

B Disaggregating Labor Payments

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B.1 Background

The treatment of labor flows in the GTAP Data Base has evolved substantially across releases. In the first three versions, labor was represented as a single factor alongside land and capital. GTAP 4 introduced a major revision by separating labor into skilled and unskilled categories (McDougall, Elbehri, and Truong 1998; Liu et al. 1998a; Liu et al. 1998b).³ This two-way labor split was then retained and extended in GTAP versions 5 through 8 as additional countries were incorporated into the database (Narayanan, Aguiar, and McDougall 2012).

Early attempts to improve the labor accounts faced important data constraints. Liu et al. 1998a; Liu et al. 1998b examined the use of ILO data for GTAP 4, but the available industry classifications were too aggregated for detailed sectoral analysis, and no unified source reported wages jointly by occupation and industry. These limitations restricted the scope for constructing a more refined labor database within the GTAP framework. In response to these shortcomings, later work revisited the underlying data sources. Efforts undertaken around 2009 reassessed ILO data and compared them with country-specific evidence for China and the U.S. (Mirza, Narayanan, and Leewuen 2010). This line of work clarified the weaknesses of the existing labor treatment and created the basis for a broader revision of the labor database.

A more substantial advance was provided by Weingarden and Tsigas 2010, who developed a method to estimate wages jointly by occupation and industry. Their approach combined industry wage information from the ILO Yearbook, occupational wage data from the ILO October Inquiry processed by Oostendorp 2005, and supplementary national data for India and China. The resulting database, which reported employment and estimated wages across five occupational categories for each country, became the main reference for subsequent GTAP labor accounts (see Weingarden and Tsigas 2010; Walmsley and Carrico 2013).

This chapter updates and extends that framework for GTAP version 12, with particular emphasis on the 2019 and 2023 base years.⁴ The objective is to construct labor data that are consistent with the expanded country and commodity coverage of GTAP 12 while improving classification consistency and temporal coverage. The remainder of this chapter proceeds as follows. The next section describes the ILO-based data sources and summary statistics. The following section explains how these data are processed and incorporated into the GTAP Data Base to construct labor accounts for the corresponding base years.

³The original approach calculated labor payment shares for seven countries using national data sources. For countries with weaker labor statistics, skilled labor payment shares were estimated using a non-transformed linear model with GDP and educational attainment as explanatory variables.

⁴Corong and Pattawee also updated the 2017 reference year labor accounts for GTAP version 11 following Weingarden and Tsigas 2010)

B.2 Labor Data Compilation

We retrieve four ILOSTAT datasets through the ILOSTAT API in R, as summarized in Table 14.17. The API codes correspond to the `Rilostat` package (Bescond 2026). For the GTAP Data Base, the relevant information is the underlying classification of the occupation- and economic-activity-based datasets. These labor datasets are reported at the two-digit disaggregation level: occupations are classified by the International Standard Classification of Occupations (ISCO), and economic activities are classified by the International Standard Industrial Classification (ISIC). For the age dimension, we retain only the 15+ group to capture total employment.⁵

Table 14.17: ILOSTAT Datasets and API Codes

Data name	API indicator in R
Employment by occupation and age	EMP_TEMP_AGE_OC2_NB_A
Employment by economic activity and age	EMP_TEMP_AGE_EC2_NB_A
Average monthly earnings of employees by sex, occupation and currency	EAR_4MTH_SEX_OCU_CUR_NB_A
Average monthly earnings of employees by sex, economic activity and currency	EAR_4MTH_SEX_ECO_CUR_NB_A

The occupation-based dataset uses the 2008 classification (ISCO-08). The two-digit sub-major observations are aggregated into nine ISCO-08 major groups. ISCO-08 serves as the primary classification; however, some country-year observations are reported under the earlier ISCO-88 classification. These observations are harmonized to the ISCO-08 major-group structure using the official ILO correspondence table before aggregation to the GTAP labor groups.⁶ The harmonized major groups are then mapped to the five labor groups used in the GTAP Data Base, following Weingarden and Tsigas 2010, as detailed in Table 14.18.

The economic-activity-based dataset is organized by industry group. We use ISIC Rev. 4, adopted by the United Nations Statistical Commission in 2006 (United Nations 2008). Table 14.19 shows the 21 economic-activity sectors under ISIC Rev. 4 used in the GTAP Data Base. For this release, ISIC Rev. 4 provides sufficient and consistent coverage; harmonization from older ISIC revisions, including Rev. 3, is therefore not required.

For the 2023 base year, the final labor dataset covers 69 countries with consistent worker and wage information. Figure 14.2 reports country-level average wages in USD per hour. Countries without data are shown in white. The distribution is highly uneven: the mean wage is USD 5.10 per hour, while the median is only USD 2.32 per hour, indicating that a small number of high-wage economies raise the average. Switzerland records the highest wage at USD 40.66 per hour, followed by the U.S., Austria, and France. The upper tail is concentrated mainly in Europe and the U.S., while most African and Southeast Asian economies remain well below the sample median. Latin American economies generally fall between these two groups.

⁵ILOSTAT reports three age groups: 15+, 15–24, and 25+.

⁶ISCO-08 is the successor to ISCO-88. The major groups remain broadly comparable, but detailed occupations may be split, merged, or reclassified across revisions (International Labor Organization 2008). Definitions of major groups may also vary; see ILOSTAT for details.

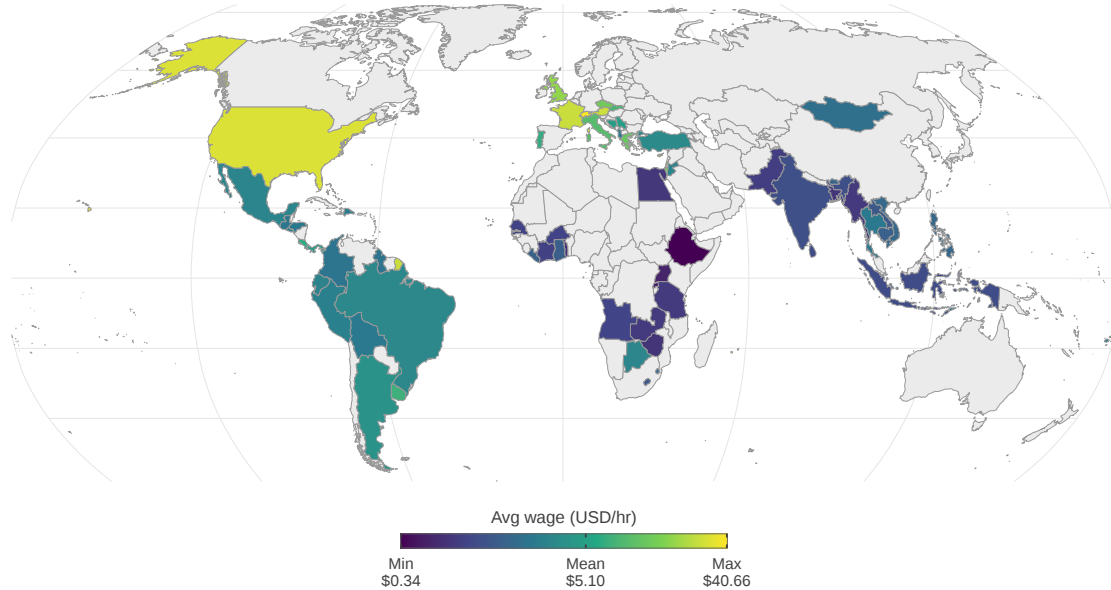
Table 14.18: ISCO-08 Major Groups, Descriptions, and GTAP Group Mapping

ISCO-08	Description	GTAP group
1	Managers	1,2
2	Professionals	1,2
3	Technicians and associate professionals	3
4	Clerical support workers	4
5	Service workers and shop and market sales workers	5
6	Skilled agricultural and fishery workers	6,7,8,9
7	Craft and related trades workers	6,7,8,9
8	Plant and machine operators, and assemblers	6,7,8,9
9	Elementary occupations	6,7,8,9

Table 14.19: ISIC Rev.4 Codes and Descriptions

ISIC Rev.4	Description
A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam and air conditioning supply
E	Water supply; sewerage, waste management and remediation activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific and technical activities
N	Administrative and support service activities
O	Public administration and defence; compulsory social security
P	Education
Q	Human health and social work activities
R	Arts, entertainment and recreation
S	Other service activities
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	Activities of extraterritorial organizations and bodies

Figure 14.2: Average Hourly Wage by Country in 2023



Figures 14.3 and 14.4 compare country-level employment structure using the two labor classifications used in the GTAP compilation. Figure 14.3 reports worker shares by ISCO major occupation, while Figure 14.4 reports worker shares by ISIC economic activity. Both figures show a similar regional pattern. African and many Asian economies have larger employment shares in agriculture-related and lower-skill labor groups, while European economies have larger shares in services, professional, technical, and managerial categories.

Figure 14.3: Worker shares by ISCO major occupation and region, 2023

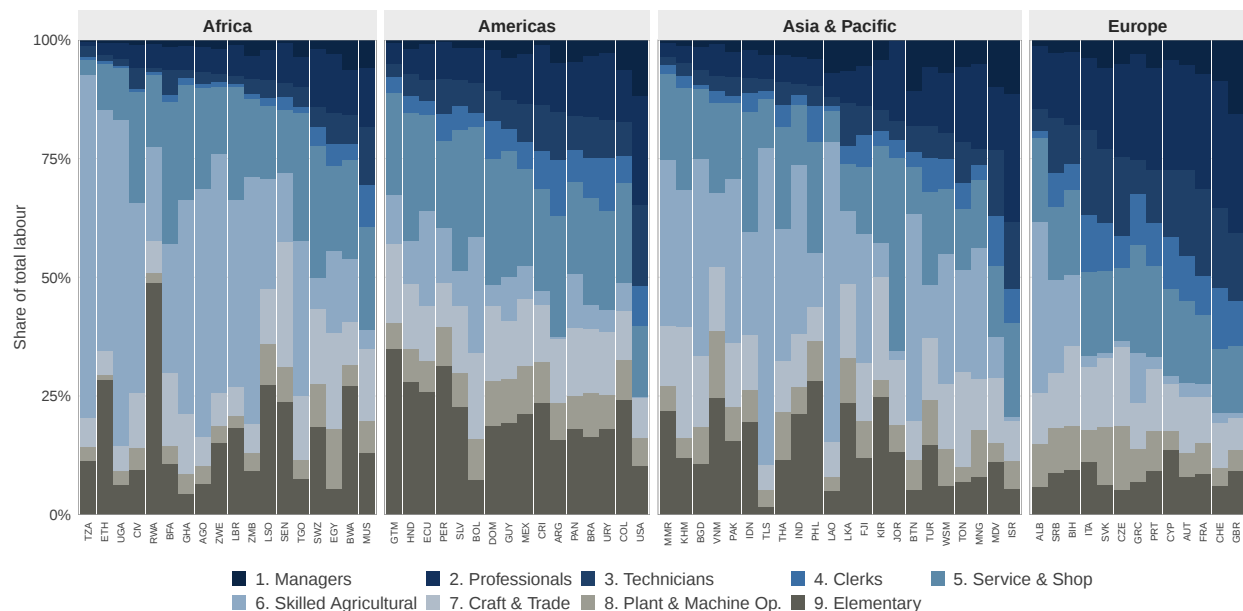
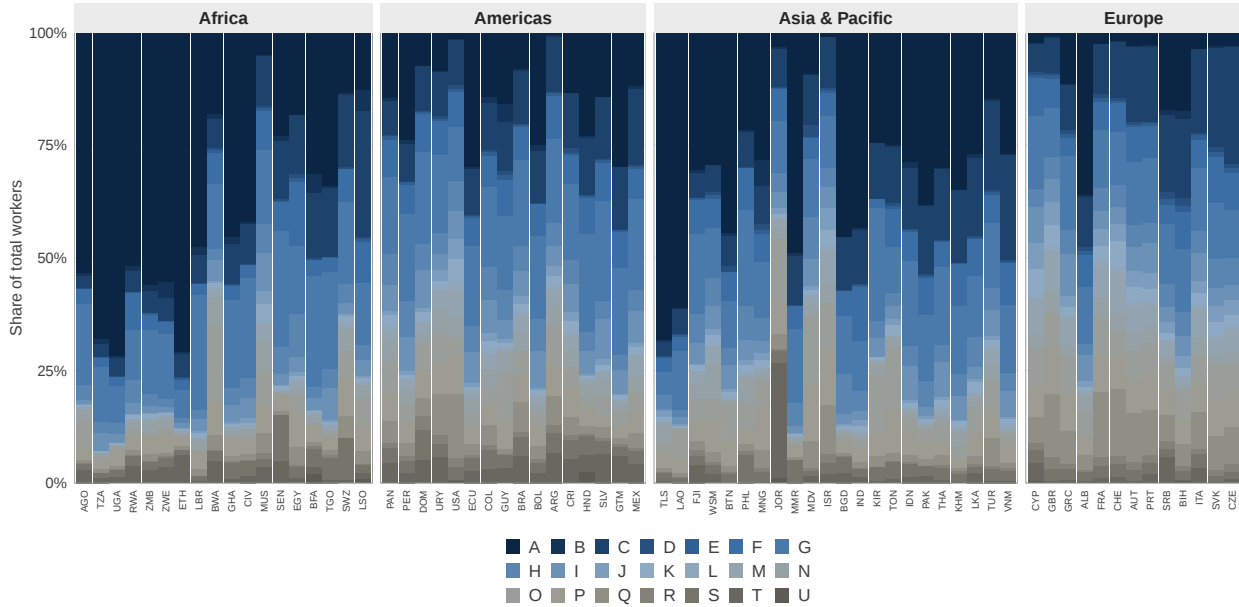


Figure 14.4: Worker shares by ISIC economic activity and region, 2023



B.3 Construction of GTAP Labour Matrices from ILOSTAT Data

For each base year, we construct a country-occupation-industry labour matrix that records employment and wages at the same cell level. This matrix provides the basis for GTAP 12 wage calibration and for splitting labour payments across GTAP labour categories. Since ILOSTAT reports occupation and industry series separately, with no joint occupation-by-industry wage-employment matrix, the database is assembled by constructing employment cells from marginal series, harmonising wages to an hourly basis, calibrating cell-level wages to observed industry wages, deriving labour payment shares, and applying a consistent year-selection rule across all inputs.

Worker Matrix

Aggregate and unclassified categories—namely, category groups “Total” and “X”—are first removed from the occupation and industry employment series, leaving clean margins over the nine ISCO major groups and ISIC Rev. 4 sections. The cleaned margins are then combined under a proportionality assumption that distributes the aggregate occupational composition uniformly across industries:

$$N_{ijc} = \left(\frac{N_{ic}^{\text{occ}}}{\sum_i N_{ic}^{\text{occ}}} \right) N_{jc}^{\text{ind}}, \quad (14.1)$$

where N_{ijc} denotes workers in occupation i and industry j for country c , N_{ic}^{occ} is total employment in occupation i , and N_{jc}^{ind} is total employment in industry j . The resulting nine ISCO major groups are subsequently aggregated to the six GTAP labour categories reported in Table 14.18.

Wage Inputs

All wage observations are converted to hourly-equivalent terms under the maintained assumption of 8 working hours per day and 22 working days per month, preserving the original USD units while harmonising the two wage series prior to calibration. Let A_{ic}^{occ} and A_{jc}^{ind} denote the reported occupation- and industry-based monthly wages. The corresponding hourly measures are

$$w_{ic}^{\text{occ}} = \frac{A_{ic}^{\text{occ}}}{8 \times 22}, \quad w_{jc}^{\text{ind}} = \frac{A_{jc}^{\text{ind}}}{8 \times 22}. \quad (14.2)$$

Wage Matrix Calibration

With the worker matrix and wage inputs in hand, the wage matrix is estimated in GAMS. Let W_{ijc} denote the calibrated wage for occupation i in industry j and country c , w_{ic}^0 denote the occupational wage prior, $\bar{w}_{jc}$ denote the observed industry wage, and β_{ijc} denote the weight attached to each prior observation. The calibration chooses W_{ijc} to minimise the weighted squared deviation from the occupational wage prior while ensuring that the employment-weighted average wage within each industry equals the observed industry wage. The weight β_{ijc} governs the tension between the two sources: cells with wages far from the country mean receive lower weight, allowing the industry constraint to bind more tightly. The calibration problem is

$$\begin{aligned} \min_{W_{ijc}} \quad & \sum_i \sum_j \beta_{ijc} (w_{ic}^0 - W_{ijc})^2 \\ \text{s.t.} \quad & \frac{\sum_i W_{ijc} N_{ijc}}{\sum_i N_{ijc}} = \bar{w}_{jc}. \end{aligned} \quad (14.3)$$

Labour Payment Shares

The calibrated wage matrix is combined with the worker matrix from equation (14.1) to compute the occupational labour payment shares used to split labour payments in the GTAP 12 Data Base. Let S_{ijc} denote the share of labour payments accruing to occupation i within industry j in country c . The payment share is defined as

$$S_{ijc} = \frac{W_{ijc} N_{ijc}}{\sum_i W_{ijc} N_{ijc}}. \quad (14.4)$$

Data Availability and Year Selection

All four series must share a common observation window for a given country before the matrices in equations (14.1) and (14.2) can be assembled. Where base-year data are available across all series, they are used directly. Otherwise, the nearest common years are identified and observations are averaged over that window, ensuring employment and wage inputs are always drawn from the

same time period. Priority is given to years closest to the base year: where three years fall within the window, all three are averaged; otherwise the two closest are retained. Countries for which no adequate common window exists are excluded. Table 14.20 summarises the method applied to each country; for base year 2023, the database covers 69 countries.

Table 14.20: Country-level data summary, base year 2023

ISO3	Workers	Wage Occ.(USD/yr)	Wage Ind.(USD/yr)	Method
AGO	9,949,109	1.47	1.27	Avg.: 2021, 2019
ALB	1,324,196	2.90	3.26	Avg.: 2022, 2021, 2020
ARG	13,293,498	4.40	4.42	Base year
AUT	3,882,496	26.50	26.95	Base year
BFA	5,284,758	1.44	1.01	Base year
BGD	70,981,962	1.01	0.96	Base year
BIH	1,340,318	4.96	4.82	Base year
BOL	6,580,994	2.83	2.92	Base year
BRA	99,281,765	3.67	3.88	Base year
BTN	366,010	1.74	1.66	Base year
BWA	753,473	3.72	4.37	Base year
CHE	4,848,180	36.36	38.14	Base year
CIV	7,643,878	1.52	1.25	Avg.: 2019, 2017
COL	22,788,394	2.48	2.64	Base year
CRI	2,163,953	7.38	6.69	Base year
CYP	389,448	17.22	16.34	Base year
CZE	4,428,195	13.33	13.77	Base year
DOM	4,835,318	3.07	2.83	Base year
ECU	8,109,647	3.80	3.78	Base year
EGY	29,886,073	0.72	0.73	Base year
ETH	35,498,000	0.47	0.47	Avg.: 2021, 2013
FJI	326,411	3.21	3.09	Avg.: 2024, 2016
FRA	23,961,270	24.34	25.87	Base year
GBR	33,013,939	15.77	18.87	Base year
GHA	11,957,428	1.93	1.85	Avg.: 2017, 2015
GRC	3,673,083	12.25	11.87	Base year
GTM	7,793,895	3.40	2.65	Base year
GUY	250,556	2.31	2.24	Avg.: 2019, 2018
HND	3,686,646	3.27	2.97	Base year
IDN	139,242,444	1.37	1.28	Base year
IND	471,885,685	1.54	1.42	Base year
ISR	4,309,320	13.50	15.46	Avg.: 2021, 2018
ITA	23,579,947	9.59	9.12	Avg.: 2020, 2019, 2018
JOR	2,754,006	3.23	3.15	Base year
KHM	9,756,289	1.90	1.80	Base year
KIR	41,138	2.25	2.17	Base year

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ISO3	Workers	Wage Occ.(USD/yr)	Wage Ind.(USD/yr)	Method
LAO	2,528,791	1.40	1.46	Avg.: 2022, 2017
LBR	1,065,106	1.60	1.73	Avg.: 2017, 2010
LKA	7,996,240	1.23	1.22	Avg.: 2022, 2021, 2020
LSO	516,377	1.97	1.69	Avg.: 2024, 2019
MDV	138,102	4.02	3.76	Avg.: 2019, 2016
MEX	58,858,618	3.42	3.46	Base year
MMR	22,845,425	0.89	0.81	Avg.: 2020, 2019, 2018
MNG	1,317,220	1.89	1.96	Base year
MUS	484,009	3.28	3.27	Base year
PAK	59,021,075	1.10	1.00	Avg.: 2021, 2020, 2019
PAN	1,937,367	5.48	5.42	Base year
PER	17,604,655	3.44	3.14	Base year
PHL	46,938,519	2.20	2.10	Base year
PRT	5,051,191	6.47	6.80	Base year
RWA	4,674,398	0.89	0.77	Base year
SEN	4,600,406	1.55	0.92	Avg.: 2022, 2019
SLV	2,946,700	3.08	2.85	Base year
SRB	2,518,363	5.10	5.05	Avg.: 2019, 2018, 2017
SVK	2,358,224	8.03	8.00	Base year
SWZ	221,536	2.29	2.11	Avg.: 2021, 2016
TGO	2,092,853	0.98	0.91	Avg.: 2022, 2017
THA	39,912,031	3.14	3.26	Base year
TLS	362,377	2.35	2.62	Avg.: 2021, 2016
TON	33,106	3.70	4.36	Base year
TUR	31,632,320	3.67	3.71	Base year
TZA	21,149,045	1.62	1.80	Avg.: 2020, 2014
UGA	14,160,013	0.84	0.92	Avg.: 2021, 2019
URY	1,702,831	8.01	7.70	Base year
USA	161,036,522	27.74	31.46	Base year
VNM	54,956,134	2.03	2.08	Base year
WSM	33,887	3.52	3.61	Avg.: 2022, 2017
ZMB	6,760,649	1.07	1.12	Base year
ZWE	5,525,267	0.75	0.79	Base year

Notes: Workers denotes total employment; Wage Occ. and Wage Ind. denote average wages by occupation (ISCO) and industry (ISIC), respectively, as reported by ILOSTAT. Method reports the year(s) used for each country; “Base year” indicates direct base-year data, and “Avg.” indicates an average over the listed years.

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