UNDERSTANDING U.S. WORKER EXPOSURE TO TRADE BY GENDER, EDUCATION LEVEL, AND OCCUPATION

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Abstract

This paper disaggregates the GTAP U.S. labor data into 20 worker types, by gender, education, and broad occupation category, to understand how different workers in the U.S. are exposed to hypothetical changes in tariff rates. First, a methodology is provided to disaggregate the U.S. labor input in GTAP into twenty types. A database of wage bill shares and mean wages by GTAP sector are calculated using 2017 data from the Current Population Survey (CPS) Annual Social and Economic Supplements (ASEC). The wage bill share matrix can be used as a tool to split wage payments in GTAP to each labor type. Second, the paper provides illustrative policy simulations on heavy manufacturing, agriculture, and services trade, demonstrating differential impacts on worker types for each of the scenarios considered.

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1 Introduction

Trade has differential impacts on different types of workers. Brussevich (2018) found that gains from trade are higher for women than men and led to a declining gender wage gap because women tend to work in services industries that do not directly compete with import varieties. Gurevich et al. (2020) assessed the economic impact of U.S. trade agreements from 1984 to 2013 on U.S. workers and found that, while both men and women generally benefit from new trade agreements, there were larger economic gains for women than for men in both wages and employment. Both papers illustrate that distributional impacts of trade policy changes are different for male and female workers.

Despite its importance, standard economic modeling tools that are used to assess trade impacts, like the Global Trade Analysis Project (GTAP) model (Hertel; 1997), typically do not contain the level of labor detail needed to analyze differences across a variety of worker types. Carrico and Tsigas (2014) proposed an approach for enriching results for U.S. labor markets from the GTAP model. Departing from the usual approach of expanding labor data in all economies in a model's database, the authors expanded only the U.S. labor data. Additionally, it introduced a modification to primary factor demands, generating more realistic labor markets in which lower-skilled jobs substitute more easily with other primary factors than higher-skilled jobs.

In this paper, we provide a methodology to disaggregate the U.S. labor primary factor in the standard GTAP model into 20 worker types. These types include two genders, two educational attainments, and five broad occupation categories. Data from the Current Population Survey (CPS) Annual Social and Economic Supplements (ASEC) 2017 survey are used to calculate wage bill shares by labor type for each of the 65 GTAP sectors. Substitution elasticities between worker types and labor supply elasticities are collected from the literature and listed in this paper as a resource. We then present illustrative simulations of

changes in tariff rates on different sectors to show differential impacts to worker types.

A brief literature review is included in Section 2 that describes other GTAP labor modifications that preceded this paper. The model modifications to the U.S. primary factor demands are described in Section 3. Section 4 details the steps taken to calculate wage bill shares by gender, education, and occupation for each of the GTAP sectors. Finally, a series of illustrative simulations are presented in Section 5 to show how the exposure of different worker types to different policy shocks. The wage bill share matrix (Table 11) and database of mean wages by type (Table 12) are included at the end of this paper.

2 Literature Review

There have been several modifications to the labor primary factor in the GTAP database. In version 3 and before, there existed only one aggregate labor factor in addition to land and capital. In the version 4 database, labor was disaggregated into two groups: skilled (managers and professionals) and unskilled (tradespersons, clerks, farm workers) (Liu et al.; 1998). Labor payment shares were computed for the two labor groups for some of the countries using national data. Thirteen of the countries had enough labor data available to compute labor payment shares directly. For countries that had less reliable data, shares were estimated using information about GDP and educational attainment. These two worker types were used in GTAP versions 5 through 8, with labor payment shares calculated and updated as the database grew larger (Dimaranan and Narayanan; 2008). However, some of the labor payment splits were still based on outdated wage and employment data and based on extrapolation for several of the countries in the database.

Weingarden and Tsigas (2010) then developed a method to impute missing wages by occupation and industry for 48 countries. Their method updated the labor payment shares to 2004 and 2005, and did not need to impose any additional assumptions on countries

lacking data. A summary of the Weingarden and Tsigas (2010) approach can be found in Walmsley and Carrico (2013).

The World Bank Group (2019) created a gender-disaggregated labor database that provides detailed accounts on employment levels, wages, labor income, and employment status for a global sample of countries. Based on the World Bank's household survey collection and other public resources, the database is disaggregated by region, skill level, economic activity and gender. It can be used to assess the distributional effects of trade policy changes on developing countries in GTAP. Compared to the data presented in this paper, it covers a wider variety of countries, but does not disaggregate by occupation type or education level. Instead, workers are still grouped into unskilled and skilled categories.

Most recently, Gurevich et al. (2020) also included gender in their GTAP analysis of the effects of U.S. trade agreements on male and female workers. As described in the introduction, using the expanded database with male and female worker types, they find that U.S. trade agreements had a larger positive impact on female workers than male workers in sectors directly affected by the changes in trade policy.

3 Model Changes to U.S. Primary Factor Demands

There are two groups of changes needed to disaggregate the U.S. labor input in GTAP: changes to the database and changes to the model. This first section details the changes made to the labor factor input in the standard GTAP model. The labor modifications presented in this section were chosen to align with the structural model presented in Johnson and Keane (2013) so that our modified GTAP structure of U.S. labor may rely on their estimated substitution and labor supply elasticities. They built an overlapping-generations model of the U.S. labor market with labor differentiated by education, occupation, gender, and age. Their model has two genders, two educations, four age groups, and ten occupation

levels, leading to 160 types of labor that enter a multi-level nested constant elasticity of substitution (CES) production function.[1] Their model allows changes in the wage structure to come from skill-based technical change, capital-skill complementarity, occupational demand shifts, demographic changes, and changing tastes for work and college. Model parameters were fitted to the Panel Study on Income Dynamics (PSID) data from 1968–96, a survey that provides wages and employment data for each of their defined labor types. Estimated elasticities of substitution are presented in Table 1.

Table 1: Substitution Elasticities from Johnson and Keane (2013)

	Elasticity Estimate
Capital, skilled labor	0.41
Capital + skilled, unskilled	1.75
Services, blue-collar	0.34
Service occupations	1.41
Blue-collar occupations	1.25
High school, college	1.59
Male, female	4.76

Note: This table presents elasticity of substitution estimates across labor types from Johnson and Keane (2013). These elasticity estimates are based on the endogenous capital model in the paper cited.

We use these elasticities in GTAP to describe how the CES production function imperfectly substitutes between labor types for each GTAP sector in the U.S. region.[2] The modified GTAP model structure for U.S. sectors is presented in Figure 1 and 2. Occupations are placed in upper-level nests first, as combinations of occupation types are needed to produce a product or service. Education types are placed next to indicate quality of the occupation's worker. Gender is placed in the lowest tier of the nesting structure. We matched the ordering to the Johnson and Keane model, who indicated that the model fit the PSID data well under this formulation. As shown in Figure 1 and 2, aggregate output first

[1]The Johnson and Keane paper used a more finely disaggregated set of occupations than are being used in this paper. We consolidate the 10 occupation groups to 5 and we do not disaggregate by age.

[2]The non-U.S. regions in the model are not disaggregated and use the standard labor formulation.

Figure 1: U.S. Labor Disaggregation by Occupation, Education, and Gender

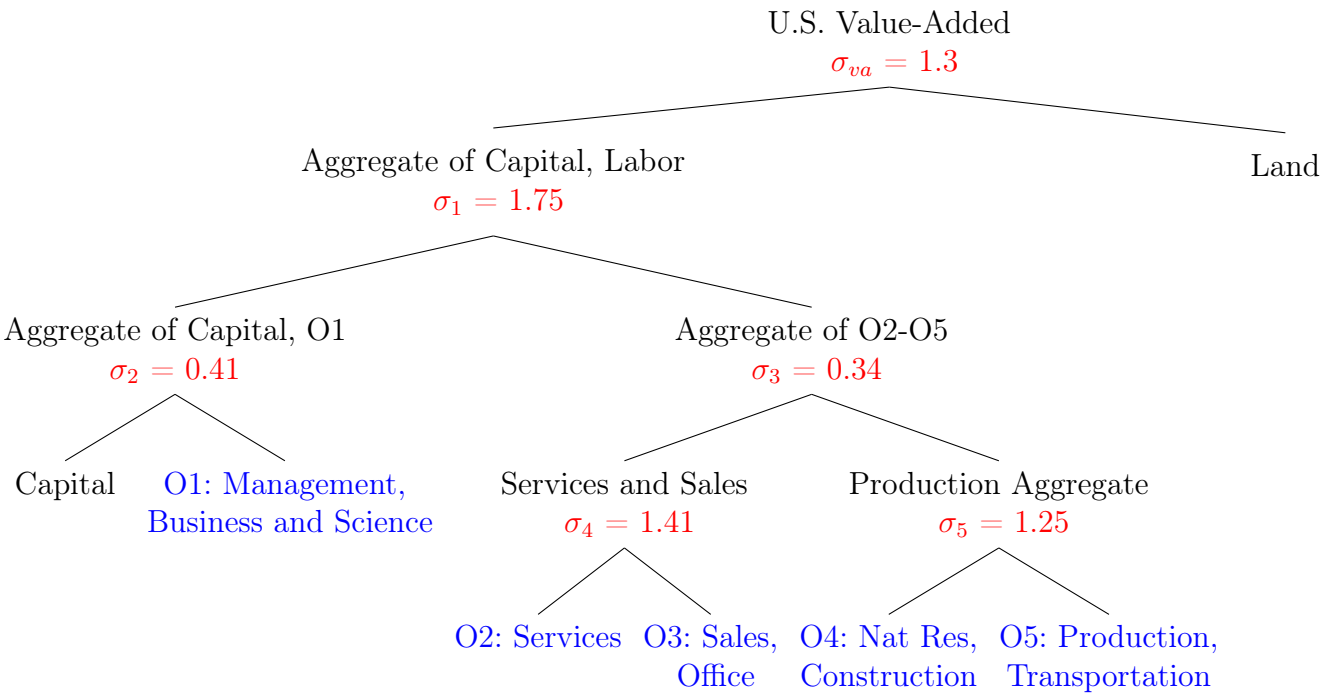
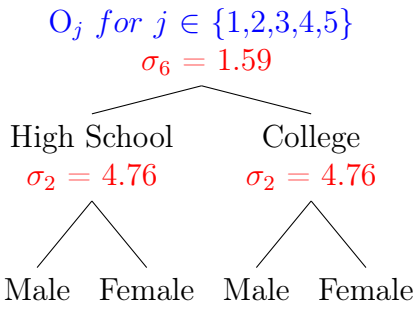


Figure 2: Education and Gender Nesting



depends on capital and a CES labor aggregate. Capital trades off directly with occupation 1, management, business, and science occupations. The elasticities of substitution indicate capital-skill complementarity, meaning growth in the capital stock increases relative demand for skilled labor (or $\sigma_1 > \sigma_2$). Each of the 65 U.S. sectors use the same CES elasticities in Table 1 and the same linkages in Figure 1. However, the primary factor demand price elasticities will be different from sector to sector because the sector i cost shares are different from those for sector j.

Table 2: Labor Supply Elasticities from Johnson and Keane (2013)

	Elasticity Estimate
High school male	0.74
College male	0.74
High school female	0.94
College female	1.13

Note: This table presents labor supply elasticities for high school and college men and women, as estimated in Johnson and Keane (2013). The equality in high school and college males is a coincidence.

We use the Johnson and Keane labor supply elasticities by gender and education level (Table 2). The inclusion of labor supply elasticities in the modified GTAP structure allows the labor inputs in the model to change in response to the real wage, rather than remain fixed as in the standard GTAP model. Therefore, workers in the model can enter the labor force if real wages increase and leave the labor force if real wages decline. This same approach is also described in detail in Gurevich et al. (2020).

4 Construction of the Wage Bill Share Matrix

A wage bill share matrix is needed to split wage payments in GTAP to each labor type. Wage bill shares for the U.S. region were calculated using the method described in this

section for each of the 20 labor types (table 3).[3]

Table 3: 20 Labor Types

	Female, High School	Female, College	Male, High School	Male, College
Management, Business, and Science (MBS)	F-H-1	F-C-1	M-H-1	M-C-1
Services	F-H-2	F-C-2	M-H-2	M-C-2
Sales and Office	F-H-3	F-C-3	M-H-3	M-C-3
Natural Resources, Construction, Maintenance (NCM)	F-H-4	F-C-4	M-H-4	M-C-4
Production, Transportation, Materials Moving (PTM)	F-H-5	F-C-5	M-H-5	M-C-5

Note: This table presents the twenty labor types used to disaggregate the labor factor input in GTAP: 2 genders, 2 education types, and 5 broad occupation categories. The labor type abbreviation is included in the table to help identify labor types later in this paper.

Wage bill shares were calculated with data from the 2017 Current Population Survey (CPS) Annual Social and Economic Supplements (ASEC).[4] The survey is a representative sample of U.S. households and contains detailed questions covering social and economic characteristics of each person who is a household member on the interview date. Observations do not include members of the Armed Forces living on post; only members living off post or living with their families on post where there is at least one civilian adult in the same household are included. In the 2017 survey used for this analysis, there are 95,006 households and 185,914 people surveyed, covering 278 selected core-based statistical areas (CBSA), 217 counties, and 76 central cities. The survey includes data on gender, education level, occupation, industry, and several measures of income. The CPS ASEC dataset was downloaded via the Integrated Public Use Microdata Series (IPUMS), a tool that provides census and survey data in readable formats for statistical software (Flood et al.; 2020).

Labor types were chosen to replicate the model structure of Johnson and Keane (2013), the source used for labor substitution and supply elasticities. There are two genders: male

[3]Note that we only augment the U.S. labor factor input, we are not disaggregating the other regions in the GTAP database. The rest of the regions use the standard GTAP structure.

[4]The CPS ASEC survey was used instead of U.S. Bureau of Labor Statistics (BLS) Occupational Employment Statistics (OES). The CPS ASEC works well for micro-level analysis because it contains rich employment and wage information for each observation. However, if one wanted to further disaggregate the survey by region, it may be difficult to perform state-level analyses with the CPS ASEC survey because of lower participation rates for some states.

Table 4: 2017 CPS ASEC Summary Statistics

Gender:	
Male	52.07%
Female	47.93%
Education:	
High school diploma or less	35.96%
Above high school diploma	64.04%

and female.[5] There are two levels of educational attainment: high school and college. The label high school refers to observations who received a high school diploma or less. College indicates any observation who has more than a high school education, including those who started college but did not finish.[6] Occupation types match the five broad occupation categories in the CPS, with some re-classifications. Occupation 1 includes management, business, and science occupations. Occupation 2 include services occupations and technicians. Occupation 3 are sales and office occupations. Occupation 4 includes occupations relating to natural resources, construction, extraction, maintenance and repair. Occupation 5 are production, transportation and materials moving occupations. As in Johnson and Keane, some of group 1 occupations were re-allocated to group 2 to better reflect skill levels and substitutability. See Table 14 at the end of this paper for a list of CPS occupation codes in each of the five groups.

The next step was to concord each observation's industry code to the 65 GTAP sectors using a customized GTAP to NAICS concordance.[7] First, GTAP sectors were concorded to ISIC Rev 4 codes using the standard GTAP-ISIC concordance on the GTAP website.[8] Then,

[5]The CPS ASEC survey question asks for the respondent's sex and lists male and female as the two answer options. The survey does not clarify if the question is referring to biological sex or gender. We use the term gender throughout.

[6]It may be interesting to split education into three types and include a type who started college but did not finish. This paper attempts to match the Johnson and Keane (2013) model structure to use their elasticity estimates. The college group was defined by the decision to attend, not completion status.

[7]The 65 GTAP sectors are listed here: `https://www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp`

[8]The GTAP-ISIC concordance can be found here: `https://www.gtap.agecon.purdue.edu/databases/contribute/concordinfo.asp`

ISIC Rev 4 codes were concorded to NAICS codes.[9] Some codes were manually matched based on the descriptions provided. Wage bill shares were then calculated for each GTAP sector and each of the 20 labor types using this concordance. Total wages, measured as pre-tax wage and salary income received as an employee for the previous calendar year, were summed for each labor group and GTAP sector. Shares were calculated within each sector as the labor type total wages divided by the total wages of the sector.

There is wide coverage of observations in each GTAP sector, with several dozen to several thousand observations per sector.[10] There are, however, some labor types in some of the GTAP sectors that do not have a wage bill share allocation. For example, there are no college-educated women in the survey who fall into the natural resources, construction, and maintenance occupation in the Accomodation, Food and Service Activities (AFS) GTAP sector. Zero shares for some labor types in certain GTAP sectors are expected.

Also, the agriculture industry codes provided in the CPS ASEC survey are detailed enough to delineate between crops and livestock, but do not provide enough detail to map to individual GTAP agricultural sectors.[11] For this reason, all GTAP crops sectors have the same crops wage bill shares, and all GTAP livestock-related sectors have the same livestock wage bill shares. Additional research and data sources are needed to calculate heterogeneous shares across GTAP agriculture sectors.

[9]The ISIC-NAICS concordance can be found here: `https://www.census.gov/eos/www/naics/concordances/concordances.html`

[10]The only exception is GTAP sector dwe: ownership of dwellings. This sector has no concorded observations. Labor shares for this sector were set to 1/20 for each of the 20 labor types.

[11]For example, census industry code 0170, crop production, maps to NAICS code 111. Census industry code 0180, animal production, maps to NAICS code 112. But it is not possible to tell if 0170 should map to GTAP code pdr (rice: seed, paddy), wht (wheat: seed, other), gro (other grains: maize, sorghum, barley, rye, oats, millets, other cereals), or another one of the GTAP crops sectors.

5 Experiments

We ran several distinct experiments using the disaggregated U.S. labor input to illustrate the distributional effects of trade on U.S. labor markets. All simulated results presented in this paper are intended to illustrate the technical modifications introduced into the GTAP database and model. In this section, we analyze aggregate employment effects by showing changes in wages and labor supply for all U.S. workers of each type. We do not present sectoral effects, though it should be noted that there are some sectors that expand and some that contract as a result of the hypothetical experiments presented here. Changes in equivalent variation by experiment are presented in table 16 at the end of this paper.

5.1 Heavy Manufacturing Simulations

In the first set of experiments, we simulated the effects of a hypothetical increase in U.S. tariff rates on imports of heavy manufacturing products from all trading partners by five percentage points. The GTAP sectors considered heavy manufactures are listed in table 15, and include petroleum, coal, chemical products, rubber, plastic, pharmaceutical, minerals, ferrous metals, computer, electronics, electrical equipment, and machinery. The labor supply elasticities from table 2 are used to allow labor supply to change in response to changes in the real wage rate. Wage and employment effects from this simulation are presented in table 5.

An increase in U.S. tariffs on heavy manufacturing sectors has differential effects on worker types because of the heterogeneity in labor shares across sectors. Sectors that expand as a result of the tariff increase will lead to higher demand for the types of workers already employed in those sectors in the baseline. This will lead to higher wages and employment for these types of workers. Sectors that contract as a result of the tariff increase will experience lower wages and labor supply. While all worker types experienced a decline in the real wage

Table 5: Simulated effects on wages and labor supply after U.S. tariff increases on all heavy manufacturing imports

	Nominal Wage (% Change)	Real Wage (% Change)	Labor Supply (% Change)
Male, high-school, services (M-H-2)	0.544	-0.030	-0.022
Male, college, services (M-C-2)	0.542	-0.032	-0.023
Female, high-school, services (F-H-2)	0.548	-0.026	-0.025
Female, college, services (F-C-2)	0.548	-0.026	-0.029
Male, college, sales (M-C-3)	0.509	-0.065	-0.048
Male, high-school, sales (M-H-3)	0.49	-0.084	-0.062
Female, college, sales (F-C-3)	0.511	-0.063	-0.071
Female, high-school, sales (F-H-3)	0.497	-0.077	-0.072
Male, college, MBS (M-C-1)	0.474	-0.1	-0.074
Female, college, MBS (F-C-1)	0.494	-0.08	-0.091
Female, high-school, MBS (F-H-1)	0.449	-0.125	-0.117
Male, high-school, MBS (M-H-1)	0.388	-0.186	-0.138
Male, college, PTM (M-C-5)	0.377	-0.197	-0.146
Male, high-school, PTM (M-H-5)	0.373	-0.201	-0.149
Female, high-school, PTM (F-H-5)	0.395	-0.179	-0.168
Female, college, PTM (F-C-5)	0.409	-0.165	-0.186
Female, college, NCM (M-C-4)	0.239	-0.335	-0.248
Male, high-school, NCM (M-H-4)	0.186	-0.388	-0.287
Female, high-school, NCM (F-H-4)	0.217	-0.357	-0.336
Female, college, NCM (F-C-4)	0.264	-0.31	-0.35

PTM = production, transportation, and materials moving occupations; NCM = natural resources, construction, and maintenance occupations; MBS = management, business and science occupations

following the 5 percent tariff increase, because of a reduction in the consumer price index, workers in natural resources, construction, extraction, maintenance and repair occupations experience the largest declines (M-C-4, M-H-4, F-H-4, and F-C-4). Both male and female workers in services sectors received the least negative declines in the real wage because a large portion of those workers are employed in service sectors that aren't directly competitive with sectors that receive the policy change. For example, highschool-educated males with services occupations are primarily employed in services sectors in GTAP. Of the workers categorized as M-H-2, 29.77% are employed in afs, accommodation, food, and services activities, 21.75% are employed in obs, other business services, and 18.0% in osg, other governmental services, services sectors that are not directly affected by a change in a heavy manufacturing tariff.

Workers with a high school degree or less experienced the largest wage effects, and male

Table 6: Simulated effects on wages and labor supply after ROW tariff increases on U.S. heavy manufacturing exports

	Nominal Wage (% Change)	Real Wage (% Change)	Labor Supply (% Change)
Female, high-school, PTM (F-H-5)	-2.044	-0.088	-0.082
Male, college, PTM (M-C-5)	-2.113	-0.157	-0.116
Male, high-school, PTM (M-H-5)	-2.117	-0.161	-0.119
Female, college, PTM (F-C-5)	-2.096	-0.139	-0.158
Male, college, MBS (M-C-1)	-2.175	-0.218	-0.161
Male, college, services (M-C-2)	-2.22	-0.263	-0.195
Female, college, MBS (F-C-1)	-2.152	-0.195	-0.221
Male, college, sales (M-C-3)	-2.273	-0.317	-0.234
Male, high-school, services (M-H-2)	-2.277	-0.32	-0.237
Male, high-school, sales (M-H-3)	-2.277	-0.321	-0.237
Female, high-school, MBS (F-H-1)	-2.24	-0.284	-0.267
Male, high-school, MBS (M-H-1)	-2.339	-0.382	-0.283
Female, high-school, services (F-H-2)	-2.279	-0.323	-0.303
Female, college, services (F-C-2)	-2.213	-0.256	-0.29
Female, high-school, sales (F-H-3)	-2.266	-0.309	-0.291
Female, college, sales (F-C-3)	-2.247	-0.29	-0.328
Male, college, NCM (M-C-4)	-2.834	-0.878	-0.649
Female, high-school, NCM (F-H-4)	-2.718	-0.761	-0.716
Male, high-school, NCM (M-H-4)	-2.957	-1.001	-0.741
Female, college, NCM (F-C-4)	-2.701	-0.744	-0.841

PTM = production, transportation, and materials moving occupations; NCM = natural resources, construction, and maintenance occupations; MBS = management, business and science occupations

workers had slightly larger wage effects than female workers. Despite larger wage effects for male workers, female workers had larger labor supply changes due in part to the higher supply elasticities for female workers in the model. All worker types experienced declines in labor supply following the declines in the real wage.

Workers labeled occupation 5–production, transportation, and materials moving occupations–were among the most negatively affected by the tariff change. This is surprising, because these are worker types who are commonly employed in sectors that expanded as a result of the heavy manufacturing tariffs. However, the 10 sectors considered heavy manufacturing employ 13.5% of workers labeled occupation 5. While the sectors that expanded demanded more of this type of labor, the overall effect is negative because of the sectors that contracted as a result of the policy change.

In the second hypothetical experiment, all other economies increase tariff rates on heavy manufacturing imports from the U.S. by five percentage points. Simulated effects on wages and labor supply are listed in table 6. The real wage declines most for both high-school and college level males in the natural resources, construction, extraction, maintenance and repair occupations, with largest effects on high-school males. Females in those occupations also experience large declines in the real wage, though not as large as their male counterparts. Labor supply declines are largest for college-educated females in these occupations, again largely due to the higher labor supply elasticity used in the model.

5.2 Agriculture Simulations

In the second set of experiments, tariff rates are increased by five percentage points on agricultural imports. The GTAP sectors included in the agriculture policy changes are listed in table 15 and include: rice, wheat, other grains, vegetables and fruit, oil seeds, cane and beet, fibres crops, other crops, cattle, other animal products, raw milk, wool, cattle meat, other meat, vegetable oils, milk, processed rice, sugar, other foods, beverages and tobacco products. First, U.S. tariff rates on agriculture imports from all other countries are increased by five percentage points. Effects on employment by labor type are presented in table 7.

Table 7 show differing impacts by labor type. After U.S. agriculture tariff increases, nominal wage changes are large enough for some worker types that real wage changes are actually positive. This leads to positive labor supply changes for both highschool- and college-educated females in natural resources and construction occupations. This is in part due to expanding U.S. production in agricultural sectors, like cattle (ctl), other crops (ocr), and wool (wol) production, that employ these types of workers.[12] Employment losses are largest for highschool- and college-educated females in the occupation 5.

[12]Cattle, for example, employs 13% of F-H-4 workers and 11% of F-C-4 workers in the baseline, so these worker types experience larger relative gains.

Table 7: Simulated effects on wages and labor supply after U.S. tariff increases on agriculture imports

	Nominal Wage (% Change)	Real Wage (% Change)	Labor Supply (% Change)
Female, high-school, NCM (F-H-4)	0.165	0.025	0.023
Female, college, NCM (F-C-4)	0.141	0.001	0.001
Male, high-school, NCM (M-H-4)	0.139	-0.001	-0.001
Male, college, NCM (M-C-4)	0.125	-0.015	-0.011
Male, high-school, MBS (M-H-1)	0.115	-0.025	-0.019
Male, college, services (M-C-2)	0.111	-0.03	-0.022
Female, high-school, MBS (F-H-1)	0.115	-0.025	-0.024
Male, high-school, services (M-H-2)	0.107	-0.033	-0.024
Male, high-school, sales (M-H-3)	0.107	-0.033	-0.024
Male, college, MBS (M-C-1)	0.106	-0.034	-0.025
Male, college, sales (M-C-3)	0.106	-0.034	-0.025
Female, college, services (F-C-2)	0.117	-0.024	-0.027
Female, high-school, services (F-H-2)	0.11	-0.03	-0.028
Female, high-school, sales (F-H-3)	0.111	-0.03	-0.028
Female, college, MBS (F-C-1)	0.11	-0.03	-0.034
Female, college, sales (F-C-3)	0.11	-0.03	-0.034
Male, high-school, PTM (M-H-5)	0.08	-0.06	-0.045
Male, college, PTM (M-C-5)	0.076	-0.065	-0.048
Female, high-school, PTM (F-H-5)	0.083	-0.057	-0.054
Female, college, PTM (F-C-5)	0.084	-0.056	-0.063

PTM = production, transportation, and materials moving occupations; NCM = natural resources, construction, and maintenance occupations; MBS = management, business and science occupations

When other countries increase tariff rates on U.S. exports of agriculture products (table 8), the reverse is true: workers in occupation 4 experience the most negative real wage and labor supply effects, and workers in occupation 5 the most positive. All workers in occupation 5 (along both gender and educational divides) actually see increases in wages and labor supply.

5.3 Services Simulations

In the third set of experiments, a trade policy change is implemented to reduce import flows of services trade. The policy change is entered as a shock to *tms* of five percentage points in GTAP. While this may seem counter-intuitive because services trade don't have

Table 8: Simulated effects on wages and labor supply after ROW tariff increases on U.S. agriculture exports

	Nominal Wage (% Change)	Real Wage (% Change)	Labor Supply (% Change)
Male, college, PTM (M-C-5)	-0.219	0.03	0.022
Female, college, PTM (F-C-5)	-0.23	0.019	0.021
Female, college, MBS (F-C-1)	-0.24	0.009	0.01
Male, college, MBS (M-C-1)	-0.238	0.011	0.008
Male, high-school, PTM (M-H-5)	-0.238	0.011	0.008
Female, high-school, PTM (F-H-5)	-0.242	0.007	0.007
Male, college, sales (M-C-3)	-0.254	-0.005	-0.004
Male, college, services (M-C-2)	-0.258	-0.009	-0.006
Female, college, sales (F-C-3)	-0.256	-0.007	-0.008
Male, high-school, sales (M-H-3)	-0.261	-0.012	-0.009
Male, high-school, services (M-H-2)	-0.263	-0.014	-0.011
Female, high-school, sales (F-H-3)	-0.262	-0.013	-0.012
Female, college, services (F-C-2)	-0.263	-0.014	-0.015
Female, high-school, services (F-H-2)	-0.266	-0.018	-0.016
Female, high-school, MBS (F-H-1)	-0.268	-0.019	-0.018
Male, high-school, MBS (M-H-1)	-0.283	-0.034	-0.025
Male, college, NCM (M-C-4)	-0.361	-0.112	-0.083
Male, high-school, NCM (M-H-4)	-0.407	-0.158	-0.117
Female, college, NCM (F-C-4)	-0.398	-0.149	-0.169
Female, high-school, NCM (F-H-4)	-0.51	-0.261	-0.245

PTM = production, transportation, and materials moving occupations; NCM = natural resources, construction, and maintenance occupations; MBS = management, business and science occupations

tariffs, we use this variable to illustrate effects on employment after a reduction in import flows for the services sectors of interest to match the other simulations as closely as possible. The GTAP sectors included in the services policy changes are listed in table 15 and include: electricity, gas manufacture, water supply, construction, wholesale and retail trade, accommodation, food and services, land transport, water transport, air transport, warehousing, information and communication, other financial intermediation, insurance, real estate, other business services, recreation, other services, government, education, health and social work, and ownership of dwellings. First, the U.S. imposes the policy change on services imports from all other countries. Second, all other countries impose the policy change on U.S. exports of services. Effects on employment by labor type are presented in table 9.

As shown in table 9, both male and female college-educated workers in services occu-

Table 9: Simulated effects on wages and labor supply after a reduction in U.S. services imports

	Nominal Wage (% Change)	Real Wage (% Change)	Labor Supply (% Change)
Female, college, services (F-C-2)	0.276	-0.013	-0.014
Male, college, services (M-C-2)	0.265	-0.024	-0.018
Male, high-school, services (M-H-2)	0.26	-0.029	-0.021
Female, college, MBS (F-C-1)	0.268	-0.021	-0.024
Female, high-school, services (F-H-2)	0.262	-0.027	-0.025
Male, college, MBS (M-C-1)	0.256	-0.034	-0.025
Male, college, sales (M-C-3)	0.252	-0.037	-0.027
Female, college, sales (F-C-3)	0.262	-0.027	-0.03
Female, high-school, sales (F-H-3)	0.256	-0.033	-0.031
Female, high-school, MBS (F-H-1)	0.254	-0.035	-0.033
Male, high-school, sales (M-H-3)	0.243	-0.046	-0.034
Male, high-school, MBS (M-H-1)	0.229	-0.06	-0.045
Male, high-school, NCM (M-H-4)	0.185	-0.104	-0.077
Male, college, NCM (M-C-4)	0.184	-0.105	-0.078
Female, high-school, NCM (F-H-4)	0.18	-0.109	-0.103
Female, college, NCM (F-C-4)	0.19	-0.099	-0.112
Male, college, PTM (M-C-5)	0.122	-0.167	-0.123
Male, high-school, PTM (M-H-5)	0.103	-0.187	-0.138
Female, college, PTM (F-C-5)	0.13	-0.159	-0.18
Female, high-school, PTM (F-H-5)	0.096	-0.193	-0.182

PTM = production, transportation, and materials moving occupations; NCM = natural resources, construction, and maintenance occupations; MBS = management, business and science occupations

pations experience the highest nominal wage gains, and the least negative real wage and employment changes. This is because these worker types are largely employed in sectors that directly compete with the imports facing the policy change, so a reduction in services imports will benefit U.S. services workers the most. Female workers have on average higher nominal wage changes than men of similar education level and occupation. When other economies implement policy changes on U.S. services exports (table 10), both highschool- and college-educated males in services occupations experience the largest decline in wages, and both highschool- and college-educated females in services occupations experience the largest decline in labor supply. Workers of occupation 5–production, transportation, and materials moving occupations– have increases in labor supply, because workers in these occupations are not typically employed in the services industries that experienced the shock.

Table 10: Simulated effects on wages and labor supply after a reduction in U.S. services exports

	Nominal Wage (% Change)	Real Wage (% Change)	Labor Supply (% Change)
Female, high-school, PTM (F-H-5)	-0.561	0.261	0.246
Female, college, PTM (F-C-5)	-0.645	0.177	0.2
Male, high-school, PTM (M-H-5)	-0.61	0.212	0.157
Male, college, PTM (M-C-5)	-0.652	0.17	0.126
Male, high-school, sales (M-H-3)	-1.014	-0.192	-0.142
Male, high-school MBS (M-H-1)	-1.018	-0.195	-0.144
Male, college, sales (M-C-3)	-1.029	-0.206	-0.153
Male, college, MBS (M-C-1)	-1.031	-0.208	-0.154
Female, high-school, MBS (F-H-1)	-1.029	-0.206	-0.194
Female, high-school, sales (F-H-3)	-1.039	-0.216	-0.203
Male, college, NCM (M-C-4)	-1.105	-0.282	-0.209
Male, college, services (M-C-2)	-1.109	-0.286	-0.212
Female, high-school, NCM (F-H-4)	-1.063	-0.24	-0.226
Male, high-school, services (M-H-2)	-1.135	-0.313	-0.232
Female, college, sales (F-C-3)	-1.036	-0.214	-0.242
Female, college, MBS (F-C-1)	-1.038	-0.216	-0.244
Male, high-school, NCM (M-H-4)	-1.165	-0.343	-0.254
Female, college, NCM (F-C-4)	-1.066	-0.243	-0.275
Female, high-school, services (F-H-2)	-1.136	-0.314	-0.295
Female, college, services (F-C-2)	-1.108	-0.285	-0.322

PTM = production, transportation, and materials moving occupations; NCM = natural resources, construction, and maintenance occupations; MBS = management, business and science occupations

These results are unsurprising.

6 Conclusion

This paper provides a methodology to disaggregate the U.S. labor primary factor input in GTAP by gender, education, and broad occupation type to understand U.S. worker exposure to trade. A database of wage bill shares by disaggregated labor type and GTAP sector is provided to split U.S. labor payments. It also describes suggested changes to the GTAP model structure, and includes labor supply and substitution elasticities from the literature to use for parameters.

Trade policy simulations on heavy manufacturing, agriculture, and services sectors use

the methodology provided to illustrate the differential impacts on worker types. U.S. trade policy changes on imports of services, for example, have most positive impacts on college-educated females in services occupations. When other countries increase tariffs on U.S. agricultural products, U.S. workers in natural resources, construction, maintenance and repair occupations are most negatively affected.

There are a few limitations to our approach. First, the CPS ASEC dataset used to calculate wage bill shares is a representative sample of U.S. consumers, and does not provide detailed industry codes for agricultural sectors. Because of this, all crops sectors receive the same labor shares and all livestock-related sectors receive the same labor shares. An extension of this work could focus on heterogeneity in wage bill shares for the agriculture sectors. Second, we were unable to find different labor supply elasticities in the literature for different occupational groups, so labor supply elasticities provided in this paper are only gender- and education- specific. It is reasonable to expect workers in different occupations to have different labor supply elasticities, so additional research in this area would be helpful.

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Table 11: Wage Bill Share Matrix by Gender, Education, Occupation, and GTAP Sector

GTAP	F-C-1	F-C-2	F-C-3	F-C-4	F-C-5	F-H-1	F-H-2	F-H-3	F-H-4	F-H-5	M-C-1	M-C-2	M-C-3	M-C-4	M-C-5	M-H-1	M-H-2	M-H-3	M-H-4	M-H-5	Total
afs	0.074	0.126	0.023	.	0.003	0.041	0.150	0.030	.	0.004	0.121	0.131	0.011	0.001	0.012	0.052	0.196	0.011	0.002	0.013	1.00
atp	0.046	0.007	0.058	0.005	0.073	0.005	.	0.018	.	0.014	0.100	0.019	0.039	0.099	0.359	0.007	0.005	0.036	0.041	0.069	1.00
b_t	0.182	0.028	0.007	.	0.016	0.001	.	0.021	.	0.009	0.202	0.015	0.075	0.053	0.106	0.065	0.000	0.028	0.027	0.167	1.00
bph	0.265	0.029	0.052	.	0.056	0.004	.	0.007	0.001	0.004	0.402	0.020	0.022	0.007	0.071	0.005	0.009	0.003	0.008	0.038	1.00
c_b	0.049	0.001	0.033	0.019	0.001	0.011	0.001	0.013	0.046	0.001	0.198	0.030	0.017	0.096	0.023	0.078	0.004	0.005	0.326	0.047	1.00
chm	0.133	0.004	0.074	.	0.013	0.010	0.005	0.004	.	0.032	0.340	0.024	0.076	0.023	0.092	0.058	0.006	0.008	0.010	0.089	1.00
cmn	0.139	0.066	0.099	0.001	0.001	0.011	0.005	0.022	0.001	.	0.318	0.083	0.071	0.074	0.003	0.031	0.013	0.022	0.037	0.004	1.00
cmt	0.026	0.025	0.016	0.005	0.057	0.025	0.009	0.009	0.032	0.160	0.064	0.006	0.020	0.030	0.108	0.031	0.007	0.020	0.037	0.317	1.00
cns	0.029	0.001	0.019	0.007	0.001	0.006	0.001	0.011	0.005	0.001	0.204	0.006	0.012	0.196	0.016	0.072	0.003	0.003	0.385	0.021	1.00
coa	0.008	.	.	0.027	.	.	.	0.032	.	.	0.049	0.014	0.044	0.340	0.061	0.017	0.001	.	0.338	0.069	1.00
ctl	0.116	0.007	0.003	0.034	.	0.017	0.003	0.003	0.041	0.009	0.212	0.009	0.007	0.110	.	0.110	0.009	0.001	0.270	0.037	1.00
edu	0.096	0.533	0.034	0.001	0.004	0.003	0.037	0.009	0.000	0.004	0.060	0.181	0.002	0.004	0.005	0.001	0.018	0.001	0.004	0.004	1.00
eeq	0.079	.	0.027	.	0.035	.	0.002	0.005	.	0.046	0.375	0.054	0.092	0.016	0.093	0.034	0.016	0.011	0.011	0.105	1.00
ele	0.159	0.004	0.027	0.002	0.022	0.024	0.003	0.003	0.001	0.021	0.539	0.039	0.041	0.012	0.042	0.013	0.006	0.006	0.004	0.030	1.00
ely	0.117	0.009	0.035	0.001	0.006	0.008	0.009	0.008	.	0.001	0.308	0.050	0.033	0.132	0.109	0.015	0.009	0.030	0.072	0.048	1.00
fmp	0.028	0.001	0.031	.	0.009	0.004	0.002	0.012	0.001	0.020	0.223	0.016	0.070	0.024	0.175	0.050	0.008	0.022	0.047	0.259	1.00
frs	0.062	0.039	0.016	0.018	0.008	.	.	.	0.000	.	0.122	0.160	0.015	0.171	0.028	0.014	0.012	0.008	0.191	0.134	1.00
fsh	0.076	0.015	.	.	.	.	0.061	0.002	.	.	0.015	0.069	0.045	.	0.048	.	0.058	0.273	0.233	0.106	1.00
gas	0.030	0.025	0.016	.	.	0.018	0.001	.	.	.	0.616	.	.	0.082	0.013	0.063	0.007	0.006	0.114	0.010	1.00
gdt	0.020	0.012	0.002	.	.	0.025	0.001	.	.	.	0.328	0.004	0.033	0.128	0.118	0.047	0.018	0.038	0.096	0.131	1.00
gro	0.049	0.001	0.033	0.019	0.001	0.011	0.001	0.013	0.046	0.001	0.198	0.030	0.017	0.096	0.023	0.078	0.004	0.005	0.326	0.047	1.00
hht	0.209	0.114	0.070	.	0.002	0.004	0.014	0.033	.	0.001	0.523	0.017	0.004	.	0.002	0.004	0.002	0.001	0.000	.	1.00
i_s	0.007	.	.	.	.	.	.	0.041	.	0.026	0.068	.	0.073	0.060	0.143	0.032	0.022	0.053	0.092	0.384	1.00
ins	0.213	0.058	0.154	0.001	0.002	0.036	0.003	0.049	0.001	.	0.293	0.010	0.160	0.003	.	0.008	0.001	0.008	0.000	.	1.00
lea	0.243	.	0.039	.	0.050	.	.	.	.	0.090	0.321	0.029	.	0.017	0.062	.	.	0.006	0.046	0.096	1.00
lum	0.038	0.012	0.023	0.005	0.034	0.010	.	0.005	.	0.039	0.150	0.017	0.062	0.024	0.082	0.027	0.007	0.009	0.091	0.367	1.00
mil	.	0.010	0.006	.	0.043	.	0.018	0.007	0.008	0.055	0.086	0.024	0.097	0.045	0.187	0.043	0.027	0.025	0.072	0.248	1.00
mvh	0.046	0.009	0.008	.	0.049	0.000	0.001	0.004	0.004	0.068	0.273	0.028	0.008	0.048	0.164	0.028	0.005	0.011	0.050	0.195	1.00
nfm	0.034	.	0.055	.	0.028	.	.	0.020	0.007	0.035	0.241	.	.	0.056	0.180	.	0.021	0.004	0.016	0.301	1.00
nmm	0.024	0.007	0.033	.	0.012	0.004	.	0.014	.	0.037	0.192	0.004	0.036	0.035	0.137	0.041	0.003	0.017	0.030	0.375	1.00
oap	0.116	0.007	0.003	0.034	.	0.017	0.003	0.003	0.041	0.009	0.212	0.009	0.007	0.110	.	0.110	0.009	0.001	0.270	0.037	1.00
obs	0.207	0.033	0.042	0.001	0.002	0.008	0.015	0.016	0.000	0.003	0.492	0.044	0.038	0.008	0.010	0.024	0.034	0.007	0.007	0.007	1.00
ocr	0.049	0.001	0.033	0.019	0.001	0.011	0.001	0.013	0.046	0.001	0.198	0.030	0.017	0.096	0.023	0.078	0.004	0.005	0.326	0.047	1.00
ofd	0.057	0.070	0.057	0.013	0.060	0.023	0.010	0.031	0.011	0.097	0.125	0.008	0.068	0.014	0.096	0.026	0.016	0.026	0.010	0.182	1.00
ofi	0.232	0.006	0.084	0.000	0.001	0.024	0.001	0.030	0.000	0.000	0.483	0.003	0.107	0.001	0.001	0.021	0.001	0.005	.	0.001	1.00
oil	0.030	0.025	0.016	.	.	0.018	0.001	.	.	.	0.616	.	.	0.082	0.013	0.063	0.007	0.006	0.114	0.010	1.00
ome	0.089	0.010	0.030	0.002	0.026	0.007	0.002	0.015	0.000	0.042	0.354	0.029	0.049	0.042	0.103	0.044	0.006	0.009	0.016	0.124	1.00
omf	0.046	0.003	0.042	0.002	0.018	0.006	0.001	0.025	.	0.053	0.233	0.033	0.068	0.027	0.101	0.043	0.007	0.036	0.033	0.223	1.00
omt	0.026	0.025	0.016	0.005	0.057	0.025	0.009	0.009	0.032	0.160	0.064	0.006	0.020	0.030	0.108	0.031	0.007	0.020	0.037	0.317	1.00
osd	0.049	0.001	0.033	0.019	0.001	0.011	0.001	0.013	0.046	0.001	0.198	0.030	0.017	0.096	0.023	0.078	0.004	0.005	0.326	0.047	1.00
osg	0.205	0.222	0.054	0.001	0.001	0.010	0.043	0.020	0.000	0.001	0.231	0.122	0.023	0.008	0.005	0.008	0.027	0.006	0.008	0.004	1.00
otn	0.076	0.008	0.022	0.001	0.011	0.003	0.002	0.014	.	0.024	0.462	0.046	0.026	0.049	0.101	0.019	0.004	0.006	0.041	0.086	1.00
otp	0.027	0.006	0.028	0.001	0.027	0.006	0.002	0.024	.	0.023	0.109	0.013	0.042	0.040	0.227	0.023	0.002	0.025	0.039	0.333	1.00
oxt	0.042	0.003	0.010	0.002	0.001	0.008	0.001	0.007	0.004	0.006	0.297	0.019	0.010	0.162	0.044	0.073	0.049	0.017	0.179	0.066	1.00
p_c	0.051	0.016	0.025	.	0.013	0.003	.	0.004	.	0.009	0.349	0.008	0.032	0.088	0.159	0.020	0.011	.	0.035	0.178	1.00
pcr	0.121	0.016	0.015	0.026	0.012	0.017	0.001	0.006	0.012	0.030	0.299	0.013	.	0.063	0.087	0.044	0.001	.	0.033	0.205	1.00
pdr	0.049	0.001	0.033	0.019	0.001	0.011	0.001	0.013	0.046	0.001	0.198	0.030	0.017	0.096	0.023	0.078	0.004	0.005	0.326	0.047	1.00
pfb	0.049	0.001	0.033	0.019	0.001	0.011	0.001	0.013	0.046	0.001	0.198	0.030	0.017	0.096	0.023	0.078	0.004	0.005	0.326	0.047	1.00
ppp	0.122	0.067	0.035	0.003	0.007	0.010	0.003	0.008	.	0.019	0.292	0.116	0.076	0.028	0.059	0.018	0.014	0.007	0.019	0.096	1.00
rmk	0.116	0.007	0.003	0.034	.	0.017	0.003	0.003	0.041	0.009	0.212	0.009	0.007	0.110	.	0.110	0.009	0.001	0.270	0.037	1.00
ros	0.072	0.214	0.033	0.001	0.000	0.007	0.151	0.017	0.001	0.003	0.101	0.211	0.031	0.016	0.007	0.009	0.098	0.008	0.018	0.003	1.00
rpp	0.034	0.002	0.018	.	0.025	0.013	0.002	0.010	.	0.108	0.133	0.040	0.069	0.037	0.112	0.031	0.015	0.009	0.069	0.273	1.00
rsa	0.137	0.014	0.168	0.000	0.000	0.020	0.005	0.044	0.001	0.002	0.249	0.015	0.200	0.012	0.007	0.042	0.032	0.018	0.025	0.009	1.00
sgr	0.160	0.045	0.051	.	0.061	.	.	0.020	.	0.077	0.076	.	0.033	0.017	0.116	.	.	0.015	0.045	0.286	1.00
tex	0.031	0.073	0.028	.	0.046	0.017	0.006	0.049	.	0.101	0.165	0.051	0.009	.	0.100	0.023	.	0.028	0.050	0.223	1.00
trd	0.062	0.023	0.129	0.001	0.007	0.010	0.019	0.081	0.001	0.010	0.113	0.020	0.224	0.037	0.034	0.015	0.014	0.094	0.046	0.059	1.00
v_f	0.049	0.001	0.033	0.019	0.001	0.011	0.001	0.013	0.046	0.001	0.198	0.030	0.017	0.096	0.023	0.078	0.004	0.005	0.326	0.047	1.00
vol	0.121	0.016	0.015	0.026	0.012	0.017	0.001	0.006	0.012	0.030	0.299	0.013	.	0.063	0.087	0.044	0.001	.	0.033	0.205	1.00
wap	0.149	0.061	0.122	.	0.087	0.005	.	0.024	0.002	0.178	0.117	0.008	0.058	.	0.057	0.026	.	0.014	0.021	0.072	1.00
whs	0.062	0.070	0.040	.	0.020	0.011	.	0.048	.	0.043	0.121	0.004	0.086	0.019	0.096	0.024	0.016	0.070	0.008	0.263	1.00
wht	0.049	0.001	0.033	0.019	0.001	0.011	0.001	0.013	0.046	0.001	0.198	0.030	0.017	0.096	0.023	0.078	0.004	0.005	0.326	0.047	1.00
wol	0.039	.	0.051	.	.	.	.	0.020	.	.	0.295	0.035	0.163	0.073	0.022	0.083	0.021	0.059	0.011	0.129	1.00
wtp	0.182	0.030	0.020	.	.	.	0.008	0.033	.	.	0.054	0.017	.	.	0.311	0.058	0.012	.	.	0.275	1.00
wtr	0.058	0.004	0.033	0.001	0.012	0.007	.	0.019	0.000	0.025	0.167	0.006	0.038	0.042	0.126	0.048	0.004	0.013	0.074	0.323	1.00

Note: This table presents the wage bill shares assigned to each gtap sector. The columns represent each of the 20 labor types, where 'F' indicates female, 'M' male, 'C' college, 'H' high school, and the third number (1 through 5) indicates the occupation type. Data used to create this table was downloaded from the CPS ASEC 2017 report.

Table 12: Mean Income by Gender, Education, Occupation, and GTAP Sector

GTAP	F-C-1	F-C-2	F-C-3	F-C-4	F-C-5	F-H-1	F-H-2	F-H-3	F-H-4	F-H-5	M-C-1	M-C-2	M-C-3	M-C-4	M-C-5	M-H-1	M-H-2	M-H-3	M-H-4	M-H-5
afs	36,714	17,166	14,813	.	16,340	28,594	14,551	9,152	.	16,483	56,634	23,257	21,061	79,500	22,755	45,296	18,529	11,072	38,400	20,130
atp	56,647	35,250	34,261	50,000	41,876	36,040	.	37,642	.	23,692	73,785	49,749	42,009	82,085	93,044	68,500	52,000	37,695	71,663	57,419
b_t	71,045	59,750	30,000	.	19,437	10,000	.	35,280	.	19,250	86,630	33,250	64,100	50,667	50,454	61,667	600	48,400	45,641	44,767
bph	112,004	67,908	69,303	.	123,962	60,000	.	33,662	22,000	26,400	133,365	56,327	83,375	35,933	91,411	72,450	56,736	41,500	58,290	45,492
c_b	25,419	28,000	33,933	18,111	16,830	10,118	1,485	16,244	11,236	15,000	26,292	199,667	67,045	28,778	37,355	15,958	19,000	19,600	26,200	29,230
chm	87,588	48,500	81,605	.	28,160	78,333	42,000	32,739	.	29,063	105,884	58,412	87,427	68,750	50,935	87,469	36,950	46,230	78,000	39,440
cmn	107,536	47,785	45,313	50,000	56,026	61,072	21,159	31,139	25,367	.	107,966	62,512	66,115	57,981	33,371	94,120	43,104	40,599	51,817	23,262
cmt	47,186	52,000	20,160	31,011	25,842	45,429	28,278	29,000	57,143	23,282	62,077	80,000	62,000	41,847	39,033	56,000	28,433	35,633	42,409	32,927
cns	57,750	30,192	34,844	34,899	34,101	43,119	19,635	28,648	20,001	30,667	86,353	47,836	57,697	43,548	51,375	60,591	38,806	37,588	37,762	39,300
coa	40,000	.	.	71,000	.	.	.	57,000	.	.	65,750	76,000	117,000	78,609	81,150	90,000	4,992	.	66,517	73,200
ctl	38,582	20,618	17,697	24,719	.	11,954	10,545	27,900	16,534	23,500	27,505	30,136	40,000	33,886	.	15,170	24,710	24,000	26,789	68,896
edu	63,586	43,882	37,592	170,000	25,109	32,398	18,470	26,885	73,000	22,157	86,076	53,096	36,247	50,296	32,773	30,145	25,463	28,442	39,798	32,585
eeq	60,579	.	48,375	.	29,601	.	34,000	39,173	.	32,181	92,676	71,227	89,276	46,000	53,940	55,222	45,200	81,501	55,667	40,080
ele	107,264	51,000	55,411	52,000	40,964	115,222	28,679	36,820	27,000	25,457	112,975	61,405	84,096	50,601	44,674	36,628	55,200	38,355	60,667	42,186
ely	128,777	89,600	39,680	75,000	77,500	68,500	94,000	42,400	.	56,000	114,749	129,788	62,728	85,343	112,583	88,333	94,200	117,975	61,363	72,796
fmp	55,875	15,760	41,521	.	34,432	82,500	27,333	29,219	40,000	25,571	110,225	77,750	77,353	43,267	50,270	65,058	39,817	47,889	49,558	37,752
frs	69,550	55,250	45,800	33,333	42,500	.	.	.	2,744	.	76,444	49,917	27,333	35,577	39,750	39,000	70,000	22,800	29,864	50,267
fsh	68,000	13,000	.	.	.	.	55,000	1,500	.	.	12,999	62,000	8,000	.	21,300	.	12,950	9,052	69,667	31,667
gas	67,667	56,467	26,866	.	.	120,000	9,400	.	.	.	182,835	.	.	92,917	92,000	86,000	50,000	40,000	70,682	65,000
gdt	58,500	70,000	11,000	.	.	72,500	5,000	.	.	.	112,517	20,500	64,667	74,450	86,406	68,750	52,500	37,334	61,944	84,836
gro	25,419	28,000	33,933	18,111	16,830	10,118	1,485	16,244	11,236	15,000	26,292	199,667	67,045	28,778	37,355	15,958	19,000	19,600	26,200	29,230
hht	120,922	40,806	31,408	.	51,750	37,540	33,044	29,813	.	50,000	238,965	49,525	36,367	.	46,167	119,000	35,450	13,000	32,000	.
i_s	14,000	.	.	.	.	.	.	42,000	.	27,000	70,000	.	150,000	61,500	48,849	66,000	45,000	54,000	63,000	52,613
ins	77,913	86,047	41,763	73,000	75,000	59,419	40,571	39,293	73,000	.	109,453	61,747	70,885	68,400	.	66,115	34,175	30,687	50,000	.
lea	105,250	.	22,400	.	29,000	.	.	.	.	26,125	111,200	50,000	.	30,000	21,500	.	.	10,700	80,000	20,879
lum	55,613	47,000	33,895	31,483	33,758	61,500	.	27,250	.	30,473	77,457	49,250	72,950	71,600	33,457	53,667	28,667	50,480	38,357	40,636
mil	.	45,000	25,000	.	37,088	.	38,500	15,175	16,500	23,714	93,530	52,500	210,000	48,250	40,485	62,040	38,667	36,100	38,987	41,369
mvh	75,630	37,778	24,917	.	36,469	9,000	20,000	28,061	51,432	33,442	101,665	55,711	63,663	60,373	49,751	79,720	35,000	36,531	53,381	40,335
nfm	70,001	.	44,800	.	28,409	.	.	20,813	30,000	23,939	108,667	.	.	56,850	48,868	.	42,500	17,000	65,002	45,261
nmm	192,500	29,250	41,538	.	33,250	65,000	.	37,083	.	35,151	103,887	20,837	58,784	56,100	48,435	66,260	13,933	67,400	44,500	60,388
oap	38,582	20,618	17,697	24,719	.	11,954	10,545	27,900	16,534	23,500	27,505	30,136	40,000	33,886	.	15,170	24,710	24,000	26,789	68,896
obs	76,396	32,897	35,599	27,962	22,388	39,861	15,682	28,347	25,673	23,270	106,968	37,238	65,100	44,165	50,699	73,085	23,695	33,366	37,764	26,089
ocr	25,419	28,000	33,933	18,111	16,830	10,118	1,485	16,244	11,236	15,000	26,292	199,667	67,045	28,778	37,355	15,958	19,000	19,600	26,200	29,230
ofd	65,198	144,545	31,090	30,700	23,479	44,167	20,258	25,003	25,608	19,411	83,677	38,416	59,881	46,571	33,163	53,455	21,829	38,941	26,492	33,425
ofi	79,984	40,621	41,729	55,000	42,571	50,314	23,992	32,290	55,000	70,000	129,046	52,077	106,385	68,333	35,000	84,179	27,903	32,219	.	50,800
oil	67,667	56,467	26,866	.	.	120,000	9,400	.	.	.	182,835	.	.	92,917	92,000	86,000	50,000	40,000	70,682	65,000
ome	73,636	41,000	42,457	110,000	38,978	48,900	37,785	37,424	20,000	29,118	102,700	54,798	85,911	63,833	48,920	102,190	52,850	41,393	53,415	41,939
omf	52,067	14,075	35,917	40,000	26,853	46,200	21,000	25,544	.	22,442	91,543	67,756	79,559	58,044	37,290	63,558	25,342	76,168	40,701	41,371
omt	47,186	52,000	20,160	31,011	25,842	45,429	28,278	29,000	57,143	23,282	62,077	80,000	62,000	41,847	39,033	56,000	28,433	35,633	42,409	32,927
osd	25,419	28,000	33,933	18,111	16,830	10,118	1,485	16,244	11,236	15,000	26,292	199,667	67,045	28,778	37,355	15,958	19,000	19,600	26,200	29,230
osg	69,974	40,838	35,514	28,020	26,680	41,802	21,216	32,119	14,936	21,170	98,934	54,738	51,814	47,123	42,144	61,896	37,137	43,145	54,492	35,591
otn	75,970	85,500	45,652	36,720	28,062	55,500	43,500	45,154	.	37,295	108,136	79,453	94,333	58,412	57,010	64,385	58,000	46,667	60,445	42,980
otp	61,926	32,865	32,724	57,000	28,364	44,624	20,663	28,889	.	27,518	81,366	67,451	48,361	52,928	43,056	58,664	40,167	38,439	45,999	42,331
oxt	84,682	63,553	38,017	33,500	65,000	87,500	14,750	38,945	34,800	63,750	161,142	74,402	76,500	75,724	62,025	100,051	178,834	58,082	65,052	53,687
p_c	66,625	170,000	87,000	.	66,560	28,000	.	45,000	.	48,280	130,893	80,000	68,000	77,417	72,674	69,000	57,500	.	46,500	64,386
pcr	65,545	30,961	14,467	77,000	35,500	32,667	5,200	36,400	36,500	25,214	126,679	40,000	.	75,146	57,208	44,000	6,000	.	27,914	50,623
pdr	25,419	28,000	33,933	18,111	16,830	10,118	1,485	16,244	11,236	15,000	26,292	199,667	67,045	28,778	37,355	15,958	19,000	19,600	26,200	29,230
pfb	25,419	28,000	33,933	18,111	16,830	10,118	1,485	16,244	11,236	15,000	26,292	199,667	67,045	28,778	37,355	15,958	19,000	19,600	26,200	29,230
ppp	78,512	48,391	37,559	63,000	24,596	43,491	9,027	20,543	.	30,452	107,340	62,294	97,052	70,860	46,038	63,938	31,987	27,922	70,793	45,017
rmk	38,582	20,618	17,697	24,719	.	11,954	10,545	27,900	16,534	23,500	27,505	30,136	40,000	33,886	.	15,170	24,710	24,000	26,789	68,896
ros	64,129	19,258	20,722	18,672	8,660	30,468	15,128	17,413	16,700	23,174	84,659	32,661	36,673	41,129	38,458	35,878	18,349	20,303	48,967	10,564
rpp	68,627	18,500	37,193	.	22,860	48,033	35,000	36,796	.	49,988	84,657	81,270	76,335	54,288	47,035	69,254	34,200	35,033	81,171	56,197
rsa	50,635	29,774	40,710	900	12,000	36,503	14,544	38,024	17,000	30,000	82,502	30,199	70,608	32,251	63,519	62,555	28,944	37,406	34,895	40,682
sgr	53,000	45,000	33,667	.	20,233	.	.	19,500	.	21,767	150,000	.	65,000	33,000	38,367	.	.	29,000	44,500	35,504
tex	51,000	53,467	36,686	.	19,111	55,000	40,000	32,343	.	21,364	98,774	67,400	60,000	.	46,743	76,500	.	45,460	36,211	34,131
trd	61,813	22,743	27,853	31,782	21,122	42,287	19,155	21,125	19,000	17,758	93,993	31,811	51,985	43,371	34,110	53,569	22,529	31,297	37,717	31,566
v_f	25,419	28,000	33,933	18,111	16,830	10,118	1,485	16,244	11,236	15,000	26,292	199,667	67,045	28,778	37,355	15,958	19,000	19,600	26,200	29,230
vol	65,545	30,961	14,467	77,000	35,500	32,667	5,200	36,400	36,500	25,214	126,679	40,000	.	75,146	57,208	44,000	6,000	.	27,914	50,623
wap	66,250	32,504	59,386	.	24,412	26,000	.	32,500	4,000	16,950	89,429	41,000	154,000	.	60,800	34,370	.	72,000	37,493	23,850
whs	44,068	375,600	28,230	.	16,462	16,686	.	24,344	.	21,840	67,895	21,500	61,537	51,250	29,471	42,143	42,300	25,673	28,440	30,554
wht	25,419	28,000	33,933	18,111	16,830	10,118	1,485	16,244	11,236	15,000	26,292	199,667	67,045	28,778	37,355	15,958	19,000	19,600	26,200	29,230
wol	56,250	.	16,400	.	.	.	.	28,600	.	.	106,000	50,000	58,500	69,667	31,000	59,250	29,500	42,490	15,269	37,120
wtp	156,000	19,375	25,500	.	.	.	20,000	42,500	.	.	69,000	43,000	.	.	57,000	37,000	32,000	.	.	54,169
wtr	61,156	33,750	39,475	23,000	38,667	46,147	.	46,325	5,000	27,724	99,730	27,225	66,382	47,300	46,202	48,139	28,333	28,444	49,017	42,553

Note: This table presents mean wages by gender, education, occupation, and GTAP sector. The columns represent each of the 20 labor types, where 'F' indicates female, 'M' male, 'C' college, 'H' high school, and the third number (1 through 5) indicates the occupation type. Data used to create this table was downloaded from the CPS ASEC 2017 report.

Table 13: Status Quo Employment Shares by Labor Type

ID	Description	Share
F-C-1	Female; College-educated; Management, Business, Science Occ	9.29968
F-C-2	Female; College-educated; Services Occ	13.7595
F-C-3	Female; College-educated; Sales Occ	8.50495
F-C-4	Female; College-educated; Natural Resources, Construction, Maintenance and Repair Occ	0.22413
F-C-5	Female; College-educated; Production, Transportation, Materials Moving Occ	1.05892
F-H-1	Female; Highschool-educated; Management, Business, Science Occ	1.27331
F-H-2	Female; Highschool-educated; Services Occ	6.69352
F-H-3	Female; Highschool-educated; Sales Occ	5.2264
F-H-4	Female; Highschool-educated; Natural Resources, Construction, Maintenance and Repair Occ	0.33998
F-H-5	Female; Highschool-educated; Production, Transportation, Materials Moving Occ	1.72156
M-C-1	Male; College-educated; Management, Business, Science Occ	12.4429
M-C-2	Male; College-educated; Services Occ	6.80504
M-C-3	Male; College-educated; Sales Occ	5.13004
M-C-4	Male; College-educated; Natural Resources, Construction, Maintenance and Repair Occ	3.36192
M-C-5	Male; College-educated; Production, Transportation, Materials Moving Occ	3.38032
M-H-1	Male; Highschool-educated; Management, Business, Science Occ	1.91537
M-H-2	Male; Highschool-educated; Services Occ	4.70993
M-H-3	Male; Highschool-educated; Sales Occ	2.85628
M-H-4	Male; Highschool-educated; Natural Resources, Construction, Maintenance and Repair Occ	5.78401
M-H-5	Male; Highschool-educated; Production, Transportation, Materials Moving Occ	5.51225

Note: This table presents US employment shares by labor type before any of the hypothetical policies were implemented. Shares were calculated using the 2017 CPS ASEC survey.

Table 14: Occupation Groups

Occupation Group	CPS Occupation Code and Description
1 Management, Business, and Science	0010 Chief Executives; 0030 Legislators; 0020-0440 Managers; 0500-0960 Business and Financial Operations; 1005-1240 Computer and Mathematical Occupations; 1305-1530 Architecture and Engineering Occupations (except 1310 Surveyors, Cartographers); 1600-1860 Life, Physical and Social Scientists; 2001-2006 Counselors and Therapists; 2050 Directors of Religious Activities and Education; 2100-2180 Legal Occupations; 2205 Postsecondary Teachers; 3000-3140 Health Practitioners (excl 3030); 3230-3235 Pathologists and Physiologists; 3250 Veterinarians; 3256 Nurse Anesthetists; 3258-3270 Nurse Practitioners; 3322 Sonographers; 3324-3330 Technologists; 3402 Paramedics
2 Services	3601-3655 Healthcare Support Occupations; 3700-3960 Protective Services Occupations; 4000-4160 Food Preparation; 4200-4255 Building and Grounds Cleaning; 4333-4655 Personal Care and Service; Plus 1310 Surveyors and Cartographers; 1541-1560 Architectural and Civil Drafters, Surveyors; 1900-1980 Science Technicians; 2011-2060 Social Workers and Specialists (excl 2050); 2300-2555 Teachers and Librarians; 2600-2970 Arts, Design, Entertainment, Sports, and Media; 3150-3220 Therapists; 3255 Registered Nurses; 3257 Nurse Midwives; 3300-3321 Technicians and Hygienists; 3323 Radiologic Technologists; 3401-3550 Technicians (excl 3402 and 3520)
3 Sales and Office	4700-4965 Sales; 5000-5940 Office and Administrative
4 Natural Resources, Construction, Maintenance	6005-6130 Farming, Fishing and Forestry; 6200-6950 Construction and Extraction; 7000-7640 Installation, Maintenance, and Repair
5 Production, Transportation, Materials Moving	7700-8990 Production; 9005-9760 Transportation and Material Moving

Note: This table lists the CPS occupation codes categorized into each of the 5 occupation types in this report. These categories broadly match the CPS occupation categories with some re-classification. More information on reclassifying technician and service workers can be found in Johnson and Keane (2013) Appendix B.

Table 15: Mapping GTAP Sectors to Aggregate Categories

Aggregate Sector	GTAP Sector Codes
Agriculture	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol, cmt, omt, vol, mil, pcr, sgr, ofd, b_t
Extraction	frs, fsh, coa, oil, gas, oxt
Textiles	tex, wap
Light manufacturing sectors	lea, lum, ppp, fmp, mvh, otn, omf
Heavy manufacturing sectors	p_c, chm, rpp, bph, nmm, i_s, nfm, ele, eeq, ome
Services sectors	ely, gdt, wtr, cns, trd, afs, otp, wtp, atp, whs, cmn, ofi, ins, rsa, obs, ros, osg, edu, hht, dwe

Note: This table lists the GTAP sector codes grouped by category. These groups were used in section 5 when running illustrative experiments on groups of sectors.

Table 16: Equivalent Variation Changes by Experiment

Experiment	U.S. EV Change ($ million)
U.S. tariff increase on ROW heavy manufacturing imports	13,463.7
ROW tariff increase on U.S. heavy manufacturing exports	-105,875.4
U.S. tariff increase on ROW agriculture imports	317.4
ROW tariff increase on U.S. agriculture exports	-11,019.7
Decreases in U.S. services imports	3,287.1
Decreases in U.S. services exports	-54,019.8