Global Labor Statistics
for submission to the GTAP Database

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Overview of Work

- The current GTAP database splits labor payments for each industry into two categories: skilled and unskilled.

- Our objective is to contribute labor payments to GTAP using more recent sources that are disaggregated by occupation.

  – We utilize publicly available statistics on employment and wages from the International Labour Organization (ILO).

  – To impute missing wage values, we apply a minimization of squared errors method.

- We have results for four countries and have identified 52 countries for which the ILO statistics are available.

  – For each country we can find wage and employment matrices by industry and occupation.

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Preview of Results: United States

Input matrix: Observed wages by job and industry averages

w(occ, ind)	Agri A	Mining C	Manu D	Util E	Constr F	Trade G	Hotel H	Transp I	Finance J	Proper K	Edu/Heal LMNOP
onetwo		$40	$26	$29					$26		$42
three		$24	$20			$12		$35	$22	$23	$23
four			$11	$15		$11	$9	$23	$13		$15
five						$14	$8	$15			$19
sixtonine	$16	$18	$14	$23	$19	$15	$8	$19			$13

w(. ind)	$9	$17	$14	$22	$17	$11	$11	$16	$15	$15	$13

Final matrix: Imputed wages by job and calculated industry averages

W(occ, ind)	A	C	D	E	F	G	H	I	J	K	LMNOP
onetwo	$25	$26	$15	$25	$24	$24	$25	$21	$18	$19	$17
three	$19	$18	$20	$20	$19	$13	$19	$16	$16	$14	$14
four	$12	$12	$10	$12	$12	$7	$7	$17	$11	$9	$13
five	$9	$9	$9	$9	$9	$6	$6	$8	$8	$8	$6
sixtonine	$6	$12	$13	$22	$15	$13	$10	$13	$14	$13	$11

- Sum of the Squared Errors
- Australia   3.78
- Canada   8.46
- Germany   7.96
- United States   18.55
- While US has largest error final data matched well to BLS industry avgs and distribution within industries plausible.

Comparison of 2002 data from ILO and Bureau of Labor Statistics (national source)

	Agri	Mining	Manu	Util	Constr	Trade	Hotel	Transp	Finance	Proper	Edu/Hea
ILO w(. ind)	$ 9	$ 18	$ 15	$ 24	$ 19	$ 12	$ 11	$ 17	$ 16	$ 16	$ 15
BLS 2002	$ 10	$ 21	$ 18	$ 25	$ 19	$ 14	$ 9	$ 17	$ 22	$ 15	$ 15

Previous GTAP Work

- Current GTAP labor splits are based on 13 national sources.

- Labor splits for other economies were econometrically estimated.

- Data are pre-1993 and there are many assumptions across countries.

Region	Year	Source	Data limitations and adjustments
USA	1992	1992 CPS	
Canada	1986	1986 Census	Uses US distribution by industry.
Australia	1991	ORANI CGE model	
EU	1988	Eurostat	Uses Australian manual/non-manual adjustments.
Japan	1970 & 1992	Japan Wage Survey	Income levels used to infer presence of skilled labor.
Taiwan	1979 & 1990	DG-Budget & Dept of Ag	
South Korea	1991	Korea National Statistical	Uses Taiwanese data for job definitions.
Brazil	1992	ILO	
Indonesia	1992	Sakarnas Survey	Skilled workers defined by education.
Philippines[a]	1986	APEX model	Skilled workers defined by high school completion.
Thailand[a]	1985	PARA CGE model	Skilled workers defined by long-term employment.
Hong Kong	1991	1991 CPS	
India	1981	1981 Census	

Source: Liu, *et al.* (1998)
[a] The Philippines and Thailand were later dropped from sample.

The ILO *Annual Yearbook* and the *October Inquiry*

- Combining two ILO databases gives us wages and employment data for more than 40 countries.

  - The *ILO Annual Yearbook* gives the number of workers by industry and occupation, $N_{Occ, Ind}$ and the average wage by industry, w_{Ind}.

    - Each country has approx.15 industries (ISIC 2 or 3 top level codes).

    - Each industry has approx. 9 occupations (one-digit ISCO codes).

  - The *ILO October Inquiry* database gives 161 wages by job, w_{Job}.

    - A job is occupation and industry-specific, such as "Mathematics teacher". The equivalent occupation/industry combination would be "Professional" in "Education". Therefore, each w_{Job} observation can be mapped to a wage by occupation and industry $w_{Occ, Ind}$.

    - The data we use has been prepared by Freeman & Oostendorp for their 2000 and 2005 working papers.

Wages and Employment Data from the *ILO Annual Yearbook*

Labor wages

Occupa-tions	Industries				
	A	*B*	*…*	*…*	*c*
1 *2* *3* *r*			Wij; i=1,..r; j=1, …c		
Average	W.1	W.2	W.3	…	W.c

MISSING VALUES: Wages by Industry & Occupation

ILO Annual Yearbook: Average Wages by Industry

Number of workers

Occupa-tions	Industries				
	A	*B*	*…*	*…*	*c*
1 *2* *3* *r*			Lij; i=1,..r; j=1, …c		
Total	L.1	L.2	L.3	…	L.c

ILO Annual Yearbook: Employment by Industry & Occupation

Wages by Job from the *ILO October Inquiry*

Job codes		Industry/Occupation
1		
2	⇒	A/6
3		
...		
...		
97	→	H/4
98	⇒	H/5
99		
100	→	H/9
101	→	I/4
102	⇒	I/5
103		
104	→	I/9
...		
...		
161	→	G/7
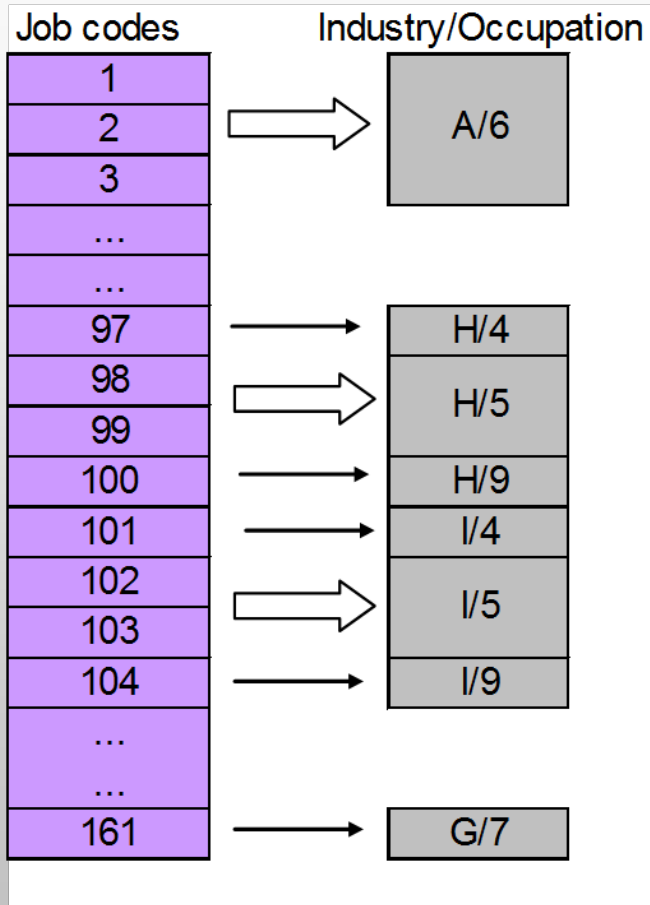
- The *October Inquiry* database has wage data for 161 jobs. These jobs map to 35 industry/occupation groups.

  - For 23 of these industry/occupation groups, more than one job mapped to the same group. In these cases we used an arithmetic average to find a wage by occupation and industry ($w_{Occ, Ind}$) from multiple wages by job (w_{Job}).

  - 35 elements of the $w_{Occ, Ind}$ matrix were estimated from w_{Job} observations but this meant that many elements of the 5 x 15 $w_{Occ, Ind}$ matrix were still missing.

W and N Data from the *ILO Annual Yearbook* and the *October Inquiry*

Labor wages with observed wages by job

Occupa-tions	Industries				
	A	*B*	…	…	*c*
1					
2					
3		W_{ij}; i=1,..r; j=1, …c				
6					
Average	W.1	W.2	W.3	…	W.c

ILO October Inquiry: Wages by Job

ILO Annual Data: Average wages by Industry

Labor wages: Final matrix

Occupa-tions	Industries				
	A	*B*	…	…	*c*
1					
2					
3		W_{ij}; i=1,..r; j=1, …c				
6					
Average	W.1	W.2	W.3	…	W.c

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Method of Imputing Wages

$$\text{minimize} \sum_{i \in Occ} \sum_{j \in Ind} \beta_{ij}[w_{ij} - W_{ij}]^2 + \sum_{i \in Occ} \sum_{j \in Ind} [w_{i.} - W_{ij}]^2$$

subject to $W_{.j} = w_{.j}$, $j \in \text{Ind}$

- Occ = Occupations set
- Ind = Industries set
- w_{ij} = initial wages values
- $w_{i.}$ = average wage for occupation i
- $w_{.j}$ = average wage for industry j
- W_{ij} = estimated wages
- L_{ij} = number of workers
- β_{ij} = belief weights

Occupations and Industries

Occupations

1: Senior officials and managers
2: Professionals
3: Technicians & associate professionals
4: Clerks
5: Service and shop workers
6: Skilled agricultural workers
7, 8, 9: Machine operators, assemblers, craft workers, etc.

Industries (ISIC Rev 3)

A : Agriculture, hunting and forestry

B : Fishing

C : Mining and quarrying

D : Manufacturing

E : Electricity, gas and water supply

F : Construction

G : Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods

H : Hotels and restaurants

I : Transport, storage and communications

J : Financial intermediation

K : Real estate, renting and business activities

L : Public administration and defense; compulsory soc.security

M : Education

N : Health and social work

O : Other community, social and personal service activities

P : Private households with employed persons

Q : Extra-territorial organizations and bodies

X: Not classifiable by economic activity

Results: Australia

Input matrix: Observed wages by job and industry averages

w(occ, ind)	Mining C	Manuf D	Elect E	Const F	Trade G	Hotels H	Transpo I	Finance J	Realest K	Public L	Edu M	Health N	Comm O
onetwo	$35	$26	$32					$27		$25	$26	$31	
three	$30	$24			$19		$31	$19	$28			$23	
four		$19	$18		$17	$16	$20	$18		$18			
five					$16	$16	$23			$23			
sixtonine	$32	$19	$24	$20	$17	$15	$22					$23	$10
w(. ind)	$31	$23	$28	$22	$20	$17	$24	$26	$24	$26	$26	$22	$22

Final matrix: Imputed wages by job and calculated industry averages

W(occ, ind)	C	D	E	F	G	H	I	J	K	L	M	N	O
onetwo	$ 36	$ 27	$ 35	$ 23	$ 27	$ 21	$ 26	$ 32	$ 27	$ 34	$ 28	$ 27	$ 28
three	$ 25	$ 23	$ 24	$ 21	$ 18	$ 19	$ 31	$ 26	$ 23	$ 25	$ 22	$ 20	$ 24
four	$ 16	$ 18	$ 18	$ 15	$ 18	$ 12	$ 19	$ 20	$ 15	$ 19	$ 15	$ 15	$ 16
five	$ 13	$ 14	$ 13	$ 13	$ 18	$ 15	$ 19	$ 13	$ 13	$ 20	$ 14	$ 14	$ 18
sixtonine	$ 32	$ 20	$ 26	$ 22	$ 18	$ 15	$ 21	$ 17	$ 18	$ 19	$ 18	$ 18	$ 15

Results: Canada

Input matrix: Observed wages by job and industry averages

w(occ, ind)	Agri A	Mining C	Manu D	Util E	Constr F	Trade G	Hotel H	Transp I	Financ J	Proper K	Public L	Educat M	Health N	Commu O
onetwo		$31		$28					$15		$23	$22	$21	
three			$20			$9		$24		$19			$15	
four			$17			$11	$10	$16	$13		$13			
five						$11	$10	$6			$20			
sixtonine	$13	$28	$14	$17	$16	$12	$9	$20					$22	

| w(. ind) | $20 | $31 | $19 | $23 | $21 | $14 | $7 | $19 | $22 | $15 | $22 | $19 | $20 | $13 |

Final matrix: Imputed wages by job and calculated industry averages

W(occ, ind)	A	C	D	E	F	G	H	I	J	K	L	M	N	O
onetwo	$18	$36	$26	$30	$21	$21	$15	$22	$19	$19	$29	$21	$23	$18
three	$15	$22	$18	$21	$16	$10	$14	$22	$27	$13	$21	$14	$20	$15
four	$11	$18	$16	$19	$12	$12	$6	$17	$18	$11	$14	$11	$17	$11
five	$9	$9	$9	$9	$9	$12	$5	$5	$9	$9	$17	$8	$19	$9
sixtonine	$20	$37	$16	$21	$22	$14	$10	$18	$12	$12	$13	$12	$17	$12

Results: Germany

Input matrix: Observed wages by job and industry averages

w(occ, ind)	Agri A	Mining C	Manu D	Util E	Constr F	Trade G	Hotel H	Transp I	Financ J	Proper K	Public M	Educat N	Health O
onetwo		€ 25	€ 20	€ 29					€ 21		€ 26	€ 25	
three		€ 24	€ 19			€ 16		€ 41	€ 12	€ 20		€ 16	
four			€ 16	€ 21		€ 13	€ 15	€ 19	€ 15				
five						€ 14	€ 10	€ 16					
sixtonine	€ 13	€ 16	€ 13	€ 16	€ 15	€ 13	€ 8	€ 15				€ 16	€ 12

w(. ind)	€ 7	€ 16	€ 16	€ 20	€ 13	€ 15	€ 10	€ 14	€ 20	€ 16	€ 16	€ 15	€ 15

Final matrix: Imputed wages by job and calculated industry averages

W(occ, ind)	A	C	D	E	F	G	H	I	J	K	M	N	O
onetwo	€ 18	€ 20	€ 20	€ 24	€ 17	€ 20	€ 18	€ 14	€ 20	€ 19	€ 18	€ 20	€ 20
three	€ 16	€ 17	€ 19	€ 20	€ 16	€ 15	€ 17	€ 18	€ 21	€ 16	€ 14	€ 17	€ 18
four	€ 12	€ 12	€ 16	€ 17	€ 11	€ 13	€ 11	€ 12	€ 20	€ 12	€ 12	€ 13	€ 13
five	€ 8	€ 8	€ 10	€ 8	€ 8	€ 13	€ 7	€ 11	€ 9	€ 8	€ 8	€ 11	€ 10
sixtonine	€ 6	€ 15	€ 14	€ 17	€ 12	€ 13	€ 9	€ 14	€ 12	€ 12	€ 12	€ 13	€ 12

Results: United States

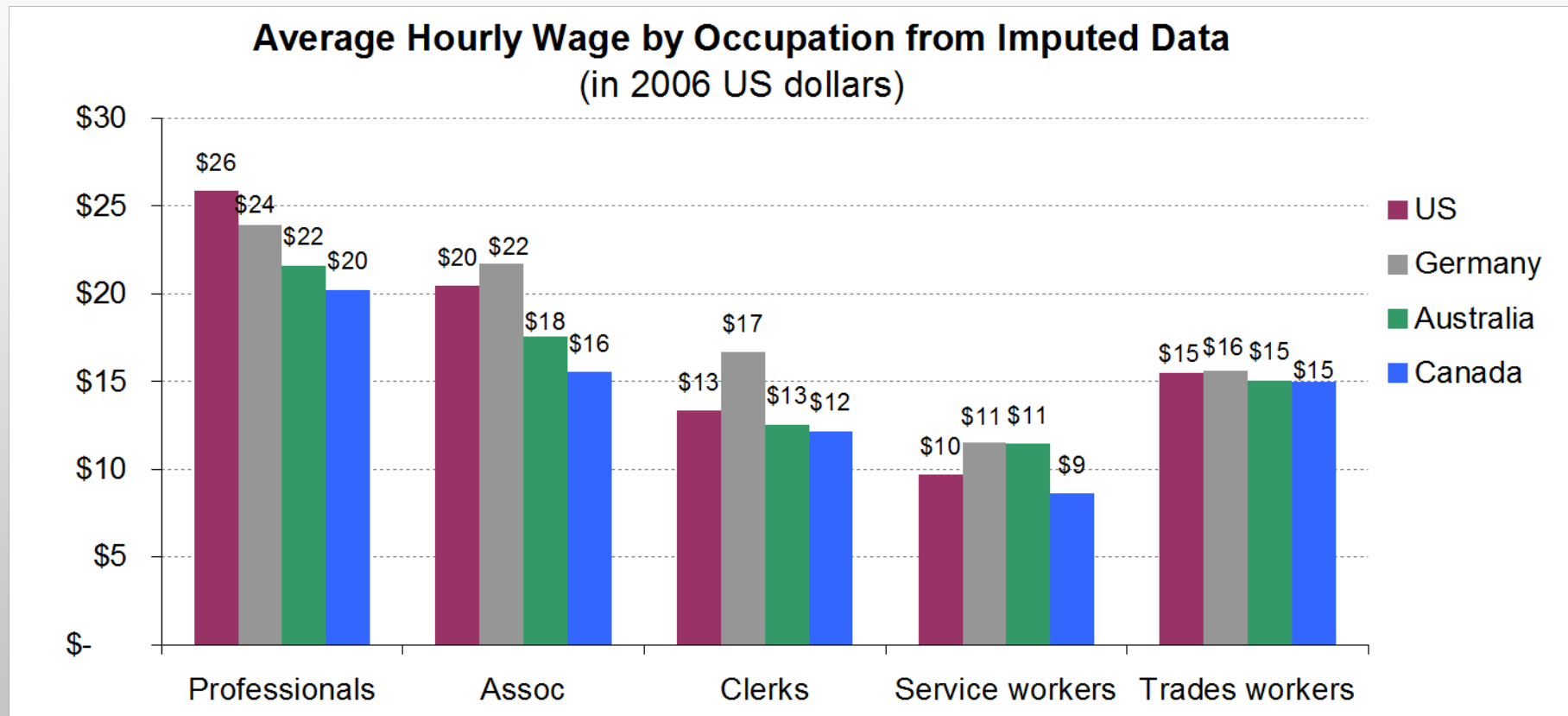Input matrix: Observed wages by job and industry averages

w(occ, ind)	Agri A	Mining C	Manu D	Util E	Constr F	Trade G	Hotel H	Transp I	Finance J	Proper K	Edu/Heal LMNOP
onetwo		$40	$26	$29					$26		$42
three		$24	$20			$12		$35	$22	$23	$23
four			$11	$15		$11	$9	$23	$13		$15
five						$14	$8	$15			$19
sixtonine	$16	$18	$14	$23	$19	$15	$8	$19			$13

w(. ind)	$9	$17	$14	$22	$17	$11	$11	$16	$15	$15	$13

Final matrix: Imputed wages by job and calculated industry averages

W(occ, ind)	A	C	D	E	F	G	H	I	J	K	LMNOP
onetwo	$ 25	$ 26	$ 15	$ 25	$ 24	$ 24	$ 25	$ 21	$ 18	$ 19	$ 17
three	$ 19	$ 18	$ 20	$ 20	$ 19	$ 13	$ 19	$ 16	$ 16	$ 14	$ 14
four	$ 12	$ 12	$ 10	$ 12	$ 12	$ 7	$ 7	$ 17	$ 11	$ 9	$ 13
five	$ 9	$ 9	$ 9	$ 9	$ 9	$ 6	$ 6	$ 8	$ 8	$ 8	$ 6
sixtonine	$ 6	$ 12	$ 13	$ 22	$ 15	$ 13	$ 10	$ 13	$ 14	$ 13	$ 11

Results: Cross-Country Comparison

Average Hourly Wage by Occupation from Imputed Data
(in 2006 US dollars)

Data Availability by Country

Country	$N_{Occ, Ind}$ Best year	w. Ind[a] Best year	Industries Number	Country	$N_{Occ, Ind}$ Best year	w. Ind[a] Best year	Industries Number
Algeria	2004	1996	13	Macau	2003	2007	14
Australia	2006	2006	13	Malawi	1998	1995	16
Austria	2006	2004	17	Mauritius	2006	2007	16
Barbados	2003	1991	16	Mexico	2006	2007	18
Belgium	2006	2006	12	Moldova	2006	2007	15
Bolivia	2000	2007	14	Netherlands	2005	2005	16
Brazil	2004	2002	18	New	2006	2006	16
Bulgaria	2006	2007	15	Nicaragua	2006	2006	16
Canada	2006	2007	14	Norway	2006	2007	14
Costa Rica	2006	2007	18	Peru	2006	2007	13
Croatia	2006	2006	16	Philippines	2006	2007	17
Cyprus	2006	2006	15	Poland	2006	2007	15
Czech Republic	2006	2006	15	Portugal	2006	2007	14
Estonia	2006	2007	15	Romania	2006	2006	14
Finland	2006	2006	16	Russia	2006	2007	17
Germany	2006	2007	13	San Marino	1999	2004	12
Hong Kong	2006	2007	14	Singapore	2006	2007	7
Hungary	2006	2007	15	Slovakia	2006	2007	15
Iceland	2000	2007	5	Slovenia	2006	2007	16
Italy	2006	2006	13	Sri Lanka	1998	2007	7
Japan	2006	2007	12	Sweden	2006	2007	15
Korea	2006	2007	14	Thailand	1998	2007	12
Kyrgyzstan	2006	2007	15	Turkey	2006	2001	14
Latvia	2006	2007	15	U.K.	2006	2007	17
Lithuania	2006	2007	15	U.S.	1998	1999	11
Luxembourg	1991	2007	7	Venezuela	1997	1997	16

(ª) The best year of wages refers to the *ILO Yearbook*. For some data, the best year of wages in the *ILO October Inquiry* does not match the best year of wages in the *ILO Yearbook*.

China has incomplete data and all data is missing for India.

Thank you!