Incorporating Job Search Frictions and Unemployment into a Dynamic GTAP Model Framework

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Introduction

Computable general equilibrium models are used to evaluate the impact of a trade policy shock on the overall economy, such as the effects of import tariffs and trade agreements (Shobande, Uddin, and Ashogbon, 2021). One distinguishing feature of most modern, large-scale CGE models is their granularity — CGE models can represent many sectors of the economy and incorporate an input-output structure to capture upstream and downstream effects associated with changes in the economy. For instance, the standard GTAP model has 141 regions and 65 sectors, which allows the model to capture economy-wide as well as detailed sectoral-level effects as a result of changes in trade policies (Corong et al., 2017 and Aguiar et al., 2019).

However, standard CGE models are limited in their capacity of analyzing labor market outcomes because most standard CGE models assume that labor can freely move across sectors, and wages would adjust to maintain full employment. These assumptions are restrictive because they do not reflect labor market frictions and unemployment. To address this research gap, we develop a dynamic GTAP model which incorporates job search frictions and introduces unemployment. The model framework is similar to the comparative static GTAP-LAB model developed by Peterson (2019). We improve that framework in a couple dimensions: 1) the start year of the model baseline is updated to 2014; 2) we've incorporated a labor module which is consistent with the theoretical underpinnings of the GTAP model; 3) we expand the types of U.S. labor identified by disaggregating U.S. labor by different occupations and gender; 4) The model is dynamic and can analyze changes in sectoral wages, employment, and unemployment over time and by worker type due to changes in trade policy. We apply this model to simulate a unilateral increase of U.S. tariffs on imports of metals. The paper is organized as follows: Section 2 provides a literature review on the recent model developments that address labor market frictions and unemployment in a CGE modeling framework. Section 3 provides a detailed explanation of the theoretical framework of the dynamic GTAP model we developed. Section 4 introduces the simulation scenarios. Section 5 presents a sensitivity analysis with different values of labor substitution elasticities

to highlight how simulation results change in the model with these alternative values. Section 6 concludes the paper.

Literature Review

Recent developments in the CGE literature have tried to address the issue of modeling labor outcomes by developing alternative labor market closures. For instance, Pant and Warr (2016) developed a recursive dynamic labor augmenting technical progress model as an extension of the standard GTAP model. The authors represent the labor relationships in the economy by a wage curve, which is derived from the empirical literature and reflects an inverse relationship between the wage rate and the unemployment rate, and therefore allows the unemployment rate to be determined endogenously in the model. Another similar example of incorporating a wage mechanism into a GTAP model can be found in Dixon, Rimmer, and Tran (2019, 2020). The authors build a recursive dynamic GTAP model (the GTAP-MVH model) which incorporates the sticky wage mechanism, i.e., real wages are sticky in the short run and flexible in the long run.[1] Therefore, policy shocks that lead to welfare gains for the whole economy would generate short-run gains in aggregate employment and long-run gains in real wages.

Another approach is to look at the distributional effect of trade on different regions and different labor categories using a combination of CGE and other models. For instance, the World Bank developed the Global Income Distribution Dynamics (GIDD) framework which connects a CGE model with a microsimulation model to look at the distributional effect of trade.[2] In this framework, workers are split by different types, such as skilled and unskilled, rural and urban, female and male, and by geographical location. When applying this approach to examine the impact of trade policy changes in Sri Lanka, the analysis suggests that more ambitious trade reform benefits the country as a whole, and results in larger

[1] This framework is a feature of models developed by Dixon and Rimmer dating back to ORANI, MONASH and USAGE. See discussion in Dixon, Koopman and Rimmer (2013). In Dixon, Rimmer and Tran (2019, 2020), real wages are sticky both ways. Meanwhile, some recent empirical labor literature suggests that nominal wages are sticky downward (see Rodriguez-Clare, 2020). The degree of downward stickiness of real wages is therefore a function of the prevailing inflation rate. In Rodriguez-Clare (2020), the fundamental assumption for the Downward Nominal Wage Rigidity (DNWR) is keeping the world nominal GDP in dollars constant, and the parameter of inflation is therefore kept constant overtime (Rodriguez-Clare et al, 2020).

[2] The microsimulation model implements a set of changes according to information from household surveys. Population and education projections were performed during the first stage of the microsimulation model, and the second stage of the microsimulation adjusts individual factor returns by skill and sector in accordance with the results of the CGE model. Maliszewska, Osorio-Rodarte, and Gupta, "Ex-Ante Evaluation of Sub-National Labor Market Impacts of Trade Reforms," November 23, 2020.

gains particularly in sectors employing a higher proportion of women (Maliszewska, Osorio-Rodarte, and Gupta, 2020).

Dixon, Johnson and Rimmer (2008) develop a recursive dynamic CGE model of the U.S. economy (USAGE-M) with a labor transition matrix incorporated to assess economy-wide effects of illegal migrants. Dixon and Rimmer (2022) further extend this framework with a more disaggregated labor transition matrix incorporated into a recursive dynamic CGE model – it has a U.S. occupation-industry matrix for 2019 identifying employment and wage bills in 233 BLS occupations and 392 BEA industries. Chen and Xiao (2018) develop a recursive dynamic GTAP model with the labor module following Dixon, Johnson and Rimmer (2008), and add in differentiation of the labor force by age and sex. Lofgren and Cicowiez (2017) incorporate costs to labor mobility in a static CGE model, and apply the model to an illustrative sub-Saharan Africa (SSA) dataset. In Lofgren and Cicowiez (2017)'s modeling approach, workers are assumed to have divergent capabilities when working in different sectors. Lofgren and Cicowiez (2017) develop a "proximity parameter" measuring the "degree of similarity between sectors in terms of capabilities" based on industry trade data.[3] Under this framework, workers who lose their jobs and have to transition to a new sector are less efficient and may receive a lower wage than workers who already work in that sector or they may become unemployed. Tsigas and Bernard (2020) explore the influence of labor reallocation across sectors subject to explicit adjustment costs under the GTAP model framework. The authors compare the results of several types of trade shocks obtained under the assumption of costless labor mobility across sectors versus their approach incorporating labor adjustment costs. To do so, the labor productivity parameter in the standard GTAP model is endogenized to reflect the assumption that the productivity of reallocated workers to a sector is lower than the productivity of experienced workers, thereby reflecting the adjustment costs when labor moves from one sector to the other due to changes in trade policy.[4] The authors conduct a simulation with a hypothetical reduction in tariffs imposed by importers of U.S. motor vehicles and parts. The simulation results show that the increase in wage rate paid by the motor vehicles and parts sector is

[3] The proximity parameter is computed on the basis of how close the two sectors are in terms of the capabilities needed for competitive production.

[4] In the Tsigas and Bernard (2020) paper, they indicate that imperfect labor mobility across sectors is different from explicitly accounting for costly labor reallocation. In comparative static simulations, costly labor reallocation influences simulated effects for sectoral production and price, employment, wages, and welfare (EV).

higher than the average U.S. wage rate increase. The sector-specific wage increase is different from the U.S. national wage rate because of differences in wages earned by reallocated workers.

The most relevant CGE model for our purposes was developed by Peterson (2019). Peterson (2019) incorporates job search frictions and unemployment into a comparative static GTAP model by including a matching function into GTAP to estimate the changes in employment and unemployment.[5] In the Peterson model, the labor endowment data (for both unskilled and skilled labor) are divided into different labor categories: existing labor, matched labor, recruiters, and unmatched labor. Existing labor refers to employed workers who carry on with their current jobs and don't switch industries. Since they don't switch industries, existing labor is sector-specific (that is, immobile) in the model. Matched labor are the new hires in each sector. Unmatched labor is the labor pool that includes all the unemployed individuals who are in the job market and the matched labor is drawn from this pool.[6] Recruiters are the workers who match those who are looking for a job with job vacancies.[7] The model incorporates the economic rationale that existing labor and matched labor (new hires) are imperfect substitutes, as the newly hired matched labor is usually less experienced and therefore assumed to be less productive than the existing labor. Moreover, for the unemployed individuals, there is a "matching cost" throughout the job research process as reflected in the matching function, and therefore it takes additional effort for unemployed individuals to find a job when there is a policy change that leads to workers moving across sectors. Yuan, Antonio and Butcher (2022) apply the Peterson model to analyze U.S.-EU trade liberalization scenarios. Simulated effects of a full bilateral tariff liberalization between the United States and the EU show that the model estimates changes in wages at the sectoral level, with the highest gains for U.S. food and agricultural workers, where the extent of the EU tariff liberalization is the biggest. The full U.S.-EU bilateral tariff removal scenario also leads to U.S. worker reallocation across industries, with the largest increase in employment in the services sectors. Sensitivity analysis shows that the simulated effects are sensitive to the labor substitution elasticities used between existing and

[5] The economic rationale behind the matching function is that unemployed individuals need to go onto the job market looking for jobs, and conversely, employers also need to go to the job market searching for an individual to fill a job vacancy. Therefore, the number of individuals who got "matched" into job vacancies will be dependent upon the total unemployment rate in the economy, as well as the matching efficiency and recruiting effort.

[6] In the Peterson model, Unmatched Labor equals to Matched Labor plus Unemployed Labor. At the beginning of the period, there are unmatched workers, some of whom get matched to job vacancies and the remaining are unemployed.

[7] The four different labor categories in the Peterson model are calibrated in the model baseline using the job turnover data and unemployment data from the U.S. Bureau of Labor Statistics.

matched labor —the wage results could be different not only in magnitude, but also in signs when using different labor substitution elasticities.

Theoretical Framework of the Dynamic GTAP Model with Job Search Frictions and Unemployment

Simulations and Results

Conclusions

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