# Model Exercise: Immigration and Structural Change

Immigration increases a country's labor supply. In this exercise, you will learn how to change a factor supply in the UNI-CGE model. You will use the Rybczynski theorem to explain the structural effects of the factor supply shock on production and trade. *Challenge Option:* You will evaluate the sensitivity of your model results to a change in the value of the factor substitution elasticity.

## CONTENTS

# 1. INTRODUCTION

Immigration has multi-dimensional effects, with social, cultural, political, and economic ramifications for the destination country. In this exercise, you will examine one aspect of the economic effects of immigration – structural change – using the Rybczynski theorem to organize your analysis and explain your results. The theorem, named after the economist Tadeusz Rybczynski, posits that if prices are constant, an increase in the supply of one factor will lead to an expansion of output in the production activity that is most intensive in the use of that factor and a decline in output of activities intensive in the use of other factors (Table 1). This occurs because the increased factor supply and the resulting fall in the factor price is most cost-saving for the sector intensive in that factor. The expansion of that industry pulls in productive resources from other sectors, causing them to contract.

**Table 1.  Rybczynski effects of a change in factor supply on production**

|  | Increased supply of labor | Increased supply of capital |
|---|---|---|
| **Labor-intensive activity** | Output increases | Output falls |
| **Capital-intensive activity** | Output falls | Output increases |

Furthermore, an increase in the supply of a factor is likely to affect the composition of trade. Export-oriented production activities sell a relatively large share of their output to foreign markets, and import-competing activities produce commodities for which imports account for a relatively large share of consumption. If the factor used intensively in the production of exportable commodities increases, so will production and the export supply of that good. The increased production of exports will cause production of the importable good to fall, increasing the demand for imports of that good.  Hence, both

exports and imports will increase. The opposite occurs if the factor used intensively in the production of importable commodities increases. As production of the importable good rises, import demand for that good will fall, and production and export by the export-oriented will also fall.

**Table 2. Rybczynski effects of a change in factor supply on trade**

|  | **Increased supply of factor used intensively in the exportable activity** | **Increased supply of factor used intensively in the import-competing activity** |
|---|---|---|
| **Exportable commodity** | Exports rise | Exports fall |
| **Import-competing commodity** | Imports rise | Imports fall |

In this case study, you will examine the results of an experiment in which immigration increases the supply of labor. You will see whether the resulting structural changes in production and trade in your model can be explained in terms of the Rybczynski theorem.

## 2. MODEL EXPERIMENT

In this model exercise, you will examine the production and trade effects of a 10% increase in the supply of labor. You will run the model with the default Armington import demand elasticity (ESUBQ) and analyze and explain results relative to predictions based on the Rybczynski theorem. This exercise uses the US333 database in the UNI-CGE model with the default closure and elasticity parameter values.

*Challenge:* Change the elasticity of import demand from 0.7 to 5, and report and compare these results with the results using the default elasticity.

# 3. INSTRUCTIONS

1. Review and follow the instructions in the "How to" Guides in the Course

   a. How to Run the UNI-CGE Model
   b. How to Define, Run and Verify an Experiment
   c. How to Change an Elasticity Parameter
   d. How to Read Results in the Excel, Listing and GDX Files
   e. How to Read Results in the Listing File

2. Prepare to run the model by completing the checklist presented in the guide "How to Run a CGE Model."

3. Use the US Structure Table in the appendix to this exercise to complete Table 3.

### Table 3. Base factor intensities and tradability

| | BASE FACTOR INTENSITIES | | | BASE TRADE SHARES | |
|---|---|---|---|---|---|
| | Factor shares in industry costs | | | Shares of imports in consumption | Share of exports in production |
| | Land | Labor | Capital | | |
| **AGR** | 11 | | | | |
| **MFG** | | | | | |
| **SER** | | | | | |

4. Change the supply of US labor

   a. Search for the term "Experiment" in the UNI-CGE model

   b. Unfold the experiment "Change a Factor Supply" by clicking on the arrow on the left of the **"$OnFold"** command. This will open sample experiments that

change the quantity of factor F (QFS$_F$) (Figure 1). The first command increases the supply of all factors "F" by 2 percent. The next command specifies that the capital factor supply increases by 2 percent. The third command increases the labor supply by 5 percent. Notice the commands to display the level of factor supplies before and after their values are redefined in the experiment. These displays can help you to verify that you have correctly defined your experiment.

c. Edit one of the commands, or add your own, to increase the supply of labor by 10 percent above the initial level.

**Figure 1.  Experiment to change factor supplies**

```
*Experiment - Change a Factor Supply
$OnFold
Display QFS.l;
* QFS.FX(F) = QFS.L(F) * 1.02 ;
* QFS.FX("F-Capital") = QFS.L("F-Capital") * 1.02 ;
 QFS.FX("F-Labor") = QFS.L("F-Labor") * 1.05 ;
Display QFS.l;
$offFold
```

5.  Option 1: Verify your experiment in the .LST file

a.  Verify the values of the labor supply, before and after the experiment.  Open the .lst file, typing `CTRL + F` and search from the bottom for "QFS" (Figure 2). The top display of QFS is the initial level of the labor supply.  The bottom display of the labor supply should be 10% greater if you defined your experiment correctly.

**Figure 2.  Verify your experiment in the .lst file**
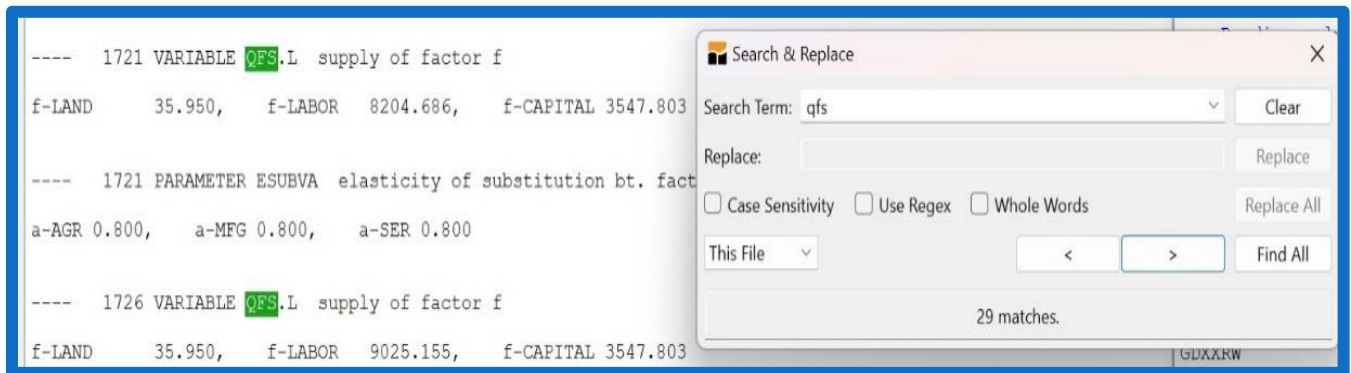


6.  Option 2: Verify your experiment in the GDX file

   a.  Verify the values of the labor supply, before and after the experiment.  Open the GDX file and search for FACT_PC (Figure 3).  The element "f-Labor QFS" is the percent change in the labor supply, which should be 10 if you defined your experiment correctly.

**Figure 3.  Verify your experiment in the GDX file**



7.   Report your results in Tables 3 and 4.

8.  *Challenge* – change the parameter value of ESUBQ (Armington elasticity of import-domestic substitution) in the US333 excel country data file from 0.7 to 5.

Save and close the data file.  Rerun the model.

9.  Verify the elasticity value by searching for ESUBQ in the GDX file.

10. Report your results in Tables 4 and 5.

11. Restore the default ESUBQ elasticity values in the US333 country data file to 0.7. Save and close the file.

## 4. RESULTS

1.  Open the UNI-RESULTS.GDX file.  Select parameter RES_QCOM_PC, the percent change in quantities. Report results for output (QX), exports (QE) and imports (QM) in Table 4.

**Table 4. Percent change in quantities with 10% increase in labor supply**

| % change in quantity | | | | | | |
|---|---|---|---|---|---|---|
| | ESUBQ = 0.7 | | | ESUBQ = 5 | | |
| | Output (QX) | Exports (QE) | Imports (QM) | Output (QX) | Exports (QE) | Imports (QM) |
| **AGR** | | | | | | |
| **MFG** | | | | | | |
| **SER** | | | | | | |

2.  Open the UNI-RESULTS.GDX file.  Select parameter QF_PC – the percent change in factor demand by activity. Report results in Table 5.

**Table 5.  Percent change in factor demand with 10% increase in labor supply**

| | ESUBQ = 0.7 | | | ESUBQ = 5 | | |
|---|---|---|---|---|---|---|
| | AGR | MFG | SER | AGR | MFG | SER |
| **Land** | | | | | | |
| **Labor** | | | | | | |
| **Capital** | | | | | | |

# 5.    DISCUSSION QUESTIONS

The characteristics of a real-life economy as depicted in the US333 database diverge from the simplified economy depicted in the Rybczynski theorem. The three production activities in the US database both export and import their products. The services sector, a large part of the US economy, is minimally traded, the most-labor-intensive, and the largest of the three activities.

Also, because growth in the labor supply increases the productive capacity of the economy, output quantities do not decline, as predicted by the theorem.  Instead, output of all commodities increases, but at faster or lower rates relative to other sectors of the economy. The CGE model also includes general equilibrium effects, such as consumer and investor responses, that are not incorporated in the theorem.

Although applied models like CGE models do not meet the strict assumptions of stylized theoretical models, it is nevertheless useful to ground your interpretation of results in relevant economic theories such as the Rybczynski theorem. This practice helps you to predict and understand the outcomes of your experiments.

1.  What does factor intensity mean? Which production activity in the US is the most labor intensive?  Which activity is the least labor intensive?

2.  What is the Rybczynski theorem's prediction on the relationship between factor supply, factor intensity and output?  Based on the theorem, in which activities do you expect output to increase the most?  Are your results consistent with the

theorem?

3. Why do you think the size of the US services activity might matter in thinking about your results? (Hint, a large industry must compete with other industries for factors. And, a small change in the large industry's factor demand has large effects on other factors and activities.)

4. Comparing AGR and MFG, which sector is more exportable or more importable? A product is more exportable the larger the share of exports in total output. A product is more importable that larger the share of imports in total consumption.

5. Based on the Rybczynski theorem, what are your expected results for trade in AGR and MFG? Are results consistent with the theorem?

6. What does economic "structure" mean? Why is the Rybczynski theorem useful to examine the structural effects of immigration?

7. How does the value of parameter ESUBQ affect consumer behavior? Do Rybczynski effects become larger and more recognizable? Why do you think this happens?

8. Draw on general equilibrium perspectives to explore results. For example, what are the effects of growth in a factor supply on income and demand for services? What happens to the exchange rate and how will that affect trade? Find a general equilibrium effect that is puzzling. Try to figure out its cause – the SAM and structure table can be of help.

## Table 4. Structure of the US Economy based on US333 SAM

| | Industry GDP $US | Industry Shares | Factor Shares in Industry Costs | | | Industry Shares in Factor Employment | | |
|---|---|---|---|---|---|---|---|---|
| | billion | in GDP | Land | Labor | Capital | Land | Labor | Capital |
| Agriculture | 139 | 1 | 11 | 16 | 16 | 100 | 1 | 1 |
| Manufacturing | 2,594 | 18 | 0 | 24 | 10 | 0 | 16 | 18 |
| Services | 11,328 | 81 | 0 | 43 | 16 | 0 | 83 | 80 |
| Total | 14,061 | 100 | na | na | na | 100 | 100 | 100 |

| | Commodity shares in: | | | | | | Import Share of Domestic Consumption | Export Share of Domestic Production |
|---|---|---|---|---|---|---|---|---|
| | Domestic Demand | | | | Trade | | | |
| | Intermediate Demand | Private Household Consumption | Government Consumption | Invest-ment Demand | Imports | Exports | | |
| Agriculture | 2 | 1 | 0 | 0 | 2 | 4 | 11 | 16 |
| Manufacturing | 38 | 20 | 0 | 40 | 84 | 70 | 25 | 15 |
| Services | 60 | 79 | 100 | 60 | 14 | 27 | 2 | 2 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | na | na |

Source: GTAP v8.1.