MAST 2026 · WORKSHOP ON CGE MODELING AND GTAP

Workshop Exercises

Three group exercises on agricultural subsidies, immigration and wages, and a trade war.

Each exercise sets out the background, step-by-step RunGTAP instructions, the results tables to complete, and the guiding questions for your group presentation.

How to use this workbook

Each group runs one assigned exercise and presents its results briefly. Report percentage changes relative to the baseline unless a table specifies US$ millions. Use the variable's exact elements, since the same variable often appears for several sectors, factors, and regions.

Throughout the workbook, menu paths, tabs, and buttons appear in bold, for example **View › Base Data › Tax Rates**. Variable names, element combinations, file names, and values you type appear in a fixed-width font, for example `qca(AGR,AGR,USA)`, `All COMM | AGR | USA`, and `default.prm`.

Workshop setup. NUS333 and NIMMIG should already be installed. Tell a facilitator immediately if a version or parameter file does not appear in RunGTAP.

Results navigation. The **Results** tab lists variables by name. Select a variable to open its matrix, locate the combination of elements shown in the table, and double-click a result cell to return to the variable list. Use "(1) Sim" for the full simulation result, rather than Pre value or Post value. In these exercises, a **% target rate** shock sets a tax or subsidy to the entered final rate; a **% change** shock changes the selected quantity by the entered percentage.

Exercise 1 · Food Fight: Agricultural Production Subsidies

Background

A production subsidy reduces firms' effective input costs, but the economy bears the cost elsewhere. In this simplified model, US agricultural producers receive subsidies on land, capital, and several domestically produced and imported intermediate inputs. Removing them changes input costs, agricultural output, factor prices, household purchases, and exports. The experiment lets us examine these linked responses in a general equilibrium setting: a change in one policy can affect several markets at once.

You will identify the initial subsidy rates, set each subsidized rate to zero, verify that RunGTAP updated the rates, and then interpret eight outcomes. A negative base tax rate means a subsidy; a zero updated rate means that subsidy has been removed. The exercise compares the baseline with a single reform that removes all eight subsidies together. It does not separate the effect of each subsidy.

Task and Deliverable

Create and solve `AgrSubs` yourself. Fill Table 1.1 with the before-and-after rates and Table 1.2 with the eight changes from the full simulation. Prepare a presentation of about six minutes explaining what happened to US agricultural production, factor owners, consumers, and trade partners. Use at least two numerical results to support your policy interpretation.

Instructions

Set up and solve the experiment

Open the right model. Launch RunGTAP. From the top menu, select **Version › Change**, select NUS333, and click **OK**. This version has the USA and ROW regions and the AGR, MFG, and SER activities used throughout the exercise.

Remove settings left by another experiment. Open the **Closure** tab. Its last line should be `Rest Endogenous`; delete any statements below that line. Open the **Shocks** tab and click **Clear shock list**. This prevents an earlier group's closure or shock from changing your result.

Find land and capital subsidy rates. From the menu, choose **View › Base Data › Tax Rates**. Double-click `RTFE`, the tax rate on a primary factor used by an activity. Set the upper-right toggles to `All ENDW | AGR | USA`. Read the LAND and CAPITAL rows and enter their base rates in Table 1.1. Both are subsidies because the rates are negative.

Find subsidies on purchased inputs. Double-click in the displayed matrix to return to the tax-rate summary. Double-click `RTFD`, the tax rate on a domestically produced commodity used by an activity. Set the toggles to `All COMM | AGR | USA` and record the AGR, MFG, and SER rows. Return to the summary and do the same for `RTFM`, which covers imported inputs. Close the tax-rate window using its upper-right **X**. Domestic and imported purchases have separate rates, even for the same commodity.

Remove the factor-use subsidies. On **Shocks**, choose `tfe` from **Variable to shock**. Select `LAND | AGR | USA`, enter `0` as the shock value, choose **% target rate** as the **Type of shock**, and click **Add to shocks list**. Repeat with `CAPITAL | AGR | USA`. A zero target rate removes each subsidy; entering a zero **% change** shock would do nothing.

Remove the six intermediate-input subsidies. Select `tfd` and add separate zero **% target rate** shocks for `tfd(AGR,AGR,USA)`, `tfd(MFG,AGR,USA)`, and `tfd(SER,AGR,USA)`. Select `tfm` and repeat for `tfm(AGR,AGR,USA)`, `tfm(MFG,AGR,USA)`, and `tfm(SER,AGR,USA)`. The first element is the input commodity, the second is the purchasing activity, and the third is the region. The list should contain eight shocks in total. Check the base rates before adding any entry: do not remove a positive tax.

Save and solve. Open **Solve**. Confirm that the solution method is Gragg 2-4-6 and the parameter file is Default; use **Change** if needed. Click **Save Experiment**, name it `AgrSubs`, and describe it as "Elimination of US AGR subsidies." Click **Solve** and acknowledge the completion prompts with **OK**.

Check the experiment before interpreting it. Select **View › Updated Data › Updated Tax Rates**. Open `RTFE`, `RTFD`, and `RTFM` with the same toggles you used to find the base rates, and enter the new rates in Table 1.1. All eight targeted rates should now be zero. If not, inspect the selected elements and the **% target rate** setting on **Shocks**, then rerun.

Collect and interpret the results

Select the full simulation. Open **Results**. Choose "(1) Sim" from the result selector on the right and USA in the upper-left filter that initially reads "Everything." "Sim" reports the percentage change caused by all eight shocks together. For each item below, open the named variable, find the indicated elements, record the result in Table 1.2, and double-click a result cell to return to the variable list.

Measure the production response. Open `qca` and read `qca(AGR,AGR,USA)`: the quantity of agricultural output supplied by the agricultural activity in the USA. This shows the scale of the sector after subsidies are removed. Then open `ps` and read `ps(AGR,AGR,USA)`: the price received by that agricultural activity for its output. Compare the output and price changes.

Compare costs to producers and income to landowners. Open `pfe` and read `pfe(LAND,AGR,USA)`, the price agricultural producers pay for land, and `pfe(CAPITAL,AGR,USA)`, the price they pay for capital. Then open `pes` and read `pes(LAND,AGR,USA)`, the supply price received by landowners. The two land prices need not change by the same amount because the subsidy creates a wedge between what producers pay and what owners receive.

Look at households and trade. Open `qpa` and read `qpa(AGR,USA)`, the quantity of agricultural goods purchased by US households. Open `qxw` and read `qxw(AGR,USA)`, the quantity of US agricultural exports. Finally, open `pxw` and read `pxw(AGR,USA)`, their export price. These variables show whether the reform has a large direct consumer effect and how changes in US supply feed into trade.

Check and discuss. Table 1.2 should contain exactly eight total percentage changes. In the textbook version, `qca(AGR,AGR,USA)` is approximately −1.42%; use that as a check on the setup. If your value differs substantially, check the model version and shocks before explaining the economics.

Results Tables

Table 1.1: Subsidy Rates in US Agriculture

Tax or Subsidy Rate	Base Rate (%)	Updated Rate (%)
RTFE(LAND,AGR,USA)		
RTFE(CAPITAL,AGR,USA)		
RTFD(AGR,AGR,USA)		
RTFD(MFG,AGR,USA)		
RTFD(SER,AGR,USA)		
RTFM(AGR,AGR,USA)		
RTFM(MFG,AGR,USA)		
RTFM(SER,AGR,USA)		

Table 1.2: Effects of Removing US Agricultural Subsidies

Outcome	RunGTAP Variable	Total Change (%)
Agricultural output quantity	qca(AGR,AGR,USA)	
Agricultural producer price	ps(AGR,AGR,USA)	
Cost of land to producers	pfe(LAND,AGR,USA)	
Cost of capital to producers	pfe(CAPITAL,AGR,USA)	
Land supply price to owners	pes(LAND,AGR,USA)	
Household agricultural consumption	qpa(AGR,USA)	
Agricultural exports	qxw(AGR,USA)	
Agricultural export price	pxw(AGR,USA)	

Guiding Questions

Production and factor costs: *How do agricultural output and the factor prices paid by producers respond? What do the different price movements suggest?*

Land prices and the subsidy wedge: *Why does the land price paid by producers change by less than the land supply price received by owners?*

Effects on US consumers: *How much does household agricultural consumption change, and why is the effect on US consumers limited?*

Implications for US trading partners: *What do the changes in agricultural exports and export prices suggest about concerns raised by US trading partners?*

Exercise 2 · How Immigration Can Raise Wages

Background

Immigration expands the available labor force, but its effect on wages depends on how workers interact with other production factors. If firms can readily substitute among factors, an increase in one kind of labor may reduce demand for another. If factors are complements, more unskilled labor can raise demand for skilled labor and capital. Investment that expands the capital stock creates another response. A CGE model lets you compare these mechanisms while accounting for changes across production activities.

The NIMMIG model distinguishes unskilled labor, skilled labor, and capital. It does not distinguish immigrant from native-born workers. We therefore represent immigration as a 10% increase in the US unskilled-labor endowment, rather than as a direct measure of immigrant workers. You will run that shock under two sets of substitution assumptions, then add capital growth in a third scenario.

The three experiments

Scenario	Parameter File	US Shocks
BORJAS	`BORJAS.prm`; `ESUBVA` = 12 in AGR, MFG, SER in USA and ROW	`qe(UNSKILLED, USA)` = 10%
OTTA1	`OTTA.prm`; `ESUBVA` = 0.2 in AGR and 0.5 in MFG and SER in USA and ROW	`qe(UNSKILLED, USA)` = 10%
OTTA2	`OTTA.prm`; same as OTTA1	`qe(UNSKILLED, USA)` = 10% and `qe(CAPITAL, USA)` = 6%

A parameter file stores assumptions about how the model behaves. An experiment stores the shocks you apply and identifies the parameter file used to solve them. OTTA1 and OTTA2 use the same parameter file; only their shock lists differ.

Task and Deliverable

Create the two parameter files, run and save all three experiments, and fill Table 2.1. Prepare a brief presentation comparing the selected factor prices and real GDP. Explain which comparison changes the substitution assumption, and which adds capital. The factor prices in the table refer to particular activities; they are not measures of the average wage of every US worker.

If NIMMIG is missing from the version list. Download `NIMMIG.ZIP` from the GTAP model resources page. In your RunGTAP375 installation folder, create a folder named NIMMIG and extract the ZIP contents directly into that folder, without an extra NIMMIG subfolder. Restart RunGTAP and check **Version › Change** again. If prompted about a missing or obsolete SLI file, run the model's test simulation. These installation steps should normally be completed with the installation guide before the workshop.

Instructions

Prepare NIMMIG

Select the model version. In RunGTAP, choose **Version › Change**, select NIMMIG, and click **OK**. This version includes the unskilled labor, skilled labor, and capital factors needed for the exercise.

Clear earlier settings. Open **Closure**. The last line should be `Rest Endogenous`; delete any statements below it. Open **Shocks** and click **Clear shock list**. This makes sure an earlier experiment does not affect yours.

Create BORJAS.prm

Start with the default parameters. Open **Solve** and check the parameter file shown in the upper right. If it is not Default, click **Change**, select Default, and click **OK**. Starting from Default prevents edits from a previous experiment from carrying into your new file.

Open the parameter editor. Choose **View › Parameters**. In the parameter window, select **File › Use Advanced, editing menu** if that option is not already active. Double-click `ESUBVA` to open its values. `ESUBVA` describes how readily firms can substitute among production factors.

Enter the BORJAS assumptions. In the `ESUBVA` table, right-click each applicable value and change it to `12`. Do this for AGR, MFG, and SER in USA, and again for AGR, MFG, and SER in ROW: six entries in total. Confirm each edit, then check that all six values are 12. A higher `ESUBVA` means factors are easier to substitute.

Save a separate parameter file. In the parameter window, choose **File › Close** and select **Yes** when prompted to save the changes. In the filename box, enter `BORJAS.prm`, then click **Save** and acknowledge the confirmation. Do not overwrite `default.prm`. Confirming an individual value edit changes the open parameter table; this file-saving step creates the reusable `.prm` file.

Run BORJAS and record its results

Enter the labor shock. On **Shocks**, select `qe` under **Variable to shock**. Select `UNSKILLED | USA`, choose a **% change** shock, enter `10`, and click **Add to shock list**. The variable `qe(UNSKILLED,USA)` is the quantity of the US unskilled-labor endowment; the shock increases that available quantity by 10%.

Select the new file and solve. On **Solve**, click **Change** beside **Parameter file**, select `BORJAS.prm`, and click **OK**. Check that the solution method is Gragg 2-4-6. Click **Save Experiment**, name it `BORJAS`, and describe it as a 10% increase in US unskilled labor with high factor substitution. Click **Solve** and acknowledge the completion prompts.

Fill the BORJAS column immediately. While BORJAS is still the current result, follow the steps under “Find the four outcomes after each solve” and enter its four values in Table 2.1. Recording a column before changing the experiment reduces the chance of mixing results from different runs.

Create OTTA.prm and run OTTA1

Return to the default parameter values. On **Solve**, click **Change** beside **Parameter file** and select Default. Then choose **View › Parameters**, enable **File › Use Advanced, editing menu** if needed, and double-click `ESUBVA`. Begin from Default so no BORJAS value of 12 remains in the OTTA file.

Enter the OTTA assumptions. Right-click and edit each of the six ESUBVA entries shown in the table below. Confirm each edit and check every entry. These lower values mean production factors are less readily substituted and are relatively more complementary.

ESUBVA values for OTTA.prm

Activity	USA	ROW
AGR	0.2	0.2
MFG	0.5	0.5
SER	0.5	0.5

Save `OTTA.prm`. Choose **File › Close**, select **Yes** when asked to save, enter `OTTA.prm` as the new filename, and click **Save**. Do not overwrite either `default.prm` or `BORJAS.prm`.

Run OTTA1 with the original labor shock. On **Shocks**, confirm that `qe(UNSKILLED,USA)` = 10% is still the only shock. On **Solve**, click **Change** beside **Parameter file** and select `OTTA.prm`. Click **Save Experiment**, name it `OTTA1`, then click **Solve**. Follow the result lookup steps and fill the OTTA1 column before changing the shocks. Comparing BORJAS with OTTA1 holds the labor shock fixed and changes the substitution assumptions.

Add capital and run OTTA2

Add the capital shock. Keep `OTTA.prm` selected. On **Shocks**, choose `qe`, select `CAPITAL | USA`, choose **% change**, enter 6, and click **Add to shock list**. Confirm that the list contains both `qe(UNSKILLED,USA)` = 10% and `qe(CAPITAL,USA)` = 6%. The capital shock does not replace the labor shock.

Solve and record OTTA2. On **Solve**, keep `OTTA.prm` and Gragg 2-4-6. Click **Save Experiment**, name it `OTTA2`, and click **Solve**. Follow the result lookup steps and fill the OTTA2 column. Comparing OTTA1 with OTTA2 holds ESUBVA fixed and adds capital.

Find the four outcomes after each solve

Open the full simulation result. Select **Results**, choose "(1) Sim" as the result, and select USA in the upper-left filter that initially displays "Everything." "Sim" gives the percentage change from the model baseline. Open each named variable, find the exact elements below, and double-click a result cell to return to the variable list between lookups.

Find `pfe(UNSKILLED,AGR,USA)`. Open `pfe`, then find `UNSKILLED | AGR | USA`. This is the price US agricultural producers pay for unskilled labor. It shows how the expanded supply affects the price of one selected unskilled labor.

Find `pfe(SKILLED,MFG,USA)`. In `pfe`, find `SKILLED | MFG | USA`. This is the price US manufacturers pay for skilled labor. Compare it across scenarios to see how the assumed relationship between production factors changes the skilled-labor response.

Find `pfe(CAPITAL,SER,USA)`. In `pfe`, find `CAPITAL | SER | USA`. This is the price US service producers pay for capital. It helps show how capital responds to more unskilled labor and, in OTTA2, to an increase in its own supply.

Find `qgdp(USA)`. Open `qgdp` and select USA. This GDP quantity index measures the percentage change in US real GDP. If `qgdp` does not appear under the USA filter, change the upper-left filter back to "Everything" and look for it there. Record it to compare the economy-wide output response with the selected factor-price responses.

Results Table

Table 2.1: Effects of increased US unskilled labor supply

Outcome (% change from base)	BORJAS	OTTA1	OTTA2
Unskilled labor price in AGR: `pfe(UNSKILLED,AGR,USA)`			
Skilled labor price in MFG: `pfe(SKILLED,MFG,USA)`			
Capital price in SER: `pfe(CAPITAL,SER,USA)`			
Real GDP: `qgdp(USA)`			

Guiding Questions

The substitution assumption: *What does changing `ESUBVA` from the BORJAS values to the OTTA values assume about substitution among production factors?*

Factor prices under different assumptions: *With the same labor shock, how do the three selected factor prices differ between BORJAS and OTTA1?*

The effect of added capital: *Compared with OTTA1, what happens to those prices when OTTA2 adds `qe(CAPITAL,USA)` = 6%? Why might the price of capital fall when its supply expands?*

Real GDP across the three experiments: *Why does real GDP rise in all three experiments? How do the different substitution assumptions affect the size of the response?*

Exercise 3 · The Anatomy of a Trade War

Background

An import tariff raises the domestic price of an imported good relative to its price at the border. This normally reduces import volume, but a large importer may also lower the price foreign suppliers receive. The unilateral tariff can therefore produce both a domestic efficiency loss and a terms-of-trade gain. Retaliation changes the trade flows and may reverse the welfare outcome. This exercise tests those ideas with a US manufacturing tariff, followed by a ROW tariff on US manufactures.

You will calculate target tariff rates, run a unilateral US tariff (TRDWAR1), and then run the US tariff together with ROW retaliation (TRDWAR2). The tariff shock is a five-percentage-point surcharge on each existing rate. RunGTAP's **% target rate** option needs the final tariff rate, rather than the number 5 entered as a proportional change. You will compare tariff-inclusive and border prices, trade volume, and the welfare components in US$ millions.

Task and Deliverable

Complete Tables 3.1 to 3.4 and prepare a brief policy explanation. Show whether the three bilateral trade results match your predictions; compare the US welfare effects in the unilateral and retaliatory cases; and explain why the world welfare outcome differs from either region's outcome. The tables report summary welfare components; you do not need to run the textbook's subtotal or detailed second-best decomposition utilities.

Instructions

Run the unilateral tariff

Select NUS333 and reset. Choose **Version › Change**, select NUS333, and click **OK**. On **Closure**, check that the last line is `Rest Endogenous` and remove extra statements. On **Shocks**, click **Clear shock list**. This prevents earlier settings from affecting the tariff experiment.

Find the two base tariffs. Select **View › Base Data › Tax Rates** and double-click `RTMS`, the source-specific import tariff rate. With the toggles at `All COMM | ROW | USA`, find MFG: this is the US tariff on manufactured imports from ROW. Then set `All COMM | USA | ROW` to find ROW's MFG tariff on imports from the USA. Enter both base rates in Table 3.1 and close the tax-rate file.

Calculate the targets. Add five percentage points to each MFG base rate in Table 3.1. For example, a base rate of 1.23% becomes 6.23%. Keep the origin and destination in the right order: `tms(MFG,ROW,USA)` changes the US tariff, while `tms(MFG,USA,ROW)` changes ROW's tariff.

Set and solve the US shock. On **Shocks**, choose `tms` in **Variable to shock**, set `MFG | ROW | USA`, enter the US target rate from Table 3.1, choose **% target rate** as the **Type of shock**, and click **Add to shocks list**. On **Solve**, check Gragg 2-4-6 and Default parameters. Save the experiment as `TRDWAR1`, describe it as the US MFG tariff surcharge on ROW, then click **Solve** and confirm the prompts.

Confirm the tariff changed. Choose **View › Updated Data › Updated Tax Rates**, open `RTMS`, and set `All COMM | ROW | USA`. The updated MFG rate should match the US target rate in Table 3.1. If it does not, recheck the order of ROW and USA in the `tms` shock and the target-rate selection.

Read trade and welfare results

Predict signs before viewing the answer. In Table 3.2, write + or − in the Expected sign column for the tariff-inclusive domestic price, the border price, and the import quantity. A simple tariff diagram gives a starting prediction; the simulation then tests whether general equilibrium effects alter it.

Read the three bilateral results. Open **Results**, select USA from the upper-left "Everything" filter, and select "(1) Sim." Open `pmds(MFG,ROW,USA)`: the domestic US price of the MFG import from ROW, including the tariff. Open `pcif(MFG,ROW,USA)`: the CIF border price before the US tariff. Open `qxs(MFG,ROW,USA)`: the quantity shipped from ROW to the USA. Double-click a result cell to return to the variable list between lookups, and enter all three percentage changes in Table 3.2. The gap between domestic and border prices helps show the tariff wedge; the quantity measures the trade response.

Read US welfare under TRDWAR1. Choose **View › Updated Data › Welfare Decomposition** and double-click **EV Decomposition Summary**. In the USA row, record allocative efficiency, terms of trade in goods and services, investment–savings terms of trade, and total equivalent variation (EV) in Table 3.3. The first captures efficiency effects of distorted resource allocation; the terms-of-trade entries reflect changes in international purchasing power; EV summarizes welfare in US$ millions. Close the file.

Add retaliation and compare

Add ROW's tariff without deleting the US tariff. Return to **Shocks**. Choose `tms`, set `MFG | USA | ROW`, enter the ROW target from Table 3.1, select **% target rate**, and click **Add to shocks list**. Check that the list now contains both bilateral shocks. Keeping the US shock means TRDWAR2 is a trade war, not a replacement ROW-only scenario.

Solve and verify TRDWAR2. On **Solve**, keep Gragg 2-4-6 and Default parameters. Save the experiment as `TRDWAR2` and click **Solve**. Under **View › Updated Data › Updated Tax Rates**, open `RTMS` and use `All COMM | ROW | USA` to check the US MFG rate and `All COMM | USA | ROW` to check the ROW MFG rate. Both should equal their target rates in Table 3.1.

Read regional and world welfare. Open **View › Updated Data › Welfare Decomposition › EV Decomposition Summary**. In Table 3.4, enter allocative efficiency, goods-and-services terms of trade, investment–savings terms of trade, and total EV for USA, ROW, and World. World aggregates the regional results; terms-of-trade changes across trading partners largely offset, while global efficiency losses need not. Report all entries in US$ millions.

Results Tables

Table 3.1: Manufacturing Tariff Rates

Tariff (RTMS)	Base Rate (%)	Target Rate (%)
USA on MFG from ROW		
ROW on MFG from USA		

Table 3.2: US Manufacturing Imports from ROW under TRDWAR1

Outcome	RunGTAP Variable	Expected Sign	Result (%)
Domestic import price including tariff	`pmds(MFG,ROW,USA)`		
CIF import price excluding tariff	`pcif(MFG,ROW,USA)`		
Bilateral import quantity	`qxs(MFG,ROW,USA)`		

Table 3.3: US Welfare under the Unilateral Tariff

Allocative Efficiency	Terms of Trade	Investment–Savings Terms of Trade	Total EV

Table 3.4: Welfare under the trade war

Region	Allocative Efficiency	Terms of Trade	Investment–Savings Terms of Trade	Total EV
USA				
ROW				
World				

Tables 3.3 and 3.4 use US$ millions. “Terms of trade” refers to the goods-and-services component; the investment–savings component is shown separately.

Guiding Questions

Expected and simulated trade responses: *Do the signs of the three bilateral trade outcomes under TRDWAR1 match the expected effects of a tariff?*

Efficiency losses and terms-of-trade gains: *Under TRDWAR1, how do the US allocative-efficiency loss and terms-of-trade gains compare?*

Welfare under retaliation: *How do US and ROW welfare change in TRDWAR2? What is the total world welfare change?*

Pre-existing tariffs and efficiency: *Why can the existing US manufacturing tariff create an efficiency loss when import volume falls further?*