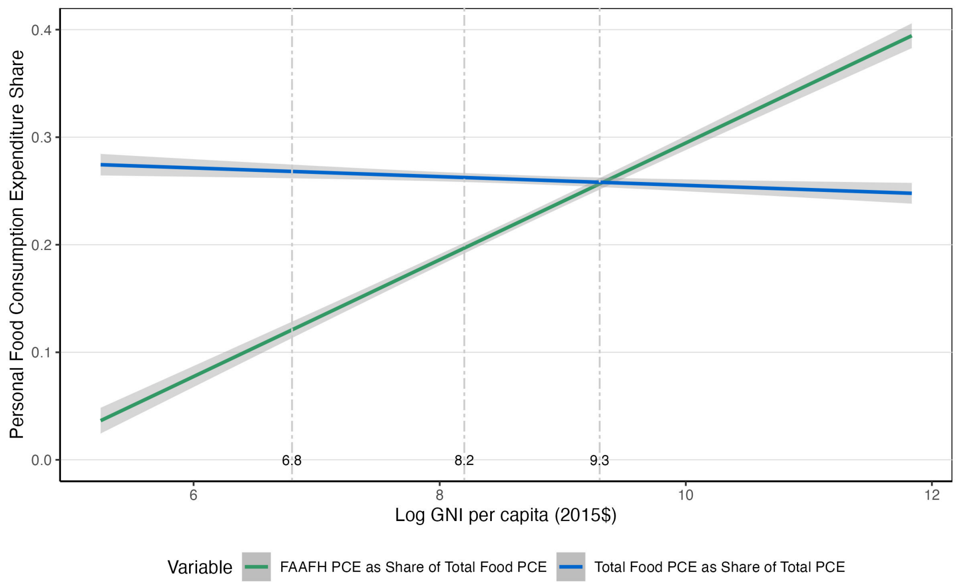


(B) Merged EORA-ILO Data Coverage Across National Income Levels



Notes: Authors' calculations from EORA data (panel A) and from merged EORA and ILO data (panel B). Note that we lose 1/1,328 observations in the gender-disaggregated ILO data, which doesn't appreciably change the kernel density plot. LIC = low-income country, LMIC = lower-middle-income country, UMIC = upper-middle-income country, and HIC = high-income country based on 2023 World Bank classifications.

FIGURE SI.2: Consumer Food Expenditures as a Share of Total Expenditures

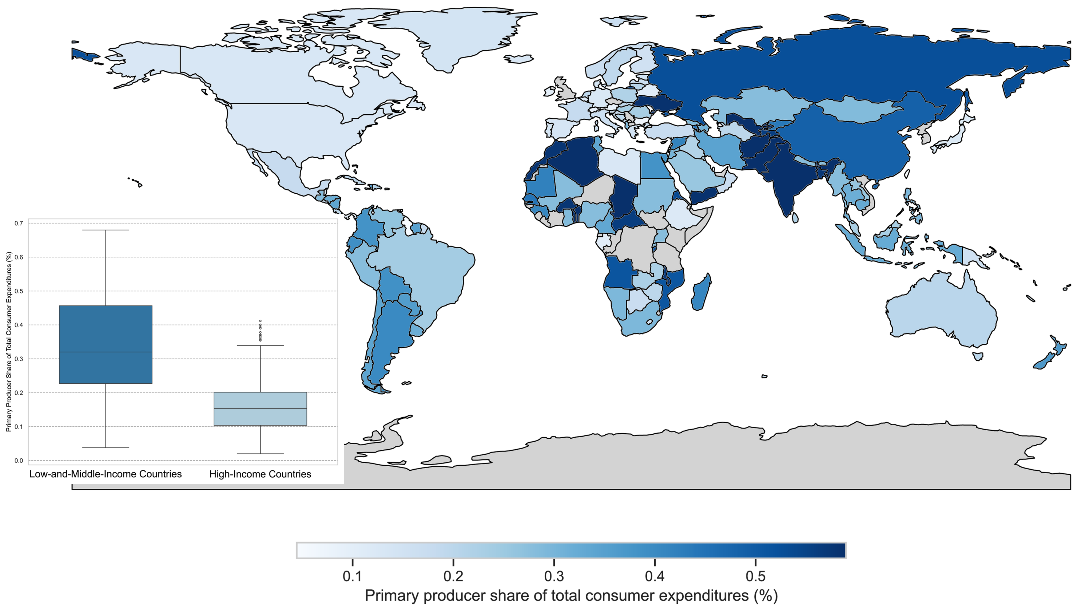


Notes: The blue trend line represents food[1] as a share of total household consumption expenditures, with the grey shaded area indicating the 95% confidence interval. The green line shows the share of FAAFH (Hotels and Restaurants) in total food expenditures. The x-axis depicts log-transformed GNI per capita (constant 2015 USD). We estimate these relationships using 2,882 country-year observations calculated from EORA 26 Purchaser Prices data.[2]
FAAFH = food and accommodations away from home, PCE = personal consumption expenditures.

[1]Include A01 Agriculture, Fishing, A04 Food and Beverage, and A18 Hotels and Restaurants sectors, and we net out tobacco from A01 and A04 sectors by multiplying the non-tobacco share calculated by the authors.

[2]Outliers were removed where FAAFH or PCE expenditures were less than zero, and when total food expenditure exceeded total PCE.

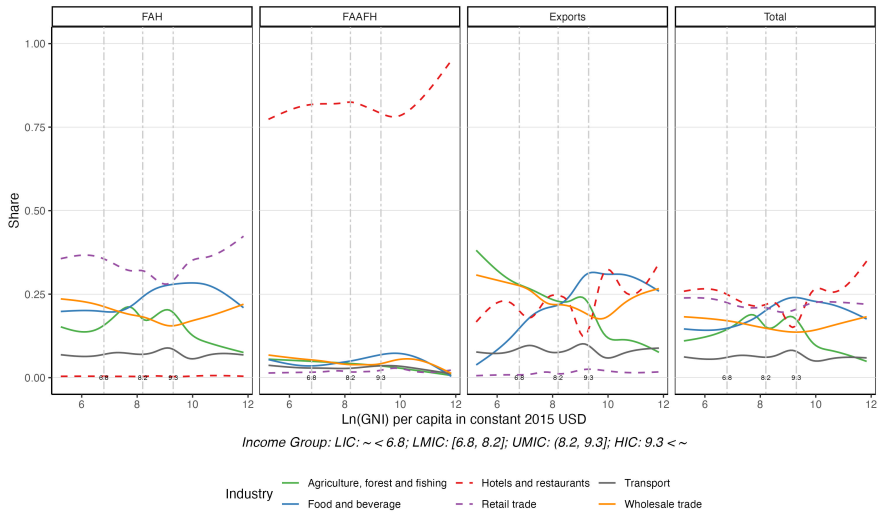
FIGURE SI.3: Farm Share of Total Consumer Food Expenditures



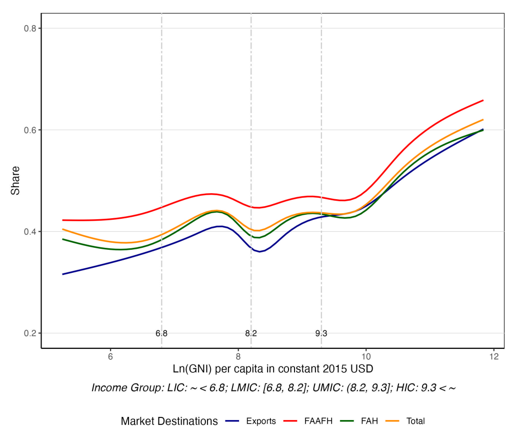
Notes: This map illustrates the average primary producer share of total consumer food expenditures across countries from 2017 to 2021. The numerator is the total value added by primary agricultural production in each country. This includes the value of all agricultural products produced domestically, irrespective of whether they are consumed domestically or exported. The denominator is total food expenditures within each country, encompassing both domestically produced and imported food items. Darker (lighter) shades indicate a higher (lower) primary producer value addition share of consumer food expenditures. The inset box plot contrasts the primary producer share between low- and middle-income countries (left) and high-income countries (right), showing that producer shares are significantly higher in lower-income regions.

FIGURE SI.4: Patterns in Value Added by National Income Level

(A) Industry Share of Labor Value Added

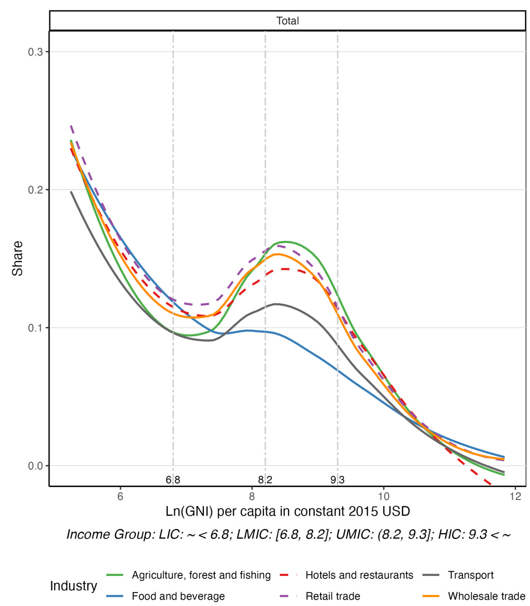


(B) Labor Share by Market Destination



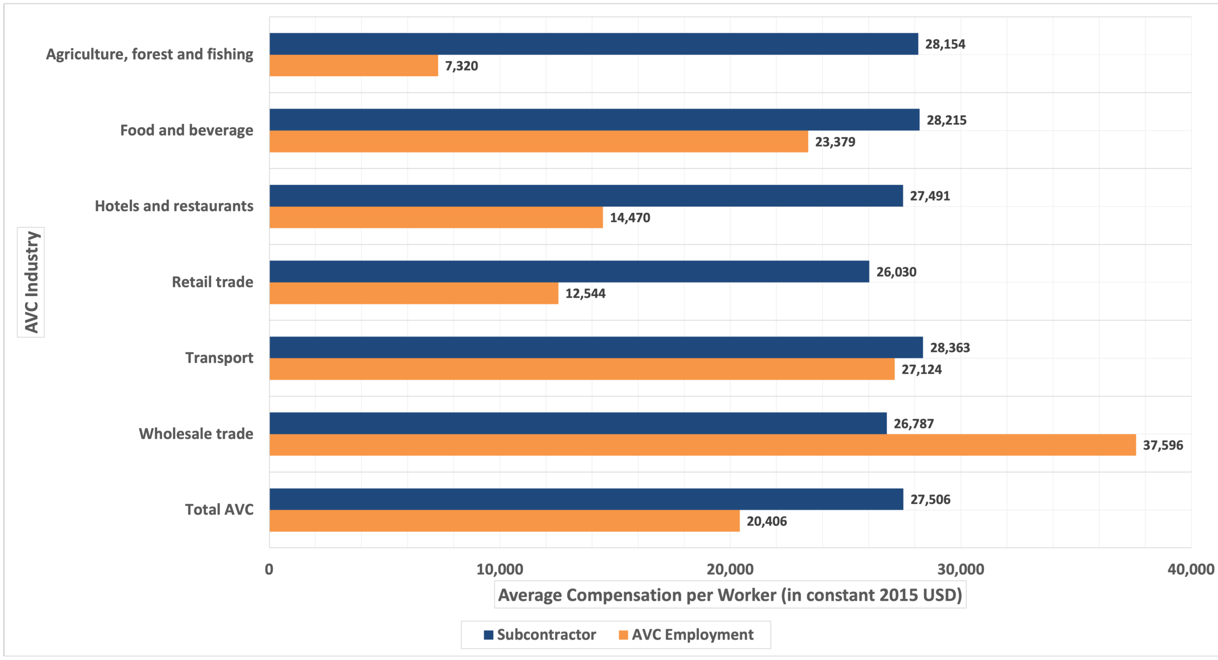
Notes: Panel A pools 3,217 country-year pairs from Eora data to show the industry shares of total labor value added $\frac{\text{Labor VA}_{ict}}{\sum_{i=1}^{6}(\text{Labor VA}_{ict})}$ for six AVC industries, with log GNI per capita values (constant 2015 USD) on the x-axis. Panel B shows the total labor value added as a share of total value added by market destinations.

FIGURE SI.5: Mixed Income as Share of Total AVC Value Addition



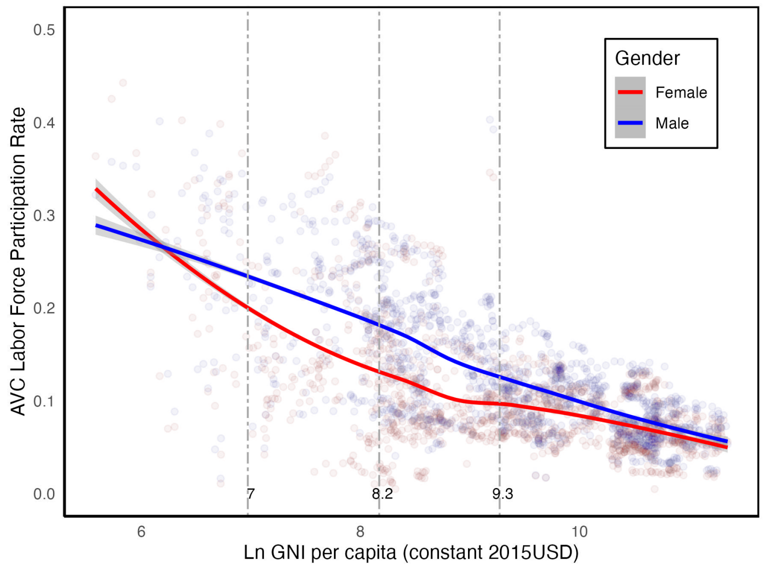
Notes: Panel A pools 3,217 country-year pairs from Eora data to show the mixed income shares of total value added for each of the six AVC industries, with log GNI per capita values (constant 2015 USD) on the x-axis.

FIGURE SI.6: Compensation per Worker by AVC Industry



Notes: This figure shows the normalized compensation rate for AVC work force and subcontractors in each industry (constant 2015 USD), calculating from 1,328 country-year paris, with log GNI per capita values (constant 2015 USD) on the x-axis.

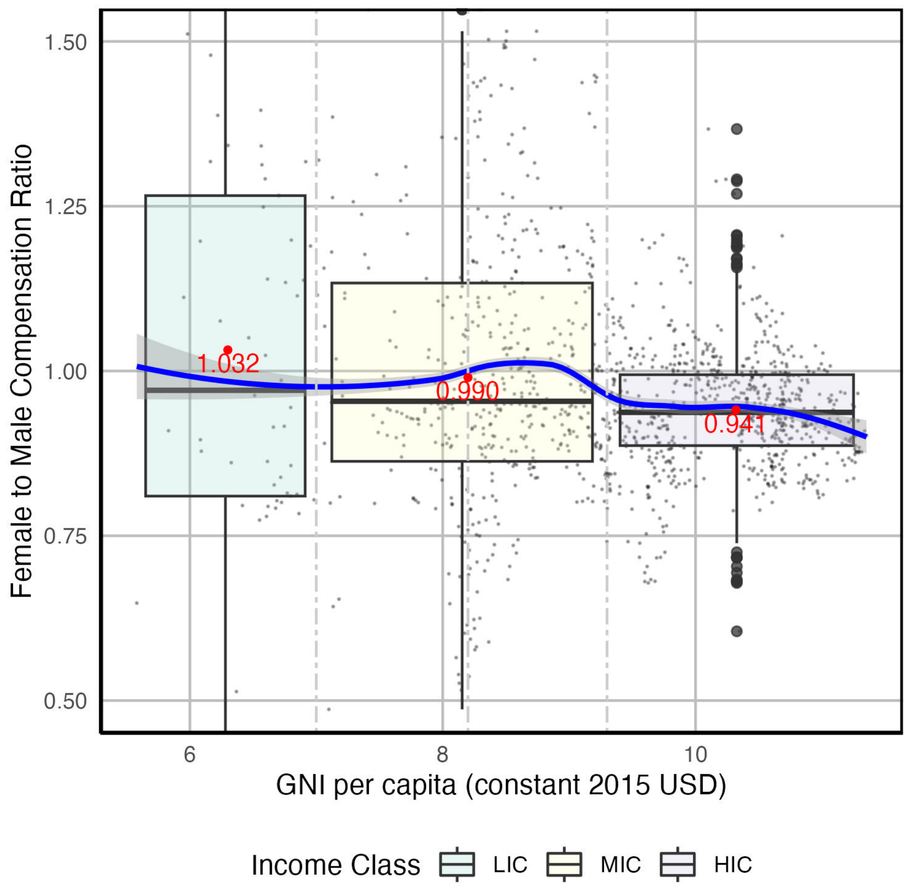
FIGURE SI.7: AVC Labor Force Participation Rate by Gender



Notes: graphs the male and female labor force participation (LFP) rates in AVC industries over time. The AVC LFP by gender are calculated as the share of the AVC workforce in the total working-age population. The red line shows the female AVC LFP rate, while the blue series represents for males.

[9] AVC Workforce data sourced from ILOSTAT: EMP_TEMP_SEX_ECO_NB_A
By gender total working age population sourced from ILOSTAT POP_XWAP_SEX_AGE_NB_A

FIGURE SI.8: Gender Annual Compensation Rate in AVC across Income Classes



Notes: This figure depicts the unconditional bivariate relationship between the female average compensation relative to male, calculating from 1,327 country-year pairs. The plot includes both the smoothed LOESS relationship, shown in blue with a grey confidence band. The box plots that illustrate the distribution of the estimates across national income classes. Red dots with figures indicate the mean values for each income class. LMICs and UMICs are combined into one MIC group for easy interpretation.

Data Description

TABLE SI.2: The 26 Sectors in the EORA26 Tables

Index	**Sectors**
A01	Agriculture
A02	Fishing
A03	Mining and Quarrying
A04	Food & Beverages
A05	Textiles and Wearing Apparel
A06	Wood and Paper
A07	Petroleum, Chemical and Non-Metallic Mineral Products
A08	Metal Products
A09	Electrical and Machinery
A10	Transport Equipment
A11	Other Manufacturing
A12	Recycling
A13	Electricity, Gas and Water
A14	Construction
A15	Maintenance and Repair
A16	Wholesale Trade
A17	Retail Trade
A18	Hotels and Restaurants
A19	Transport
A20	Post and Telecommunications
A21	Financial Intermediation and Business Activities
A22	Public Administration
A23	Education, Health and Other Services
A24	Private Households
A25	Others
A26	Re-export & Re-import

TABLE SI.3: Summary of Variables and Symbols (Page 1)

Variable	Description
SC, NSC	Within the agri-food value chains, we use the terms SC to designate the supply chain industries. In particular, SC encompasses agriculture (A01), fishing (A02), food and beverages (A04), hotels and restaurants (A18), transportation (A19), wholesale trade (A16), and retail trade (A17). Meanwhile, all remaining industries are denoted as NSC.
fah	The food at home demand, which includes the demand for agriculture (A01), fishing (A02), and food and beverages (A04)
$faafh$	The food and accommodations away from home.
r, R	A country or region, where $r \in R$, listed in Table SI.7.
t, T	Year, where $t \in T$, 1993-2021.
c	Marketing channel, including 'food at home' (fah) and 'food and accommodations away from home' ($faafh$).
i,I	Sectors, where $i \in I$, listed in Table SI.2.
*	Indicates all rows or all columns in a matrix or vector.
$\mathbf{j}$	Unit summation vector, with the same dimensions as the matrix or vector it is multiplied with.
PF	Primary factors (PF), listed in Table SI.5.
F	Final demand categories (F), listed in Table SI.6.
$\boldsymbol{\pi}$	Margin industry indicator, where A16 represents wholesale trade, A17 retail trade, and A19 transportation services.
$\mathbf{E26}_{R\times I,*}$	Eora26 MRIO account.
$\mathbf{M}$	The inter-industry transaction matrix of dimension $\mathbf{M}_{R\times I,R\times I}$, where $R \times I$ represents all country/sector pairs.
$\mathbf{V}$	Value-added matrix of dimension $\mathbf{V}_{PF,R\times I}$.
$\mathbf{Y}$	Final demand matrix of dimension $\mathbf{Y}_{R\times I,R\times F}$.
YH and **YF**	Final household demand matrix and final household demand net of tobacco, respectively. Both dimensions are $(R \times I, R)$.
Tr	Transportation margin matrix, derived from detailed industry data and aggregated into EORA26 sectors.
$\mathbf{x}$	Gross output vector of dimension $R \times I$, representing both annual supply and use of all country/sector pairs.
$\mathbf{A}$	The direct requirement matrix, see Equation 3.
$\mathbf{L}$	Total requirement matrix, see Equations 4a and 4b.
emp	Country/sector employment (number of workers).
$\mathbf{V}_{l,*}$	Labor compensation matrix.
$\mathbf{v}$	Gross domestic product.
e, **w**, and **g**	Employment, wage, and value-added requirements per unit of gross output by country/sector pair, respectively.
et, **wt**, **gt**	Total employment, wage, and value-added requirements.
$\mathbf{B}$	Matrix measuring non-tobacco shares of final household demand across all country/sector pairs with the dimension $(R \times I, R)$.
$\boldsymbol{\Omega}$	Margin ratio across country/sector pairs, where $\boldsymbol{\Omega}^{t,c,\pi=\text{A19}}$, $\boldsymbol{\Omega}^{t,c,\pi=\text{A16}}$, and $\boldsymbol{\Omega}^{t,c,\pi=\text{A17}}$ represent the transportation, wholesale, and retail margin ratio matrices, respectively, each with dimensions $(R \times I, R \times I)$.
Tr	Transportation margin matrix for the hotel and restaurant industry, a subset of the full transportation margin matrix with dimensions $(R \times I, R)$. It is derived from detailed industry-level data and aggregated to the EORA26 sector level.
M	A subset of the matrix $\mathbf{M}$, where the columns correspond to the hotel and restaurant industry. The matrix $\mathbf{M}$ represents transportation margins or other relevant metrics for different sectors.

TABLE SI.4: Summary of Variables and Symbols (Page 2)

Variable	Description
$\boldsymbol{D\Omega}^{t,\pi}$	Domestic trade margin matrix with dimensions $(1 \times R)$, capturing the services provided by domestic margin industries for both domestically produced and imported commodities purchased by households.
$YW^{t,\pi}$	Household final demand for domestic wholesale and retail services with dimensions $(1 \times R)$, corresponding to the domestic services consumed by households.
YA	The total household demand for industires and commodities A01, A02, ..., A12 with dimensions $(1 \times R)$.

Table SI.5: Primary Factors in EORA26 Tables

Index	**Definition**
LH01	Compensation of employees (D.1)
LG01	Taxes on production (D.29)
LG02	Subsidies on production (D.39)
LK01	Net operating surplus (B.2n)
LK02	Net mixed income (B.3n)
LK03	Consumption of fixed capital (K.1)

Table SI.6: Final Demand in EORA26 Tables

Index	**DESCRIPTION**
XH	Household final consumption (P.3h)
XNPISH	Non-profit institutions serving households (P.3n)
XG	Government final consumption (P.3g)
XK01	Gross fixed capital formation (P.51)
XK02	Changes in inventories (P.52)
XK03	Acquisitions less disposals of valuables (P.53)

TABLE SI.7: Countries Included in EORA Data

Country Code	**Country**	**Country Code**	**Country**
AFG	Afghanistan	BGR	Bulgaria
ALB	Albania	BFA	Burkina Faso
DZA	Algeria	BDI	Burundi
AND	Andorra	KHM	Cambodia
AGO	Angola	CMR	Cameroon
ATG	Antigua	CAN	Canada
ARG	Argentina	CPV	Cape Verde
ARM	Armenia	CYM	Cayman Islands
ABW	Aruba	CAF	Central African Republic
AUS	Australia	TCD	Chad
AUT	Austria	CHL	Chile
AZE	Azerbaijan	CHN	China
BHS	Bahamas	COL	Colombia
BHR	Bahrain	COG	Congo
BGD	Bangladesh	CRI	Costa Rica
BRB	Barbados	HRV	Croatia
BLR	Belarus	CUB	Cuba
BEL	Belgium	CYP	Cyprus
BLZ	Belize	CZE	Czech Republic
BEN	Benin	CIV	Cote d'Ivoire
BMU	Bermuda	PRK	North Korea
BTN	Bhutan	COD	DR Congo
BOL	Bolivia	DNK	Denmark
BIH	Bosnia and Herzegovina	DJI	Djibouti
BWA	Botswana	DOM	Dominican Republic
BRA	Brazil	ECU	Ecuador
VGB	British Virgin Islands	EGY	Egypt
BRN	Brunei	SLV	El Salvador
BGR	Bulgaria	ERI	Eritrea
BFA	Burkina Faso	EST	Estonia
BDI	Burundi	ETH	Ethiopia
KHM	Cambodia	FJI	Fiji
CMR	Cameroon	FIN	Finland
CAN	Canada	FRA	France
CPV	Cape Verde	PYF	French Polynesia

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Country Code	Country	Country Code	Country
CYM	Cayman Islands	GAB	Gabon
CAF	Central African Republic	GMB	Gambia
TCD	Chad	GEO	Georgia
CHL	Chile	DEU	Germany
CHN	China	GHA	Ghana
COL	Colombia	GRC	Greece
COG	Congo	GRL	Greenland
CRI	Costa Rica	GTM	Guatemala
HRV	Croatia	GIN	Guinea
CUB	Cuba	GUY	Guyana
CYP	Cyprus	HTI	Haiti
CZE	Czech Republic	HND	Honduras
CIV	Cote d'Ivoire	HKG	Hong Kong
PRK	North Korea	HUN	Hungary
COD	DR Congo	ISL	Iceland
DNK	Denmark	IND	India
DJI	Djibouti	IDN	Indonesia
DOM	Dominican Republic	IRN	Iran
ECU	Ecuador	IRQ	Iraq
EGY	Egypt	ISR	Israel
SLV	El Salvador	ITA	Italy
ERI	Eritrea	JAM	Jamaica
EST	Estonia	JPN	Japan
ETH	Ethiopia	JOR	Jordan
FJI	Fiji	KAZ	Kazakhstan
FIN	Finland	KEN	Kenya
FRA	France	KWT	Kuwait
PYF	French Polynesia	KGZ	Kyrgyzstan
GAB	Gabon	LAO	Laos
GMB	Gambia	LVA	Latvia
GEO	Georgia	LBN	Lebanon
DEU	Germany	LSO	Lesotho
GHA	Ghana	LBR	Liberia
GRC	Greece	LBY	Libya
GRL	Greenland	LIE	Liechtenstein
GTM	Guatemala	LTU	Lithuania
GIN	Guinea	LUX	Luxembourg

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Country Code	Country	Country Code	Country
GUY	Guyana	MDG	Madagascar
HTI	Haiti	MWI	Malawi
HND	Honduras	MYS	Malaysia
HKG	Hong Kong	MDV	Maldives
HUN	Hungary	MLI	Mali
ISL	Iceland	MLT	Malta
IND	India	MRT	Mauritania
IDN	Indonesia	MUS	Mauritius
IRN	Iran	MEX	Mexico
IRQ	Iraq	MDA	Moldova
IRL	Ireland	MCO	Monaco
ISR	Israel	MNG	Mongolia
ITA	Italy	MNE	Montenegro
JAM	Jamaica	MAR	Morocco
JPN	Japan	MOZ	Mozambique
JOR	Jordan	MMR	Myanmar
KAZ	Kazakhstan	NAM	Namibia
KEN	Kenya	NPL	Nepal
KWT	Kuwait	NLD	Netherlands
KGZ	Kyrgyzstan	ANT	Netherlands Antilles
LAO	Laos	NCL	New Caledonia
LVA	Latvia	NZL	New Zealand
LBN	Lebanon	NIC	Nicaragua
LSO	Lesotho	NER	Niger
LBR	Liberia	NGA	Nigeria
LBY	Libya	NOR	Norway
LIE	Liechtenstein	PSE	Gaza Strip
LTU	Lithuania	OMN	Oman
LUX	Luxembourg	PAK	Pakistan
MAC	Macao SAR	PAN	Panama
MDG	Madagascar	PNG	Papua New Guinea
MWI	Malawi	PRY	Paraguay
MYS	Malaysia	PER	Peru
MDV	Maldives	PHL	Philippines
MLI	Mali	POL	Poland
MLT	Malta	PRT	Portugal
MRT	Mauritania	QAT	Qatar

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Country Code	Country	Country Code	Country
MUS	Mauritius	KOR	South Korea
MEX	Mexico	MDA	Moldova
MCO	Monaco	ROU	Romania
MNG	Mongolia	RUS	Russia
MNE	Montenegro	RWA	Rwanda
MAR	Morocco	WSM	Samoa
MOZ	Mozambique	SMR	San Marino
MMR	Myanmar	STP	Sao Tome and Principe
NAM	Namibia	SAU	Saudi Arabia
NPL	Nepal	SEN	Senegal
NLD	Netherlands	SRB	Serbia
ANT	Netherlands Antilles	SYC	Seychelles
NCL	New Caledonia	SLE	Sierra Leone
NZL	New Zealand	SGP	Singapore
NIC	Nicaragua	SVK	Slovakia
NER	Niger	SVN	Slovenia
NGA	Nigeria	SOM	Somalia
NOR	Norway	ZAF	South Africa
PSE	Gaza Strip	SDS	South Sudan
OMN	Oman	ESP	Spain
PAK	Pakistan	LKA	Sri Lanka
PAN	Panama	SUD	Sudan
PNG	Papua New Guinea	SUR	Suriname
PRY	Paraguay	SWZ	Swaziland
PER	Peru	SWE	Sweden
PHL	Philippines	CHE	Switzerland
POL	Poland	SYR	Syria
PRT	Portugal	TWN	Taiwan
QAT	Qatar	TJK	Tajikistan
KOR	South Korea	THA	Thailand
MDA	Moldova	MKD	TFYR Macedonia
ROU	Romania	TGO	Togo
RUS	Russia	TTO	Trinidad and Tobago
RWA	Rwanda	TUN	Tunisia
WSM	Samoa	TUR	Turkey
SMR	San Marino	TKM	Turkmenistan
STP	Sao Tome and Principe	USR	Former USSR

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Country Code	Country	Country Code	Country
SAU	Saudi Arabia	UGA	Uganda
SEN	Senegal	UKR	Ukraine
SRB	Serbia	ARE	UAE
SYC	Seychelles	GBR	UK
SLE	Sierra Leone	TZA	Tanzania
SGP	Singapore	USA	USA
SVK	Slovakia	URY	Uruguay
SVN	Slovenia	UZB	Uzbekistan
SOM	Somalia	VUT	Vanuatu
ZAF	South Africa	VEN	Venezuela
SDS	South Sudan	VNM	Viet Nam
ESP	Spain	YEM	Yemen
LKA	Sri Lanka	ZMB	Zambia
SUD	Sudan	ZWE	Zimbabwe

TABLE SI.8: The 11 Countries Excluded from the Food-At-Home Analysis

Country	**Sector**
Canada	Food products, beverages and tobacco
Greenland	Food, beverage and tobacco manufacturing
Hong Kong	Beverages and tobacco
Israel	Manufacture of alcoholic beverages, beer and tobacco products
Kenya	Beverages and tobacco
New Zealand	Beer, wine, spirit and tobacco manufacturing
Paraguay	Beverage and tobacco production
Russia	Food products, beverages and tobacco
South Africa	Beverages& tobacco
Switzerland	Manufacture of food products and beverages; Manufacture of tobacco products
UK	Growing of oleaginous fruits, Growing of spices, aromatic, drug and pharmaceutical crops, Growing of other perennial crops, Post-harvest crop activities, Seed processing for propagation, Growing of tobacco

TABLE SI.9: ILO ISIC Economic Activities (ISIC-Rev.3.1, 2-digit level)

Code	Description
01	Agriculture, hunting and related service activities
02	Forestry, logging and related service activities
05	Fishing, aquaculture and service activities incidental to fishing
10	Mining of coal and lignite; extraction of peat
11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying
12	Mining of uranium and thorium ores
13	Mining of metal ores
14	Other mining and quarrying
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness, and footwear
20	Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	Manufacture of paper and paper products
22	Publishing, printing, and reproduction of recorded media
23	Manufacture of coke, refined petroleum products, and nuclear fuel
24	Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastics products
26	Manufacture of other non-metallic mineral products
27	Manufacture of basic metals
28	Manufacture of fabricated metal products, except machinery and equipment
29	Manufacture of machinery and equipment n.e.c.
30	Manufacture of office, accounting, and computing machinery
31	Manufacture of electrical machinery and apparatus n.e.c.
32	Manufacture of radio, television, and communication equipment and apparatus
33	Manufacture of medical, precision, and optical instruments, watches, and clocks
34	Manufacture of motor vehicles, trailers, and semi-trailers
35	Manufacture of other transport equipment
36	Manufacture of furniture; manufacturing n.e.c.
37	Recycling

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Code	Description
40	Electricity, gas, steam, and hot water supply
41	Collection, purification, and distribution of water
45	Construction
50	Sale, maintenance, and repair of motor vehicles and motorcycles; retail sale of automotive fuel
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles
52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
55	Hotels and restaurants
60	Land transport; transport via pipelines
61	Water transport
62	Air transport
63	Supporting and auxiliary transport activities; activities of travel agencies
64	Post and telecommunications
65	Financial intermediation, except insurance and pension funding
66	Insurance and pension funding, except compulsory social security
67	Activities auxiliary to financial intermediation
70	Real estate activities
71	Renting of machinery and equipment without operator and of personal and household goods
72	Computer and related activities
73	Research and development
74	Other business activities
75	Public administration and defense; compulsory social security
80	Education
85	Health and social work
90	Sewage and refuse disposal, sanitation, and similar activities
91	Activities of membership organizations n.e.c.
92	Recreational, cultural, and sporting activities
93	Other service activities
95	Activities of private households as employers of domestic staff
96	Undifferentiated goods-producing activities of private households for own use
97	Undifferentiated service-producing activities of private households for own use
99	Extraterritorial organizations and bodies

TABLE SI.10: ILO ISIC Economic Activities (ISIC-Rev.4, 2-digit level)

Code	Description
01	Crop and animal production, hunting and related service activities
02	Forestry and logging
03	Fishing and aquaculture
05	Mining of coal and lignite
06	Extraction of crude petroleum and natural gas
07	Mining of metal ores
08	Other mining and quarrying
09	Mining support service activities
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of pharmaceuticals, medicinal chemical and botanical products
22	Manufacture of rubber and plastics products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other manufacturing
33	Repair and installation of machinery and equipment
35	Electricity, gas, steam and air conditioning supply
36	Water collection, treatment and supply
37	Sewerage

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Continued from previous page

Code	Description
38	Waste collection, treatment and disposal activities; materials recovery
39	Remediation activities and other waste management services
41	Construction of buildings
42	Civil engineering
43	Specialized construction activities
45	Wholesale and retail trade and repair of motor vehicles and motorcycles
46	Wholesale trade, except of motor vehicles and motorcycles
47	Retail trade, except of motor vehicles and motorcycles
49	Land transport and transport via pipelines
50	Water transport
51	Air transport
52	Warehousing and support activities for transportation
53	Postal and courier activities
55	Accommodation
56	Food and beverage service activities
58	Publishing activities
59	Motion picture, video and television programme production, sound recording and music publishing activities
60	Programming and broadcasting activities
61	Telecommunications
62	Computer programming, consultancy and related activities
63	Information service activities
64	Financial service activities, except insurance and pension funding
65	Insurance, reinsurance and pension funding, except compulsory social security
66	Activities auxiliary to financial service and insurance activities
68	Real estate activities
69	Legal and accounting activities
70	Activities of head offices; management consultancy activities
71	Architectural and engineering activities; technical testing and analysis
72	Scientific research and development
73	Advertising and market research
74	Other professional, scientific and technical activities
75	Veterinary activities
77	Rental and leasing activities
78	Employment activities

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Code	Description
79	Travel agency, tour operator, reservation service and related activities
80	Security and investigation activities
81	Services to buildings and landscape activities
82	Office administrative, office support and other business support activities
84	Public administration and defence; compulsory social security
85	Education
86	Human health activities
87	Residential care activities
88	Social work activities without accommodation
90	Creative, arts and entertainment activities
91	Libraries, archives, museums and other cultural activities
92	Gambling and betting activities
93	Sports activities and amusement and recreation activities
94	Activities of membership organizations
95	Repair of computers and personal and household goods
96	Other personal service activities
97	Activities of households as employers of domestic personnel
98	Undifferentiated goods- and services-producing activities of private households for own use
99	Activities of extraterritorial organizations and bodies

TABLE SI.11: Concordance Table Mapping ISIC to Eora26

Eora26	ISIC Rev.3	ISIC Rev.4
A01T02	1, 2, 5	1, 2, 3
A03	10, 11, 12, 13, 14	5, 6, 7, 8, 9
A04	15, 16	10, 11, 12
A05	17, 18, 19	13, 14, 15
A06	20, 21, 22	16, 17, 18
A07	23, 24, 25, 26	19, 20, 21, 22, 23
A08	27, 28	24, 25
A09	29, 30, 31, 32, 33	26, 27, 28
A10	34, 35	29, 30
A11	36	31, 32, 33
A12	37	38, 39
A13	40, 41	35, 36, 37
A14	45	41, 42, 43
A15	50	45
A16	51	46
A17	52	47
A18	55	55, 56
A19	60, 61, 62, 63	49, 50, 51, 52
A20	64	53, 58, 59, 60, 61, 62, 63
A21	65, 66, 67, 70 - 74	64, 65, 66, 68, 69, 70, 77, 78, 79
A22	75	82, 84
A23	80, 85, 90 - 93	71 - 75, 80, 81, 85 - 88, 90 - 96
A24	95, 96, 97	97, 98
A25	99	99

TABLE SI.12: Regression: Labor Ratio vs GNI

	Coefficient	Standard Error	t-value	p-value	95% CI Lower	95% CI Upper
const	3.5743	0.4338	8.2385	0.0000	2.7236	4.4249
Log_GNIpc	0.0350	0.0012	29.2210	0.0000	0.0326	0.0373
Year	-0.0017	0.0002	-7.9216	0.0000	-0.0021	-0.0013

TABLE SI.13: Industry Share of Total Work Force $\frac{\text{Total Employment}_{ict}}{\text{Total Work Force}_{ct}}$

	(1) FAH	(2) FAAFH	(3) Exports	(4) Total
Base Category: Agriculture, forest and fishing				
Ln GNI per capita (2015USD)	-0.055***	-0.005***	-0.006***	-0.066***
	(0.005)	(0.001)	(0.001)	(0.005)
Food and beverage × Ln GNI per capita (2015USD)	0.048***	0.004***	0.008***	0.060***
	(0.004)	(0.001)	(0.001)	(0.004)
Hotels and restaurants × Ln GNI per capita (2015USD)	0.049***	0.008***	0.007***	0.064***
	(0.004)	(0.002)	(0.001)	(0.005)
Retail trade × Ln GNI per capita (2015USD)	0.047***	0.004***	0.006***	0.057***
	(0.005)	(0.001)	(0.001)	(0.005)
Transport × Ln GNI per capita (2015USD)	0.049***	0.004***	0.007***	0.059***
	(0.004)	(0.001)	(0.001)	(0.004)
Wholesale trade × Ln GNI per capita (2015USD)	0.051***	0.004***	0.007***	0.063***
	(0.004)	(0.001)	(0.001)	(0.004)
Ag TFP	-0.031**	-0.003	-0.006	-0.039**
	(0.013)	(0.002)	(0.004)	(0.016)
Food and beverage × Ag TFP	0.033**	0.002	0.006	0.041**
	(0.015)	(0.002)	(0.005)	(0.019)
Hotels and restaurants × Ag TFP	0.040***	0.006	0.009*	0.055***
	(0.014)	(0.008)	(0.005)	(0.018)
Retail trade × Ag TFP	0.023	0.002	0.007	0.032
	(0.022)	(0.002)	(0.005)	(0.026)
Transport × Ag TFP	0.038**	0.003	0.007	0.048**
	(0.015)	(0.002)	(0.005)	(0.019)
Wholesale trade × Ag TFP	0.035**	0.003	0.007	0.045**
	(0.015)	(0.002)	(0.005)	(0.019)
Ln Urban Population (million)	-0.007	-0.001	-0.002	-0.010
	(0.013)	(0.003)	(0.003)	(0.013)
Ln Total Population (million)	0.020	0.001	0.000	0.022
	(0.016)	(0.005)	(0.005)	(0.015)
Constant	0.673***	0.055***	0.065***	0.794***
	(0.053)	(0.011)	(0.015)	(0.054)
Sector Fixed Effect	Yes	Yes	Yes	Yes
Country Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
Observations	7848	7848	7848	7848
R-squared	0.715	0.772	0.584	0.721

Standard errors clustered at the country level are shown in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
FAH: food at home; *FAAFH*: food and accommodations away from home; *Total*: FAH + FAAFH + Exports.
All regressions include 7848 observations across 109 countries, annually 1993-2021.

TABLE SI.14: Ln Annual Average Compensation per worker (constant 2015USD)

	(1) AVC Workers	(2) Subcontractors
Base Category: Agriculture, forest and fishing		
Ln GNI per capita (2015USD)	1.376***	0.746***
	(0.205)	(0.185)
Food and beverage × Ln GNI per capita (2015USD)	-0.308***	0.025**
	(0.062)	(0.011)
Hotels and restaurants × Ln GNI per capita (2015USD)	-0.609***	0.016
	(0.102)	(0.012)
Retail trade × Ln GNI per capita (2015USD)	-0.571**	0.030
	(0.268)	(0.022)
Transport × Ln GNI per capita (2015USD)	-0.360***	0.002
	(0.076)	(0.010)
Wholesale trade × Ln GNI per capita (2015USD)	-0.986***	0.050***
	(0.293)	(0.015)
Ag TFP	0.195	0.097
	(0.476)	(0.121)
Food and beverage × Ag TFP	-0.654	-0.108
	(0.476)	(0.082)
Hotels and restaurants × Ag TFP	-0.182	-0.188**
	(0.770)	(0.090)
Retail trade × Ag TFP	-0.122	-0.138*
	(0.595)	(0.072)
Transport × Ag TFP	0.001	0.045
	(0.424)	(0.063)
Wholesale trade × Ag TFP	-0.039	-0.093
	(0.715)	(0.079)
Ln Urban Population (million)	0.491	0.433
	(0.732)	(0.659)
Ln Total Population (million)	-0.683	-0.453
	(0.957)	(0.784)
Constant	-9.938***	-2.704
	(2.760)	(2.029)
Sector Fixed Effect	Yes	Yes
Country Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
Observations	7848	7848
R-squared	0.687	0.932

Standard errors clustered at the country level are shown in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
All regressions include 7848 observations across 109 countries, annually 1993-2021.

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