Shipping the Good Horses Out

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Abstract

The Alchian-Allen (1964) effect states that when a fixed per-unit cost is added to two substitutes, the more expensive (higher quality) one becomes relatively cheaper, and thus its consumption will increase. When applied to trade in vertically-differentiated goods, the importing regions demand relatively more high-quality goods. We examine how this result changes when the importing region is also endowed with the goods. We use a vertically-differentiated goods model with heterogeneous consumers in which prices are endogenously determined. We show that the importing regions with an endowment have a stronger Alchian-Allen effect than the regions that are not endowed. We use the auction data of Australian thoroughbred yearlings to empirically test our model and find consistent empirical patterns.

Keywords: Alchian-Allen result, Shipping the good apples out, non-iceberg trade cost
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1 Introduction

In their classic 1964 textbook, Alchian and Allen (1964) describe the effect of adding a fixed transportation cost to good and bad apples to explain why New York consumers would buy more good apples relative to bad ones than consumers residing in the apple exporting state of Washington. This result came to be known as the "shipping the good apples out" effect.

In this paper, we extend this result by comparing the importing regions that grow their own apples with those that do not. The intuition is as follows: because of the per-unit shipping cost, the good apples are more likely to be shipped instead of the bad ones. If a region grows its own apples, it is less likely to import apples relative to other regions that do not grow apples. However, conditional on it importing apples, a region having its own apples makes it even less likely to import bad apples relative to good ones.

We examine this intuitive prediction in Section 3 by constructing a three-regions, vertically-differentiated goods model. The model incorporates an important insight illustrated in Razzolini, Shughart II, and Tollison (2003), that equilibrium prices are endogenously determined.

Razzolini, Shughart II, and Tollison (2003) point out that apple sellers consider the per-unit shipping cost in setting their prices. Therefore, whether a per-unit shipping cost makes bad apples comparatively more expensive in an importing region depends on the sellers' pricing strategy. We use horses as the context for illustration to better bridge the model with our data on throughbred yearlings. Although auction is their de facto trading platform, their prices are determined by aggregate demand and aggregate supply.

As the aggregate demand is a function of the per-unit shipping cost, the equilibrium prices also become functions of the per-unit shipping cost. An explicit model is potentially important. Consider a region that has both high- and low-quality horses. Shipping a horse to another region costs t regardless of the horse's quality. Fix the prices for the two types of horses (say, p^h and p^l). Adding the per-unit shipping cost makes the high-quality horses relatively cheaper (i.e., $\frac{p^h+t}{p^l+t} < \frac{p^h}{p^l}$). If the prices do not respond to the importing region's demand, such a mechanical change in the relative prices will raise the average quality of the horses that are shipped out. However, the prices do respond to the importing regions' demand. The fact that high-quality horses are relatively cheaper in the importing regions makes their aggregate demand increase more than that of the low-quality horses. Such a feedback differential should in turn increase the equilibrium price of high-quality horses more than that of low-quality horses (i.e., p^h rises more than p^l), potentially off-setting the mechanical change in the relative prices because of the per-unit shipping cost. We follow Razzolini, Shughart II, and Tollison (2003) by deriving the Alchian-Allen result within the model in which prices are endogenously determined to make all these effects explicit.

Moreover, we incorporate the fact that equilibrium prices are also a function of both the exporting and importing regions' horse endowment, that is, the aggregate supply. The fact that an importing region has horses affects the equilibrium prices by changing both aggregate demand and supply. A way to picture this is to consider a three-region case in which one region has no horse and the remaining two do. Suppose further that one of the regions is relatively more endowed with horses than the other. If the per-unit shipping cost is prohibitively high, there would be no trade among regions. If the per-unit shipping cost declines enough, the relatively more endowed region will start shipping horses out to the less endowed one. Therefore, the aggregate demand is a function of both the shipping cost and the horse endowment for the relatively less endowed region. Suppose that the prices of horses again do not respond to the emergence of trade among regions. The per-unit shipping cost mechanically increases the relative price of the low-quality imported horses. However, prices do respond to any changes in the demand and supply. The way how the Alchian-Allen effect plays out becomes less obvious. In our model, we make these forces explicit in the following ways:

First, we illustrate the Alchian-Allen effect when prices are endogenously determined, that is, when horses that are shipped out to a region with no horse are indeed of higher quality than those that are not shipped out.

Second, we show that the strength of the effect depends on the endowment of the importing region. Specifically, if the endowment of horses in the importing region is not of substantially higher-quality than that of the exporting region, the per-unit shipping cost will cause a stronger effect on increasing the average quality of the horses that are shipped out relative to those shipped to an importing region with no horse endowment.

After reviewing the literature in section 2, we introduce the model and derive its implications in section 3. Section 4 introduces the Australian auction data of thoroughbred yearlings, which are horses specially bred for racing. The data features three unique characteristics. First, the hammer price is an exceptionally good proxy for the expected underlying quality of the yearling. Second, the data set identifies the buyers and their locations. Therefore, we know exactly what horses are shipped from which part of Australia to which part of the world. Third, a substantial fraction of the cost of shipping a horse can hardly be justified as "iceberg."[1]

Section 5 shows empirical patterns that are consistent with the model. First, horses shipped outside Australia are of higher quality than those shipped domestically. Second, horses shipped to another Australian state other than to the one that held the auction are of higher quality than those shipped within the auction state. Third, horses that are shipped to a state where the next auction will be held are of higher quality than those shipped to any other state. Our results remain robust when we use direct quality measures instead of the hammer price.

[1] Specifically, following Hummels and Skiba (2004), the general function of a trade cost (or the shipping cost) is $\tau P + f$, where $\tau \geq 0$ is the (ad-valorem) tariff rate, and P is the price of the goods. If the per-unit cost $f = 0$, the trade cost is iceberg; if $f > 0$, the trade cost is non-iceberg.

2 Previous Works

The Alchian and Allen (1964) effect has a significant status in price theory. Since the publication of their classic textbook, interesting studies on either formalizing and extending, or empirically testing the Alchian-Allen result has never ceased. A recent seminal work by Hummels and Skiba (2004) reassures that the effect is important in explaining international trade patterns. Other related studies with a fixed shipping cost in trade include Hummels, Lugovskyy, and Skiba (2009), which endogenize the shipping cost; and Lugovskyy and Skiba (2012), which endogenize both the shipping cost and the quality choice of producers.

Gould and Segall (1968), Borcherding an Silberberg (1978), and Umbeck (1980) are the earlier contributors to the formalization and clarification of the Alchian-Allen effect. The recent theoretical contributions include Razzolini, Shughart II, and Tollison (2003), who point out that the relative prices of the different quality levels of a good in an importing region are endogenously determined by the shipping cost. Bauman (2004) demonstrates the robustness of the effect in an n-good world, where the goods in question are not close substitutes. He shows that as long as a per-unit fixed cost makes lower-quality goods more likely to be substituted by other goods than by higher-quality goods, the Alchian-Allen effect remains valid. Creative empirical works have demonstrated the result in various interesting contexts. Bertonazzi, Maloney, and McCormick (1993) show that the result can be applied to situations in which the goods are "shipped out" as well as to situations in which consumers are "shipped in." They also show consistent evidence that football game attendants who live farther away from the event tend to buy better tickets than those who live nearby. Cowen and Tabarrok (1995) further clarify the result in situations in which consumers are "shipped in." Staten and Umbeck (1989) apply the Alchian-Allen effect to help understand the effects of different fixed per-semester tuition fees between a resident and a non-resident on students' choices of courses.

Our paper contributes to the literature by showing that the strength of shipping the good apples out effect depends on whether an importing region is endowed with the imported goods. To our knowledge, no study has contemplated this scenario before. A per-unit shipping cost exerts a stronger effect on regions endowed with the imported goods than those not endowed with the imported goods. The endowment-strengthening effect is a novel extension of the Alchian-Allen effect. The auction data on thorougbred yearlings give us a great opportunity to illustrate these predictions.

3 The model

In this section, we construct a simple model with which we analyze the demand and supply primitives in the market for horses and develop some testable implications.

3.1 Supply

Consider a model with three regions, A, B, and C, selling horses of high (h) and low-quality (l). Region A's endowment of horses is denoted by ν_A; $s_A \nu_A$ of them are of high-quality and $(1 - s_A)\,\nu_A$ of them are of low-quality, where $s_A \in (0, 1)$. Region B is endowed with $\nu_B \geq 0$ of horses; $s_B \nu_B$ of them are of high-quality and $(1 - s_B)\,\nu_B$ of them are of low-quality, where $s_B \in (0, 1)$. Region C is endowed with $\nu_C \geq 0$ of horses; $s_C \nu_C$ of them are of high-quality and $(1 - s_C)\,\nu_C$ of them are of low-quality, where $s_C \in (0, 1)$. In each region, horse sellers are perfectly competitive. No seller has sufficient market power to influence the equilibrium prices.[2] The cost of shipping a horse between regions is independent from the quality of the horse, and the per-unit shipping costs from region A to B, and from A to C are denoted by t_B and t_C respectively. We assume that region A is the only exporter and that its endowment is larger than that of regions B and C. We derive the conditions under which such a pattern of trade flow emerges in equilibrium.

[2]In our data, there were 804 vendors selling an average of three horses throughout all auctions. Together with the use of auction as a mechanism to sell horses, we expect the supply side to be reasonably competitive.

3.2 Demand

Regions A, B, and C each has a continuum of potential buyers of size $n_{_A}$, $n_{_B}$, and $n_{_C}$, respectively. Therefore, the total population of potential buyers is of size $n = n_{_A} + n_{_B} + n_{_C}$. Each buyer has an option of buying one horse at most. Therefore, a discrete-choice model emerges in which a buyer chooses to either buy a high-quality horse or a low-quality horse or not to buy a horse.

We take $n > \nu_{_A} + \nu_{_B} + \nu_{_C}$; therefore, the total potential demand exceeds the total supply. Consequently, some consumers do not buy any horses in equilibrium.

Buyers are heterogeneous and characterized by a θ parameter in their utility function.[3] The utility function of a θ-type buyer is as follows:

$$u(\theta, p') = \begin{cases} \gamma\theta - p' & \text{if} \quad \text{buys a high-quality horse,} \\ \theta - p' & \text{if} \quad \text{buys a low-quality horse,} \\ 0 & \text{if} \quad \text{does not buy a horse,} \end{cases}$$

where p' is the gross price (free on board (f.o.b) plus shipping cost) that the buyer pays for the horse. The gross price p' is equal to p, the f.o.b price of the horse, if the buyer buys from his/her own region. The gross price p' is equal to $p + t_i$ if the buyer purchases from region A and is located in region $i = \{B, C\}$. The higher the θ, the more value a buyer can derive from a horse. The variable $\gamma > 1$ captures the difference in quality between a low- and a high-quality horse. One way to consider θ and γ is that θ captures the ability of the buyer to race the horse and γ captures the ability of the horse itself. A high-quality horse is more likely to win if it is raced by a more able jockey. A high-quality horse is more valuable to buyers than a low-quality horse, except for those with $\theta = 0$. Buyers in each region are distributed uniformly across the range of θ, that is, $\theta \sim U[0, 1]$. We assume that the distributions of the buyers' ability to race horses are symmetric across the three regions.

[3]The demand side of this model is similar to that in Bacchiega and Minniti (2009).

3.3 Equilibrium

Equilibrium is a list of prices $\left[\left(p_A^h, p_A^l\right), \left(p_B^h, p_B^l\right), \left(p_C^h, p_C^l\right)\right]$, where the subscripts denote region and the superscripts denote horse quality, such that the quantity demanded is equal to the quantity supplied for each type of horses in each region. Given $\left[\left(p_A^h, p_A^l\right), \left(p_B^h, p_B^l\right), \left(p_C^h, p_C^l\right)\right]$, every buyer is utility-maximizing.

We assume that trade flows from region A to regions B and C. As we are interested in examining the Alchian-Allen effect, we consider only the case in which t_B and t_C are small enough for trade to occur in both types of horses.

Three equilibrium properties require elaboration.

1. In equilibrium, $p_A^h > p_A^l$, $p_B^h > p_B^l$, and $p_C^h > p_C^l$, that is, a high-quality horse is always more expensive than a low-quality horse. If not, any buyer who buys a low-quality horse can instead buy a high-quality horse to increase his utility.

2. In the case in which t_B and t_C are small and trade among regions exists, there is no arbitrage opportunity in equilibrium, that is,

$$p_B^h = p_A^h + t_B, \tag{1}$$

$$p_B^l = p_A^l + t_B, \tag{2}$$

and,

$$p_C^h = p_A^h + t_C, \tag{3}$$

$$p_C^l = p_A^l + t_C. \tag{4}$$

For instance, if $p_B^h > p_A^h + t_B$, any buyer can buy a high-quality horse from region A and sell it at a higher price in region B to realize an immediate profit. The same logic applies to region C.

3. Any importing region imports from A only. We assume that the endowments in B and C are small enough not to warrant exporting. In this case, any importing region that imports from both of the other two regions cannot be equilibrium. Take region C as an example. An imported horse of quality $q = h, l$ from A is $p_{_A}^q + t_{_C}$ and $p_{_B}^q + t$ from B, where $t > 0$ is the shipping cost between B and C. Given (1) and (2), the price is $p_{_A}^q + t_{_C} + t$ from B, making importing from A always cheaper. If anyone imports a horse from B to C, someone must be able to make an instant profit. Such an arbitrage opportunity cannot be equilibrium. Similar arguments apply to region B.

Region A's demand: As region A exports and does not imports horses, the only relevant prices for region A's buyers are $p_{_A}^h$ and $p_{_A}^l$. Define two thresholds $\theta_{_A}^h$ and $\theta_{_A}^l$ for region A such that buyers of type $\theta_{_A}^h$ are indifferent between buying a high-quality or a low-quality horse (i.e., $\gamma\theta_{_A}^h - p_{_A}^h = \theta_{_A}^h - p_{_A}^l$), and the buyers of type $\theta_{_A}^l$ are indifferent between buying a low-quality horse and not buying any horse (i.e., $\theta_{_A}^l - p_{_A}^l = 0$). Rearranging the terms gives

$$\theta_{_A}^h = \frac{p_{_A}^h - p_{_A}^l}{\gamma - 1}, \tag{5}$$

and

$$\theta_{_A}^l = p_{_A}^l. \tag{6}$$

As buyers are distributed uniformly from 0 to 1, the demand for high-quality horses is $n_{_A}(1 - \theta_{_A}^h)$ and that for low-quality horses is $n_{_A}(\theta_{_A}^h - \theta_{_A}^l)$.

Region B's Demand: Buyers from this region buy from both A and B and do not differentiate horses based on location. Similarly, define two thresholds (denoted by $\theta_{_B}^h$ and $\theta_{_B}^l$) for region B. At threshold $\theta_{_B}^h$, the marginal buyer should be indifferent between buying a high-quality horse and a low-quality horse, that is, $\gamma\theta_{_B}^h - p_{_B}^h = \theta_{_B}^h - p_{_B}^l$. At threshold $\theta_{_B}^l$, the marginal buyer should be indifferent between buying a low-quality horse and not buying, that is, $\theta^l_B - p^l_B = 0$.

Rearranging the terms and substituting the no arbitrage conditions in (1) and (2) give

$$\theta^h_B = \frac{p^h_A - p^l_A}{\gamma - 1}, \tag{7}$$

and

$$\theta^l_B = p^l_A + t_B. \tag{8}$$

Region B's demand for high-quality horses from region A is $n_B(1 - \theta^h_B) - s_B\nu_B$. Market-clearing in region B requires exactly $s_B\nu_B$ of region B's high-quality horses sold within region B. Similarly, region B's demand for low-quality horses from region A is $n_B(\theta^h_B - \theta^l_B) - (1 - s_B)\nu_B$.

Region C's Demand: Similarly, buyers from this region buy from both A and C. Define two thresholds (denoted by θ^h_C and θ^l_C) for region C. The marginal buyer at threshold θ^h_C is such that $\gamma\theta^h_C - p^h_A = \theta^h_C - p^l_A$. The marginal buyer at threshold θ^l_C is such that $\theta^l_C - p^l_A - t_C = 0$. Rearranging the terms gives

$$\theta^h_C = \frac{p^h_A - p^l_A}{\gamma - 1}, \tag{9}$$

and

$$\theta^l_C = p^l_A + t_C. \tag{10}$$

Region C's demands for high-quality and low-quality horses from region A are $n_C(1 - \theta^h_C) - s_C\nu_C$ and $n_C(\theta^h_C - \theta^l_C) - (1 - s_C)\nu_C$, respectively.

Two points are noteworthy. [1] The three regions have the same threshold that divides the consumption of high- versus low-quality horses, that is, $\theta^h_A = \theta^h_B = \theta^h_C$. [2] The importing regions' threshold that divides the consumption of low-quality horses versus not buying is pushed upward by the shipping cost, t_i, relative to that of region A, that is, $\theta^l_B = \theta^l_A + t_B$, and $\theta^l_C = \theta^l_A + t_C$.

Market-clearing: Market-clearing requires that the quantities demanded equal the quantities supplied for each type of horses.

$$
\begin{aligned}
n_A(1-\theta_A^h)+n_B(1-\theta_B^h)+n_C(1-\theta_C^h) &= s_A\nu_A+s_B\nu_B+s_C\nu_C \\
n_A(\theta_A^h-\theta_A^l)+n_B(\theta_B^h-\theta_B^l)+n_C(\theta_C^h-\theta_C^l) &= (1-s_A)\,\nu_A+(1-s_B)\,\nu_B+(1-s_C)\,\nu_C.
\end{aligned}
$$

Substituting (5)-(10) in the market-clearing conditions, we give the following solutions:

$$
\begin{aligned}
p_A^l &= \frac{n-(\nu_A+\nu_B+\nu_C)-(n_Bt_B+n_Ct_C)}{n}, \\
p_A^h &= \frac{\gamma\,(n-(\nu_A+\nu_B+\nu_C))+(\gamma-1)\,((1-s_A)\,\nu_A+(1-s_B)\,\nu_B+(1-s_C)\,\nu_C)-(n_Bt_B+n_Ct_C)}{n}.
\end{aligned}
$$

Using the no arbitrage conditions in (1) and (4), we give the corresponding prices in regions B and C:

$$
\begin{aligned}
p_B^l &= \frac{n-(\nu_A+\nu_B+\nu_C)+n_At_B+n_C\,(t_B-t_C)}{n}, \\
p_B^h &= \frac{\gamma\,(n-(\nu_A+\nu_B+\nu_C))+(\gamma-1)\,((1-s_A)\,\nu_A+(1-s_B)\,\nu_B+(1-s_C)\,\nu_C)+n_At_B+n_C\,(t_B-t_C)}{n}, \\
p_C^l &= \frac{n-(\nu_A+\nu_B+\nu_C)+n_At_C+n_C\,(t_C-t_B)}{n}, \\
p_C^h &= \frac{\gamma\,(n-(\nu_A+\nu_B+\nu_C))+(\gamma-1)\,((1-s_A)\,\nu_A+(1-s_B)\,\nu_B+(1-s_C)\,\nu_C)+n_At_C+n_B\,(t_C-t_B)}{n},
\end{aligned}
$$

Equilibrium is characterized by this list of prices that exhibit intuitive patterns. All prices in all markets are dependent on $n-(\nu_A+\nu_B+\nu_C)$, which measures the difference between the size of potential buyers and that of the supply of horses. All prices increase in this difference, implying that the more scarce the horses, the higher are their prices. The supply of low quality horses, measured by $(1-s_A)\,\nu_A+(1-s_B)\,\nu_B+(1-s_C)\,\nu_C$, pushes up the prices of high-quality horses in all regions. In other words, if high-quality horses are relatively more scarce, their prices will be higher. Moreover, the price of high-quality horses increases in γ.[4] The higher the shipping costs, the lower are the prices in region A and the higher are the prices in all other regions.

The equilibrium above is derived under the condition that region A is the only exporter and regions B and C import both types of horses. For this condition to be true, the case must be that regions B and C demand more horses of both types than they are endowed with. Moreover, the opposite must be true for region A, such that:

	High-quality	Low-quality
For A :	$n_{A}\left(1-\theta_{A}^{h}\right) < s_{A}\nu_{A}$	$n_{A}\left(\theta_{A}^{h}-\theta_{A}^{l}\right) < \left(1-s_{A}\right)\nu_{A}$,
For B :	$n_{B}\left(1-\theta_{B}^{h}\right) > s_{B}\nu_{B}$	$n_{B}\left(\theta_{B}^{h}-\theta_{B}^{l}\right) > \left(1-s_{B}\right)\nu_{B}$,
For C :	$n_{C}\left(1-\theta_{C}^{h}\right) > s_{C}\nu_{C}$	$n_{B}\left(\theta_{C}^{h}-\theta_{C}^{l}\right) > \left(1-s_{C}\right)\nu_{C}$.

Let $s_{A}\nu_{A}+s_{B}\nu_{B}+s_{C}\nu_{C}=s\nu$, and $\left(1-s_{A}\right)\nu_{A}+\left(1-s_{B}\right)\nu_{B}+\left(1-s_{C}\right)\nu_{C}=(1-s)\nu$, we obtain

	High-quality	Low-quality
For A :	$\frac{s\nu}{n} < \frac{s_{A}\nu_{A}}{n_{A}}$	$\frac{(1-s)\nu}{n}+\frac{n_{B}}{n}t_{B}+\frac{n_{C}}{n}t_{C} < \frac{\left(1-s_{A}\right)\nu_{A}}{n}$,
For B :	$\frac{s\nu}{n} > \frac{s_{B}\nu_{B}}{n_{B}}$	$\frac{(1-s)\nu}{n}+\frac{n_{C}}{n}\left(t_{C}-t_{B}\right)-\frac{n_{A}}{n}t_{B} > \frac{\left(1-s_{B}\right)\nu_{B}}{n_{B}}$,
For C :	$\frac{s\nu}{n} > \frac{s_{C}\nu_{C}}{n_{C}}$	$\frac{(1-s)\nu}{n}+\frac{n_{B}}{n}\left(t_{B}-t_{C}\right)-\frac{n_{A}}{n}t_{C} > \frac{\left(1-s_{C}\right)\nu_{C}}{n_{C}}$,

For high-quality horses, the conditions state that the global per capita endowments should be smaller than the per capita endowments in region A and larger than those in regions B and C. If these conditions are satisfied, A will export high-quality horses to regions B and

[4] As we interpret γ as the ability of the horse to race, the more the horse is able to race, the higher the price it will command.

C. We have similar conditions for low-quality horses.[5] In this case, the conditions include two extra terms that adjust for the differences in the cost associated with shipping a horse to the region in question instead of the other. For example, considering the condition for region B, the difference in cost between transporting a horse to region C and to region B is included. Note also that the third term in this condition can be written as $+\frac{n_A}{n}(0 - t_B)$, which is the difference between transporting a horse to region A instead of B.

3.4 Effects of the per unit shipping cost

To see the effect of the per unit shipping cost, define R_j as the ratio of high-quality to low-quality horses sold by region A to region $j = \{A, B, C\}$. Thus, we have

$$\begin{aligned}
R_A &= \frac{n_A(1-\theta_A^h)}{n_A(\theta_A^h - \theta_A^l)}, \\
R_B &= \frac{n_B(1-\theta_B^h) - s_B \nu_B}{n_B(\theta_B^h - \theta_B^l) - (1-s_B)\nu_B}, \\
R_C &= \frac{n_C(1-\theta_C^h) - s_C \nu_C}{n_C(\theta_C^h - \theta_C^l) - (1-s_C)\,\nu_C}.
\end{aligned}$$

By substituting the equations in the equilibrium list of prices, we have:

$$\begin{aligned}
R_A &= \frac{s_A \nu_A + s_B \nu_B + s_C \nu_C}{(1-s_A)\,\nu_A + (1-s_B)\,\nu_B + (1-s_C)\,\nu_C + n_B t_B + n_C t_C}, \\
R_B &= \frac{s_A \nu_A + s_B \nu_B + s_C \nu_C - s_B \nu_B \frac{n}{n_B}}{(1-s_A)\,\nu_A + (1-s_B)\,\nu_B + (1-s_C)\,\nu_C - n_A t_B + n_C\,(t_C - t_B) - (1-s_B)\,\nu_B \frac{n}{n_B}}, \\
R_C &= \frac{s_A \nu_A + s_B \nu_B + s_C \nu_C - s_C \nu_C \frac{n}{n_C}}{(1-s_A)\,\nu_A + (1-s_B)\,\nu_B + (1-s_C)\,\nu_C - n_A t_C + n_B\,(t_B - t_C) - (1-s_C)\,\nu_C \frac{n}{n_C}}.
\end{aligned}$$

[5] Note that region A's condition for low-quality horses can be written as

$$\frac{(1-s)\,\nu}{n} - \frac{n_B}{n}\,(0 - t_B) - \frac{n_C}{n}\,(0 - t_C) < \frac{(1-s_A)\,\nu_A}{n}$$

The classic Alchian-Allen effect is obtained when there are no endowments in the importing regions. Therefore, we set ν_B and ν_C to zero and observe the difference between R_A, R_B, and R_C:

$$
\begin{aligned}
R_A &= \frac{s_A \nu_A}{(1 - s_A)\,\nu_A + n_B t_B + n_C t_C},\\
R_B &= \frac{s_A \nu_A}{(1 - s_A)\,\nu_A - n_A t_B + n_C\,(t_C - t_B)},\\
R_C &= \frac{s_A \nu_A}{(1 - s_A)\,\nu_A - n_A t_C + n_B\,(t_B - t_C)}.
\end{aligned}
$$

Note that $R_A < R_B$ and $R_A < R_C$ as the denominators in R_B and R_C are both smaller than that of R_A. Comparing R_B and R_C in this situation is also interesting. Here, we have two regions that are not endowed with any horses, and the only difference is the transportation cost. As predicted by the classic Alchian-Allen effect, $R_B > R_C$ if and only if $t_B > t_C$.

Proposition 1. *Suppose that shipping costs are such that trade of both types of horses between regions A and B, and between regions A and C occurs. If $\nu_B = \nu_C = 0$, then $R_B > R_A$ and $R_C > R_A$. Furthermore, if $t_B > t_C$, then $R_B > R_C$, and vice versa.*

If the two importing regions have no endowments, the high-to-low quality import ratios of regions B and C will be higher than the one region A keeps to its own consumers. This ratio is higher for the importing region with the higher transportation cost.

Let us compare the regions when one of them has an endowment and the other does not. Without loss of generality, suppose $\nu_C = 0$, that is, region C has no horse. In this case, we have the following solution:

$$R_A = \frac{s_A \nu_A + s_B \nu_B}{(1 - s_A)\,\nu_A + (1 - s_B)\,\nu_B + n_B t_B + n_C t_C},$$

$$R_B = \frac{s_A \nu_A + s_B \nu_B - s_B \nu_B \frac{n}{n_B}}{(1 - s_A)\,\nu_A + (1 - s_B)\,\nu_B - n_A t_B + n_C\,(t_C - t_B) - (1 - s_B)\,\nu_B \frac{n}{n_B}},$$

$$R_C = \frac{s_A \nu_A + s_B \nu_B}{(1 - s_A)\,\nu_A + (1 - s_B)\,\nu_B - n_A t_C + n_B\,(t_B - t_C)}.$$

Note that $R_C - R_A = (s_A \nu_A + s_B \nu_B)\, n t_C > 0$, and is increasing in t_C. What matters is the total size of the market instead of the size of each region separately, that is, the difference between R_A and R_C depends on $n t_C$. This result is new: as long as the size of the "global" market is fixed, any reallocation of buyers across the regions does not affect the differences in the relative consumption of high- versus low-quality horses in these regions. We summarize these results in the following proposition:

Proposition 2. *Suppose that shipping costs are such that trade of both types of horses between regions A and C occurs. Then $R_C > R_A$, and $(R_C - R_A)$ increases in n and t_C, but not on the relative market size among regions.*

In words, region C's high-to-low quality import ratio is higher than the one that region A keeps to its consumers. This difference is larger with a higher per-unit shipping cost (t_C increases). Moreover, this difference increases in the total size of the market but not on the relative market size among regions.

We extend the classic Alchian-Allen effect by comparing the ratios of the two importing regions R_B and R_C. Note that if $R_B > R_C$, we will also have $R_B > R_A$ as $(R_B - R_A) - (R_B - R_C) = R_C - R_A > 0 \Rightarrow (R_B - R_A) > (R_B - R_C)$. The horse endowment in region B will make the per-unit shipping cost effect even more pronounced, that is, $R_B > R_C$ as long as

$$\left((t_B - t_C)\, s_A \nu_A + \nu_B \frac{s_B}{n_B} \left[\nu_A \left(\frac{s_A}{s_B} - 1 \right) + n_A t_C \right] \right) > 0. \tag{11}$$

Note that n_B only shows up in the second term. Moreover, if transporting a horse to region C costs the same as transporting it to region B, the first term drops out. We are left with the following condition:

$$\nu_B \frac{s_B}{n_B}\left[\nu_A\left(\frac{s_A}{s_B}-1\right)+n_A t\right]>0,$$

which will be positive if and only if $\left[\nu_A\left(\frac{s_A}{s_B}-1\right)+n_A t\right] > 0$. Although the size of the potential demand in region B determines the difference in absolute value between R_B and R_C, it does not determine whether B will have a higher or lower high-to-low quality import ratio than C. We summarize this in the following proposition:

Proposition 3. *Suppose trade occurs among regions where shipping costs are the same. If $\nu_B > 0$, $\nu_C = 0$, and $\frac{s_A}{s_B} > 1 - \frac{n_A}{\nu_A}t$, then $R_B > R_C > R_A$. This ranking does not depend on the sizes of the importing markets.*

Similar to Proposition 2, Proposition 3 states that region B will have a larger high-to-low quality import ratio than that region A keeps to its own consumers. The results hold even when $\frac{s_A}{s_B}$ is smaller than 1; that is, region B can be endowed with a higher proportion of high-quality horses than region A. Moreover, the condition is silent on the absolute endowment of region B compared with region A. Therefore, it is possible for region B to have a larger endowment of high-quality horses than does region A and still have its high-to-low quality import ratio higher than the one that A keeps to its own consumers. If the transportation costs to B and C do not differ much, the first term of (11) will be inconsequential. If the two differ substantially, we will have condition (11) in which the difference between the transport costs plays a role in determining which region imports more high- versus low-quality horses.

Proposition 4. *Suppose trade occurs among regions where shipping costs are not the same. If $\nu_B > 0$, $\nu_C = 0$, and $\left((t_B - t_C)\, s_A \nu_A + \nu_B \frac{s_B}{n_B}\left[\nu_A\left(\frac{s_A}{s_B}-1\right)+n_A t_C\right]\right) > 0$, then $R_B > R_C > R_A$.*

Propositions 3 and 4 are new but intuitive ideas not previously explored. The shipping the good apples out effect is stronger if the importing region is endowed with the good. The intuition is that, in contrast to a region without its own apples, if another region has its own apples, justifying importing bad apples relative to good apples is even more difficult because of the per unit shipping cost. Conditional on importing apples, such a region would import relatively more good apples than would one without its own apples. The case in which all regions are endowed with horses complicates the model further but does not add much new insight. Therefore, we do not present that case here.

4 Data

To take the model to the data, we use a sample of auction results of thoroughbred yearlings published by the only two auction houses in Australia, namely, William Inglis and Son Ltd., and Magic Millions Sales Pty. Ltd.

4.1 Why horses?

The auction data of thoroughbred yearlings give us a rare opportunity to test our predictions. First, thoroughbred yearlings are distinctive; they are traded among regions and have good information on their quality. Second, transporting a horse involves substantial costs that do not vary with the underlying quality of the horse.

The quality of a good is usually unobserved. Prices (or unit values) are usually used as a proxy for quality. However, prices can reflect not just quality but also costs, market structure, and market power, among others. Innovative research deals with this problem using two approaches. First, a structure is imposed to estimate the underlying quality of traded goods using their prices and other observable data (e.g., Khandelwal, 2010). Second, other observables are used as quality proxies. For instance, Crozet, Head, and Mayer (2012) use expert assessments to proxy for the quality of Champagne.

Contrasting to these two approaches, we find the hammer price of a yearling in an auction to be an exceptionally good proxy for its underlying quality. A thoroughbred yearling is a horse that is bred purely for racing. It is between one and two years old, and has never been raced. Thoroughbred yearlings are investment vehicles to buyers with a clear objective: to maximize the investment return. The value of a thoroughbred yearling is straightforward: the faster it is expected to run, the more valuable it is. To avoid over-bidding on a yearling that will not perform, buyers have every incentive to carefully assess the potential racing ability of the yearlings by studying their information, including their bloodlines, and to observe them physically (yearlings are available for examination at the auction). Bargain prices are rare because buyers abound in auctions. In other words, great investment opportunities can be hard to find given that the markets are full of potential investors. Therefore, the hammer price of a yearling is unlikely to be far away from their potential racing ability, a condition that makes its price an exceptionally good proxy for its quality.

The real economic costs of shipping a horse from one location to another are non-trivial and not "iceberg." First, horses are present in the auctions for potential buyers, their vets, or their agents on their behalf, to examine. The buyer pays for the shipping cost of the horses.[6] Second, specific rules and regulations governing horse transport in Australia exist. Third, Australia enforces these rules. In particular, transportation between states is checked at stations.

For example, the Code of Practice for the Transportation of Horses in Western Australia requires the owner of the transported horse to consider the following issues when transporting a horse: minimization of stress, pre-transport preparation of horses, load-

[6]From the conditions of sales published by Inglis. Condition 10.1:" The purchaser acknowledges that: He has had the opportunity to inspect the lot prior to the sale."

Also in condition 6.2, "upon the fall of the hammer, the sole risk and responsibility for a lot shall be borne by the purchaser, who shall thereafter be responsible for all expenses incurred in respect of the lot, including care of the lot. The purchaser will be liable for stabling, agistment and transport charges for any lot not removed from Inglis' stables on the day of the sale and they may be moved to alternate stables or agistment at Inglis' discretion."
http://www.inglis.com.au/uploads/documents/COS.pdf

ing, transport design, loading density during transport, travel, rest periods, and unloading.[7] Australia requires specific documents in transporting a horse. For instance, in New South Wales, moving a horse must be accompanied by a completed Transported Stock Statement. The *Model Code of Practice for the Welfare of Animals: Land Transport of Horses* provides directions on how to safeguard the welfare of horses in transit. The *Prevention of Cruelty to Animals Act 1979* defines minimum standard for the keeping of all animals, including horses.

Cattle ticks are one of the most serious cattle parasites in Australia, and they can easily spread through horse movement. Inter-state control of movement of horses across Australia exists, and it involves stringent restrictions. e.g., movement certifications for horses are required. Moreover, vaccination proofs are always a must. Transporters also have to book appointments at the inter-state stations to have their horses examined by officers. Adhering to all these stringent regulations can add a substantial cost to the transport of horses. Any injuries can cripple the racing ability of a thoroughbred yearling; thus, owners take extra precautions in their transportation to avoid causing injury to horses.

The regulations on transporting horses do not discriminate against any type of horse. A cheaper horse will not be subject to fewer of these regulations compared with the more expensive ones. Aside from Australian regulations, the transportation process is also subject to additional freight regulations and the regulations of the destination country if a horse is shipped overseas.[8] Therefore, a substantial component of the cost of transporting a horse cannot be modeled as "iceberg."

We do not intend to entirely rule out the iceberg cost component in transporting a horse. In particular, the insurance cost of transporting a horse tends to vary with the horse's price. Instead, we argue that the non-iceberg component is non-trivial. In our

[7]see http://www.agric.wa.gov.au/objtwr/imported_assets/content/pw/ah/welfare /codeofpractice_horsetransportation.pdf

[8]Unlike shipping cats or dogs, horses are transported on air cargo carriers in specially constructed stall crates. One attendant must accompany the horse. The International Airline Transport Association (IATA) governs the process through the IATA's Live Animal Regulations.

Table 1: Basic information on the auctions

Name of Auction	Venue	Date (2005)	No. of yearlings	No. of yearlings sold	Average price(AU$)
WI Classic	Newmarket, NSW	16th-17th January	569	415	$34,792.70
WI Premier	Oaklands Vic	13th-16th February	597	451	$52,130.80
WI Australian Easter	Newmarket, NSW	29th-31st March	598	436	$207,633.00
WI Autumn	Oaklands Vic	17th-18th April	374	272	$10,495.00
WI Scone	Scone, NSW	22nd May	200	159	$12,926.90
MM Conrad Jupiters	Gold Coast, Qld	6th-12th January	1151	876	$83,717.50
MM Adelaide	Adelaide, SA	22nd-27th February	684	493	$33,856.00
MM Perth	Perth, WA	8th-11th March	505	371	$24,447.90
MM Gold Coast Premier	Gold Coast, Qld	20th-22nd March	649	413	$15,169.50
MM National	Gold Coast, Qld	9th-10th June	382	263	$27,550.40
Total			5709	4149	$59,305.60

estimation, the existence of an iceberg component works against us by making it harder for us to find an empirical pattern that is consistent with the Alchian-Allen result.

4.2 Description

Our data are provided by Ng et al. (2013), which includes 4,149 transactions from the 10 auctions held by the two auction houses between January and June 2005. Table 1 shows the basic information of the auctions. The auction houses publish detailed information, including pedigree tables of the auctioned horses, to facilitate transactions. This information includes basic characteristics, such as color, sex, birthday, breeder, bloodline, track record of the lineage, including its grandfathers and grandmothers, and its siblings (the mother's side). Table 1 shows the distribution of the prices of yearlings sold in the auctions and the basic information of the auctions.

Ng et al. (2013) collect all the information mentioned above for each sale. We are only interested in the average quality of the horses that gets sold across Australia as well as abroad, which therefore requires information on buyers' locations. Eleven observations are lost because we do not have such information. Moreover, we need this information to be accurate. Therefore, we exclude all observations that are recorded under a buying agent agreement. In this situation, the location of the agent is recorded instead of the location of the actual buyer. Accordingly, a total of 350 observations are excluded. A

Kolmogorov-Smirnov test is conducted to determine whether both samples come from the same distribution to rule out any sample selection. This test has a p-value of approximately 15.6%. Therefore, we are confident that a selection problem between the buying agents and other buyers acting on their own behalf does not exist.

5 Results

Table 2 breaks down the thoroughbred yearlings into three groups: [1] foreign - those sold to buyers located outside of Australia, [2] national - those sold to buyers residing in Australia but not from the state where the auction is held, and [3] local - those sold to buyers from the same state where the auction is held. Of all the thoroughbred yearlings, 9.56% are from group [1], and approximately 56% are from group [3]. The average price illustrates a pattern consistent with the Alchian-Allen result. On average, horses from group [1] are among the highest-quality, followed by those from group [2]. The horses from group [3] have the lowest quality. The horses from group [1] on average are 57% more expensive than those sold within Australia. A comparison between those shipped to New Zealand with those shipped to more distant countries indicates that the latter are more expensive than the former, which is a pattern consistent with the Alchian-Allen effect.[9]

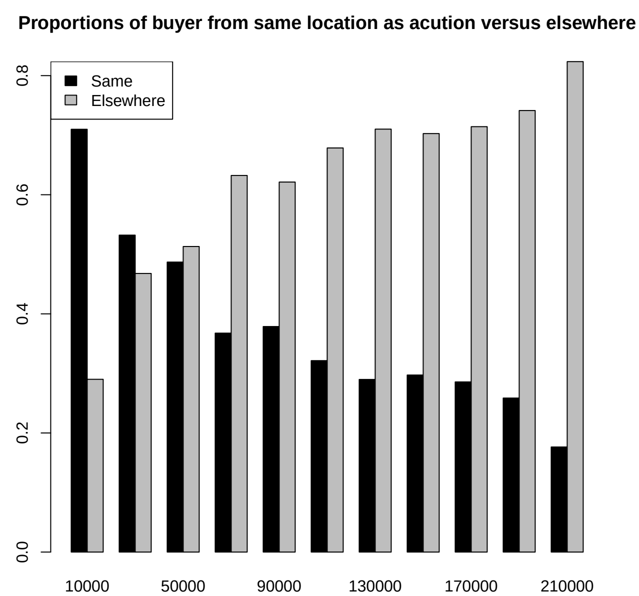
Figure 1 shows the proportion of horses sold to local versus non-local buyers conditional on the hammer price between the 5th and 95th percentile. For instance, among all horses sold for $90,000, more than 60% are shipped away. As the hammer price increases, a larger fraction of horses is shipped away instead of sold to local buyers, a pattern that is again consistent with the Alchian-Allen result.

[9] However, geographic distance is only one of the many determinants of the transportation cost. Shipment frequency, ports infrastructure, countries' specific rules and regulations, etc, are other determinants of the cost of shipping a horse there from Australia. We are unable to find the 2005 shipping cost of horses to those countries in Table 2. This precludes us from using the shipment data to different countries to test our model's prediction.

Table 2: Transactions by the locations of the buyers

Buyer's Location	No. of Transactions	Average Price	Standard Deviation
Australia	3426	56903.17	106916.4
Local	2100	44802.32	103478.226
National	1326	76067.42	109480.712
Foreign	362	87551.10	124024.585
New Zealand	139	80848.92	125788.292
South Africa	50	90020	102323.664
Malaysia	43	22837.21	21685.721
Hong Kong	35	130542.9	70469.577
Japan	32	106750	112831.948
Singapore	22	32545.45	20560.543
Korea	11	14681.82	6842.049
United Kingdom	8	212125	177821.289
Philippines	6	15833.33	12746.241
Ireland	5	460000	344873.165
France	4	181250	145852.380
USA	4	162000	172904.598
Macau	2	237500	258093.975
China	1	170000	N/A
All	3788	59832.04	109022.601

Figure 1: Proportions of horses shipped locally versus elsewhere, conditional on their hammer prices.



To account for the possibility of different market mechanisms through different auction houses and any possible differences between different series of auctions, we construct a model that accounts for any unobservable market characteristics that are constant in each auction but not across auctions. Choo and Eid (2011) show how missing information on the number of bidders in each auction leads to biased estimates. Therefore, we include auction fixed effects in some specifications to account for this concern. We are not concerned with endogenous entry in the auctions. Specifically, we do not intend to control foreign buyers going to particular auctions because these specific auctions are known to have better-quality horses. We are only interested in whether foreigners purchase the relatively higher-quality horses irrespective of which auction they buy from. To account for this scenario as well, we estimate our model without auction fixed effects. We also estimate a model in which we control for a sire fixed effect to round our results. The data show that some popular sires have multiple yearlings sold in various auctions throughout the year. Thus, to control this condition, we estimate a model that has a fixed effect for any sire that has more than 10 yearlings in total in all the 10 auctions. Therefore, we run the following regression:

$$\log(\text{Price}_{ij}) = \beta \text{ Foreign}_{ij} + \epsilon_{ij}, \tag{M-1}$$

$$\log(\text{Price}_{ij}) = \beta \text{ Foreign}_{ij} + \Gamma_j'\gamma + \epsilon_{ij}, \tag{M-2}$$

$$\log(\text{Price}_{ij}) = \beta \text{ Foreign}_{ij} + \Gamma_j'\gamma + H_{ij}'\eta + \epsilon_{ij}, \tag{M-3}$$

where Price_{ij} is the price of horse i in auction j, Foreign_{ij} is an indicator variable of whether the horse was sold to a foreign buyer, Γ_j are auction fixed effects, and H_{ij} are fixed effects for sires that have more than 10 children across all auctions. The null hypothesis is that internationally shipped horses are of the same quality as those domestically shipped, that is, $\beta = 0$.

Table 3 shows the estimation results, indicating that horses sold to foreign buyers are

Table 3: Regression results

	(M-1)	(M-2)	(M-3)
Dep. var.		log (Price)	
Foreign	0.568***	0.206***	0.207***
	(0.0628)	(0.0477)	(0.0406)
Constant	10.16***	9.130***	8.711***
	(0.0215)	(0.0690)	(0.0816)
Auction FE	No	Yes	Yes
Sire FE	No	No	Yes
Observations	3788	3788	3788
Adjusted (R^2)	0.017	0.462	0.632

OLS estimates are reported with their robust standard errors in parenthesis. *, ** and *** represent statistical significance at the 10% 5% and 1% level.

23% to 76% more expensive than those sold to national buyers (model M-3 and M-1). Although the size of the estimated coefficient varies across models, the significance remains robust. The results lend direct support to the Alchian-Allen result and Proposition 1.

Table 3 does not differentiate between yearlings shipped locally and shipped to Australian buyers located outside the state where the auction is held. Comparing horses shipped to other countries also precludes us from ruling out the possibilities that the specific demand characteristics of the other countries drive our pattern. For instance, it is plausible that Hong Kong buyers only have a preference for much higher quality horses than do average Australian buyers. This possibility may drive our previous results. We address this concern by comparing the horses sold within the auction state with those shipped to another state. A great feature of the data is that with 10 auctions, the auction state rotates across the 10 auctions. Therefore, if any particular state has potential buyers having a different preference compared with buyers from other Australian states, estimating the 10 auctions together makes it unlikely for this systematic preference difference to drive our result. In one auction, this state may be the auction state, whereas in another auction, it can be a non-hosting state. To investigate if the highest-quality horses are shipped to foreign locations, we re-estimate M-1 to M-3 including a dummy variable for yearlings sold within their auctions states (group [3]):

Table 4: Regressions including a local dummy

	(M-4)	(M-5)	(M-6)
Dep. var.		log (Price)	
Foreign	0.123	-0.0121	0.0862
	(0.0675)	(0.0525)	(0.0442)
Local	-0.725***	-0.367***	-0.203***
	(0.0423)	(0.0356)	(0.0300)
Constant	10.61***	9.442***	8.892***
	(0.0328)	(0.0790)	(0.0867)
Auction FE	No	Yes	Yes
Sire FE	No	No	Yes
Observations	3788	3788	3788
Adjusted (R^2)	0.088	0.478	0.637

OLS estimates are reported with their robust standard errors in parentheses. *, ** and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

$$\log\left(\text{Price}_{ij}\right) = \beta_1 \text{ Foreign}_{ij} + \beta_2 \text{ Local}_{ij} + \Gamma_j'\gamma + \epsilon_{ij}, \tag{M-4}$$

$$\log\left(\text{Price}_{ij}\right) = \beta_1 \text{ Foreign}_{ij} + \beta_2 \text{ Local}_{ij} + \Gamma_j'\gamma + \epsilon_{ij}, \tag{M-5}$$

$$\log\left(\text{Price}_{ij}\right) = \beta_1 \text{ Foreign}_{ij} + \beta_2 \text{ Local}_{ij} + \Gamma_j'\gamma + H_{ij}'\eta + \epsilon_{ij}, \tag{M-6}$$

Tables 4 shows the estimation results. The estimated coefficient of Foreign is no longer significant. However, this result does not reject the Alchian-Allen effect. Table 4 suggests that, on average, yearlings sold to foreign and national out-of-state buyers are about the same quality and are both of relatively higher-quality than those shipped within their auctioned states (between 18% and 52% less expensive).

Proposition 3 in our model deals with the endowment of the importing region: the Alchian-Allen effect becomes stronger if the importing region is endowed with the importing goods. The lack of endowment data on horses prohibits us from distinguishing among importing countries. However, we do have some information on the endowments in Australia. Specifically, as only one auction is held at a time, an importing state within Australia where the next auction is to be held can be regarded as relatively "more endowed" with horses than other importing-states in Australia. Therefore, we expect the horses that are shipped to these "more endowed" importing-states to be of relatively higher-quality than those shipped to other states within Australia, consistent with Proposition 2. Using the notations of the model, the auction state is region A, the state that hosts the next auction is region B in the model, and the other importing states within Australia are region C. With 10 auctions, not only the hosting state but also the "more endowed" and "less endowed" states rotate across the auctions. Such rotations make it unlikely for any specific state's demand characteristics to drive our result. Accordingly, we construct an indicator variable, denoted by Next_{ij}, which takes a value of one if the buyer is from a state where the next auction will be held. We estimate the following augmented models including the variable Next_{ij}:

$$\log\left(\text{Price}_{ij}\right) = \beta_1 \text{ Foreign}_{ij} + \beta_2 \text{ Local}_{ij} + \beta_3 \text{ Next}_{ij} + \Gamma_j' \gamma + \epsilon_{ij}, \tag{M-7}$$

$$\log\left(\text{Price}_{ij}\right) = \beta_1 \text{ Foreign}_{ij} + \beta_2 \text{ Local}_{ij} + \beta_3 \text{ Next}_{ij} + \Gamma_j' \gamma + \epsilon_{ij}, \tag{M-8}$$

$$\log\left(\text{Price}_{ij}\right) = \beta_1 \text{ Foreign}_{ij} + \beta_2 \text{ Local}_{ij} + \beta_3 \text{ Next}_{ij} + \Gamma_j' \gamma + H_{ij}' \eta + \epsilon_{ij}, \tag{M-9}$$

Table 5: Regressions including a local dummy and the next dummy

	(M-7)	(M-8)	(M-9)
Dep. var.		log (Price)	
Foreign	0.375***	0.0339	0.120*
	(0.0715)	(0.0566)	(0.0478)
next	0.648***	0.109*	0.0792
	(0.0650)	(0.0540)	(0.0450)
Local	-0.473***	-0.326***	-0.173***
	(0.0483)	(0.0408)	(0.0344)
Constant	10.35***	9.407***	8.869***
	(0.0403)	(0.0811)	(0.0878)
Auction FE	No	Yes	Yes
Sire FE	No	No	Yes
Observations	3788	3788	3788
Adjusted (R^2)	0.110	0.478	0.637

OLS estimates are reported with their robust standard errors in parentheses. *, ** and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Table 5 shows the estimation results. The results are consistent with Propositions 3 and 4: the horses shipped to Australian states where the next auctions will be held are of relatively higher quality than those shipped to other states within Australia. These models estimate that these horses are between 8% and 91% more expensive than the horses shipped to other states in Australia. Except model M-8, models M-7 and M-9 suggest that horses shipped to foreign countries are of higher quality than those shipped to the states where auctions will not be held soon. Model M-9 again suggests that the Alchian-Allen effect for horses shipped to foreign countries are of the highest quality. It is worthy to mention that horses shipped within their auctioned states are always of the lowest-quality, a pattern consistent from models M-1 to M-9. Such consistency lends support to the Alchian-Allen result.

Table 6: Regressions using direct quality measures (M-10 and M-11)

	(1) Colt	(2) Derby	(3) Champion Sire	(4) Champion Dam	(5) Winfoald	(6) Winsib
foreign	0.158***	0.0543**	0.0888**	0.00614	0.0717*	0.298*
	(0.0283)	(0.0188)	(0.0306)	(0.00540)	(0.0312)	(0.120)
next	-0.00960	0.0805***	0.124***	-0.000224	0.0454	0.0195
	(0.0278)	(0.0157)	(0.0276)	(0.00266)	(0.0280)	(0.0952)
Local	-0.0264	-0.00887	-0.0309	-0.00465	0.0308	0.117
	(0.0203)	(0.0143)	(0.0191)	(0.00277)	(0.0207)	(0.0735)
Observations	3788	3788	3788	3788	3788	3788
Adjusted (R^2)						0.001

Robust standard errors are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively. Probit estimation is used for columns (1)-(5) and their marginal effects are reported. OLS is used for column (6).

5.1 Robustness

A concern of models M-1 to M-9 is that the dependent variable is the hammer price, which we argue as an exceptional proxy for the underlying quality of the yearling. We also use direct measures of the underlying quality of the yearlings as robustness checks. Table 6 shows the estimation of the following equation:

$$Prob\left(\text{Dep. Var=1}|X\right) = \Phi\left(\beta_o + \beta_1\text{Foreign}_{ij} + \beta_2\text{Next}_{ij} + \beta_3\text{Local}_{ij}\right), \quad \text{(M-10)}$$

$$\text{Dep. Var} = \beta_o + \beta_1\text{Foreign}_{ij} + \beta_2\text{Next}_{ij} + \beta_3\text{Local}_{ij} + \epsilon_{ij}, \quad \text{(M-11)}$$

where Dep. Var is one of the following five dummies: Colt, Derby, Champion sire, Champion dam, and Winfoald.[10] The dependent variable in column (6) is the number of winning siblings by the same dam - Winsib. For the indicator variables, we estimate a Probit model and report the marginal effects of the variables. For the Winsib variable, we estimate and report the OLS coefficients. In each of these direct quality measures, the models predict higher probabilities to be shipped to foreign countries. Moreover, whenever the next variable is significant, it takes a positive expected sign. Finally, although the local dummy is not significant when we use direct quality measures, it again does not go against our propositions. Foreign and "next" locations still obtain the better quality mix.

One may still be concerned about whether our results are driven by demand characteristics in the other states and foreign countries instead of the transportation cost. To address this concern, we collect some information about demand shifters in Australia and New Zealand. We collect the betting turnover in all states in Australia[11] and New Zealand[12] for 2007 to 2008 season. As these are thoroughbred horses that are bred for the sole purpose of racing, betting turnover, which is the total amount of horse race betting in each state and in New Zealand, is a good proxy for demand. Once we include this new variable to proxy for demand, we have to delete all the horses that are shipped abroad except to New Zealand. It is because we do not have information about the rest of the

[10] Their definitions are as follows: (1) Colt: $= 1$ if the yearling is a colt, $= 0$ if otherwise; (2) Derby: $= 1$ if the yearling is Derby eligible, $= 0$ if otherwise; (3) Champion sire: $= 1$ if the yearling's sire has been a champion, $= 0$ if otherwise; (4) Champion dam: $= 1$ if the yearling's mother has been a champion, $= 0$ if otherwise; (5) Winfoald: $= 1$ if the yearling's mother has a winning son/daughter, $= 0$ if otherwise; (6) Winsib: the number of winning siblings by the same dam.

[11] http://www.australianracingboard.com.au/factbook

[12] http://www.nzracing.co.nz/About/Publications.aspx

countries to proxy for demand and also because, by far, New Zealand accounts for most of the foreign transactions (Table 2). We reproduce the models from Tables 5 and 6 in Tables 7 and 8. Note that Betting Turnover has the correct sign in the tables, and these tables show that our results are not driven by demand characteristics. Indeed, the magnitude of the coefficient on foreign regressions of log prices is larger and more significant. To see whether these magnitudes and significance are due to restricting the data to Australia and New Zealand, we reproduce Table 5 but only restrict the data to Australia and New Zealand. Table 9 does not support the hypothesis that New Zealand drives our results because its results are similar to those in Table 5.

Table 7: Regressions including a local dummy and the next dummy with betting turnover

	(M-7)	(M-8)	(M-9)
Dep. var.		log (Price)	
foreign	0.879***	0.551***	0.411***
	(0.106)	(0.0846)	(0.0755)
next	0.519***	0.0420	0.0434
	(0.0647)	(0.0535)	(0.0451)
Local	-0.395***	-0.246***	-0.130***
	(0.0487)	(0.0395)	(0.0348)
Betting Turnover	0.000246***	0.000197***	0.000110***
	(0.0000209)	(0.0000196)	(0.0000176)
Constant	9.719***	8.698***	9.363***
	(0.0686)	(0.105)	(0.219)
Observations	3565	3565	3565
Adjusted (R^2)	0.139	0.487	0.637

OLS estimates are reported with their robust standard errors in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

6 Conclusion

This paper shows that the Alchian-Allen result remains robust in a setting where consumers are heterogeneous and prices are endogenously determined by a fixed shipping cost. Furthermore, we show that the Alchian-Allen effect is stronger if an importing region also has its own supply of the imported goods; this second prediction is new and has not been explored by the literature.

Table 8: Regressions using direct quality measures with betting turnover

	(1) Colt	(2) Derby	(3) Champion Sire	(4) Champion Dam	(5) Winfoald	(6) Winsib
foreign	0.195***	0.0457	0.384***		0.0785	0.206
	(0.0432)	(0.0301)	(0.0484)		(0.0489)	(0.168)
next	-0.000169	0.0811***	0.0776**	-0.000832	0.0378	-0.00611
	(0.0282)	(0.0164)	(0.0274)	(0.00144)	(0.0285)	(0.0981)
Local	-0.0321	-0.00811	-0.0100	-0.00262	0.0354	0.132
	(0.0205)	(0.0147)	(0.0195)	(0.00196)	(0.0209)	(0.0743)
Betting Turnover	-0.0000180*	0.00000314	0.0000824***	0.00000211*	0.0000146	0.0000489
	(0.00000879)	(0.00000634)	(0.00000865)	(0.000000940)	(0.00000889)	(0.0000327)
Observations	3565	3565	3565	3426	3565	3565
Adjusted (R^2)						0.000

Robust standard errors are reported in parentheses.*, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively. Probit estimation is used for columns (1)-(5) and their marginal effects are reported. OLS is used for column (6).

Table 9: Regressions including a local dummy and the next dummy for Australia and New Zealand only

	(M-7)	(M-8)	(M-9)
Dep. var.		log (Price)	
foreign	0.347***	0.0688	0.141*
	(0.0953)	(0.0733)	(0.0631)
next	0.648***	0.101	0.0755
	(0.0650)	(0.0541)	(0.0452)
Local	-0.473***	-0.328***	-0.171***
	(0.0483)	(0.0410)	(0.0347)
Constant	10.35***	9.616***	9.998***
	(0.0403)	(0.0952)	(0.203)
Observations	3565	3565	3565
Adjusted (R^2)	0.106	0.473	0.633

OLS estimates are reported with their robust standard errors in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

We use the auction data of thoroughbred yearlings in Australia as a rare opportunity for us to test these predictions. First, the observed hammer price of a yearling is an exceptionally good proxy for its underlying quality. Second, the non-discriminatory nature of the regulations on horse transportation makes a substantial portion of the shipping cost non-iceberg. Third, the data provide the locations of the buyers and therefore the directions of the trade flows. Different models consistently show that good horses are relatively more likely to be shipped out. Using the location where the auction will be held next as a proxy for the relative endowment differences of horses across different states in

Australia, we also find empirical pattern to support our new prediction.

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