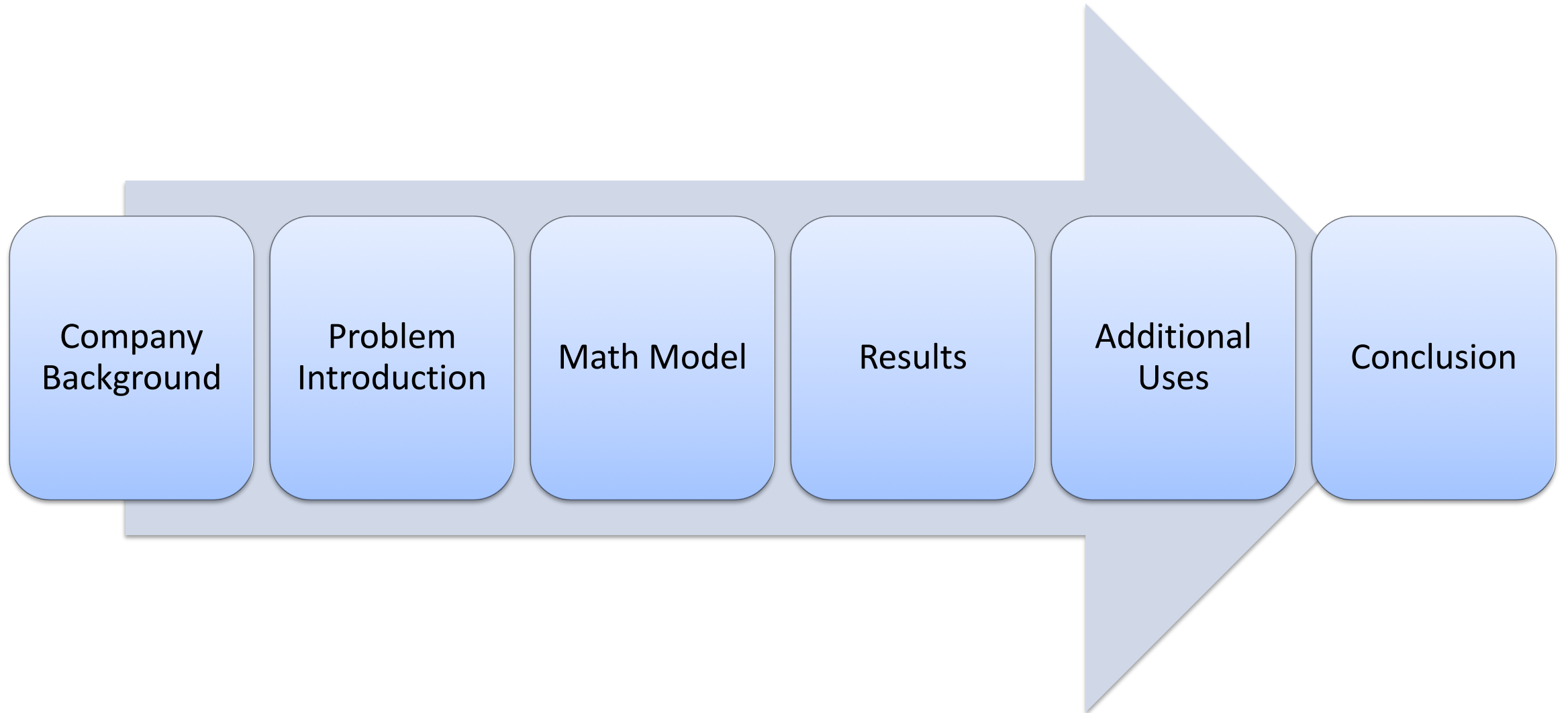


# International Production Planning

David Cheung and Ross Pieper

Advisors: Tim Russell & Jarrod Goentzel

# Outline



# Sponsor Company

Multinational chemical producer

Subsidiaries and joint ventures in more than 80 countries

Supplies chemicals to over 190 countries

Six integrated production sites and 390 other production sites

# Agriculture Business Unit

- Produces herbicides, insecticides, fungicides, seed solutions and other specialty solutions
- Project focused on two plants
  - Brazil (Mercosur)
  - Puerto Rico (NAFTA)
  - Plants service customers from 20 countries



# Problem



How do import custom duties and credits impact global production planning and network design?

# Duties

- A form of tax typically on goods imported into a country. Used to promote purchase of goods manufactured within the country.



# Duty Credits

A form of duty relief where countries remove or credit back duty charges on good that meet specific criteria.

Drawback

- A product is imported transformed then re-exported

Subassembly

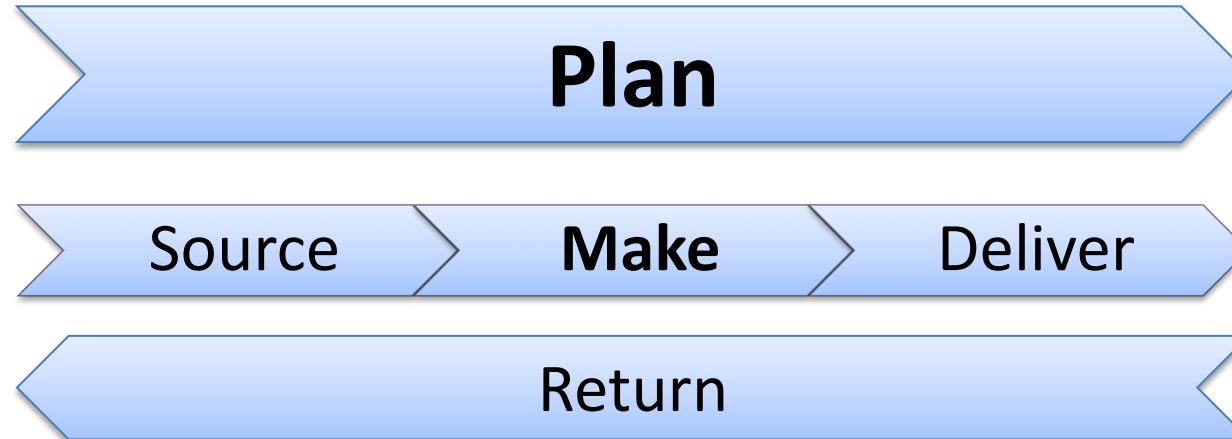
- A product is imported then transformed as part of a subassembly and re-exported

Re-import

- A product is exported transformed and re-imported

# Production Planning

- The high level planning of finished good production and the raw materials needed to make that production.
  - Often uses optimization
  - Subject to capacity constraints
  - Sales forecast is the input that the production plan meets





# Sponsor Company Production Plan

Manually planned

Simulation used to compare scenarios

Production, purchasing, duty, and ocean transit costs included

# Math Model

- Minimizes total costs
- Incorporates duties and the duty drawback form of duty credits
- Built in excel because the demand data was aggregated by country
- Biggest challenge: building the duty credit constraint

# Math Model Objective Function

$$\begin{aligned}
 z = & \sum_i \sum_j \sum_g C_{ij} X_{ijg} + \sum_z \sum_n \sum_j E_{z nj} Y_{z nj} + \\
 & \underbrace{\sum_n \sum_j d_{nj} + \sum_j \sum_g f_{jg}}_{\text{Duties}} + \\
 & \sum_i \sum_j \sum_g l_{ijg} X_{ijg} + \sum_z \sum_n \sum_j w_{z nj} Y_{z nj} - \\
 & \underbrace{\sum_z \sum_i \sum_n \sum_j \sum_g C_{z injg}}_{\text{Duty Credits}}
 \end{aligned}$$

# Math Model Constraints

Effective Duties on Raw Materials Constraint

$$d_{nj} \geq \sum_z B_{znj} d_{znj} Y_{znj} \quad \forall n, j$$

$$d_{nj} \leq M(1 - T_{nj}) \quad \forall n, j$$

Effective Duties on Finished Products Constraint

$$f_{jg} \geq \sum_i V_{ijg} f_{ijg} X_{ijg} \quad \forall j, g$$

$$f_{jg} \leq M(1 - S_{jg}) \quad \forall j, g$$

Effective Duty Credits Constraint

$$c_{zinjg} \leq B_{znj} d_{znj} \frac{X_{ijg}}{R_{zij}} \quad \forall z, i, n, j, g$$

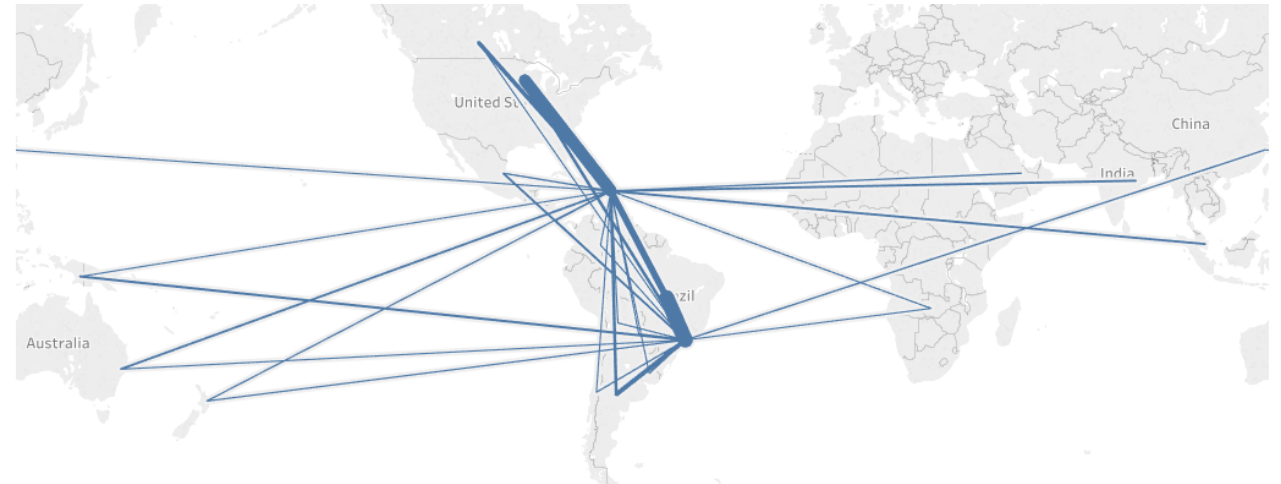
$$c_{zinjg} \leq M(1 - T_{nj}) \quad \forall z, i, n, j, g$$

$$c_{zinjg} \leq M(1 - S_{jg}) \quad \forall z, i, n, j, g$$

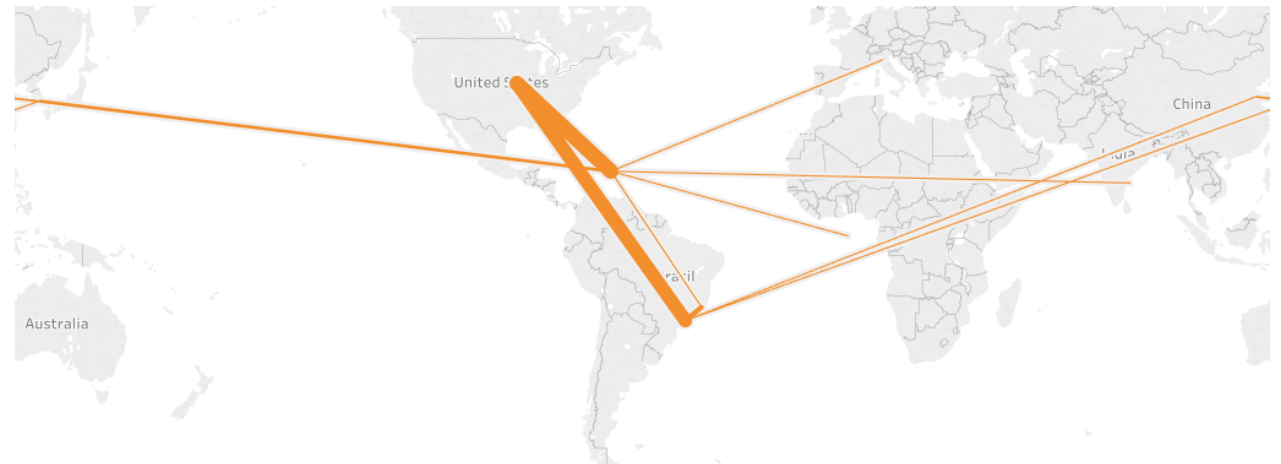
# Current Production Plan Results

- Puerto Rico volume = 1,182,193 kgs
- Brazil volume = 1,107,331 kgs
- Total Cost = € 200.6 MM
- Duty Costs = € 2.4 MM
- Duty Credits = € 350k

Finished Goods



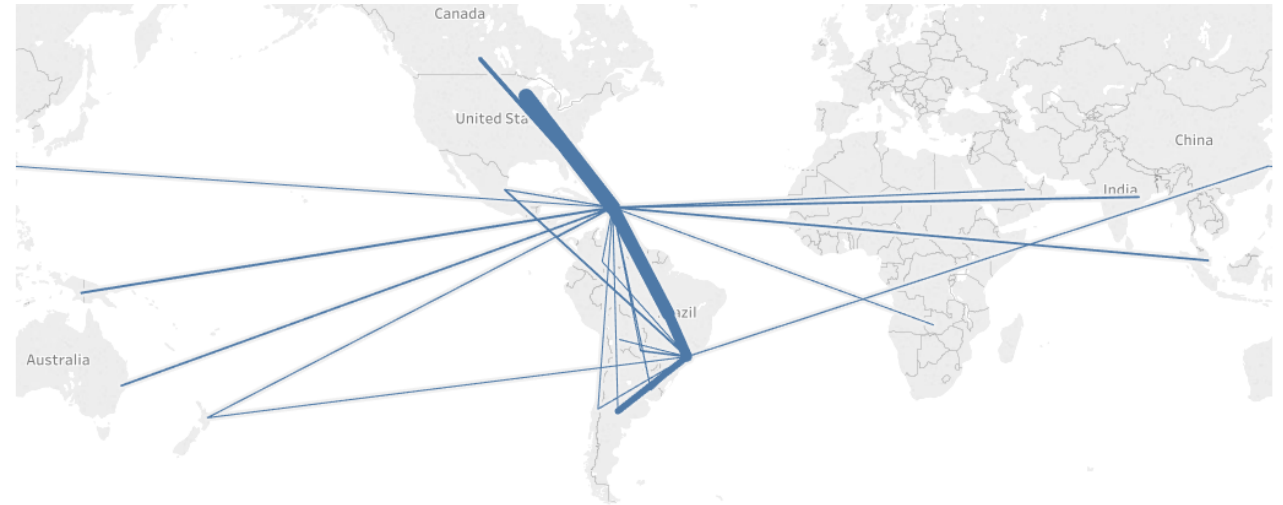
Raw Materials



# Math Model Results

- Puerto Rico volume = 1,536,923 kgs
- Brazil volume = 752,601 kgs
- Total Cost = € 199 MM
- Duty Costs = € 1.8 MM
- Duty Credits = € 104k

Finished Goods



Raw Materials



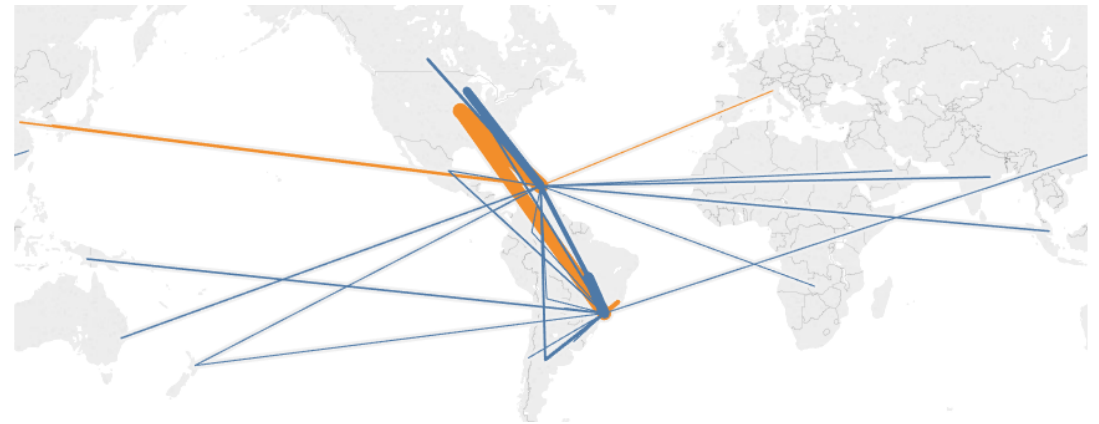
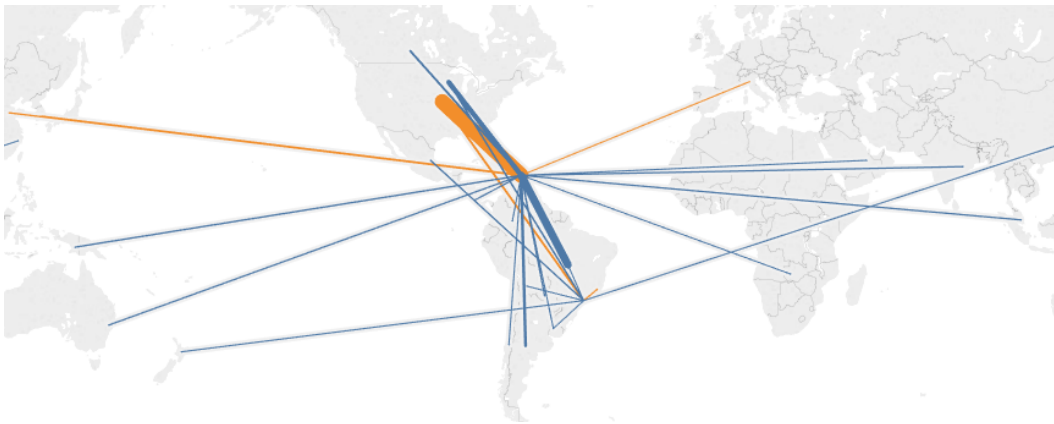
# High Duty Cost Scenario (15% Raw Material Duties)

## Math Model

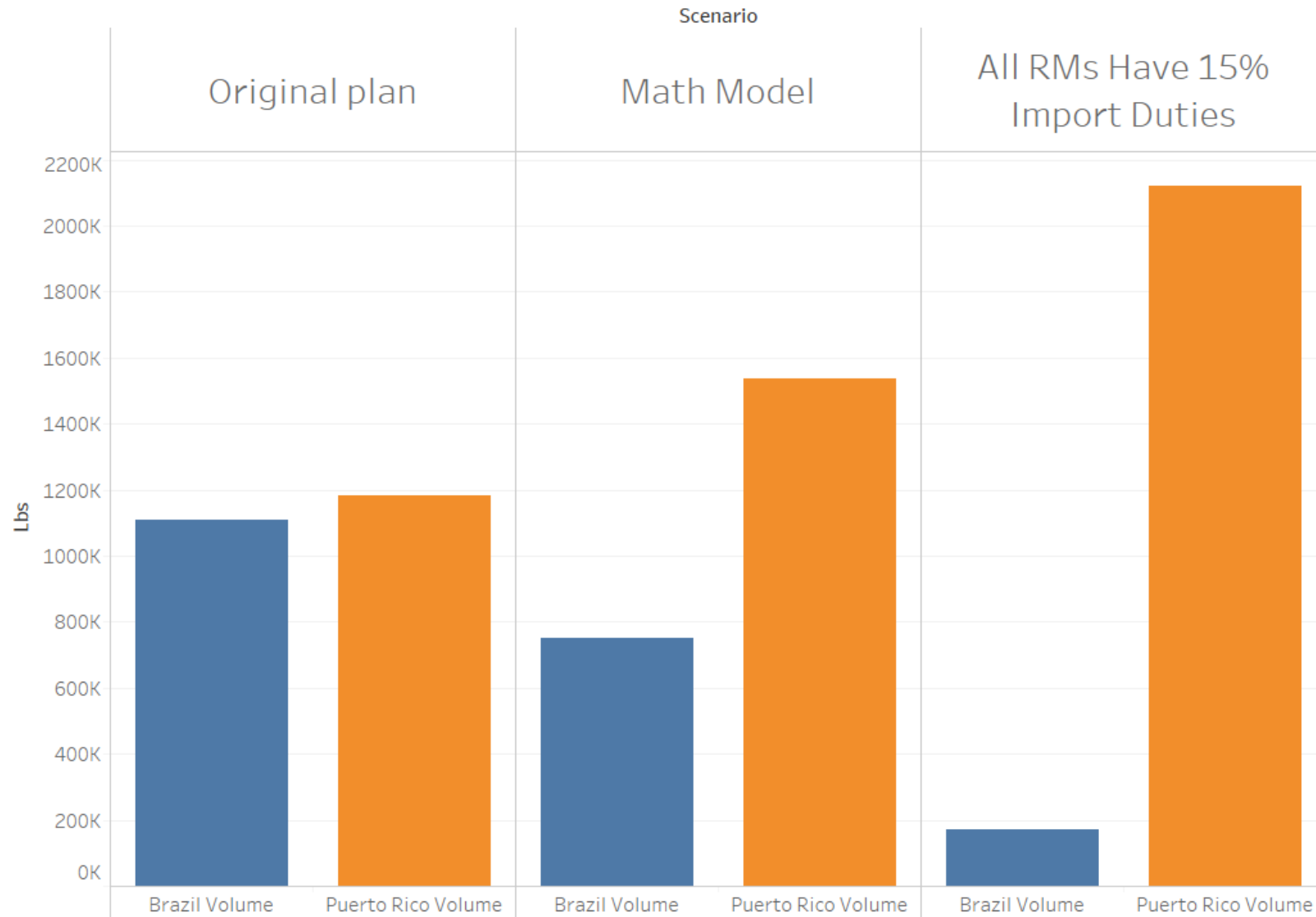
- Puerto Rico volume = 2,119,765 kgs
- Brazil volume = 169,759 kgs
- Total Cost = € 206.9 MM
- Duty Costs = € 18.7 MM
- Duty Credits = € 10.6 MM

## Original Plan

- Puerto Rico volume = 1,182,193 kgs
- Brazil volume = 1,107,331 kgs
- Total Cost = € 214.5 MM
- Duty Costs = € 20.9 MM
- Duty Credits = € 4.6 MM

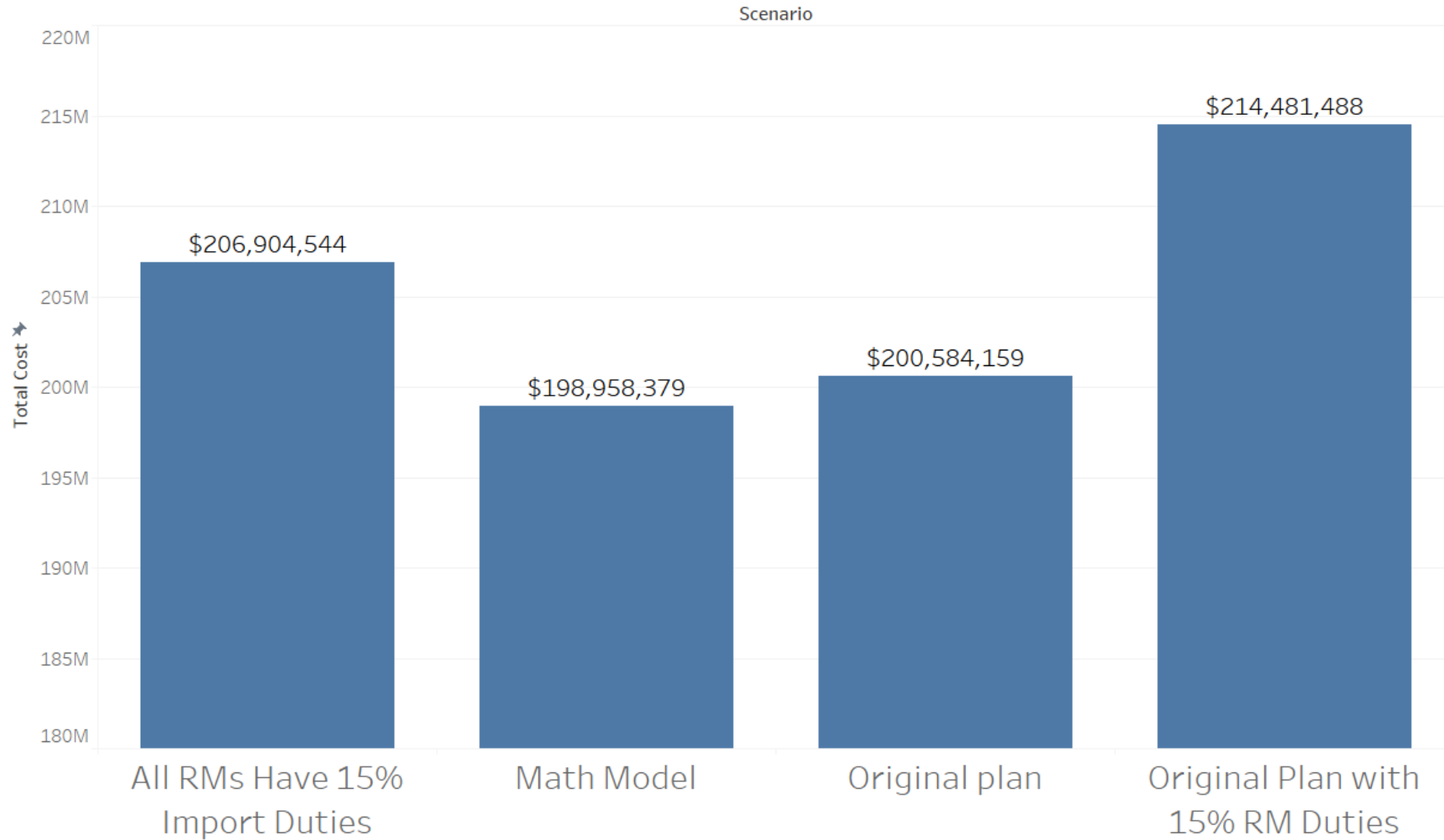


# Volume Comparison

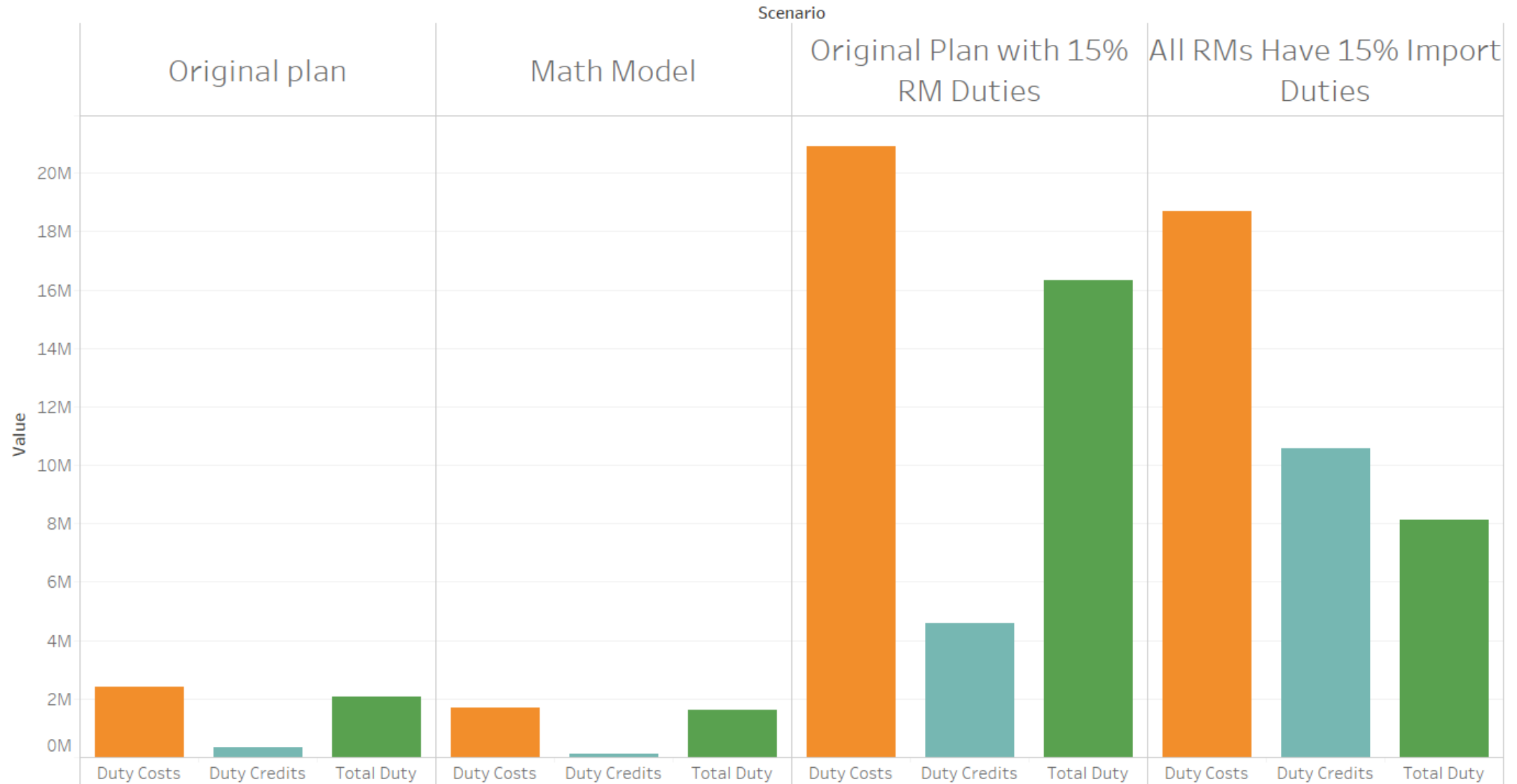




# Financial Comparison



# Duty Comparison



# Additions

Use by other business units

Include distribution costs

Include other forms of duty credits

Monthly time buckets

Add in taxes

# Conclusion

Duties and duty credits should be included in production planning, especially when the suppliers and customers are in different trading blocs than the manufacturing plants.

# Questions?

# Appendix

# Additional Results

	Brazil Volume	Puerto Rico Volume	Total Cost	Duty Costs	Duty Credits
Initial Model	752,601	1,536,923	€ 198,958,379	€ 1,705,162	€ 104,997
No Duty Credits	743,680	1,545,845	€ 199,035,264	€ 1,785,667	€ -
No Duties or Duty Credits	655,612	1,633,913	€ 196,998,383	€ -	€ -
Original plan	1,107,331	1,182,193	€ 200,584,159	€ 2,421,389	€ 353,832
Only J200	1,493,666	795,858	€ 201,877,418	€ 3,302,192	€ 463,128
Only Manati	0	2,289,524	€ 201,075,519	€ 2,406,530	€ 3,203
All RMs Have 15% Import Duties	169,759	2,119,765	€ 206,904,544	€ 18,691,604	€ 10,552,410
FGs and RMs have 25% Import Duties	163,029	2,126,495	€ 266,363,538	€ 85,355,314	€ 17,713,812
15% RM Duties Plant 1	66,352	2,223,172	€ 200,718,504	€ 3,052,042	€ 730,408
15% RM Duties Plant 2	906,215	1,383,309	€ 204,311,113	€ 9,805,831	€ 3,407,998
Actual Plan with 15% RM Duties	1,107,331	1,182,193	€ 214,481,488	€ 20,919,802	€ 4,601,084