

# Modeling the Impact of Fresh Market Cucumber Imports on U.S. Producers

*Seasonal Effects Model Release*

## **Read Me :**

This model accompanies the USITC report, *Cucumbers: Effect of Imports on U.S. Seasonal Markets, with a Focus on the U.S. Southeast*, Inv. 332-583. The report includes a quantitative analysis of the economic impact of fresh market cucumber imports on U.S. domestic prices, production, revenue, operating income, and employment. Economic effects are modeled to reflect seasonal implications, where harvesting periods are split into June-October and November-May. The model inputs (BLUE-shaded cells) include elasticities that describe responsiveness to price changes, and domestic production and imports data for each growing season from 2015 to 2020. Data sources are listed in the cell above the data input. The model then lowers imports to a counterfactual level where the historical above-average growth rates are removed. Outputs are in the GREEN-shaded cells. The white cells are intermediate calculations.

This PDF is a printout of the Mathematica file “Seasonal cucumber model - model release.nb”.

## **Table of Contents**

Nov 2019 - Oct 2020 .....	2
1 Model Parameters.....	2
1.1 Elasticity of Substitution.....	2
1.2 Industry Price Elasticity of Demand .....	2
1.3 Domestic Supply Elasticities .....	2
2 Data Inputs.....	2
2.1 Production Values and Quantities.....	2
2.2 Import Values and Quantities.....	3
2.3 Domestic Export Quantities.....	4
2.4 Domestic Employment.....	4
3 Calibration.....	4
3.1 Supply Parameters.....	4
3.2 Demand Parameters.....	5
4 New Equilibrium Calculation.....	5
5 Results.....	6
Nov 2018 - Oct 2019 .....	7
Nov 2017 - Oct 2018 .....	12
Nov 2016 - Oct 2017 .....	17
Nov 2015 - Oct 2016 .....	22

# Nov 2019 - Oct 2020

```
In[ ]:= ClearAll[f];
```

## 1. Model Parameters

### 1.1 Elasticity of Substitution

Source: USITC's econometric estimation using the trade cost method in Riker (2020).

Riker, David. "A Trade Cost Approach to Estimating the Elasticity of Substitution." Economics Working Paper Series 2020-07-D, U.S. International Trade Commission, July 2020. [https://www.usitc.gov/publications/332/working\\_papers/ecwp\\_2017-07-d.pdf](https://www.usitc.gov/publications/332/working_papers/ecwp_2017-07-d.pdf).

```
In[ ]:= sigma = 4.7756;
```

### 1.2 Industry Price Elasticity of Demand

Source: USITC staff estimate.

```
In[ ]:= eta = -1;
```

### 1.3 Domestic Supply Elasticities

Source: USITC staff estimate and interviews with industry participants.

June-October domestic supply elasticity

```
In[ ]:= en = 6;
```

November-May domestic supply elasticity

```
In[ ]:= ef = 6;
```

## 2. Data Inputs

### 2.1 U.S. Production Values and Quantities

Source: USITC estimates. Annual state level data obtained from U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). State level data was split into June-October and November-May production using information about state-level harvesting months. These estimates also include production grown under protection by season.

U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). "Cucumber Production, Area harvested, and Yield," Quick Stats database. Accessed various dates. <https://quickstats.nass.usda.gov/>.

June-October domestic production quantity (mt) and value (\$)

$ln[\cdot] :=$  **qdn0 = 92,407;**

$ln[\cdot] :=$  **vdn0 = 73,457,603;**

$ln[\cdot] :=$  **pdn0 = vdn0 / qdn0;**

November-May domestic production quantity (mt) and value (\$)

$ln[\cdot] :=$  **qdf0 = 65,915;**

$ln[\cdot] :=$  **vdf0 = 50,724,514;**

$ln[\cdot] :=$  **pdf0 = vdf0 / qdf0;**

## 2.2 Import Values and Quantities

*Source: USITC estimates. Monthly import data was obtained from USITC DataWeb/Census for HTS product code 0707.00. Imports data were reduced by an estimate of cucumber imports sent to the pickling and processing markets. The import counterfactuals were calculated by removing the above-average increases in imports from 2008 to 2020, reducing the high-growth years growth rates in imports to follow average growth rates.*

*U.S. International Trade Commission Interactive Tariff and Trade DataWeb (USITC DataWeb)/U.S. Census Bureau (Census). Accessed various dates. <http://dataweb.usitc.gov>.*

June-October import quantity (mt) and value (\$)

$ln[\cdot] :=$  **qfn0 = 301,934;**

$ln[\cdot] :=$  **vfn0 = 311,234,332;**

$ln[\cdot] :=$  **pfn0 = vfn0 / qfn0;**

November-May import quantity (mt) and value (\$)

$ln[\cdot] :=$  **qff0 = 610,745;**

$ln[\cdot] :=$  **vff0 = 564,928,145;**

$ln[\cdot] :=$  **pff0 = vff0 / qff0;**

June-October counterfactual import quantity (mt)

$ln[\cdot] :=$  **qcn0 = 208,455;**

November-May counterfactual import quantity (mt)

```
ln[ ]:= qcf0 = 475,841;
```

## 2.3 Domestic Export Quantity

Source: USITC estimates. Monthly exports data were obtained from USITC DataWeb/Census for HTS product code 0707.00. Exports data were reduced by an estimate of exports for the pickling and processing markets.

U.S. International Trade Commission Interactive Tariff and Trade DataWeb (USITC DataWeb)/U.S. Census Bureau (Census). Accessed various dates. <http://dataweb.usitc.gov>.

June-October exports quantity (mt)

```
ln[ ]:= qdne0 = 1550;
```

```
ln[ ]:= vdn0 = (qdn0 - qdne0) * pdn0;
```

November-May exports quantity (mt)

```
ln[ ]:= qdfe0 = 2371;
```

```
ln[ ]:= vdf0 = (qdf0 - qdfe0) * pdf0;
```

## 2.4 Domestic Employment

Source: USITC estimates. The number of full-time equivalent (FTE) workers was estimated using information about per-acre labor hours and acreage data from USDA NASS.

U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). "Cucumber Production, Area harvested, and Yield," Quick Stats database. Accessed various dates. <https://quickstats.nass.usda.gov/>.

June-October number of FTEs

```
ln[ ]:= qempn0 = 983;
```

November-May number of FTEs

```
ln[ ]:= qempf0 = 701;
```

# 3. Calibration

## 3.1 Supply Parameters

```
ln[ ]:= adn = qdn0 pdn0-en;
```

```
ln[ ]:= adf = qdf0 pdf0-ef;
```

### 3.2 Demand Parameters

$$\begin{aligned} \ln[ ]:= \text{bf}n &= \frac{\text{vfn}0}{\text{v}dn0} \left( \frac{\text{pfn}0}{\text{p}dn0} \right)^{\text{sigma}-1}; \\ \ln[ ]:= \text{pin}0 &= \left( \text{p}dn0^{1-\text{sigma}} + \text{bf}n \text{pfn}0^{1-\text{sigma}} \right)^{\frac{1}{1-\text{sigma}}}; \\ \ln[ ]:= \text{kn} &= (\text{q}dn0 - \text{q}dne0) \text{pin}0^{-\text{sigma}-\text{eta}} \text{p}dn0^{\text{sigma}}; \\ \ln[ ]:= \text{bff} &= \frac{\text{vff}0}{\text{v}df0} \left( \frac{\text{pff}0}{\text{p}df0} \right)^{\text{sigma}-1}; \\ \ln[ ]:= \text{pif}0 &= \left( \text{p}df0^{1-\text{sigma}} + \text{bff} \text{pff}0^{1-\text{sigma}} \right)^{\frac{1}{1-\text{sigma}}}; \\ \ln[ ]:= \text{kf} &= (\text{q}df0 - \text{q}dfe0) \text{pif}0^{-\text{sigma}-\text{eta}} \text{p}df0^{\text{sigma}}; \end{aligned}$$

## 4. New Equilibrium Calculation

### June-October Equilibrium Calculation

$$\begin{aligned} \ln[ ]:= \text{pin} &= \left( \text{pd}1^{1-\text{sigma}} + \text{bf}n \text{pf}1^{1-\text{sigma}} \right)^{\frac{1}{1-\text{sigma}}}; \\ \ln[ ]:= \text{Eqn11} &= \text{adn} \text{pd}1^{\text{en}} == \text{q}dne0 + \text{kn} \text{pin}^{\text{sigma}+\text{eta}} \text{pd}1^{-\text{sigma}}; \\ \ln[ ]:= \text{Eqn12} &= \text{qcn}0 == \text{kn} \text{bf}n \text{pin}^{\text{sigma}+\text{eta}} \text{pf}1^{-\text{sigma}}; \\ \ln[ ]:= \text{FindRoot} &[\{\text{Eqn11}, \text{Eqn12}\}, \{\text{pd}1, \text{pdn}0\}, \{\text{pf}1, \text{pfn}0\}] \\ \text{Out}[ ]:= &\{\text{pd}1 \rightarrow 848.199, \text{pf}1 \rightarrow 1290.98\} \\ \ln[ ]:= \text{pdn1} &= \text{pd}1 /. \%; \\ \ln[ ]:= \text{pfn1} &= \text{pf}1 /. \%; \\ \ln[ ]:= \text{qdn1} &= \text{adn} \text{pdn1}^{\text{en}}; \\ \ln[ ]:= \text{qfn1} &= \text{qcn}0; \end{aligned}$$

### November-May Equilibrium Calculation

$$\begin{aligned} \ln[ ]:= \text{pif} &= \left( \text{pd}2^{1-\text{sigma}} + \text{bff} \text{pf}2^{1-\text{sigma}} \right)^{\frac{1}{1-\text{sigma}}}; \\ \ln[ ]:= \text{Eqn21} &= \text{adf} \text{pd}2^{\text{ef}} == \text{q}dfe0 + \text{kf} \text{pif}^{\text{sigma}+\text{eta}} \text{pd}2^{-\text{sigma}}; \\ \ln[ ]:= \text{Eqn22} &= \text{qcf}0 == \text{kf} \text{bff} \text{pif}^{\text{sigma}+\text{eta}} \text{pf}2^{-\text{sigma}}; \\ \ln[ ]:= \text{FindRoot} &[\{\text{Eqn21}, \text{Eqn22}\}, \{\text{pd}2, \text{p}df0\}, \{\text{pf}2, \text{pff}0\}] \\ \text{Out}[ ]:= &\{\text{pd}2 \rightarrow 820.057, \text{pf}2 \rightarrow 1127.72\} \\ \ln[ ]:= \text{p}df1 &= \text{pd}2 /. \%; \\ \ln[ ]:= \text{pff1} &= \text{pf}2 /. \%; \end{aligned}$$

$ln[*]:= qdf1 = adf pdf1^{ef};$

$ln[*]:= qff1 = qcfo;$

$ln[*]:= pif1 = (pdf1^{1-sigma} + bff pff1^{1-sigma})^{\frac{1}{1-sigma}};$

## 5. Results

Percent change in prices of domestic product, {June-October, November-May}

$ln[*]:= PriceChange = \left\{ \frac{100 (pdn1 - pdn0)}{pdn0}, \frac{100 (pdf1 - pdf0)}{pdf0} \right\}$

$Out[*]:= \{6.70032, 6.56397\}$

Percent change in quantities of domestic product, {June-October, November-May}

$ln[*]:= QuantityChange = \left\{ \frac{100 (qdn1 - qdn0)}{qdn0}, \frac{100 (qdf1 - qdf0)}{qdf0} \right\}$

$Out[*]:= \{47.5687, 46.4409\}$

Percent change in price of imported product, {June-October, November-May}

$ln[*]:= ImportPChange = \left\{ \frac{100 (pfn1 - pfn0)}{pfn0}, \frac{100 (pff1 - pff0)}{pff0} \right\}$

$Out[*]:= \{25.2401, 21.918\}$

Percent change in quantities of imported product, {June-October, November-May}

$ln[*]:= ImportQChange = \left\{ N \left[ \frac{100 (qfn1 - qfn0)}{qfn0} \right], N \left[ \frac{100 (qff1 - qff0)}{qff0} \right] \right\}$

$Out[*]:= \{-30.9601, -22.0884\}$

Change in revenue of domestic producers (\$), {June-October, November-May}

$ln[*]:= Revenues = \{IntegerPart[pdn1 qdn1 - pdn0 qdn0], IntegerPart[pdf1 qdf1 - pdf0 qdf0]\}$

$Out[*]:= \{42,205,992, 28,432,723\}$

Change in operating income of domestic producers (\$), {June-October, November-May}

$ln[*]:= OP = IntegerPart \left[ \left\{ \left( \frac{1}{sigma} \right) (pdn1 qdn1 - pdn0 qdn0), \left( \frac{1}{sigma} \right) (pdf1 qdf1 - pdf0 qdf0) \right\} \right]$

$Out[*]:= \{8,837,840, 5,953,748\}$

Change in employment (# of FTEs), {June-October, November-May}

$$In[ ] := \text{Employment} = \left\{ q_{\text{empn0}} \frac{(q_{\text{dn1}} - q_{\text{dn0}})}{q_{\text{dn0}}}, q_{\text{empf0}} \frac{(q_{\text{df1}} - q_{\text{df0}})}{q_{\text{df0}}} \right\}$$

Out[ ] := {467.6, 325.551}

## Nov 2018 - Oct 2019

In[ ] := **ClearAll[f];**

### 1. Model Parameters

#### 1.1 Elasticity of Substitution

Source: USITC's econometric estimation using the trade cost method in Riker (2020).

Riker, David. "A Trade Cost Approach to Estimating the Elasticity of Substitution." Economics Working Paper Series 2020-07-D, U.S. International Trade Commission, July 2020. [https://www.usitc.gov/publications/332/working\\_papers/ecwp\\_2017-07-d.pdf](https://www.usitc.gov/publications/332/working_papers/ecwp_2017-07-d.pdf).

In[ ] := **sigma = 4.7756;**

#### 1.2 Industry Price Elasticity of Demand

Source: USITC staff estimate.

In[ ] := **eta = -1;**

#### 1.3 Domestic Supply Elasticities

Source: USITC staff estimate and interviews with industry participants..

June-October domestic supply elasticity

In[ ] := **en = 6;**

November-May domestic supply elasticity

In[ ] := **ef = 6;**

### 2. Data Inputs

#### 2.1 U.S. Production Values and Quantities

Source: USITC estimates. Annual state level data obtained from U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). State level data was split into June-October and November-May production using information about state-

level harvesting months. These estimates also include production grown under protection by season.

U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). "Cucumber Production, Area harvested, and Yield," Quick Stats database. Accessed various dates. <https://quickstats.nass.usda.gov/>.

June-October domestic production quantity (mt) and value (\$)

$ln[\bullet] :=$  **qdn0 = 142,700;**

$ln[\bullet] :=$  **vdn0 = 108,967,960;**

$ln[\bullet] :=$  **pdn0 = vdn0 / qdn0;**

November-May domestic production quantity (mt) and value (\$)

$ln[\bullet] :=$  **qdf0 = 88,728;**

$ln[\bullet] :=$  **vdf0 = 71,627,837;**

$ln[\bullet] :=$  **pdf0 = vdf0 / qdf0;**

## 2.2 Import Values and Quantities

Source: USITC estimates. Monthly import data was obtained from USITC DataWeb/Census for HTS product code 0707.00. Imports data were reduced by an estimate of cucumber imports sent to the pickling and processing markets. The import counterfactuals were calculated by removing the above-average increases in imports from 2008 to 2020, reducing the high-growth years growth rates in imports to follow average growth rates.

U.S. International Trade Commission Interactive Tariff and Trade DataWeb (USITC DataWeb)/U.S. Census Bureau (Census). Accessed various dates. <http://dataweb.usitc.gov>.

June-October import quantity (mt) and value (\$)

$ln[\bullet] :=$  **qfn0 = 277,164;**

$ln[\bullet] :=$  **vfn0 = 264,634,343;**

$ln[\bullet] :=$  **pfn0 = vfn0 / qfn0;**

November-May import quantity (mt) and value (\$)

$ln[\bullet] :=$  **qff0 = 637,137;**

$ln[\bullet] :=$  **vff0 = 519,272,818;**

$ln[\bullet] :=$  **pff0 = vff0 / qff0;**

June-October counterfactual import quantity (mt)



$ln[\bullet] :=$  **qcn0 = 200,826;**

November-May counterfactual import quantity (mt)

$ln[\bullet] :=$  **qcf0 = 496,403;**

## 2.3 Domestic Export Quantity

Source: USITC estimates. Monthly exports data were obtained from USITC DataWeb/Census for HTS product code 0707.00. Exports data were reduced by an estimate of exports for the pickling and processing markets.

U.S. International Trade Commission Interactive Tariff and Trade DataWeb (USITC DataWeb)/U.S. Census Bureau (Census). Accessed various dates. <http://dataweb.usitc.gov>.

June-October exports quantity (mt)

$ln[\bullet] :=$  **qdne0 = 1853;**

$ln[\bullet] :=$  **vdn0 = (qdn0 – qdne0) \* pdn0;**

November-May exports quantity (mt)

$ln[\bullet] :=$  **qdfe0 = 3053;**

$ln[\bullet] :=$  **vdf0 = (qdf0 – qdfe0) \* pdf0;**

## 2.4 Domestic Employment

Source: USITC estimates. The number of full-time equivalent (FTE) workers was estimated using information about per-acre labor hours and acreage data from USDA NASS.

U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). "Cucumber Production, Area harvested, and Yield," Quick Stats database. Accessed various dates. <https://quickstats.nass.usda.gov/>.

June-October number of FTEs

$ln[\bullet] :=$  **qempn0 = 1133;**

November-May number of FTEs

$ln[\bullet] :=$  **qempf0 = 704;**

## 3. Calibration

### 3.1 Supply Parameters

$$\ln[ \circ ] := \text{adn} = \text{qdn0} \text{pdn0}^{-\text{en}};$$

$$\ln[ \circ ] := \text{adf} = \text{qdf0} \text{pdf0}^{-\text{ef}};$$

### 3.2 Demand Parameters

$$\ln[ \circ ] := \text{bf0} = \frac{\text{vfn0}}{\text{vdn0}} \left( \frac{\text{pf0}}{\text{pdn0}} \right)^{\text{sigma}-1};$$

$$\ln[ \circ ] := \text{pin0} = \left( \text{pdn0}^{1-\text{sigma}} + \text{bf0} \text{pf0}^{1-\text{sigma}} \right)^{\frac{1}{1-\text{sigma}}};$$

$$\ln[ \circ ] := \text{kn} = \left( \text{qdn0} - \text{qdn0} \right) \text{pin0}^{-\text{sigma}-\text{eta}} \text{pdn0}^{\text{sigma}};$$

$$\ln[ \circ ] := \text{bff} = \frac{\text{vff0}}{\text{vdf0}} \left( \frac{\text{pff0}}{\text{pdf0}} \right)^{\text{sigma}-1};$$

$$\ln[ \circ ] := \text{pif0} = \left( \text{pdf0}^{1-\text{sigma}} + \text{bff} \text{pff0}^{1-\text{sigma}} \right)^{\frac{1}{1-\text{sigma}}};$$

$$\ln[ \circ ] := \text{kf} = \left( \text{qdf0} - \text{qdf0} \right) \text{pif0}^{-\text{sigma}-\text{eta}} \text{pdf0}^{\text{sigma}};$$

## 4. New Equilibrium Calculation

### June-October Equilibrium Calculation

$$\ln[ \circ ] := \text{pin} = \left( \text{pd1}^{1-\text{sigma}} + \text{bf0} \text{pf1}^{1-\text{sigma}} \right)^{\frac{1}{1-\text{sigma}}};$$

$$\ln[ \circ ] := \text{Eqn11} = \text{adn} \text{pd1}^{\text{en}} = \text{qdn0} + \text{kn} \text{pin}^{\text{sigma}+\text{eta}} \text{pd1}^{-\text{sigma}};$$

$$\ln[ \circ ] := \text{Eqn12} = \text{qcn0} = \text{kn} \text{bf0} \text{pin}^{\text{sigma}+\text{eta}} \text{pf1}^{-\text{sigma}};$$

$$\ln[ \circ ] := \text{FindRoot}[\{\text{Eqn11}, \text{Eqn12}\}, \{\text{pd1}, \text{pdn0}\}, \{\text{pf1}, \text{pf0}\}]$$

$$\text{Out}[ \circ ] := \{\text{pd1} \rightarrow 797.299, \text{pf1} \rightarrow 1126.63\}$$

$$\ln[ \circ ] := \text{pdn1} = \text{pd1} /. \%;$$

$$\ln[ \circ ] := \text{pf1} = \text{pf1} /. \%;$$

$$\ln[ \circ ] := \text{qdn1} = \text{adn} \text{pdn1}^{\text{en}};$$

$$\ln[ \circ ] := \text{qfn1} = \text{qcn0};$$

$$\ln[ \circ ] := \text{pin1} = \left( \text{pdn1}^{1-\text{sigma}} + \text{bf0} \text{pf1}^{1-\text{sigma}} \right)^{\frac{1}{1-\text{sigma}}};$$

### November-May Equilibrium Calculation

$$\ln[ \circ ] := \text{pif} = \left( \text{pd2}^{1-\text{sigma}} + \text{bff} \text{pf2}^{1-\text{sigma}} \right)^{\frac{1}{1-\text{sigma}}};$$

$$\ln[ \circ ] := \text{Eqn21} = \text{adf} \text{pd2}^{\text{ef}} = \text{qdf0} + \text{kf} \text{pif}^{\text{sigma}+\text{eta}} \text{pd2}^{-\text{sigma}};$$

```

ln[*]:= Eqn22 = qcf0 == kf bff pifsigma+eta pf2-sigma;

ln[*]:= FindRoot[{Eqn21, Eqn22}, {pd2, pdf0}, {pf2, pff0}]

Out[*]:= {pd2 → 853.918, pf2 → 976.85}

ln[*]:= pdf1 = pd2 /. %;

ln[*]:= pff1 = pf2 /. %%;

ln[*]:= qdf1 = adf pdf1ef;

ln[*]:= qff1 = qcf0;

ln[*]:= pif1 = ( pdf11-sigma + bff pff11-sigma ) $\frac{1}{1-sigma}$ ;

```

## 5. Results

Percent change in prices of domestic product, {June-October, November-May}

```

ln[*]:= PriceChange = {  $\frac{100 (pdn1 - pdn0)}{pdn0}$ ,  $\frac{100 (pdf1 - pdf0)}{pdf0}$  }

```

```
Out[*]:= {4.41105, 5.77788}
```

Percent change in quantities of domestic product, {June-October, November-May}

```

ln[*]:= QuantityChange = {  $\frac{100 (qdn1 - qdn0)}{qdn0}$ ,  $\frac{100 (qdf1 - qdf0)}{qdf0}$  }

```

```
Out[*]:= {29.5624, 40.0777}
```

Percent change in price of imported product, {June-October, November-May}

```

ln[*]:= ImportPChange = {  $\frac{100 (pfn1 - pfn0)}{pfn0}$ ,  $\frac{100 (pff1 - pff0)}{pff0}$  }

```

```
Out[*]:= {17.9968, 19.8575}
```

Percent change in quantities of imported product, {June-October, November-May}

```

ln[*]:= ImportQChange = { N[  $\frac{100 (qfn1 - qfn0)}{qfn0}$  ], N[  $\frac{100 (qff1 - qff0)}{qff0}$  ] }

```

```
Out[*]:= {-27.5425, -22.0885}
```

Change in revenue of domestic producers (\$), {June-October, November-May}

```

ln[*]:= Revenues = { IntegerPart [ pdn1 qdn1 - pdn0 qdn0 ], IntegerPart [ pdf1 qdf1 - pdf0 qdf0 ] }

```

```
Out[*]:= {38,441,085, 34,504,009}
```

Change in operating income of domestic producers (\$), {June-October, November-May}

$\text{In}[\#] := \text{OP} = \text{IntegerPart} \left[ \left\{ \left( \frac{1}{\text{sigma}} \right) (\text{pdn1} \text{ qdn1} - \text{pdn0} \text{ qdn0}), \left( \frac{1}{\text{sigma}} \right) (\text{pdf1} \text{ qdf1} - \text{pdf0} \text{ qdf0}) \right\} \right]$

$\text{Out}[\#] := \{8,049,477, 7,225,062\}$

Change in employment (# of FTEs), {June-October, November-May}

$\text{In}[\#] := \text{Employment} = \left\{ \text{qempn0} \frac{(\text{qdn1} - \text{qdn0})}{\text{qdn0}}, \text{qempf0} \frac{(\text{qdf1} - \text{qdf0})}{\text{qdf0}} \right\}$

$\text{Out}[\#] := \{334.942, 282.147\}$

## Nov 2017 - Oct 2018

$\text{In}[\#] := \text{ClearAll}[\text{f}];$

### 1. Model Parameters

#### 1.1 Elasticity of Substitution

Source: USITC's econometric estimation using the trade cost method in Riker (2020).

Riker, David. "A Trade Cost Approach to Estimating the Elasticity of Substitution." Economics Working Paper Series 2020-07-D, U.S. International Trade Commission, July 2020. [https://www.usitc.gov/publications/332/working\\_papers/ecwp\\_2017-07-d.pdf](https://www.usitc.gov/publications/332/working_papers/ecwp_2017-07-d.pdf).

$\text{In}[\#] := \text{sigma} = 4.7756;$

#### 1.2 Industry Price Elasticity of Demand

Source: USITC staff estimate.

$\text{In}[\#] := \text{eta} = -1;$

#### 1.3 Domestic Supply Elasticities

Source: USITC staff estimate and interviews with industry participants..

June-October domestic supply elasticity

$\text{In}[\#] := \text{en} = 6;$

November-May domestic supply elasticity

$\ln[\cdot] :=$  **ef = 6;**

## 2. Data Inputs

### 2.1 U.S. Production Values and Quantities

Source: USITC estimates. Annual state level data obtained from U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). State level data was split into June-October and November-May production using information about state-level harvesting months. These estimates also include production grown under protection by season.

U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). "Cucumber Production, Area harvested, and Yield," Quick Stats database. Accessed various dates. <https://quickstats.nass.usda.gov/>.

June-October domestic production quantity (mt) and value (\$)

$\ln[\cdot] :=$  **qdn0 = 189,578;**

$\ln[\cdot] :=$  **vdn0 = 141,656,920;**

$\ln[\cdot] :=$  **pdn0 = vdn0 / qdn0;**

November-May domestic production quantity (mt) and value (\$)

$\ln[\cdot] :=$  **qdf0 = 92,436;**

$\ln[\cdot] :=$  **vdf0 = 72,693,912;**

$\ln[\cdot] :=$  **pdf0 = vdf0 / qdf0;**

### 2.2 Import Values and Quantities

Source: USITC estimates. Monthly import data was obtained from USITC DataWeb/Census for HTS product code 0707.00. Imports data were reduced by an estimate of cucumber imports sent to the pickling and processing markets. The import counterfactuals were calculated by removing the above-average increases in imports from 2008 to 2020, reducing the high-growth years growth rates in imports to follow average growth rates.

U.S. International Trade Commission Interactive Tariff and Trade DataWeb (USITC DataWeb)/U.S. Census Bureau (Census). Accessed various dates. <http://dataweb.usitc.gov>.

June-October import quantity (mt) and value (\$)

$\ln[\cdot] :=$  **qfn0 = 254,865;**

$\ln[\cdot] :=$  **vfn0 = 256,282,557;**

$\ln[\cdot] :=$  **pfn0 = vfn0 / qfn0;**

November-May import quantity (mt) and value (\$)

$ln[\bullet] :=$  **qff0 = 619,233;**

$ln[\bullet] :=$  **vff0 = 468,035,265;**

$ln[\bullet] :=$  **pff0 = vff0 / qff0;**

June-October counterfactual import quantity (mt)

$ln[\bullet] :=$  **qcn0 = 193,826;**

November-May counterfactual import quantity (mt)

$ln[\bullet] :=$  **qcf0 = 482,453;**

## 2.3 Domestic Export Quantity

Source: USITC estimates. Monthly exports data were obtained from USITC DataWeb/Census for HTS product code 0707.00. Exports data were reduced by an estimate of exports for the pickling and processing markets.

U.S. International Trade Commission Interactive Tariff and Trade DataWeb (USITC DataWeb)/U.S. Census Bureau (Census). Accessed various dates. <http://dataweb.usitc.gov>.

June-October exports quantity (mt)

$ln[\bullet] :=$  **qdne0 = 1547;**

$ln[\bullet] :=$  **vdn0 = (qdn0 - qdne0) \* pdn0;**

November-May exports quantity (mt)

$ln[\bullet] :=$  **qdfe0 = 3507;**

$ln[\bullet] :=$  **vdf0 = (qdf0 - qdfe0) \* pdf0;**

## 2.4 Domestic Employment

Source: USITC estimates. The number of full-time equivalent (FTE) workers was estimated using information about per-acre labor hours and acreage data from USDA NASS.

U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). "Cucumber Production, Area harvested, and Yield," Quick Stats database. Accessed various dates. <https://quickstats.nass.usda.gov/>.

June-October number of FTEs

$ln[\bullet] :=$  **qempn0 = 1359;**

November-May number of FTEs

```
ln[*]:= qempf0 = 663;
```

## 3. Calibration

### 3.1 Supply Parameters

```
ln[*]:= adn = qdn0 pdn0-en;
```

```
ln[*]:= adf = qdf0 pdf0-ef;
```

### 3.2 Demand Parameters

```
ln[*]:= bfn =  $\frac{vfn0}{vdn0} \left( \frac{pfn0}{pdn0} \right)^{\sigma-1}$ ;
```

```
ln[*]:= pin0 =  $\left( pdn0^{1-\sigma} + bfn pf n0^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ ;
```

```
ln[*]:= kn = (qdn0 - qdne0) pin0-sigma-eta pdn0sigma;
```

```
ln[*]:= bff =  $\frac{vff0}{vdf0} \left( \frac{pff0}{pdf0} \right)^{\sigma-1}$ ;
```

```
ln[*]:= pif0 =  $\left( pdf0^{1-\sigma} + bff pff0^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ ;
```

```
ln[*]:= kf = (qdf0 - qdfe0) pif0-sigma-eta pdf0sigma;
```

## 4. New Equilibrium Calculation

### June-October Equilibrium Calculation

```
ln[*]:= pin =  $\left( pd1^{1-\sigma} + bfn pf1^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ ;
```

```
ln[*]:= Eqn11 = adn pd1en == qdne0 + kn pinsigma+eta pd1-sigma;
```

```
ln[*]:= Eqn12 = qcn0 == kn bfn pinsigma+eta pf1-sigma;
```

```
ln[*]:= FindRoot[{Eqn11, Eqn12}, {pd1, pdn0}, {pf1, pf n0}]
```

```
Out[*]:= {pd1 → 771.001, pf1 → 1143.23}
```

```
ln[*]:= pdn1 = pd1 /. %;
```

```
ln[*]:= pf n1 = pf1 /. %%;
```

```
ln[*]:= qdn1 = adn pdn1en;
```

```
ln[*]:= qfn1 = qcn0;
```

```
ln[*]:= pin1 =  $\left( pdn1^{1-\sigma} + bfn pf n1^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ ;
```

### November-May Equilibrium Calculation

```

ln[ ]:= pif = (pd21-sigma + bff pf21-sigma) $\frac{1}{1-sigma}$ ;
ln[ ]:= Eqn21 = adf pd2ef == qdfe0 + kf pifsigma+eta pd2-sigma;
ln[ ]:= Eqn22 = qcf0 == kf bff pifsigma+eta pf2-sigma;
ln[ ]:= FindRoot[{Eqn21, Eqn22}, {pd2, pdf0}, {pf2, pff0}]
Out[ ]:= {pd2 → 829.964, pf2 → 901.392}

ln[ ]:= pdf1 = pd2 /. %;
ln[ ]:= pff1 = pf2 /. %%;
ln[ ]:= qdf1 = adf pdf1ef;
ln[ ]:= qff1 = qcf0;

ln[ ]:= pif1 = (pdf11-sigma + bff pff11-sigma) $\frac{1}{1-sigma}$ ;

```

## 5. Results

Percent change in prices of domestic product, {June-October, November-May}

$$\text{PriceChange} = \left\{ \frac{100 (pdn1 - pdn0)}{pdn0}, \frac{100 (pdf1 - pdf0)}{pdf0} \right\}$$

```
Out[ ]:= {3.18224, 5.53648}
```

Percent change in quantities of domestic product, {June-October, November-May}

$$\text{QuantityChange} = \left\{ \frac{100 (qdn1 - qdn0)}{qdn0}, \frac{100 (qdf1 - qdf0)}{qdf0} \right\}$$

```
Out[ ]:= {20.6784, 38.1706}
```

Percent change in price of imported product, {June-October, November-May}

$$\text{ImportPChange} = \left\{ \frac{100 (pfn1 - pfn0)}{pfn0}, \frac{100 (pff1 - pff0)}{pff0} \right\}$$

```
Out[ ]:= {13.6902, 19.2585}
```

Percent change in quantities of imported product, {June-October, November-May}

$$\text{ImportQChange} = \left\{ N \left[ \frac{100 (qfn1 - qfn0)}{qfn0} \right], N \left[ \frac{100 (qff1 - qff0)}{qff0} \right] \right\}$$

```
Out[ ]:= {-23.9495, -22.0886}
```

Change in revenue of domestic producers (\$), {June-October, November-May}



$ln[\ast] := \text{Revenues} = \{ \text{IntegerPart}[\text{pdn1 qdn1} - \text{pdn0 qdn0}], \text{IntegerPart}[\text{pdf1 qdf1} - \text{pdf0 qdf0}] \}$

$Out[\ast] := \{ 34,732,465, 33,308,643 \}$

Change in operating income of domestic producers (\$), {June-October, November-May}

$ln[\ast] := \text{OP} = \text{IntegerPart} \left[ \left\{ \left( \frac{1}{\text{sigma}} \right) (\text{pdn1 qdn1} - \text{pdn0 qdn0}), \left( \frac{1}{\text{sigma}} \right) (\text{pdf1 qdf1} - \text{pdf0 qdf0}) \right\} \right]$

$Out[\ast] := \{ 7,272,900, 6,974,755 \}$

Change in employment (# of FTEs), {June-October, November-May}

$ln[\ast] := \text{Employment} = \left\{ \text{qempn0} \frac{(\text{qdn1} - \text{qdn0})}{\text{qdn0}}, \text{qempf0} \frac{(\text{qdf1} - \text{qdf0})}{\text{qdf0}} \right\}$

$Out[\ast] := \{ 281.02, 253.071 \}$

## Nov 2016 - Oct 2017

$ln[\ast] := \text{ClearAll}[\text{f}];$

### 1. Model Parameters

#### 1.1 Elasticity of Substitution

Source: USITC's econometric estimation using the trade cost method in Riker (2020).

Riker, David. "A Trade Cost Approach to Estimating the Elasticity of Substitution." Economics Working Paper Series 2020-07-D, U.S. International Trade Commission, July 2020. [https://www.usitc.gov/publications/332/working\\_papers/ecwp\\_2017-07-d.pdf](https://www.usitc.gov/publications/332/working_papers/ecwp_2017-07-d.pdf).

$ln[\ast] := \text{sigma} = 4.7756;$

#### 1.2 Industry Price Elasticity of Demand

Source: USITC staff estimate.

$ln[\ast] := \text{eta} = -1;$

#### 1.3 Domestic Supply Elasticities

Source: USITC staff estimate and interviews with industry participants..

June-October domestic supply elasticity

```
ln[ ]:= en = 6;
```

November-May domestic supply elasticity

```
ln[ ]:= ef = 6;
```

## 2. Data Inputs

### 2.1 U.S. Production Values and Quantities

Source: USITC estimates. Annual state level data obtained from U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). State level data was split into June-October and November-May production using information about state-level harvesting months. These estimates also include production grown under protection by season.

U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). "Cucumber Production, Area harvested, and Yield," Quick Stats database. Accessed various dates. <https://quickstats.nass.usda.gov/>.

June-October domestic production quantity (mt) and value (\$)

```
ln[ ]:= qdn0 = 158,235;
```

```
ln[ ]:= vdn0 = 124,575,998;
```

```
ln[ ]:= pdn0 = vdn0 / qdn0;
```

November-May domestic production quantity (mt) and value (\$)

```
ln[ ]:= qdf0 = 95,212;
```

```
ln[ ]:= vdf0 = 73,398,655;
```

```
ln[ ]:= pdf0 = vdf0 / qdf0;
```

### 2.2 Import Values and Quantities

Source: USITC estimates. Monthly import data was obtained from USITC DataWeb/Census for HTS product code 0707.00. Imports data were reduced by an estimate of cucumber imports sent to the pickling and processing markets. The import counterfactuals were calculated by removing the above-average increases in imports from 2008 to 2020, reducing the high-growth years growth rates in imports to follow average growth rates.

U.S. International Trade Commission Interactive Tariff and Trade DataWeb (USITC DataWeb)/U.S. Census Bureau (Census). Accessed various dates. <http://dataweb.usitc.gov>.

June-October import quantity (mt) and value (\$)

```
ln[ ]:= qfn0 = 251,467;
```

$ln[\bullet] :=$  **vfn0 = 232,883,773;**

$ln[\bullet] :=$  **pfn0 = vfn0 / qfn0;**

November-May import quantity (mt) and value (\$)

$ln[\bullet] :=$  **qff0 = 563,283;**

$ln[\bullet] :=$  **vff0 = 406,236,757;**

$ln[\bullet] :=$  **pff0 = vff0 / qff0;**

June-October counterfactual import quantity (mt)

$ln[\bullet] :=$  **qcn0 = 191,242;**

November-May counterfactual import quantity (mt)

$ln[\bullet] :=$  **qcf0 = 452,456;**

## 2.3 Domestic Export Quantity

Source: USITC estimates. Monthly exports data were obtained from USITC DataWeb/Census for HTS product code 0707.00. Exports data were reduced by an estimate of exports for the pickling and processing markets.

U.S. International Trade Commission Interactive Tariff and Trade DataWeb (USITC DataWeb)/U.S. Census Bureau (Census). Accessed various dates. <http://dataweb.usitc.gov>.

June-October exports quantity (mt)

$ln[\bullet] :=$  **qdne0 = 1081;**

$ln[\bullet] :=$  **vdn0 = (qdn0 - qdne0) \* pdn0;**

November-May exports quantity (mt)

$ln[\bullet] :=$  **qdfe0 = 3069;**

$ln[\bullet] :=$  **vdf0 = (qdf0 - qdfe0) \* pdf0;**

## 2.4 Domestic Employment

Source: USITC estimates. The number of full-time equivalent (FTE) workers was estimated using information about per-acre labor hours and acreage data from USDA NASS.

U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). "Cucumber Production, Area harvested, and Yield," Quick Stats database. Accessed various dates. <https://quickstats.nass.usda.gov/>.

June-October number of FTEs

```
ln[ ]:= qempn0 = 1334;
```

November-May number of FTEs

```
ln[ ]:= qempf0 = 802;
```

## 3. Calibration

### 3.1 Supply Parameters

```
ln[ ]:= adn = qdn0 pdn0-en;
```

```
ln[ ]:= adf = qdf0 pdf0-ef;
```

### 3.2 Demand Parameters

```
ln[ ]:= bfn =  $\frac{vfn0}{vdn0} \left( \frac{pfn0}{pdn0} \right)^{\sigma-1}$ ;
```

```
ln[ ]:= pin0 =  $\left( pdn0^{1-\sigma} + bfn \, pf n0^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ ;
```

```
ln[ ]:= kn = (qdn0 - qdne0) pin0-sigma-eta pdn0sigma;
```

```
ln[ ]:= bff =  $\frac{vff0}{vdf0} \left( \frac{pff0}{pdf0} \right)^{\sigma-1}$ ;
```

```
ln[ ]:= pif0 =  $\left( pdf0^{1-\sigma} + bff \, pff0^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ ;
```

```
ln[ ]:= kf = (qdf0 - qdfe0) pif0-sigma-eta pdf0sigma;
```

## 4. New Equilibrium Calculation

### June-October Equilibrium Calculation

```
ln[ ]:= pin =  $\left( pd1^{1-\sigma} + bfn \, pf1^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ ;
```

```
ln[ ]:= Eqn11 = adn pd1en == qdne0 + kn pinsigma+eta pd1-sigma;
```

```
ln[ ]:= Eqn12 = qcn0 == kn bfn pinsigma+eta pf1-sigma;
```

```
ln[ ]:= FindRoot[{Eqn11, Eqn12}, {pd1, pdn0}, {pf1, pf n0}]
```

```
Out[ ]:= {pd1 → 812.875, pf1 → 1054.41}
```

```
ln[ ]:= pdn1 = pd1 /. %;
```

```
ln[ ]:= pf n1 = pf1 /. %%;
```

```
ln[ ]:= qdn1 = adn pdn1en;
```

```
ln[ ]:= qfn1 = qcn0;
```

```
ln[ ]:= pin1 = ( pdn11-sigma + bfn pfn11-sigma )1/(1-sigma);
```

### November-May Equilibrium Calculation

```
ln[ ]:= pif = ( pd21-sigma + bff pf21-sigma )1/(1-sigma);
```

```
ln[ ]:= Eqn21 = adf pd2ef == qdfe0 + kf pifsigma+eta pd2-sigma;
```

```
ln[ ]:= Eqn22 = qcf0 == kf bff pifsigma+eta pf2-sigma;
```

```
ln[ ]:= FindRoot[{Eqn21, Eqn22}, {pd2, pdf0}, {pf2, pff0}]
```

```
Out[ ]:= {pd2 → 806.59, pf2 → 837.62}
```

```
ln[ ]:= pdf1 = pd2 /. %;
```

```
ln[ ]:= pff1 = pf2 /. %%;
```

```
ln[ ]:= qdf1 = adf pdf1ef;
```

```
ln[ ]:= qff1 = qcf0;
```

```
ln[ ]:= pif1 = ( pdf11-sigma + bff pff11-sigma )1/(1-sigma);
```

## 5. Results

Percent change in prices of domestic product, {June-October, November-May}

```
ln[ ]:= PriceChange = { 100 (pdn1 - pdn0) / pdn0, 100 (pdf1 - pdf0) / pdf0 }
```

```
Out[ ]:= {3.25046, 4.63006}
```

Percent change in quantities of domestic product, {June-October, November-May}

```
ln[ ]:= QuantityChange = { 100 (qdn1 - qdn0) / qdn0, 100 (qdf1 - qdf0) / qdf0 }
```

```
Out[ ]:= {21.1579, 31.2015}
```

Percent change in price of imported product, {June-October, November-May}

```
ln[ ]:= ImportPChange = { 100 (pfn1 - pfn0) / pfn0, 100 (pff1 - pff0) / pff0 }
```

```
Out[ ]:= {13.8549, 16.1433}
```

Percent change in quantities of imported product, {June-October, November-May}

$$In[*]:= \text{ImportQChange} = \left\{ N \left[ \frac{100 (qfn1 - qfn0)}{qfn0} \right], N \left[ \frac{100 (qff1 - qff0)}{qff0} \right] \right\}$$

Out[\*]:= { -23.9495, -19.6752 }

Change in revenue of domestic producers (\$), {June-October, November-May}

$$In[*]:= \text{Revenues} = \{ \text{IntegerPart}[\text{pdn1 qdn1} - \text{pdn0 qdn0}], \text{IntegerPart}[\text{pdf1 qdf1} - \text{pdf0 qdf0}] \}$$

Out[\*]:= { 31,263,739, 27,360,227 }

Change in operating income of domestic producers (\$), {June-October, November-May}

$$In[*]:= \text{OP} = \text{IntegerPart} \left[ \left\{ \left( \frac{1}{\text{sigma}} \right) (\text{pdn1 qdn1} - \text{pdn0 qdn0}), \left( \frac{1}{\text{sigma}} \right) (\text{pdf1 qdf1} - \text{pdf0 qdf0}) \right\} \right]$$

Out[\*]:= { 6,546,557, 5,729,170 }

Change in employment (# of FTEs), {June-October, November-May}

$$In[*]:= \text{Employment} = \left\{ \text{qempn0} \frac{(\text{qdn1} - \text{qdn0})}{\text{qdn0}}, \text{qemp0} \frac{(\text{qdf1} - \text{qdf0})}{\text{qdf0}} \right\}$$

Out[\*]:= { 282.247, 250.236 }

## Nov 2015 - Oct 2016

In[\*]:= **ClearAll[f];**

### 1. Model Parameters

#### 1.1 Elasticity of Substitution

Source: USITC's econometric estimation using the trade cost method in Riker (2020).

Riker, David. "A Trade Cost Approach to Estimating the Elasticity of Substitution." *Economics Working Paper Series 2020-07-D*, U.S. International Trade Commission, July 2020. [https://www.usitc.gov/publications/332/working\\_papers/ecwp\\_2017-07-d.pdf](https://www.usitc.gov/publications/332/working_papers/ecwp_2017-07-d.pdf).

In[\*]:= **sigma = 4.7756;**

#### 1.2 Industry Price Elasticity of Demand

Source: USITC staff estimate.

In[\*]:= **eta = -1;**

## 1.3 Domestic Supply Elasticities

Source: USITC staff estimate and interviews with industry participants..

June-October domestic supply elasticity

$\ln[\bullet] :=$  **en = 6;**

November-May domestic supply elasticity

$\ln[\bullet] :=$  **ef = 6;**

## 2. Data Inputs

### 2.1 U.S. Production Values and Quantities

Source: USITC estimates. Annual state level data obtained from U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). State level data was split into June-October and November-May production using information about state-level harvesting months. These estimates also include production grown under protection by season.

U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). "Cucumber Production, Area harvested, and Yield," Quick Stats database. Accessed various dates. <https://quickstats.nass.usda.gov/>.

June-October domestic production quantity (mt) and value (\$)

$\ln[\bullet] :=$  **qdn0 = 244,846;**

$\ln[\bullet] :=$  **vdn0 = 158,361,571;**

$\ln[\bullet] :=$  **pdn0 = vdn0 / qdn0;**

November-May domestic production quantity (mt) and value (\$)

$\ln[\bullet] :=$  **qdf0 = 122,233;**

$\ln[\bullet] :=$  **vdf0 = 93,346,707;**

$\ln[\bullet] :=$  **pdf0 = vdf0 / qdf0;**

### 2.2 Import Values and Quantities

Source: USITC estimates. Monthly import data was obtained from USITC DataWeb/Census for HTS product code 0707.00. Imports data were reduced by an estimate of cucumber imports sent to the pickling and processing markets. The import counterfactuals were calculated by removing the above-average increases in imports from 2008 to 2020, reducing the high-growth years growth rates in imports to follow average growth rates.

U.S. International Trade Commission Interactive Tariff and Trade DataWeb (USITC DataWeb)/U.S. Census Bureau (Census). Accessed

various dates. <http://dataweb.usitc.gov>.

June-October import quantity (mt) and value (\$)

$ln[\bullet] :=$  **qfn0 = 234,876;**

$ln[\bullet] :=$  **vfn0 = 212,220,768;**

$ln[\bullet] :=$  **pfn0 = vfn0 / qfn0;**

November-May import quantity (mt) and value (\$)

$ln[\bullet] :=$  **qff0 = 571,277;**

$ln[\bullet] :=$  **vff0 = 469,487,380;**

$ln[\bullet] :=$  **pff0 = vff0 / qff0;**

June-October counterfactual import quantity (mt)

$ln[\bullet] :=$  **qcn0 = 178,624;**

November-May counterfactual import quantity (mt)

$ln[\bullet] :=$  **qcf0 = 458,877;**

## 2.3 Domestic Export Quantity

Source: USITC estimates. Monthly exports data were obtained from USITC DataWeb/Census for HTS product code 0707.00. Exports data were reduced by an estimate of exports for the pickling and processing markets.

U.S. International Trade Commission Interactive Tariff and Trade DataWeb (USITC DataWeb)/U.S. Census Bureau (Census). Accessed various dates. <http://dataweb.usitc.gov>.

June-October exports quantity (mt)

$ln[\bullet] :=$  **qdne0 = 2366;**

$ln[\bullet] :=$  **vdn0 = (qdn0 - qdne0) \* pdn0;**

November-May exports quantity (mt)

$ln[\bullet] :=$  **qdfe0 = 3967;**

$ln[\bullet] :=$  **vdf0 = (qdf0 - qdfe0) \* pdf0;**

## 2.4 Domestic Employment

Source: USITC estimates. The number of full-time equivalent (FTE) workers was estimated using information about per-acre labor hours and acreage data from USDA NASS.



U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). "Cucumber Production, Area harvested, and Yield," Quick Stats database. Accessed various dates. <https://quickstats.nass.usda.gov/>.

June-October number of FTEs

$ln[\bullet] :=$  **qempn0 = 1395;**

November-May number of FTEs

$ln[\bullet] :=$  **qempf0 = 696;**

## 3. Calibration

### 3.1 Supply Parameters

$ln[\bullet] :=$  **adn = qdn0 pdn0<sup>-en</sup>;**

$ln[\bullet] :=$  **adf = qdf0 pdf0<sup>-ef</sup>;**

### 3.2 Demand Parameters

$ln[\bullet] :=$  **bfn =  $\frac{vfn0}{vdn0} \left( \frac{pfn0}{pdn0} \right)^{\sigma-1}$ ;**

$ln[\bullet] :=$  **pin0 =  $\left( pdn0^{1-\sigma} + bfn pf n0^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ ;**

$ln[\bullet] :=$  **kn =  $\left( qdn0 - qdne0 \right) pin0^{-\sigma-\eta} pdn0^{\sigma}$ ;**

$ln[\bullet] :=$  **bff =  $\frac{vff0}{vdf0} \left( \frac{pff0}{pdf0} \right)^{\sigma-1}$ ;**

$ln[\bullet] :=$  **pif0 =  $\left( pdf0^{1-\sigma} + bff pf f0^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ ;**

$ln[\bullet] :=$  **kf =  $\left( qdf0 - qdfe0 \right) pif0^{-\sigma-\eta} pdf0^{\sigma}$ ;**

## 4. New Equilibrium Calculation

### June-October Equilibrium Calculation

$ln[\bullet] :=$  **pin =  $\left( pd1^{1-\sigma} + bfn pf1^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ ;**

$ln[\bullet] :=$  **Eqn11 = adn pd1<sup>en</sup> == qdne0 + kn pin<sup>sigma+eta</sup> pd1<sup>-sigma</sup>;**

$ln[\bullet] :=$  **Eqn12 = qcn0 == kn bfn pin<sup>sigma+eta</sup> pf1<sup>-sigma</sup>;**

$ln[\bullet] :=$  **FindRoot[{Eqn11, Eqn12}, {pd1, pdn0}, {pf1, pf n0}]**

**Out[ $\bullet$ ] := {pd1 → 663.57, pf1 → 1014.11}**

```
ln[ ]:= pdn1 = pd1 / . %;
ln[ ]:= pfn1 = pf1 / . %%;
ln[ ]:= qdn1 = adn pdn1en;
ln[ ]:= qfn1 = qcn0;

ln[ ]:= pin1 = ( pdn11-sigma + bfn pfn11-sigma ) 1/1-sigma;
```

### November-May Equilibrium Calculation

```
ln[ ]:= pif = ( pd21-sigma + bff pf21-sigma ) 1/1-sigma;
ln[ ]:= Eqn21 = adf pd2ef == qdfe0 + kf pifsigma+eta pd2-sigma;
ln[ ]:= Eqn22 = qcf0 == kf bff pifsigma+eta pf2-sigma;
ln[ ]:= FindRoot[{Eqn21, Eqn22}, {pd2, pdf0}, {pf2, pff0}]
Out[ ]:= {pd2 -> 797.699, pf2 -> 950.846}

ln[ ]:= pdf1 = pd2 / . %;
ln[ ]:= pff1 = pf2 / . %%;
ln[ ]:= qdf1 = adf pdf1ef;
ln[ ]:= qff1 = qcf0;

ln[ ]:= pif1 = ( pdf11-sigma + bff pff11-sigma ) 1/1-sigma;
```

## 5. Results

Percent change in prices of domestic product, {June-October, November-May}

$$\text{PriceChange} = \left\{ \frac{100 (pdn1 - pdn0)}{pdn0}, \frac{100 (pdf1 - pdf0)}{pdf0} \right\}$$

```
Out[ ]:= {2.59582, 4.45477}
```

Percent change in quantities of domestic product, {June-October, November-May}

$$\text{QuantityChange} = \left\{ \frac{100 (qdn1 - qdn0)}{qdn0}, \frac{100 (qdf1 - qdf0)}{qdf0} \right\}$$

```
Out[ ]:= {16.6213, 29.8882}
```

Percent change in price of imported product, {June-October, November-May}

$$In[*]:= \text{ImportPChange} = \left\{ \frac{100 (pfn1 - pfn0)}{pfn0}, \frac{100 (pff1 - pff0)}{pff0} \right\}$$

Out[\*]:= {12.2371, 15.6999}

Percent change in quantities of imported product, {June-October, November-May}

$$In[*]:= \text{ImportQChange} = \left\{ N \left[ \frac{100 (qfn1 - qfn0)}{qfn0} \right], N \left[ \frac{100 (qff1 - qff0)}{qff0} \right] \right\}$$

Out[\*]:= {-23.9497, -19.6752}

Change in revenue of domestic producers (\$), {June-October, November-May}

$$In[*]:= \text{Revenues} = \{ \text{IntegerPart} [pdn1 qdn1 - pdn0 qdn0], \text{IntegerPart} [pdf1 qdf1 - pdf0 qdf0] \}$$

Out[\*]:= {31,115,875, 33,300,915}

Change in operating income of domestic producers (\$), {June-October, November-May}

$$In[*]:= \text{OP} = \text{IntegerPart} \left[ \left\{ \left( \frac{1}{\text{sigma}} \right) (pdn1 qdn1 - pdn0 qdn0), \left( \frac{1}{\text{sigma}} \right) (pdf1 qdf1 - pdf0 qdf0) \right\} \right]$$

Out[\*]:= {6,515,594, 6,973,137}

Change in employment (# of FTEs), {June-October, November-May}

$$In[*]:= \text{Employment} = \left\{ qempn0 \frac{(qdn1 - qdn0)}{qdn0}, qempf0 \frac{(qdf1 - qdf0)}{qdf0} \right\}$$

Out[\*]:= {231.868, 208.022}