The Tequila Puzzle: The Large Surge of Small Exporting Distilleries following NAFTA

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Abstract

After the enactment of NAFTA, the total number of Tequila producers in Mexico exploded; particularly, there was a large surge of small distilleries that produce expensive Tequila, most of it for exports. This paper discards three possible explanations using the Melitz (2003) model as a benchmark. The explanations are: (1) the US cannot produce a close substitute to Tequila; (2) the US produces a close substitute to Tequila; lastly, (3) consumer preferences are represented by “price independent generalized linearity” utility (Muellbauer 1976). This utility represents non-homothetic preferences.

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Part I

Introduction

After the enactment of the North American Free Trade Agreement in 1994, the total number of Tequila producers in Mexico exploded. In particular, there was a large surge of small distilleries that produce expensive Tequila, most of it for exports.

The previews fact contradicts the prediction of the standard model of monopolistic competition and international trade (Melitz 2003). According to this model, a tariff reduction drives the smallest producers out of business, while only large firms that produce low-priced products export.

This paper tests three different hypotheses using the Melitz (2003) model as a benchmark. Each of these hypothesis reflect a realistic and particular feature of the Tequila industry; nevertheless, this paper shows that none of these hypotheses can explain the evolution of the Tequila industry.

The first hypothesis assumes that the US cannot produce a close substitute to Tequila. This hypothesis arises because NAFTA explicitly states that any product sold as Tequila in North America must be produced in Mexico. In other words, this hypothesis argues that the Denomination of Origin in the Tequila industry caused the drastic change in the size distribution of Tequila distilleries.

When the benchmark model incorporates the first hypothesis, it predicts that transportation costs (tariffs) have no impact on the size distribution of distilleries. Thus, the first hypothesis is discarded as a possible explanation.

The second hypothesis assumes that the US produces a close substitute to Tequila. This hypothesis reflects that NAFTA explicitly protects Bourbon and Tennessee Whiskey producers in the US in a similar way it protects Tequila producers in Mexico: any product sold in North America as Bourbon or Tennessee Whiskey must be produce in the US.

After including this second hypothesis into the benchmark model, this paper shows that the model cannot account for an increase in the number of small distilleries that sell expensive Tequila while keeping the number of Bourbon producers unchanged when there is a reduction in transportation costs. The problem with this hypothesis is that, as section 2 shows, the number of total distilleries of Bourbon and Tennessee Whiskey remains mostly unchanged throughout the same period.

The third hypothesis assumes that preferences are non-homothetic and the US does not produce a close substitute to Tequila. In this version, consumer preferences are represented by “price independent generalized linear utility” (Muellbauer 1976). This assumption tests the impact of income distribution in the size distribution of firms. This test is important because some economists believe that the rise in the number of small batch distilleries in Mexico is due to their access to the American market that has a significant larger set of wealthy consumers willing to buy more expensive varieties than their counterparts in Mexico.

In this third case, the benchmark model predicts that the size of the smallest firm increases after a reduction in transportation costs. Nevertheless, this is not what we observe on data: the number of small distilleries is what increases significantly, not the size of the smallest distillery. Thus, this third hypothesis is discarded as a possible explanation as well.

This paper proposes a puzzle in the literature of firm size heterogeneity and international trade. In this sub-field, Melitz (2003) and Bernard, Eaton, Jensen, and Kortum (2003) are the standard theories. Neither approach can explain the evolution of the size distribution of Tequila producers.

Melitz (2003) extends the competitive model with heterogenous firms (Hopenhayn 1992) to an environment with monopolistic competition (Dixit and Stiglitz 1977) and international trade. Chaney (2008) shows that Melitz (2003) can overturn the predictions in Krugman (1980), a model of monopolistic competition and international trade with homogenous size firms. In both cases, Chaney (2008) and Krugman (1980), the number of firms within the industry is smaller after a reduction in tariffs, contrary to the experience in the Tequila sector.

Andrew Bernard et. al. (2003) extends the Ricardian environment in Dornbusch, Fischer, and Samuelson (1979) to include heterogenous firms within industries. Their goal is to explain the evidence documented by Bernard and Jensen (1995) in the US: large plants within narrowly defined industries are more likely to be exporters than small plants, and firms only export a small fraction of their output. Thus, the evolution of the Tequila industry does not fit in this pattern.

Finally, Holmes and Stevens (2014) use a version of Bernard et. al. (2003) to argue that large plants produce a different type of goods than small plants even when Census data classify them in the same industry. In this case, smaller plants are less likely to export as well. Therefore, this story cannot account for the phenomenon in the Tequila industry either.

The rest of the paper proceeds as follows: section 2 describes the change in the size distribution of Tequila distilleries, shows that the number of Bourbon and Tennessee Whiskey producers remains mostly constant, and illustrates how NAFTA protects Tequila, Bourbon, and Tennessee Whiskey producers; section 3 displays the version of the model in which Tequila does not have a close substitute being produced in the US; section 4 describes the version of Melitz in which the US produces a close substitute to Tequila; section 5 exhibits the version of Melitz with “price independent generalized linearity” utility; and section 6 concludes the paper.

Part II

2. NAFTA and Tequila, Bourbon, and Tennessee Whiskey

This section shows three things: (1) the drastic change in the distribution of Tequila distilleries after NAFTA was implemented, (2) how the number of Bourbon and Tennessee Whiskey distilleries remained mostly unchanged, and (3) how NAFTA protects these three industries with a policy of Denomination of Origin.

2.1 Regional Products

NAFTA protects the Tequila, Bourbon, and Tennessee Whiskey industries in a special section called "Regional Products" (Chapter 3 Annex 313). In particular for these three industries, this section protects them with the following two paragraphs:

> 1. Canada and Mexico shall recognize Bourbon Whiskey and Tennessee Whiskey, which is a straight Bourbon Whiskey authorized to be produced only in the State of Tennessee, as distinctive products of the United States. Accordingly, Canada and Mexico shall not permit the sale of any product as Bourbon Whiskey or Tennessee Whiskey, unless it has been manufactured in the United States in accordance with the laws and regulations of the United States governing the manufacture of Bourbon Whiskey and Tennessee Whiskey.
>
> 3. Canada and the United States shall recognize Tequila and Mescal as distinctive products of Mexico. Accordingly, Canada and the United States shall not permit the sale of any product as Tequila or Mescal, unless it has been manufactured in Mexico in accordance with the laws and regulations of Mexico governing the manufacture of Tequila and Mescal. This provision shall apply to Mescal, either on the date of entry into force of this Agreement, or 90 days after the date when the official standard for this product is made obligatory by the Government of Mexico, whichever is later.

2.2 Size distribution of distilleries in the Tequila industry

According to Mexican regulations, any Tequila distillery must be registered at the Consejo Regulador del Tequila (Tequila Regulation Council). Table 1 shows the number of distilleries officially registered to produce Tequila according to the size of their output for 1995 and 2012. In 1995, the first year for which there are clear records, the total number of distilleries registered to produce Tequila is 36. Previously, in the early 90's before the enactment of NAFTA, the total number of distilleries was between 30 and 34. In 2012, the total number of distilleries reached 155. Notice that most of this increment comes from the birth of many "micro distilleries" (those that produce under 300,000 liters of Tequila yearly normalized at 40% alcohol content). The number of this type of distilleries went from 13 in 1995 to 116 in 2012. While the Tequila Council cannot provide exact numbers, they argue that most of these new micro distilleries were born as firms highly engaged in exports.

TABLE 1: NUMBER OF TEQUILA DISTILERIES BY OUTPUT

YEAR	$X \leq 0.3$	$0.3 < X \leq 1$	$1 < X \leq 3$	$3 < X$
1995	13	9	9	5
2012	116	14	11	14

X: Millions of liters of Tequila produced at 40% alcohol content.
Data provided by the Consejo Regulador del Tequila.

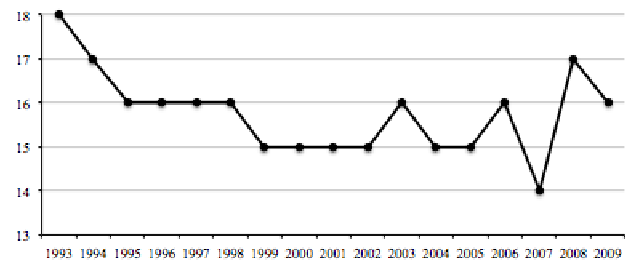
To show some examples of how these newly born distilleries were highly engaged in exports, the Consejo Regulador del Tequila provided the contact of some micro distilleries for the development of this project. One of these examples is Casa Maestri. This distillery was born after the enactment of NAFTA; 99% of its production is sold in the United States. In a personal interview, his CEO explained that most of his production is customized to satisfy the american market. Thus, they employ more expensive methods to distill and bottle their Tequila than large manufacturers, this makes their prices be higher than the average.

2.3 Size distribution of Bourbon and Tennessee Whiskey distilleries

The Tennessee Whiskey industry currently has 5 distilleries only. The two largest have been around since the 1870's: Jack Daniel's and George Dickel. The other three were born much recently and are significantly smaller that the former two: Benjamin Pichard's (born in 1997), Corsair Artisan (born in 2010), and Collier McKeel (born in 2010).

The Bourbon industry in Kentucky has remained mostly unchanged as well. As Figure 1 shows, the total number of registered Bourbon distilleries in the County Business Patterns (CBP) from the US Census Bureau fluctuates between 14 and 18 from 1993 to 2009. Most years, the number of distilleries were between 15 and 16 (Coomes and Kornstein 2012).

FIGURE 1: NUMBER OF BOURBON DISTILLERIES IN KENTUCKY



County Business Program (CBP) from US Census Bureau

3. Hypothesis 1: The US cannot produce a close substitute for Tequila

This section presents a version of the Melitz model with two countries: Mexico and the US. In this version, only Mexico produces a good for which individuals have love-for-variety preferences. This paper thinks of Tequila being that good. On the other hand, both countries produce a homogenous, freely tradable good.

This section shows that a model of this type is unable to explain the explosion in the number of Tequila distilleries after a reduction in transportation costs, because the model predicts that transportation costs has no effect on the size distribution of Tequila distilleries.

3.1 Households

Assume that households in country j, $j \in \{mx, us\}$, have the following indirect utility function:

$$\log(w_j h) - (1-\gamma)\log p_0^j - \frac{\gamma}{1-\sigma}\log\left(\int_0^{n_{mx}^j} p_{mx}^j(i)^{1-\sigma}\, di\right) \tag{1}$$

Here, $w_j h$ is the wage income of a household in country j with efficiency units of labor h; p_0^j is the price of the numeraire good in country j; $p_{mx}^j(i)$ is the price of variety of Tequila i in country j; n_{mx}^j is the measure of varieties of Tequila consumed in country j; $\gamma \in (0,1)$ is the share of income spent on Tequila; and $\sigma > 1$ is the elasticity of substitution between varieties of liquor. Notice that this indirect utility function is dual to the (direct) utility function:

$$(1-\gamma)\log c_0^j + \frac{\gamma}{\rho}\log\left(\int_0^{n_{mx}^j} c_{mx}^j(i)^{\rho}\, di\right) \tag{2}$$

where $\rho = {}^{(\sigma-1)}/_{\sigma}$.

Using Roy's identity, we can calculate the demand functions:

$$c_0^j(h) = \frac{(1-\gamma)\, wh}{p_0^j} \tag{3}$$

$$c_{mx}^j(i) = \frac{\gamma wh}{p_{mx}^j(i)^{\frac{1}{1-\rho}} P_j^{\frac{-\rho}{1-\rho}}} \tag{4}$$

where

$$P_j = \left(\int_0^{n_{mx}^j} p_{mx}^j(i)^{\frac{-\rho}{1-\rho}}\, di \right)^{\frac{1-\rho}{-\rho}} \tag{5}$$

is the standard constant elasticity of substitution price index for Tequila in country j.

Further, assume that there is a mass of households m_{mx} in Mexico who have a distribution of effective labor units that follows a Pareto distribution $h : 1 - \underline{h}_{mx}^{\eta} h^{-\eta}$ with minimum effective labor units $\underline{h}_{mx}$. Similarly, assume that, in the United States, there is a mass of households m_{us} and a Pareto distribution of effective labor units $h : 1 - \underline{h}_{us}^{\eta} h^{-\eta}$. Notice that the mean effective labor in country j is

$$\bar{h}_j = \int_{\underline{h}_j}^{\infty} h \eta \underline{h}_j^{\eta} h^{-\eta-1} dh = -\frac{\eta}{\eta-1} \underline{h}_j^{\eta} h^{-\eta+1} \mid_{\underline{h}_j}^{\infty} = \frac{\eta}{\eta-1} \underline{h}_j \tag{6}$$

In a calibrated model, m_{mx} and m_{us} can be chosen to match the relative sizes of populations of Mexico and the United States, and $\underline{h}_{mx}$ and $\underline{h}_{us}$ can be chosen to match relative mean household incomes.

3.2 Firms

This model has two types of industries. One of them produces the numeraire good; it operates in both countries. Given that we can adjust $\underline{h}_{mx}$ and $\underline{h}_{us}$, we assume that the production fuctions are the same in Mexico and United States:

$$y_{oj} = h_{oj} \tag{7}$$

Assume that the numeraire good is freely traded across countries. If the numeraire good is produced in both countries in equilibrium, then the price of the numeraire good and wages per effective unit across countries are equalized in equilibrium, $p_0^{mx} = p_0^{us}$ and $w_{mx} = w_{us}$. Notice that this will be the case when the fraction of income spent on Tequila, γ, is sufficiently small.

The other industry is the Tequila sector. The producers in this sector are located in

Mexico only. Each firm i in this industry has increasing returns to scale in the form of a fixed cost f_{mx}^{mx} of producing for domestic consumption plus a constant marginal cost $z(i)^{-1}$, where $z(i)$ is the efficiency of firm i. In case where the good is shipped to the United States, the firm pays a fixed cost f_{mx}^{us} and there is an iceberg cost to transport the good $\tau_{mx}^{us} - 1 \geq 0$. This model interprets NAFTA as a reduction in this cost. The production functions are

$$y_{mx}^{mx}(i) = z(i) \max\{h_{mx}^{mx}(i) - f_{mx}^{mx}, 0\} \tag{8}$$

$$y_{mx}^{us}(i) = \frac{z(i)}{\tau_{mx}^{us}} \max\{h_{mx}^{us}(i) - f_{mx}^{us}, 0\} \tag{9}$$

where $z(i)$ is drawn from a Pareto distribution $z(i) : 1 - z^{-\theta}$ with a cost of a draw ϕ.

3.3 Equilibrium

Since individual demands are linear in income, all that matters is the total labor endowment in each country:

$$H_J = m_j \int_{\underline{h}_j}^{\infty} h\eta \underline{h}^{\eta}{}_j h^{-\eta-1} dh = m_j \eta \underline{h}_j^{\eta} \int_{\underline{h}_j}^{\infty} h^{-\eta} dh = m_j \frac{\eta \underline{h}_j}{\eta - 1} \tag{10}$$

which, in turn, implies that the demand for good i is

$$c_{mx}^{mx}(i) = \frac{\gamma w H_{mx}}{p_{mx}^{mx}(i)^{\frac{1}{1-\rho}} P_{mx}^{\frac{-\rho}{1-\rho}}} \tag{11}$$

where

$$P_{mx} = \left(\mu \int_0^{n_{mx}^{mx}} p_{mx}^{mx}(j)^{\frac{-\rho}{1-\rho}} dj\right)^{\frac{\rho-1}{\rho}} \tag{12}$$

is the standard Dixit-Stiglitz price aggregator. Similarly, the demand for good i in the United States is

$$c_{mx}^{us}(i) = \frac{\gamma w H_{us}}{p_{mx}^{us}(i)^{\frac{1}{1-\rho}} P_{us}^{\frac{-\rho}{1-\rho}}} \tag{13}$$

where

$$P_{us} = \left(\mu \int_0^{n_{mx}^{us}} p_{mx}^{us}(j)^{\frac{-\rho}{1-\rho}} dj\right)^{\frac{\rho-1}{\rho}} \tag{14}$$

Solving the firm's profit maximization problem, we obtain

$$\begin{aligned} p_{mx}^{mx}(i) &= \tfrac{w}{\rho z(i)} \\ p_{mx}^{us}(i) &= \tfrac{\tau w}{\rho z(i)} \end{aligned} \tag{15}$$

From now on, firms will be indexed by z rather than by i, and wages will be normalized to one, $w = 1$. Consequently, the expressions for individual prices, price index, and aggregate demand per variety in Mexico are

$$p_{mx}^{mx}(z) = \frac{1}{\rho z} \tag{16}$$

$$P_{mx} = \left(\frac{\mu \rho^{\frac{\rho}{1-\rho}} (1-\rho) \theta \left(\widehat{z}_{mx}^{mx}\right)^{\frac{\rho - \theta(1-\rho)}{1-\rho}}}{\theta (1-\rho) - \rho} \right)^{\frac{1-\rho}{-\rho}} \tag{17}$$

$$c_{mx}^{mx}(z) = \frac{(\theta (1-\rho) - \rho) \rho z^{\frac{1}{1-\rho}} \gamma H_{mx}}{\mu (1-\rho) \theta \left(\widehat{z}_{mx}^{mx}\right)^{\frac{\rho - \theta(1-\rho)}{1-\rho}}} \tag{18}$$

Similarly, for the case of the United States

$$p_{mx}^{us}(z) = \frac{\tau}{\rho z} \tag{19}$$

$$P_{us} = \left(\frac{\tau^{\frac{-\rho}{1-\rho}} \mu \rho^{\frac{\rho}{1-\rho}} (1-\rho) \theta \left(\widehat{z}_{mx}^{us}\right)^{\frac{\rho - \theta(1-\rho)}{1-\rho}}}{\theta (1-\rho) - \rho} \right)^{\frac{1-\rho}{-\rho}} \tag{20}$$

$$c_{mx}^{us}(z) = \frac{(\theta (1-\rho) - \rho) \rho z^{\frac{1}{1-\rho}} \gamma H_{us}}{\tau \mu (1-\rho) \theta \left(\widehat{z}_{mx}^{us}\right)^{\frac{\rho - \theta(1-\rho)}{1-\rho}}} \tag{21}$$

where $\widehat{z}_{mx}^{mx}$ is the productivity of the least productive firm that makes Tequila for local consumption (also known as the cut-off productivity of local producers), $\widehat{z}_{mx}^{us}$ is the productivity of the least productive firm that exports (also known as the cut-off productivity of exporters), and μ is the mass of firms.

To calculate the cut-off productivities, it is necessary to use the zero profit condition of the leads productive firm:

$$p_{mx}^{mx}\left(\hat{z}_{mx}^{mx}\right) c_{mx}^{mx}\left(\hat{z}_{mx}^{mx}\right) - \frac{c_{mx}^{mx}\left(\hat{z}_{mx}\right)}{\hat{z}_{mx}^{mx}} - f_{mx}^{mx} = 0 \tag{22}$$

Thus, after substituting for the demands and the price, the cut-off productivity is

$$\left(\hat{z}_{mx}^{mx}\right)^{-\theta} = \frac{\left(\theta\left(1-\rho\right)-\rho\right)\gamma H_{mx}}{\mu\theta f_{mx}^{mx}} \tag{23}$$

In a similar way, the zero profit condition of the least productive exporter can be used to derive the cut-off productivity of exporters:

$$p_{mx}^{us}\left(\hat{z}_{mx}^{us}\right)c_{mx}^{us}\left(\hat{z}_{mx}^{us}\right) - \frac{\tau c_{mx}^{us}\left(\hat{z}_{mx}^{us}\right)}{\hat{z}_{mx}^{us}} - f_{mx}^{us} = 0 \tag{24}$$

thus,

$$\left(\hat{z}_{mx}^{us}\right)^{-\theta} = \frac{\left(\theta\left(1-\rho\right)-\rho\right)\gamma H_{us}}{\mu\theta f_{mx}^{us}} \tag{25}$$

Notice that both productivities, $\hat{z}_{mx}^{mx}$ and $\hat{z}_{mx}^{us}$, are written in terms of the mass of firms, μ, which is also an unknown variable. To find this number, it is necessary to use the costly entry condition.

The costly entry condition states that the cost of entering, ϕ, has to be equal to the value of entering to the economy. Mathematically, this is

$$\mu\phi = \mu\int_{\hat{z}_{mx}^{ms}}^{\infty}\left(p_{mx}^{mx}\left(z\right)c_{mx}^{mx}\left(z\right) - \frac{c_{mx}^{mx}\left(z\right)}{z} - f_{mx}^{mx}\right)\theta z^{-\theta-1}dz + \mu\int_{\hat{z}_{mx}^{us}}^{\infty}\left(p_{mx}^{us}\left(z\right)c_{mx}^{us}\left(z\right) - \frac{\tau c_{mx}^{us}\left(z\right)}{z} - f_{mx}^{us}\right)\theta z^{-\theta-} \tag{26}$$

The previews expression can be simplified to

$$\mu = \frac{\gamma\rho\left(H_{mx}+H_{us}\right)}{\phi\theta} \tag{27}$$

Plugging this formula into the expressions for $\hat{z}_{mx}^{mx}$ and $\hat{z}_{mx}^{us}$, the values of the cut-off productivities are found:

$$\left(\hat{z}_{mx}^{mx}\right)^{-\theta} = \frac{\phi\left(\theta\left(1-\rho\right)-\rho\right)H_{mx}}{\rho\left(H_{mx}+H_{us}\right)f_{mx}^{mx}} \tag{28}$$

$$\left(\hat{z}_{mx}^{us}\right)^{-\theta} = \frac{\phi\left(\theta\left(1-\rho\right)-\rho\right)H_{us}}{\rho\left(H_{mx}+H_{us}\right)f_{mx}^{us}} \tag{29}$$

3.4 Analysis

Notice that the expressions for the cut-off productivities and the mass of firms do not depend on the value of transportation costs. Thus, this hypothesis is discarded as a possible explanation.

As a final remark, notice that this version of the model predicts there will be small producers specialized in exports if and only if

$$\frac{H_{mx}}{f_{mx}^{mx}} > \frac{H_{us}}{f_{us}^{us}} \tag{30}$$

4. Melitz model with liquor industries in both countries

This section the previous model by incorporating varieties of the same good being produced in the United States. In this framework, we assume that Tequila and Whiskey varieties are substitutable. However, given that Mexico systematically exports more liquor to the United States than the other way around, this section assumes that Mexico has a comparative advantage in the production of Tequila.

As it will be shown at the end of this section, this version of the model cannot account for the change in the distribution of Tequila producers, because, if this were the case, the model predicts that the number of Whiskey distilleries should have grown, opposite to what data reveals.

4.1 Consumers

Assume that the preferences of the consumers in this model are represented by the following indirect utility function:

$$\log (wh) - (1-\gamma) \log p_0 - \frac{\gamma}{1-\sigma} \log \left(\int_0^{n_{mx}^j} p_{mx}^j (i)^{1-\sigma} \, di + \int_0^{n_{us}^j} p_{us}^j (i)^{1-\sigma} \, di \right) \tag{31}$$

Notice that this utility is an extension of the one described by equation (1).

Similar to before, p_0 is the price of the numeraire good; wh is the income of an individual with efficiency units of labor h; $p_k^j (i)$ is the price of variety of liquor i produced in country $k \in \{mx, us\}$ and consumed in country $j \in \{mx, us\}$, and $\sigma = 1/(1-\rho)$ is the elasticity of substitution between varieties of liquor.

Using Roy's identity, the individual demand for each good is given by

$$c_0^j (h) = \frac{(1-\gamma)\, wh}{p_0^j} \tag{32}$$

$$c_j^k (i) = \frac{\gamma wh}{p_j^k (i)^{\frac{1}{1-\rho}} \, P_k^{\frac{-\rho}{1-\rho}}} \tag{33}$$

Where the price index, P_k, is the standard Dixit-Stiglitz (1977) price aggregator. The assumption regarding effective units of labor done in section 3 stays true for this section as well.

4.2 Firms

This section assumes that the production function of the numeraire good is the same as in section 3, given by equation (7). In the same way, the production technology of a variety of the liquor good is given by the following generalization of equation (8) production function:

$$y_j^k(i) = \frac{z(i)}{\tau_j^k} \max\left\{h_j^k(i) - f_j^k, 0\right\} \tag{34}$$

Where $y_j^k(i)$ is the amount of variety i produced in country j and exported to country k. As before, $z_j(i)$ is drawn from the Pareto distribution with c.d.f. $z_j(i) \sim 1 - \underline{z}_j^{\theta} z^{-\theta}$ with the cost of a draw ϕ_j. Since this section assumes that Mexico has comparative advantage at the production of liquor, the following inequality holds: $\underline{z}_{mx} > \underline{z}_{us}$.

4.3 Equilibrium

This paper is interested in equilibria in which there is a positive production of the numeraire good in both countries. This ensures that $w_{mx} = w_{us}$. Given that individuals have a homothetic utility function, all that matters is the total labor endowment in each country, as we had before, given by equation (10). Hence, the market demands for each variety of liquor is

$$c_j^k(i) = \frac{\gamma w H_k}{p_j^k(i)^{\frac{1}{1-\rho}} P_k^{\frac{-\rho}{1-\rho}}} \tag{35}$$

From now on, firms are indexed by z rather than by i, and w is normalized to 1.

Following the profit maximization strategy, the firms that operate decide to set the following prices

$$p_j^j(z) = \frac{w}{\rho z} \tag{36}$$

$$p_j^k(z) = \frac{\tau_j^k w}{\rho z} \tag{37}$$

which, in turn, implies the following demand

$$c_j^k(z) = \frac{\gamma H_k \rho^{\frac{1}{1-\rho}} z^{\frac{1}{1-\rho}}}{\left(\tau_j^k\right)^{\frac{1}{1-\rho}} P_k^{\frac{-1}{1-\rho}}} \tag{38}$$

where

$$P_k = \left(\frac{\rho^{\frac{\rho}{1-\rho}} (1-\rho) \theta \left(\mu_{mx} \left(\tau_{mx}^k \right)^{\frac{-\rho}{1-\rho}} \underline{z}_{mx}^{\theta} \left(\hat{z}_{mx}^k \right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}} + \mu_{us} \left(\tau_{us}^k \right)^{\frac{-\rho}{1-\rho}} \underline{z}_{us}^{\theta} \left(\hat{z}_{us}^k \right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}} \right)}{\theta (1-\rho) - \rho} \right)^{\frac{1-\rho}{-\rho}} \tag{39}$$

Consequently,

$$c_j^k(z) = \frac{\rho (\theta (1-\rho) - \rho) \gamma H_k z^{\frac{1}{1-\rho}}}{\left(\tau_j^k \right)^{\frac{1}{1-\rho}} (1-\rho) \theta \left(\mu_{mx} \left(\tau_{mx}^k \right)^{\frac{-\rho}{1-\rho}} \underline{z}_{mx}^{\theta} \left(\hat{z}_{mx}^k \right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}} + \mu_{us} \left(\tau_{us}^k \right)^{\frac{-\rho}{1-\rho}} \underline{z}_{us}^{\theta} \left(\hat{z}_{us}^k \right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}} \right)} \tag{40}$$

the cut-off level of productivity for producing a good in country j for consumption in country k, $\hat{z}_j^k$, is determined by

$$p_j^{us} \left(\hat{z}_j^k \right) c_j^k \left(\hat{z}_j^k \right) - \frac{\tau_j^k c_j^k \left(\hat{z}_j^k \right)}{\hat{z}_j^k} - f_j^k = 0 \tag{41}$$

which implies that

$$\frac{\left(\tau_j^k \right)^{\frac{-\rho}{1-\rho}} (\theta (1-\rho) - \rho) \gamma H_k \left(\hat{z}_j^k \right)^{\frac{\rho}{1-\rho}}}{\theta \left(\mu_{mx} \left(\tau_{mx}^k \right)^{\frac{-\rho}{1-\rho}} \underline{z}_{mx}^{\theta} \left(\hat{z}_{mx}^k \right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}} + \mu_{us} \left(\tau_{us}^k \right)^{\frac{-\rho}{1-\rho}} \underline{z}_{us}^{\theta} \left(\hat{z}_{us}^k \right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}} \right)} - f_j^k = 0 \tag{42}$$

By dividing the equation that determines $\hat{z}_{mx}^{us}$ by that for $\hat{z}_{us}^{us}$, equation (43) follows:

$$\hat{z}_{mx}^{us} = \hat{z}_{us}^{us} \tau_{mx}^{us} \left(\frac{f_{mx}^{us}}{f_{us}^{us}} \right)^{\frac{1-\rho}{\rho}} \tag{43}$$

Similarly,

$$\hat{z}_{us}^{mx} = \hat{z}_{mx}^{mx} \tau_{us}^{mx} \left(\frac{f_{us}^{mx}}{f_{mx}^{mx}} \right)^{\frac{1-\rho}{\rho}} \tag{44}$$

The same procedure but for the cut-offs $\hat{z}_{mx}^{mx}$ and $\hat{z}_{mx}^{us}$ yields the following relationship

$$\frac{\left(\hat{z}_{mx}^{mx} \right)^{\frac{\rho}{1-\rho}}}{\left(\hat{z}_{mx}^{us} \right)^{\frac{\rho}{1-\rho}}} = \frac{H_{us} f_{mx}^{mx}}{H_{mx} f_{mx}^{us}} \left(\frac{\mu_{mx} \underline{z}_{mx}^{\theta} \left(\hat{z}_{mx}^{mx} \right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}} + \mu_{us} \left(\tau_{us}^{mx} \right)^{\frac{-\rho}{1-\rho}} \underline{z}_{us}^{\theta} \left(\hat{z}_{us}^{mx} \right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}}{\mu_{mx} \left(\tau_{mx}^{us} \right)^{\frac{-\rho}{1-\rho}} \underline{z}_{mx}^{\theta} \left(\hat{z}_{mx}^{us} \right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}} + \mu_{us} \underline{z}_{us}^{\theta} \left(\hat{z}_{us}^{us} \right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}} \right) \left(\tau_{mx}^{us} \right)^{\frac{-\rho}{1-\rho}} \tag{45}$$

Then, equation (42) can be rewritten for the case of Mexico:

$$\frac{\left(\theta\left(1-\rho\right)-\rho\right)\gamma H_{mx}\left(f_{mx}^{mx}\right)^{\frac{\rho-\theta(1-\rho)}{\rho}}\left(\hat{z}_{mx}^{mx}\right)^{\theta}}{\theta\left(\mu_{us}\underline{z}_{mx}^{\theta}\left(\tau_{mx}^{mx}\right)^{-\theta}\left(f_{mx}^{mx}\right)^{\frac{\rho-\theta(1-\rho)}{\rho}}+\mu_{us}\underline{z}_{us}^{\theta}\left(\tau_{us}^{mx}\right)^{-\theta}\left(f_{us}^{mx}\right)^{\frac{\rho-\theta(1-\rho)}{\rho}}\right)}=f_{mx}^{mx} \tag{46}$$

Consequently,

$$\left(\hat{z}_{mx}^{mx}\right)^{-\theta}=\frac{\left(\theta\left(1-\rho\right)-\rho\right)\gamma H_{mx}\left(f_{mx}^{mx}\right)^{\frac{-\theta(1-\rho)}{\rho}}}{\theta\left(\mu_{mx}\underline{z}_{mx}^{\theta}\left(f_{mx}^{mx}\right)^{\frac{\rho-\theta(1-\rho)}{\rho}}+\mu_{us}\underline{z}_{us}^{\theta}\left(\tau_{us}^{mx}\right)^{-\theta}\left(f_{us}^{mx}\right)^{\frac{\rho-\theta(1-\rho)}{\rho}}\right)} \tag{47}$$

Notice that the only variables on the right-hand side of equation (47) are μ_{mx} and μ_{us}. To calculate both, the entry condition must be solved:

$$\phi_{mx}=\frac{\left(1-\rho\right)\gamma H_{mx}\underline{z}_{mx}^{\theta}\left(\tau_{mx}^{mx}\right)^{\frac{-\rho}{1-\rho}}\left(\hat{z}_{mx}^{mx}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}}{\left(\mu_{mx}\underline{z}_{mx}^{\theta}\left(\tau_{mx}^{us}\right)^{\frac{-\rho}{1-\rho}}\left(\hat{z}_{mx}^{mx}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}+\mu_{us}\underline{z}_{us}^{\theta}\left(\tau_{us}^{mx}\right)^{\frac{-\rho}{1-\rho}}\left(\hat{z}_{us}^{mx}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}\right)}-\underline{z}_{mx}^{\theta}f_{mx}^{mx}\left(\hat{z}_{mx}^{mx}\right)^{-\theta}+\frac{(1-}{\left(\mu_{mx}\underline{z}_{mx}^{\theta}\left(\tau_{mx}^{us}\right)^{\frac{-}{1-}}\right.} \tag{48}$$

Substituting (47) into (48), the following equation is found:

$$\phi_{mx}=\sum_{j=mx,us}\left\{\frac{\left(1-\rho\right)\gamma H_{j}\underline{z}_{mx}^{\theta}\left(\tau_{mx}^{j}\right)^{\frac{-\rho}{1-\rho}}\left(\hat{z}_{mx}^{j}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}}{\sum_{i'=mx,us}\mu_{i'}\underline{z}_{i'}^{\theta}\left(t_{i'}^{j}\right)^{\frac{-\rho}{1-\rho}}\left(\hat{z}_{i'}^{j}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}}-\frac{\left(\theta\left(1-\rho\right)-\rho\right)\gamma H_{j}\left(\tau_{mx}^{j}\right)^{-\theta}\left(f_{mx}^{j}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}}{\theta\sum_{i'=mx,us}\mu_{i'}\underline{z}_{i'}^{\theta}\left(\tau_{i'}^{j}\right)^{\frac{-\rho}{1-\rho}}\left(f_{i'}^{j}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}}\right\} \tag{49}$$

Substituting (49) in (47),

$$\sum_{j=mx,us}\left\{\frac{H_{j}\left(\tau_{mx}^{j}\right)^{-\theta}\left(f_{mx}^{j}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}}{\sum_{i'=mx,us}\mu_{i'}\underline{z}_{i'}^{\theta}\left(\tau_{i'}^{j}\right)^{\frac{-\rho}{1-\rho}}\left(f_{i'}^{j}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}}\right\}=\frac{\phi_{mx}\theta}{\rho\gamma} \tag{50}$$

Similarly for the United States,

$$\sum_{j=mx,us}\left\{\frac{H_{j}\left(\tau_{us}^{j}\right)^{-\theta}\left(f_{us}^{j}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}}{\sum_{i'=mx,us}\mu_{i'}\underline{z}_{i'}^{\theta}\left(\tau_{i'}^{j}\right)^{\frac{-\rho}{1-\rho}}\left(f_{i'}^{j}\right)^{\frac{\rho-\theta(1-\rho)}{1-\rho}}}\right\}=\frac{\phi_{us}\theta}{\rho\gamma} \tag{51}$$

Equations (50) and (51) determine the mass of firms operating in each market, μ_{mx} and μ_{us}, which, using equation (47) determines the cut-off for Mexican firms selling to their domestic market, $\hat{z}_{mx}^{mx}$. Finally, equations (43), (44), and (45) determine the remaining cut-offs: $\hat{z}_{us}^{mx}$, $\hat{z}_{mx}^{us}$, and $\hat{z}_{us}^{us}$. Hence, this becomes a system of six equations with six unknowns. This system characterizes the equilibrium.

4.4 Analysis

This part shows that this model in unable to account for a fall in the cut-off producer in Mexico, and increase in the measure of firms producing in Mexico, while it keeps the mass of firms in the United States and the cut-off producer in the US unchanged. This is done by introducing a tariff reduction, $\triangle\tau_{us}^{mx} < 0$ and $\triangle\tau_{ms}^{us} < 0$, in the six equations that characterize the equilibrium – equations (43), (44), (45), (47), (50), and (51) – and showing that it is impossible to keep the variables in the United States without changing – $\triangle\hat{z}_{us}^{us} = 0$, $\triangle\hat{z}_{us}^{mx} = 0$, and $\triangle\mu_{us} = 0$ – while the cut-off firm in Mexico falls, $\triangle\min\{\hat{z}_{mx}^{us}, \hat{z}_{mx}^{mx}\} < 0$, and the mass of firms operating in Mexico increases, $\triangle\mu_{us} = 0$.

From equations (43) and (44), it can be seen that a fall in both iceberg costs, while keeping constant the cutoffs for the United States, is consistent only with a fall in the export cut-off in Mexico, and an increase in the domestic cut-off for Mexican firms selling to the domestic market. This, together with the condition that the lowest cut-off in Mexico should fall after the fall in tariffs implies that our equilibrium requires $\hat{z}_{mx}^{us} < \hat{z}_{mx}^{mx}$. This condition can easily be met as long as the size of the United States is sufficiently larger than the size of Mexico (see equation (45)). Furthermore, from the analysis of equations (43) and (44), it can be deduced that the changes in cut-offs has to satisfy $\triangle\hat{z}_{mx}^{us} = \triangle\tau_{mx}^{us}$ and $\triangle\hat{z}_{mx}^{mx} = -\triangle\tau_{us}^{mx}$.

Now, lets focus on equation (45). Notice that this equation can meet the desired requirements outlined before as long as the change in the mass of firms from Mexico is proportional to the change of tariffs, $\triangle\mu_{mx} = -\triangle\tau_{mx}^{us^{\theta}}$, and as long as the change in tariffs are of the same magnitude, $\triangle\tau_{us}^{mx} = \triangle\tau_{mx}^{us}$. Even more, under these restrictions, equation (47) still holds.

However, the problem arises when it is verified if these restrictions can be applied to the last two equations, (50) and (51). For example, pick equation (50). Under the aforementioned restrictions, it is easy to see that the left-hand side term should fall (both denominators increase, and the numerator of one of the terms falls while the other one stays constant), but the right-hand side term has to stay constant. Hence, it cannot be reconciled, at once, the fall in the cut-off for Mexican firms, the increase in the mass of Mexican firms, and the absence of change in the mass of US firms.

5. “Price independent generalized linearity” preferences

This section describes an international trade model of Tequila with a change in the preferences from the the standard models. The demand structure follows “price independent generalized linearity” preferences proposed by Muellbuer (1975) which cannot, in general, be expressed by means of direct utility functions, but, instead, are represented by indirect utility functions. However, the class of preferences described by this indirect utility function is consistent with well-behaved utility functions.

5.1 Consumers

Consumers derive utility from the following version of the indirect utility function of Boppart (2013), in which, different from Boppart (2013), we assume that one of the sectors is a Dixit-Stiglitz aggregate of Tequila:

$$v\left(wh,\left(p_{mx}^{j}\left(i\right)\right),p_{0}^{j}\right)=\frac{1}{\varepsilon}\left(\frac{wh}{\left(\int_{0}^{n_{mx}^{j}}p_{mx}^{j}\left(i\right)^{\frac{-\rho}{1-\rho}}di\right)^{\frac{1-\rho}{-\rho}}}\right)^{\varepsilon}-\frac{\beta}{\gamma}\left(\frac{p_{0}^{j}}{\left(\int_{0}^{n_{mx}^{j}}p_{mx}^{j}\left(i\right)^{\frac{-\rho}{1-\rho}}di\right)^{\frac{1-\rho}{-\rho}}}\right)^{\gamma} \tag{52}$$

where p_0^j is the price of the numeraire good by an individual with efficiency units of labor h (and, hence, income wh) of country $j \in \{mx, us\}$, $p_{mx}^j(i)$ is the price of variety of Tequila i, n_{mx}^j is the measure of varieties of Tequila consumed in $j \in \{mx, us\}$, and $\sigma = {}^{1}/_{(1-\rho)}$ is the elasticity of substitution between varieties of Tequila. As in Boppart, this paper assumes that $\varepsilon < \gamma < 1$.

The indirect utility in (52) induces the following consumption functions:

$$\begin{aligned} c_{mx}^{j}\left(i\right) &= \left(1-\beta\frac{h^{-\varepsilon}p_{0}^{\gamma}}{\left(\int_{0}^{n_{mx}^{j}}p_{mx}^{j}(i)^{\frac{-\rho}{1-\rho}}di\right)^{\left(\frac{\rho-1}{\rho}\right)(\gamma-\varepsilon)}}\right)\frac{hp_{mx}^{j}(i)^{\frac{-1}{1-\rho}}}{\int_{0}^{n_{mx}^{j}}p_{mx}^{j}(i)^{\frac{-\rho}{1-\rho}}di} \\ c_{o}^{j} &= \beta\left(\frac{h^{1-\varepsilon}p_{0}^{\gamma\cdot 1}}{\left(\int_{0}^{n_{mx}^{j}}p_{mx}^{j}(i)^{\frac{-\rho}{1-\rho}}di\right)^{\left(\frac{\rho-1}{\rho}\right)(\gamma-\varepsilon)}}\right) \end{aligned} \tag{53}$$

This section makes use of the same assumptions of effective labor units as in Section 3.1.

5.2 Firms

Similarly, this section follows the same assumptions regarding the distribution of technologies, the production of the numeraire good, and the iceberg cost done in Section 3.2.

5.3 Equilibrium

Hence, by normalizing the price of good 0, the market demand for each variety can be found by adding all individual demands for that variety. Equation (54) shows the market demand in country j for the variety of Tequila produced using productivity z:

$$Q_{mx}^{j}(z) = \left(H_{j,1} - \beta H_{j,2} P_j^{-\varepsilon+\gamma}\right) P_j^{\frac{\rho}{1-\rho}} p_{mx}^{j}(z)^{\frac{-1}{1-\rho}} \tag{54}$$

where the price index is the standard Dixit-Stiglitz price aggregator, like the one shown in (12), and the wealth aggregates are given by

$$H_{j,1} = m_j \int_{\underline{h}_j}^{\infty} h\eta \underline{h}_j^{\eta} h^{-\eta-1} dh = \frac{m_j \underline{h}_j \eta}{\eta - 1} \tag{55}$$

$$H_{j,2} = m_j \int_{\underline{h}_j}^{\infty} h^{1-\varepsilon} \eta \underline{h}_j^{\eta} h^{-\eta-1} dh = \frac{m_j \underline{h}_j^{1-\varepsilon} \eta}{\eta + \varepsilon - 1} \tag{56}$$

Solving the firm's maximization problem, the profit-maximizing price given productivity z is

$$p_k^j(z) = \frac{\tau_{mx}^{j}}{\rho z} \tag{57}$$

Consequently, the aggregate price index is exactly the same as in the first model:

$$P_j = \frac{\tau_{mx}^{j}}{\hat{z}_{mx}^{j} \rho} \left(\frac{\mu\theta(1-\rho)}{\theta(1-\rho)-\rho} \left(\frac{\underline{z}_{mx}}{\hat{z}_{mx}^{j}}\right)^{\theta}\right)^{\frac{\rho-1}{\rho}} \tag{58}$$

Now, the cut-off productivity for a firm in Mexico selling in country j can be determined:

$$\hat{z}_{mx}^{j-\theta} = \frac{(1-\rho)\theta - \rho}{\underline{z}_{mx}^{\theta} \mu\theta f_j} \left(H_{j,1} - \beta H_{j,2} P_j^{-\varepsilon+\gamma}\right) \tag{59}$$

This model also requires that the costly entry condition is satisfied. Just like it was done before, this is achieved by equating expected profits from entering to the market with the cost of entry, which, in turn, delivers

$$\mu = \frac{\rho}{\theta\phi} \left(H_{mx,1} - \beta H_{mx,2} P_{mx}^{-\varepsilon+\gamma} + H_{us,1} - \beta H_{us,2} P_{us}^{-\varepsilon+\gamma}\right) \tag{60}$$

Substituting (60) into the two version of equation (59), the two cut-off conditions are found:

$$\left(\hat{z}_{mx}^{mx}\right)^{\theta} = \frac{1 + \frac{H_{us,1} - \beta H_{us,2} P_{us}^{-\varepsilon+\gamma}}{H_{mx,1} - \beta H_{mx,2} P_{mx}^{-\varepsilon+\gamma}}}{\left(\frac{\phi}{\rho}\right)\left(\frac{(1-\rho)\theta-\rho}{\underline{z}_{mx}^{\theta} f_{mx}}\right)} \tag{61}$$

$$\left(\hat{z}_{mx}^{us}\right)^{\theta} = \frac{1 + \frac{H_{mx,1} - \beta H_{mx,2} P_{mx}^{-\varepsilon+\gamma}}{H_{us,1} - \beta H_{us,2} P_{us}^{-\varepsilon+\gamma}}}{\left(\frac{\phi}{\rho}\right)\left(\frac{(1-\rho)\theta-\rho}{\underline{z}_{mx}^{\theta} f_{mx}}\right)} \tag{62}$$

5.4 Impact of a reduction in tariffs

This part shows that a reduction in transportation costs increases the cut-off productivity of Tequila producers that export, and it has no impact on the cut-off productivity of the distilleries that sell in Mexico.

To prove this, first, this section constructs an equation that characterizes the mapping from parameters to equilibrium variables. Then, it implicitly differentiates each of the cut-off productivities with respect to the transportation cost. Finally, it shows that the value of the derivative of the cut-off productivity of the firms that sell in Mexico with respect to the transportation cost is zero while the derivative of the cut-off productivity of the firms that export is strictly positive.

To build the equation that characterizes the mapping from parameters to equilibrium variables, I add the three conditions stated in the following definition of equilibrium:

The equilibrium in this environment is a vector $(\hat{z}_{mx}, \hat{z}_{us}, \hat{\mu})$ such that satisfies the following three conditions: (i) $\pi_{mx}(\hat{z}_{mx}, \hat{\mu}) = 0$, (ii) $\pi_{us}(\hat{z}_{us}, \hat{\mu}) = 0$, and (iii) $\hat{\mu}\phi = \hat{\mu}\int_{\hat{z}_{mx}}^{\infty} \pi_{mx}(z, \hat{\mu})\, \theta z^{-\theta-1} \underline{z}^{\theta} dz + \hat{\mu}\int_{\hat{z}_{mx}}^{\infty} \pi_{mx}(z, \hat{\mu})\, \theta z^{-\theta-1} \underline{z}^{\theta} dz$.

The first condition is the zero-profits condition of the firms with the cut-off productivity that supplies Mexico; the second condition is the equivalent zero-profits condition for the firms with the cut-off productivity that supply the US; and (iii) is the costly-entry condition.

Thus, the equation that characterizes the equilibrium is

$$\int_{\hat{z}_{mx}}^{\infty} \pi_{mx}(z, \hat{\mu})\, \theta z^{-\theta-1} \underline{z}^{\theta} dz + \int_{\hat{z}_{mx}}^{\infty} \pi_{mx}(z, \hat{\mu})\, \theta z^{-\theta-1} \underline{z}^{\theta} dz - \phi + \pi_{mx}(\hat{z}_{mx}, \hat{\mu}) + \pi_{us}(\hat{z}_{us}, \hat{\mu}) = 0 \tag{63}$$

To show the impact on the cut-off productivities caused by a reduction in transportation costs, this section differentiates both cut-offs with respect to transportation costs using (63).

(64) shows the derivative of the cut-off productivity of the distilleries that supply the US with respect to transportation costs:

$$-\beta p_0^{\alpha} (\varepsilon - \gamma) P_{us}^{\varepsilon-\gamma-1} w^{1-\varepsilon} H_{us,2} \left[\left(\frac{\partial P_{us}}{\partial \hat{z}_{us}} \right) \left(\frac{\delta \hat{z}_{us}}{\partial \tau} \right) + \frac{\partial P_{us}}{\partial \tau} \right] \left[\hat{z}_{us}^{\theta} (\theta (1-\gamma) - \gamma) + 1 - \rho \right] + \Big(w H_{us,1} - \beta p_0^{\gamma} P_{us}^{\varepsilon-\gamma} \tag{64}$$

Notice that

$$\frac{\partial P_{us}}{\partial \hat{z}_{us}} = \left(\frac{\theta (1-\rho) - \rho}{\rho} \right) \frac{P_{us}}{\hat{z}_{us}} \tag{65}$$

$$\frac{\partial P_{us}}{\partial \tau} = \frac{P_{us}}{\tau} \tag{66}$$

Thus, the impact of a reduction in transportation costs on the cut-off productivity of firms that sell in the US is negative:

$$\frac{d\hat{z}_{us}}{d\tau} < 0 \tag{67}$$

Now, I will take the derivative of the cut-off productivity of the firms that supply Mexico with respect to transportation costs:

$$-\left(\varepsilon-\gamma\right)\beta p_0^{\gamma} P_{mx}^{\varepsilon-\gamma-1} w^{1-\varepsilon} H_{mx,2} \left(\frac{\partial P_{mx}}{\partial \hat{z}_{mx}}\right) \left(\frac{d\hat{z}_{mx}}{d\tau}\right) \left[\hat{z}_{mx}^{\theta}\left(\theta\left(1-\rho\right)-\rho\right)+1-\rho\right] + \Big(w H_{mx,1} - \beta p_0^{\gamma} P_{mx}^{\varepsilon-\gamma} w^{1-\varepsilon} H \tag{68}$$

Therefore, the value of the derivative is zero:

$$\frac{d\hat{z}_{mx}}{d\tau} = 0 \tag{69}$$

5.5 Analysis

This final part shows that the the model predicts that the smallest firm that exports increases size after a reduction in transportation costs. Nonetheless, this is not consistent with data. Data shows that the smallest firms are still producing less than 300,000 liters of Tequila, but there are many more of these distilleries operating now.

To show that the smallest firm increases size after a reduction in tariffs, I employ equation (57) and the zero profits condition of the smallest firm. these two equations imply the following relation:

$$p\left(\hat{z}\right) Q\left(\hat{z}\right) - \frac{w\tau}{\hat{z}} Q\left(\hat{z}\right) - wf = p\left(\hat{z}\right) Q\left(\hat{z}\right)\left(1-\rho\right) - wf = 0 \tag{70}$$

Equation (57) implies that a reduction in transportation costs and an increment in the cut-off productivity reduces the price of the Tequila supplied by the cut-off technology. Thus, by using equation (70), it is easy to verify that the quantity produced of the firm with the cut-off productivity must increase to make zero-profits. Otherwise, its profits would be negative.

6. Conclusions

This paper develops three versions of the Melitz (2003) to show its incapability to account for the sharp increase in the number of Tequila distilleries, especially the small and high price exporters after NAFTA. Each version includes a realistic and particular feature of the Tequila industry.

The first version addresses the Denomination of Origin protection that NAFTA assigns to Tequila producers in Mexico. This feature is incorporated into the Melitz (2003) model by assuming that Tequila does not have a close substitute being produced in the US. In studying this version of the model, it finds that a reduction in transportation costs has no impact on the size distribution of Tequila distilleries. Hence, this assumption version is discarded as a possible explanation.

The second version addresses that NAFTA protects Bourbon and Tennessee Whiskey producers in the US similarly to the way it protects Tequila producers in Mexico. This feature is incorporated into Melitz (2003) by assuming that Bourbon and Tennessee Whiskey are close substitutes to Tequila. As this paper shows, this version of the model cannot account for an increase in the number of small, high-priced producers in Mexico while not changing the number of producers in the United States after a reduction in transportation costs. Yet, data shows that the number of producers in both american industries remained mostly unchanged.

The third version addresses the impact of income distribution on the market demands for Tequila, Bourbon, and Tennessee Whiskey producers. This feature is incorporated by making consumer preferences be non-homothetic. Instead, this paper employs the "price independent generalized linearity" utility functions developed by Muellbauer (1976). In this version, Tequila does not have a close substitute being produced in the US. This paper shows that a reduction in transportation costs induces a growth in the size of the smallest producer according to this model. This is not what data shows though. Data shows that the size of the smallest producers remains unchanged, but there are many more of them operating today.

Therefore, this paper concludes that Melitz (2003) cannot account for the change in size distribution of Tequila distilleries even when the model is extended to more real scenarios.

7. References

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