# Modeling Probability of Notifications of Phytosanitary Non-Conformities in Apples and Pears Cargos Imported by Brazil

**Eduardo Monteferrante, Willian Lopes, Sílvía Miranda**

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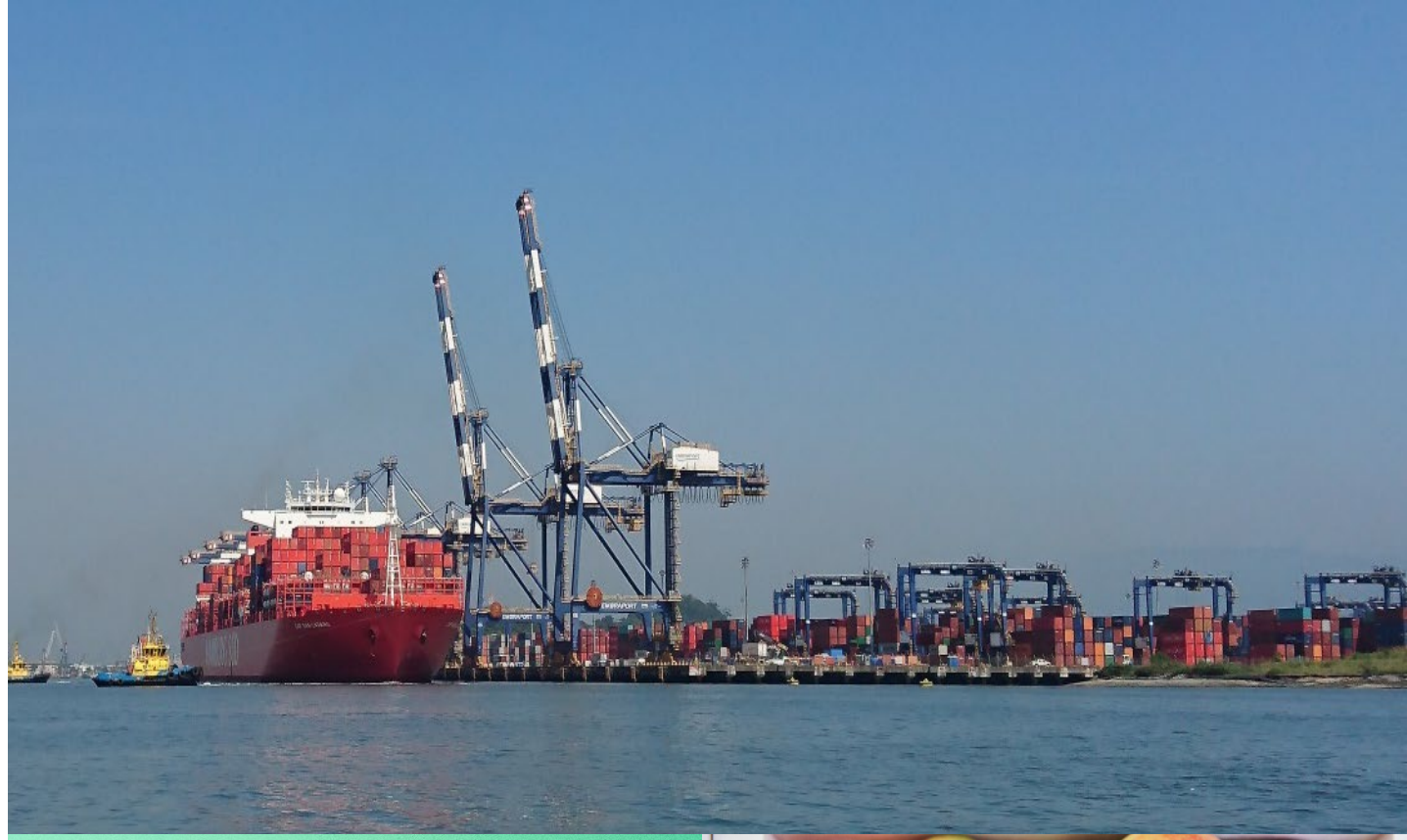
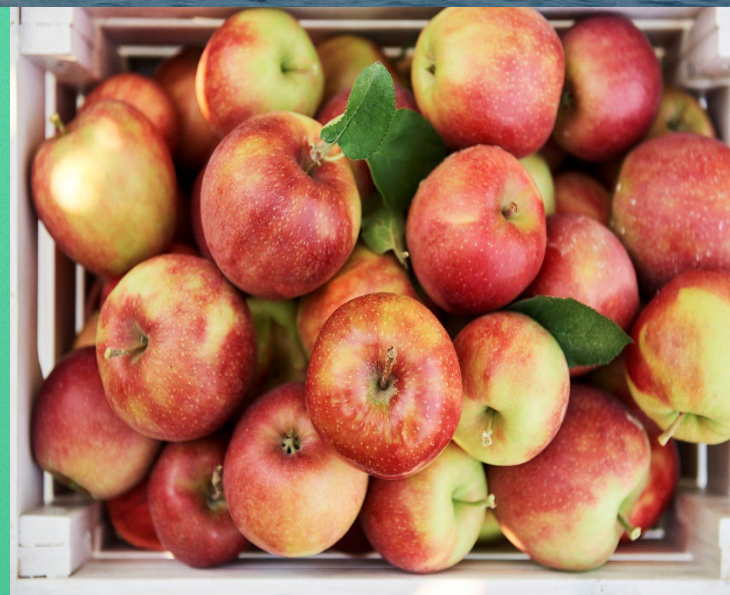




**Work in progress**


Eduardo Cassettari Monteferrante

Willian Fabrício Arboleya Lopes

Sílvia Helena Galvão de Miranda

# Introduction

Increase in international trade and movement of people

Transportation of vegetable products

Risk of biological invasion

Potential to cause economic, social and environmental losses

# Introduction

## Exemple of biological invasion

*Phytophthora infestans*
"potato blight"

"Great Famine"
Ireland
19th century

**Images:** Wikipedia

# Introduction

## Exemple of biological invasion in Brazil

***Cydia pomonella***

**codling moth**

## Impacts

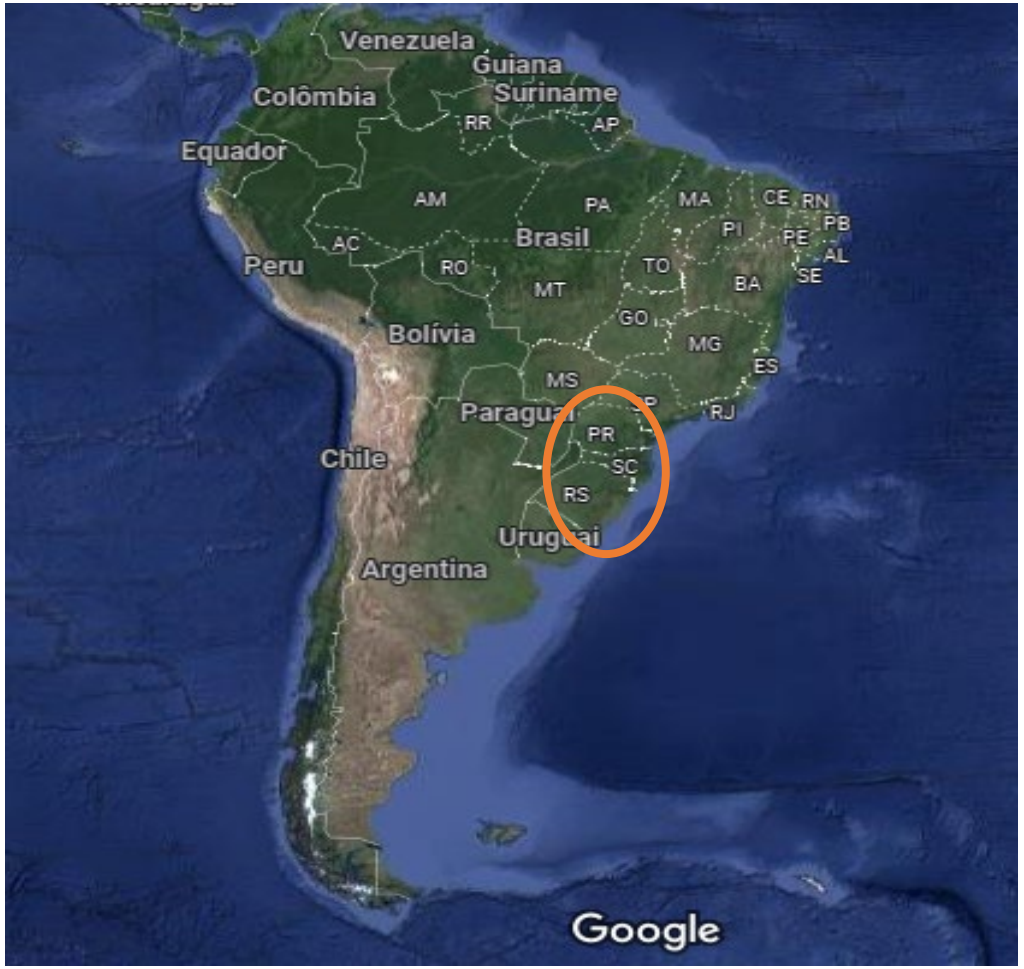
- US$ 4.900.000 decrease in anual production
- US$ 20 million increase in production costs
- Environmental imbalance
- Risk to human health
- Phytosanitary barriers in export

**Reference:** Kovaleski et al., 2015. In: Vilela e Zucchi, 2015.

**Images:** Adalécio Kovaleski - EMBRAPA

# Introduction

## Importance of apple production in Brazil




- Contributes to generating income and jobs
- 1.297.424 tons of apples produced in 2021
- 99 thousand tons of apples exported in 2022
- 130 thousand tons of apples imported in 2022
- 133 thousand tons of pears imported in 2022

**References:** IBGE, 2021; COMTRADE, 2022

# Introduction

## Agencies and policies

### Brazil

International Agricultural Surveillance System (Vigiagro)

The agency will issue an Agricultural Fiscal Notification “in the event of indications, suspicions or doubts as to the identity, quality, conformity, hygiene, health, origin, provenance, destination, proposed use, as well as in cases of other documentary or physical non-conformities that can be corrected, adjusted or further analyzed”

**Reference:** Normative Instruction No. 39 of 2017 Brazil, 2017

### International standards

Food and Agriculture Organization of the United Nations

International Plant Protection Convention

ISPM No. 6 - surveillance - emphasize that the National Surveillance System must be supported, among other things, by prioritization, planning and information management systems

**Reference:** FAO, 2018

# Introduction

## Aims

### General

- To identify the factors that determine the likelihood of imported apple and pear cargoes being subject to an Agricultural Fiscal Notification

### Specific

- To associate the factors identified in the general objective with economic issues
- To convert the results obtained into proposals for agricultural inspection strategies at border posts

# Methodology

## Logistic Regression

Rocha (2013) - Brazil

Lichtenberg and Olson (2018) - United States

Surkov et al. (2008) - Netherlands

Provides the probability of an event happening

# Methodology

## Applied Logistic Regression

**Response variable** → **Categorical**

- the cargo received NFA → $Y_i = 1$
- the cargo did not receive NFA → $Y_i = 0$

$$Y_i \mid X_i \sim Bernoul(n_i;p_i), i=1,\ldots,m$$

The estimated coefficients in linear form

$$logit\ (p_i)=ln\ (p_{i1}-p_i) = B_0 + B_1 x_1 + \cdots + B_i x_i$$

- $B_i$ + → Increase probability of NFA
- $B_i$ - → Decrease probability of NFA

**Odds ratio of the estimated model** → exponential of the logit of the respective explanatory variable → OR(X_k )=e^(β_k)

# Methodology

## Applied Logistic Regression

Mixed effects logistic regression

Includes fixed and random effects → Control the heterogeneity of import processes

- packaging type
- season
- product
- quantity
- year

estimate the model in which countries of origin are nested within border posts

# Methodology

## Applied Logistic Regression

ROC curve area → Was used to compare models

The likelihood ratio test was used to check for heterogeneity among individuals

Rejection of the null hypothesis indicates that the mixed logit is better than the linear logit

# Methodology

## Data

Information on each inspection carried out on imported agricultural products at Brazilian border posts → from 2016 to 2020

- border post
- date of the inspection
- quantity of the shipment
- country of origin
- product
- result of the inspection

Other explanatory variables in addition:

- the share of agricultural exports in the total exports of the exporting country
- the share of exports of the specific product in the agricultural exports of the exporting country
- the income level of this country
- the share of exports of the specific product from a specific country in worldwide exports of that product

Food and Agriculture Organization of the United Nations

World Trade Organization

Analysis was carried out for products separately

Each observation corresponds to a shipment inspected

28.659 observations

42.881 observations

# Results

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| **NFA** | | | |
| **Apples not in boxes** | | 0.000 (.) | 0.000 (.) |
| **Apples in boxes** | | -1.427*(0.682) | -1.455* (0.684) |
| **Pears not in boxes** | | 0.515 (0.801) | 0.845 (0.809) |
| **Pears in boxes** | | -1.490* (0.688) | -1.181 (0.694) |
| **Apples in winter** | | 0.000 (.) | 0.000 (.) |
| **Apples in fall** | | 0.517*** (0.105) | 0.545*** (0.105) |
| **Apples in spring** | | 0.034 (0.104) | 0.048 (0.108) |
| **Apples in summer** | | 0.149 (0.116) | 0.161 (0.120) |
| **Pears in winter** | | 0.204* (0.090) | 0.190* (0.091) |
| **Pears in fall** | | 0.009 (0.093) | 0.010 (0.094) |
| **Pears in spring** | | -0.041 (0.094) | -0.024 (0.097) |
| **Pears in summer** | | 0.000 (.) | 0.000 (.) |
| **Year** | | 0.292*** (0.017) | 0.296*** (0.018) |
| **Ln quantity** | | -0.139*** (0.035) | -0.131** (0.047) |
| **Intercept** | -3.206*** (0.397) | -590.588*** (35.086) | -597.620*** (36.370) |
| **Var of custom point** | 2.711* (1.071) | 2.511* (0.980) | 2.749** (1.050) |
| **Var of origin nested with custom point** | 0.908*** (0.274) | 0.756** (0.255) | 0.614* (0.253) |
| **Var of PLANT** | | | 0.068* (0.030) |
| **N** | 71540.000 | 71516.000 | 71442.000 |
| **Aic** | 17307.605 | 16906.267 | 16741.737 |
| **Bic** | 17335.139 | 17034.754 | 16879.386 |
| **Ll** | -8650.803 | -8439.133 | -8355.868 |
| **Lr test** | 1605.70*** | 1638.94*** | 1578.47*** |
| **Area under ROC** | 0.7461 | 0.7763 | 0.7808 |

Apples in boxes have lower chances to NFA occurrences

Apples imported in fall and pears in winter are more likely to NFA occurrences in comparison to apples in winter

Over the years, we observed an increase in the chances of NFA that can be explained by the learning curve and the effectiveness of inspections by agricultural authorities

When more products are imported, shipments may tend to be handled more carefully because they are more expensive

Rejection of the null hypothesis. Mixed logit model is preferred over the linear logit model

Includes random and fixed effects

# Thank you

**Work in progress**

eduardocm@usp.br