



24th Annual Conference on Global Economic Analysis
"Global Food System: Opportunities and Challenges"
June 23-25, 2021

**INPUT-OUTPUT ANALYSIS:
THE CASE OF FOOT-AND-MOUTH
DISEASE IN BRAZIL**

Taís Cristina de Menezes¹, Marcelo Pereira da Cunha²

¹Graduate Program in Applied Economics, Luiz de Queiroz College of Agriculture, University of São Paulo, Brazil

²Economics Institute, Campinas State University, Brazil

OUTLINE

1

Introduction

2

Data and Methods

3

Results and Discussion

4

Final Comments

1. Introduction



Latin America

Brazil

Brazil in the world ranking:

- 1st beef exporter
- 2nd cattle producer
- 4th pig producer
- 4th pork exporter

	Brazil	Mato Grosso do Sul (MS)
	214,9 million	21,5 million
	41,1 million	1,5 million
	1,4 million	14,9 thousand





Foot-and-mouth disease (FMD)



1. Introduction

2005/2006

Last outbreak of FMD
in Brazil (Mato Grosso do Sul)



58 trading partners imposed
restrictions on Brazilian beef and pork



Such countries represented around
87% of Brazil's beef export market

2018

Brazil internationally recognized as a
FMD-free country

2019 - 2022

Suspension of vaccination against
FMD in Brazil

What could be the impact of a FMD outbreak in Brazil assuming a reduction in exports of beef and pork from the state of Mato Grosso do Sul as the same observed in 2006?

2. Data and Methods

■ Data:

- Input-Output Matrix (2015) - 67 sectors
- Tables of Resources and Uses (2015) - 68 sectors
- Brazilian beef and pork exports in USD FOB* (2005, 2006, 2014 and 2015) - Mercosur Common Nomenclature (NCM 8 digits)

} Data available only
at national level

Type	Code	Description
Beef	02.01.1000	Carcases/half-carcases of bovine fresh/chilled
	02.01.2010	Fresh/chilled forequarters of bovine with bone in
	02.01.2020	Fresh/chilled hindquarters of bovine with bone in
	02.01.2090	Other fresh/chilled cuts of bovine with bone in
	02.01.3000	Fresh or chilled bovine meat, boneless
	02.02.1000	Frozen bovine carcasses and half-carcasses
	02.02.2010	Frozen forequarters of bovines, with bone in, frozen
	02.02.2020	Frozen hindquarter of bovines, with bone in, frozen
	02.02.2090	Other frozen bovine cuts
	02.02.3000	Frozen bovine meat, boneless
	02.06.1000	Edible offal of bovine, fresh or chilled
	02.06.2100	Frozen edible bovine tongues
	02.06.2200	Frozen edible bovine livers
	02.06.2910	Frozen edible bovine tails
	02.06.2990	Other frozen edible bovine offal
	02.10.2000	Meat of bovine, salted/in brine/dried/smoked
	05.04.0011	Fresh/chilled/frozen/salted/smoked guts of bovine

Type	Code	Description
Pork	02.03.1100	Fresh or chilled carcasses and half-carcasses of swine
	02.03.1200	Fresh/chilled hams/shoulders/cuts of swine with bone in
	02.03.1900	Other fresh or chilled meat of swine
	02.03.2100	Frozen carcasses and half-carcasses of swine
	02.03.2200	Frozen hams, shoulders and cuts of swine
	02.03.2900	Other swine meat, frozen
	02.06.3000	Fresh or chilled edible offal of swine
	02.06.4100	Frozen edible livers of swine
	02.06.4900	Other edible offal of swine, frozen
	02.10.1100	Hams, should.and cuts of swine, with bone in, salted, etc.
	02.10.1200	Bellies and chest "streaky" of swine, salted, etc.
	02.10.1900	Other meat of swine, salted, brine, dried, etc.
	05.04.0013	Fresh/chilled/frozen/salted/smoked guts of swine

*Export data converted to Reais (BRL) with a real exchange rate for 2015

2. Data and Methods

■ Methods:

❖ Input-Output Analysis

■ Model closure:

- Given the objective of analyzing the impacts of a reduction in beef and pork exports on the Brazilian economy, the final demand for each product must be exogenous to the model.

$$(I - B \times D)^{-1} \times E = Q$$

 
exogenous endogenous

Miller & Blair (2009)

$$\Delta X = L \times \Delta Y$$

where:

I = identity matrix;

B = matrix of technical coefficients of sectors in relation to products;

D = market-share matrix;

E = vector of final demand for products;

Q = total demand for products.

where:

ΔX = vector of variation in the production value of the sectors of the economy;

L = Leontief inverse matrix;

ΔY = vector of variation in the final demand of the economy.

2. Data and Methods

Shock at E_{beef} in vector E of final demand for products

■ Methods:

❖ Input-Output Analysis

■ Exogenous shocks:

- Two shocks calculated in different ways.

Shock 1
Beef

Beef exports from MS	
Year	R\$ billion (2015)
2005	1.03
2006	0.17

↪ - 83.17%

Beef exports from MS	
Year	R\$ billion (2015)
2014	1.84
2015	1.64

- 83.17%

Beef exports from MS with a FMD outbreak	
Year	R\$ billion (2015)
2014	1.84
2015	$1.84 - (83.17\% \times 1.84) = 0.309$

Shock: $0.309 - 1.64 = - \text{R\$ } 1.33 \text{ billion}$

2. Data and Methods

Shock at E_{pork} in vector E
of final demand for products

■ Methods:

❖ Input-Output Analysis

■ Exogenous shocks:

- Two shocks calculated in different ways.

Shock 1
Pork

Pork exports from MS	
Year	R\$ million (2015)
2005	172.30
2006	29.75

↪ - 82.74%

Pork exports from MS	
Year	R\$ million (2015)
2014	107.35
2015	118.81

- 82.74%

Pork exports from MS with a FMD outbreak	
Year	R\$ million (2015)
2014	107.35
2015	$107.35 - (82.74\% \times 107.35) = 18.53$

Shock: $18.53 - 118.81 = - \text{R\$ } 100.28 \text{ million}$

2. Data and Methods

Shock at E_{beef} in vector E of final demand for products

Shock 2 Beef

Countries	Reduction in exports 2005/2006 (%)	Reduction in exports 2014/2015 (R\$ million 2015)
Russia	-99.1%	-745.70
Venezuela	-100.0%	-174.87
Chile	-100.0%	-150.14
Egypt	-99.6%	-138.19
Italy	-95.9%	-38.42
Netherlands	-95.7%	-33.54
Germany	-87.8%	-20.28
Algeria	-99.0%	-17.39
United Arab Emirates	-92.8%	-13.57
Spain	-97.1%	-6.61
Angola	-100.0%	-6.11
United Kingdom	-98.7%	-5.95
Moldavia	-86.2%	-5.11
Lebanon	-100.0%	-4.18
Israel	-65.4%	-2.38
Canary Islands	-83.2%	-2.54
Singapore	-96.0%	-2.25
Sweden	-96.3%	-2.14
Philippines	-99.3%	-1.46
Vietnam	-100.0%	-1.36
Latvia	-17.5%	-0.23
Switzerland	-100.0%	-1.30
Portugal	-100.0%	-1.29
Ukraine	-99.6%	-1.14
Uzbekistan	-100.0%	-0.73
China	-97.4%	-0.60
Norway	-100.0%	-0.50
Belgium	-100.0%	-0.37
France	-100.0%	-0.24
Mauritius	-100.0%	-0.24
Armenia	-100.0%	-0.12
Macedonia	-100.0%	-0.12
TOTAL		-1,379.08

Beef exports from MS with a FMD outbreak	
Year	R\$ billion (2015)
2014	1.84
2015	$1.84 - 1.379 = 0.46$



Shock: $0.46 - 1.64 = - \text{R\$1.18 billion}$
(2015)

2. Data and Methods

Shock at E_{pork} in vector E
of final demand for products

Shock 2 Pork

Countries	Reduction in exports 2005/2006 (%)	Reduction in exports 2014/2015 (R\$ million 2015)
Ukraine	-100.00%	-33.32
Georgia	-21.39%	-2.06
Angola	-100.00%	-7.76
Moldavia	-100.00%	-4.66
Armenia	-66.62%	-1.90
Azerbaijan	-75.87%	-1.23
Netherlands Antilles	-100.00%	-0.52
TOTAL		-51.46

Pork exports from MS with a FMD outbreak	
Year	R\$ million (2015)
2014	107.35
2015	$107,35 - 51.46 = 55.89$



Shock: $55.89 - 118.81 = - \text{R\$62.92 million}$
(2015)

3. Results and Discussion

Shock 1

Table 1. Economic impacts of shock 1 (in Reais, R\$ of 2015)

Sectors	ΔY (R\$ million)	ΔX (R\$ million)	Participation of the induced effect in ΔX	ΔGDP (R\$ million)	Δ tax revenues (R\$ million)	Δ employment (number of people)
Agriculture	-1.3	-186.7	40.3%	-116.9	-1.3	-3,605.1
Livestock	-4.4	-559.7	7.8%	-332.9	-25.4	-25,329.2
Other agricultural products	-0.1	-27.4	40.2%	-21.9	-0.6	-815.6
Extractive industries	0.0	-75.3	51.6%	-43.8	-3.3	-68.9
Slaughter and other livestock products	-1,403.7	-1,627.0	5.6%	-334.2	-51.9	-4,698.6
Other food products	-12.7	-288.1	31.7%	-78.1	-8.7	-1,407.1
Manufacture of footwear and other leather goods	-2.5	-16.7	80.0%	-7.4	-0.7	-202.9
Manufacture of organic and inorganic chemicals	-0.6	-81.0	37.4%	-38.4	-3.6	-56.3
Manufacture of cleaning products and cosmetics	-0.3	-18.4	81.5%	-7.1	-0.9	-63.5
Trade	-10.6	-645.6	60.4%	-440.5	-24.3	-11,069.0
Ground transportation	0.0	-249.3	43.6%	-128.7	-10.5	-2,831.0
Manufacturing industries	-0.1	-804.8	60.4%	-325.6	-48.4	-3,222.1
Electricity and gas	0.0	-153.6	59.3%	-69.0	-5.3	-90.3
Water, sewage and waste management	0.0	-23.0	80.4%	-15.6	-1.0	-192.1
Construction	0.0	-13.4	67.3%	-7.7	-0.9	-183.7
Transport, storage and mail	0.0	-200.2	74.0%	-120.4	-12.0	-2,833.3
Information and communication	0.0	-136.8	73.3%	-77.3	-8.6	-441.0
Financial and insurance activities	0.0	-384.3	65.7%	-267.6	-16.7	-1,550.8
Real estate activities	0.0	-264.6	94.4%	-246.4	-3.7	-202.1
Other service activities	0.0	-269.7	68.5%	-184.9	-11.8	-7,029.1
Health	0.0	-85.9	99.9%	-58.2	-4.8	-1,120.1
Education	0.0	-54.0	94.8%	-41.0	-2.5	-1,197.6
Administration, defense and social security	0.0	-18.7	59.8%	-13.9	-0.3	-132.6
HOUSEHOLDS	0.0	-1,914.7	100.0%	-	-	-
TOTAL	-1,436.3	-8,099.0	32.1%	-2,977.6	-247.2	-68,342.2



Shock at $E_{\text{beef}} + E_{\text{pork}}$ translates into variations in Y = vector of final demand of the economy

3. Results and Discussion

Shock 2

Table 2. Economic impacts of shock 2 (in Reais, R\$ of 2015)

Sectors	ΔY (R\$ million)	ΔX (R\$ million)	Participation of the induced effect in ΔX	ΔGDP (R\$ million)	Δ tax revenues (R\$ million)	Δ employment (number of people)
Agriculture	-1.1	-162.6	40.3%	-101.8	-1.1	-3,138.7
Livestock	-3.8	-487.8	7.8%	-290.2	-22.2	-22,077.5
Other agricultural products	0.0	-23.9	40.2%	-19.1	-0.5	-710.8
Extractive industries	0.0	-65.6	51.6%	-38.2	-2.9	-60.0
Slaughter and other livestock products	-1,223.5	-1,418.2	5.6%	-291.3	-45.3	-4,095.6
Other food products	-10.5	-250.4	31.7%	-67.9	-7.5	-1,223.2
Manufacture of footwear and other leather goods	-2.3	-14.6	80.0%	-6.5	-0.6	-177.5
Manufacture of organic and inorganic chemicals	-0.5	-70.6	37.4%	-33.4	-3.1	-49.0
Manufacture of cleaning products and cosmetics	-0.3	-16.0	81.5%	-6.2	-0.8	-55.4
Trade	-9.4	-562.8	60.4%	-384.0	-21.2	-9,648.9
Ground transportation	0.0	-217.2	43.6%	-112.1	-9.1	-2,466.7
Manufacturing industries	-0.1	-701.2	60.4%	-283.8	-42.2	-2,807.8
Electricity and gas	0.0	-133.9	59.3%	-60.2	-4.6	-78.7
Water, sewage and waste management	0.0	-20.1	80.4%	-13.6	-0.9	-167.4
Construction	0.0	-11.7	67.3%	-6.7	-0.8	-160.1
Transport, storage and mail	0.0	-174.5	74.0%	-104.9	-10.4	-2,469.1
Information and communication	0.0	-119.2	73.3%	-67.4	-7.5	-384.3
Financial and insurance activities	0.0	-334.9	65.7%	-233.2	-14.5	-1,351.3
Real estate activities	0.0	-230.6	94.4%	-214.7	-3.2	-176.1
Other service activities	0.0	-235.0	68.5%	-161.1	-10.3	-6,125.4
Health	0.0	-74.9	99.9%	-50.8	-4.2	-976.1
Education	0.0	-47.0	94.8%	-35.7	-2.2	-1,043.6
Administration, defense and social security	0.0	-16.3	59.8%	-12.2	-0.3	-115.5
HOUSEHOLDS	0.0	-1,668.5	100.0%	-	-	-
TOTAL	-1,251.5	-7,057.5	32.1%	-2,594.7	-215.4	-59,558.7



Shock at $E_{\text{beef}} + E_{\text{pork}}$ translates into variations in Y = vector of final demand of the economy

3. Results and Discussion

Comparison between shocks

Shock			ΔY (R\$ million)	ΔX (R\$ million)	Participation of the induced effect in ΔX	ΔGDP (R\$ million)	Δ tax revenues (R\$ million)	Δ employment (number of people)
1	Beef exports	- R\$1,336 million	-1,436.3	-8,099.0	32.1%	-2,977.6	-247.2	-68,342.2
	Pork exports	- R\$100.28 million						
2	Beef exports	- R\$1,188 million	-1,251.5	-7,057.5	32.1%	-2,594.7	-215.4	-59,558.7
	Pork exports	- R\$62.92 million						

Shock 1 is **13%** greater than Shock 2

I-O -> linear model

Shock 1 results are **13%** higher than Shock 2 results

- **Losses in the production value (ΔX)** are equivalent to approximately **5.6 times the value of shocks** in the final demand of the economy. In other words, the direct shocks to beef and pork exports caused by an outbreak of FMD could have a negative effect 5.6 times greater on the Brazilian economy.
- This multiplier effect can be explained by several factors determined by the relations between the sectors of the Brazilian economy.

Table 3. Hirschman-Rasmussen linkage indexes (selected sectors)

Sector	Backward Linkage	Forward Linkage
Agriculture	0.951	1.895
Livestock	0.991	0.903
Slaughter and other livestock products	1.386	0.796
Other food products	1.300	0.991
Manufacture of footwear and other leather goods	1.158	0.646
Manufacture of organic and inorganic chemicals	1.112	1.824
Manufacture of cleaning products and cosmetics	1.206	0.641
Trade	0.849	3.842

Source: Model results

3. Results and Discussion

Comparison
between shocks

$\Delta\text{GDP Shock 1} = -\text{R\$ } 2,98 \text{ billion}$



-0.055% shock in 2015 GDP

$\Delta\text{GDP Shock 2} = -\text{R\$ } 2,59 \text{ billion}$



-0.048% shock in 2015 GDP

Seems small...

BUT

Budget executed for Agricultural Defense by the
Ministry of Agriculture, Livestock and Supply in 2015



R\$ 91.86 million

$\Delta\text{GDP}_1 = 32\times$ greater than this budget
 $\Delta\text{GDP}_2 = 25\times$ greater than this budget

Considering only the impacts on exports!



4. Final Comments

- ❑ Adverse events to animal health can cause significant socioeconomic losses, reducing not only the value of production, GDP and revenue, but also the number of jobs and household income.
- ❑ The results show the importance of promoting investments in agricultural defense, in order to prevent the entry and spread of animal diseases in Brazil.
- ❑ Ensuring a health status free of several animal diseases is essential for Brazil to guarantee access to the international market and maintain its position as an important meat exporter to the rest of the world.

Limitations:

- The model closure do not allow to evaluate changes in the final demand from other sectors, since it is exogenous;
- The shocks may overestimate export losses - there is no way to predict countries' behavior in the event of an outbreak;
- The shocks do not consider new markets conquered after 2006 (also uncertain behavior);
- The model is not interregional, preventing shocks on the specifically affected state;
- The I-O model at the national level does not allow the analysis of the substitution effects between different types of meat and between Brazilian states.
- The I-O approach also leaves out crucial price-related adjustments that may be important in determining the economic impacts of shocks.
- A FMD outbreak causes several negative economic impacts and the closing of export markets is just one of them.

There is still much to be done in the economic modeling of the losses caused by the occurrence of FMD – especially in Brazil, where there are few studies on this topic.



24th Annual Conference on Global Economic Analysis
"Global Food System: Opportunities and Challenges"
June 23-25, 2021

INPUT-OUTPUT ANALYSIS: THE CASE OF FOOT-AND-MOUTH DISEASE IN BRAZIL

Taís Cristina de Menezes*, Marcelo Pereira da Cunha

***taismenezes@usp.br**