

Home Bias in Multimarket Cournot Games*

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Abstract

We explore the role played by trade costs for the home bias in trade. In a series of Cournot duopoly experiments with a home and an export market, we compare output choices when firms face different levels of export costs. We find that there is two-way trade in identical products and that firms hold the majority market share in their home market. The resulting home bias turns out to be, however, stronger than that predicted by theory, and it even occurs without trade costs. We have strong evidence that collusion contributes to the home bias observed in our experiment.

JEL Classification: F12, L13, C91

Keywords: Intra-Industry Trade; Spatial Oligopoly; Home Bias; Collusion; Experiment.

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1 Introduction

The phenomenon that domestic products have a disproportionately high market share on many goods markets is often referred to as the home bias in trade and is documented by a large empirical literature.¹ In this paper, we run a laboratory experiment to study the role of trade costs for the home bias in trade. We find strong evidence that tacit collusive agreements between market players contribute to the part of the home bias that remains unexplained by trade costs.

Evidence on the home bias is in itself not surprising, but the magnitude of the estimated effects seems unbelievably large. For example, McCallum (1995) finds that intranational trade flows in Canada are twenty times larger than trade flows to the United States. In similar vein, estimates of the economic impact of the border between the United States and Canada find an effect equivalent to shipping a good 75,000 miles (Engel and Rogers, 1996) and to a distance exceeding the one to the Moon between the United States and Japan (Parsley and Wei, 2001). Although subsequent literature has typically tempered these estimates (see, for example, Anderson and Smith (1999) and Evans (2003)), the size of the bias remains difficult to explain.² The home bias in trade is, thus, one of the six major puzzles in international macroeconomics (Obstfeld and Rogoff, 2001).

Prevalent explanations of the home bias center around two main lines: consumer preferences and trade barriers.³ The home bias may result from the fact that domestic consumers have a preference for buying domestic goods (see, for example, Trefler (1995), Combes et al. (2005) and Brühlhart and Trionfetti (2009)) or that elasticities of substitution between domestic and foreign goods are large (see, for example, Evans (2003)). Alternatively, the home bias may due to trade barriers.

¹While the home bias is mentioned in relation with unbalanced intensity of trade within a region or country, border effects typically refer to trade flows across regions or countries. Sometimes they are used as synonyms. In this paper, we use ‘home bias’ according to the terminology of Obstfeld and Rogoff (2001).

²For example, Anderson and van Wincoop (2004) find that the trade pattern between the United States and Canada can be rationalized only, for an elasticity of substitution of 5, by international trade costs – tariffs plus transport costs – of 91%. They note, however, that trade costs are merely about five to ten percent for high-income countries.

³Some researchers also indicate that the home bias may occur as a statistical artefact. See, for example, Anderson and van Wincoop (2003) for misspecification of the gravity model, Hillberry and Hummels (2008) for aggregation problems and Gorodnichenko and Tesar (2009) for issues related to the measure of border frictions.

On the one hand, international trade costs - tariffs, transport costs, sunk export market entry costs - provide an intuitive explanation for the effect of national borders on trade volume (see, for example, Obstfeld and Rogoff (2001); Melitz (2003); Anderson and van Wincoop (2004); Yi (2010)). On the other hand, social and business networks (Rauch, 2001; Combes et al., 2005) as well as ethnicity (Aker et al., 2014) may influence trade via transaction costs.

Empirically, it is hard to distinguish the effects of preferences from those of trade costs using aggregated trade data.⁴ However, the economic implications and welfare consequences of the home bias depend on the channel that generates it. In particular, if the home bias only reflects consumer preferences or transport costs, there is no reason for governmental market intervention. If, however, the source of the bias is tariffs, intervention may be welfare enhancing and thus be warranted.

In this paper, we run a series of Cournot duopoly experiments based on Brander and Krugman (1983)'s model of international trade with a home and an export market. We compare firms' output choices in these two markets for different levels of export costs. Our goal is to understand how these costs impact occurrence and size of the home bias. Our experimental design rules out any explanation based on differences in consumer preferences, on transaction costs, as well as on sunk export market entry costs. To our knowledge, this is the first experimental study of the home bias in trade.⁵

We have four main results. First, we find qualitative support for Brander and Krugman (1983), namely, there is two-way trade in identical products, and each firm has the majority market share in its home market. Second, however, we find a stronger home bias than that predicted by their theoretical model. Third, the home bias is present even without trade costs, and thus, these costs alone cannot explain the home bias visible in our data. Fourth, we have evidence that tacit collusion contributes to the home bias observed in our experiment. This last finding indicates that gains from trade in oligopolistic markets can be hampered by collusive division of geographic markets.⁶

⁴Anderson and van Wincoop (2004), for example, note that differences in preferences are impossible to distinguish from trade costs.

⁵See, for example, Ackert et al. (2005) for an experimental study of the equity home bias in investment behavior.

⁶Salvo (2010) provides a similar suggestion based on an empirical analysis of the Brazilian

A study on recent cartel cases in Europe reports that a common principle of market sharing, typically used in collusive agreements with an international scope, is the “home-market principle” (Harrington, 2006, p.24). Cartel members would reduce supply in each other’s home market with the ultimate goal to achieve a scheme in which each cartel member had exclusive control over its home market. In prominent cartels such as choline chloride, lysine and copper plumbing tools, firms have adhered to the home-market principle. The decision of the European Commission on the lysine cartel, for example, states that⁷

Kyowa insisted on the home-market principle. The participants agreed to sell, in 1991, within the export quantities of 1990. Ajinomoto and Kyowa requested Sewon to reduce substantially its sales to the USA and Europe on the principle that the local producer should sell as much as possible in its region.

In the methionine industry, the home-market principle was even the instigating factor for the cartel agreement.⁸ In our experiment, we detect behavior consistent with the home-market principle: firms typically undersupply relative to the best-response quantity in the export market.

Our paper is linked to various strands of research. First of all, it contributes to the literature on the home bias in trade mentioned above. In particular, it suggests that there are factors on the supply side other than trade costs, namely, the firms’ coordination across markets, leading to a home bias. Although, the possibility of collusion in intra-industry trade has been acknowledged (Baake and Normann, 2002; Bond and Syropoulos, 2008), it has not been associated with the home bias nor has it been experimentally tested.

Another strand of research related to our analysis studies the question of how trade barriers, especially the reduction of those in the realm of trade liberalization, influence the stability of collusive agreements. One branch of this literature studies a situation where home and foreign firms form a collusive arrangement that covers only one of the markets (Davidson, 1984; Rotemberg and Saloner, 1989; Fung, 1992). In this setting, trade barriers affect the firms’ incentives asymmetrically.

cement industry.

⁷OJ L 152/24, 7.6.2001, 57, 68 and Harrington (2006).

⁸OJ L 255/1, 8.10.2003, 82-3, 91 and Harrington (2006).

Another branch of this literature focuses on reciprocal changes in trade costs which affect all cartel members symmetrically in the context of multimarket collusion (Pinto, 1986; Krishna, 1989; Lommerud and rgard, 2001; Colonescu and Schmitt, 2003; Bond and Syropoulos, 2008). The finding of the latter is that the effect of lower trade costs on collusion is ambiguous. Not only do lower trade costs make deviation from collusion by invading foreign markets more attractive, but they also make punishment cheaper. The overall effect depends on the specific conditions under which the collusive agreement takes place. In our experiment, we find that the degree of collusion, namely, by how much firms undersupply relative to the best-response quantity in the export market, is rather stable across the treatments with different trade costs.

Parallel to the above literature in international trade, another strand of research in industrial organization related to our analysis studies how multimarket contact between firms affects the extent of collusion that can be sustained across different markets. In their seminal paper, Bernheim and Whinston (1990) show that multimarket contact may strengthen firms' ability to collude: under a number of circumstances, typically involving asymmetries between firms and markets, multimarket contact can help firms to optimize the allocation of available enforcing power between markets. The main interest of Bernheim and Whinston (1990) lies in the comparison of the single-market with the multimarket collusive outcome. Their comparative static question is thus different from ours. In an extension, Byford and Gans (2014) explicitly consider firms' decisions to participate in a market prior to their actions within the market. They analyze the conditions under which the firms' coordination of their participation across different markets outperform their coordination of behavior within the single markets. Again, our paper is different in that we do not reveal firms' entry decisions prior to output decisions and that we do not ask whether firms engage in one rather than in the other form of collusion.

Finally, our paper is also embedded in the experimental literature on Cournot duopolies. Holt (1985), Huck et al. (2004) and Roux and Thöni (2015) find that in multi-period duopoly games, the quantity choices of players fall between the Nash and collusive levels.⁹ Our findings for multimarket Cournot duopolies are

⁹See Haan et al. (2009) for a review of the experimental literature on collusion.

consistent with this evidence. More generally, our paper contributes to the experimental literature on international trade (see, for example, Noussair et al. (1995); Engelmann and Normann (2007); Noussair et al. (2007); Johnson (2010)).

The remainder of this paper is organized as follows. Section 2 lays out the model of Brander and Krugman (1983). Section 3 describes the experimental design. Section 4 discusses our results, and section 5 concludes.

2 The Model

There are two firms that can sell their output in two markets. The domestic firm produces output x for domestic and output x^* for foreign consumption. The marginal cost in the home market is a constant, $c \geq 0$, and the marginal cost of export is c/g , where $0 \leq g \leq 1$. Similarly, the foreign firm produces output y for export and output y^* for its home market, and faces a symmetric cost structure. Using p and p^* to denote domestic and foreign prices and assuming linear demand, we have

$$p = a - b(x + y) \quad \text{and} \quad p^* = a - b(x^* + y^*),$$

where $a > 0$ and $b > 0$.¹⁰ Hence, the profits of the domestic and foreign firms are given by

$$\begin{aligned} \pi &= [a - b(x + y)]x - cx + [a - b(x^* + y^*)]x^* - cx^*/g - F \\ &= \pi(x, y) + \pi(x^*, y^*) - F \end{aligned}$$

and

$$\begin{aligned} \pi^* &= [a - b(x + y)]y - cy/g + [a - b(x^* + y^*)]y^* - cy^* - F^* \\ &= \pi^*(x, y) + \pi^*(x^*, y^*) - F^* \end{aligned}$$

respectively, where asterisks generally denote variables associated with the foreign market and F denotes fixed costs. The profit maximizing choice of x is independent of x^* and similarly for y and y^* : each country can be considered separately. By symmetry, we need to consider only the domestic market.

¹⁰Brander (1981) considers a linear demand. Brander and Krugman (1983) consider a general demand function.

Each firm maximizes profit with respect to own output in the domestic market, which yields the first-order conditions:

$$\pi_x = a - 2bx - by - c = 0 \quad \text{and} \quad \pi_y^* = a - 2by - bx - c/g = 0.$$

Solving this system with respect to x and y we obtain

$$x^N = \frac{a - 2c + c/g}{3b} \quad \text{and} \quad y^N = \frac{a - 2c/g + c}{3b}.$$

It follows from these two equations that $x^N \geq y^N$, that is, the Nash-equilibrium output of the domestic firm in the domestic market is greater than or equal to the Nash-equilibrium exports of the foreign firm to the domestic market. Similarly, we have

$$(x^*)^N = \frac{a - 2c/g + c}{3b} \quad \text{and} \quad (y^*)^N = \frac{a - 2c + c/g}{3b}.$$

An important assumption is that output y^N is strictly positive, otherwise, the foreign firm does not export to the domestic market. For that to be the case, we must have

$$g > \frac{2c}{a + c}.$$

This inequality means that trade costs must be below a certain threshold before two-way trade in identical products takes place (trade costs fall as g rises). Note that when $g = 1$ (trade costs are zero) the equilibrium is

$$x^N = y^N = (x^*)^N = (y^*)^N = \frac{a - c}{3b}.$$

Thus, as trade costs fall, goods produced abroad make up a greater and greater share of domestic consumption, with the share being equal to $1/2$ when $g = 1$.

3 Experimental Design and Procedures

We consider three trade cost treatments: HighTC, LowTC, and NoTC. Each treatment consists of 20 periods of the baseline game in which two symmetric firms can produce in two equal-sized markets. In each market, firms face the same linear demand and produce at a constant marginal cost. The firms simultaneously and independently choose the quantities for the home and export markets. In each market, their action sets are numbers between 0 and 74 with 0.1 as the smallest increment. Producing 0 is equivalent to not entering the market. The price in the domestic and foreign market, respectively, are determined by the market demand functions:

$$p = \max\{74 - (x + y), 0\} \quad \text{and} \quad p^* = \max\{74 - (x^* + y^*), 0\}.$$

The marginal cost of production is equal to 2. There are no fixed costs, that is, $F = F^* = 0$.¹¹ Hence, the profits of the domestic firm and foreign firm are given by

$$\begin{aligned} \pi &= \max\{74 - (x + y), 0\}x + \max\{74 - (x^* + y^*)\}x^* - 2(x + x^*/g) \\ \pi^* &= \max\{74 - (x + y), 0\}y + \max\{74 - (x^* + y^*)\}y^* - 2(y/g + y^*), \end{aligned}$$

respectively. In HighTC, the trade cost is 10 ($g = 0.2$), in LowTC, the trade cost is 4 ($g = 0.5$), and, in NoTC, the trade cost is zero ($g = 1$).

The Nash equilibrium of the HighTC game is each firm offering 26.7 units in its home market and exporting 18.7 units. The Nash equilibrium of the LowTC game is each firm offering 24.7 units in its home market and exporting 22.7 units. Finally, the Nash equilibrium of the NoTC game is each firm offering 24 units in its home market and exporting 24 units.

At the end of each period, the players are informed about their profits earned in each market and the shares of the two players in the two markets. Each market is displayed in a different color (yellow, red), and each player is assigned one of these two colors. The colors are exogenously determined and do not have any

¹¹When $a = 74$ and $c = 2$ we have $g > \frac{2c}{a+c} = \frac{1}{19}$. This condition is satisfied in the three treatments.

other function than the one of giving a clear representation of the market shares in each market. The colors stay the same during the 20 periods and are observed by the two players. All game parameters and the number of periods are commonly known.

We also consider a final treatment, NoTCEnd, to check the influences of the color labels on our results. The NoTCEnd treatment is the same as the NoTC treatment in all features except that the two markets do not have a color (they are just labelled markets 1 and 2). In this treatment, the home and the export market are determined endogenously. To analyze the data, we assume that the home market of a firm is the one in which it offers the highest average quantity.

The sessions were run in the Decision Science Laboratory of the ETH Zurich in June 2013 and were programmed in z-Tree (Bock et al., 2014; Fischbacher, 2007). Subjects were randomly allocated to computer terminals in the laboratory so that they could not infer with whom they would interact. For the entire experiment, communication was not allowed. We provided written instructions which informed the subjects of all the features of the markets (see the Appendix). Similar to other studies on experimental Cournot games, we used an economic framing (see, for example, Huck et al. (2004)). We told the subjects that they were representing a manager of a firm which, with another firm, had access to two markets and that their job was to decide which markets to serve and how much to produce. When answering the control question and when choosing the quantity during the game, players had access to a profit calculator allowing them to calculate the payoff of hypothetical combinations of their quantity and the quantity produced by their competitor.

For the profits during the experiment, we used an experimental currency unit called Guilders. The payments to the subjects consisted of a 10 Swiss francs (CHF) show-up fee plus the sum of the profits over the course of the experiment. Losses, if they occurred, were deducted from the show-up fee. The sessions lasted for about 105 minutes, and the average earnings were about 34 CHF (standard deviation: 6.6, range from 5 to 51). We conducted five sessions with a total of 160 participants. The subjects were undergraduate students from the University of Zurich and the ETH Zurich.

4 Results

In this section, we report the findings of our experiment. We start by describing the main findings. After that we discuss if the home bias is caused by trade costs. We end the section by analyzing the role played by tacit collusion.

4.1 Main findings

The left panel of Figure 1 shows the results for the treatments HighTC and LowTC. Bars show quantities in the home and export market, respectively, and spikes indicate standard errors (we calculate standard errors clustered on group). Horizontal lines indicate the quantities predicted by the Nash equilibrium.

In both treatments, there is two-way trade in identical products, and firms have the majority market share in their home market. We observe a substantial deviation from the Nash prediction: quantities in the home market are higher than predicted while export quantities are lower than predicted, with all deviations

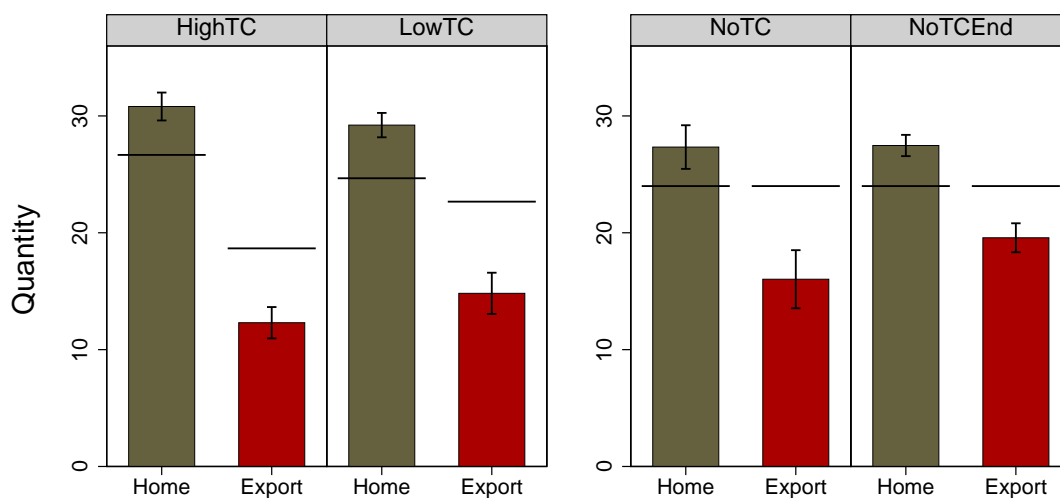


Figure 1: Average quantity in home and export markets for HighTC and LowTC (left panel) and the two treatments without trade costs (right panel). Spikes indicate standard errors, clustered on pairs of subjects. Horizontal lines indicate Nash-equilibrium quantities; numbers are p -values from one-sample t-tests, comparing the respective quantity to the theoretical prediction.

	HighTC			LowTC		
	<i>obs</i>	<i>ne</i>	<i>p</i>	<i>obs</i>	<i>ne</i>	<i>p</i>
Quantity home	30.8	26.7	.003	29.2	24.7	.000
Quantity export	12.3	18.7	.000	14.8	22.7	.000
Total quantity	43.1	45.3	.201	44.0	47.3	.037
Home bias	18.5	8.0	.000	14.4	2.0	.000
Residual home bias	10.5	0.0	.000	12.4	0.0	.000
	NoTC			NoTCEnd		
	<i>obs</i>	<i>ne</i>	<i>p</i>	<i>obs</i>	<i>ne</i>	<i>p</i>
Quantity home	27.3	24.0	.092	27.5	24.0	.001
Quantity export	16.0	24.0	.005	19.6	24.0	.001
Total quantity	43.4	48.0	.016	47.0	48.0	.365
Home bias	11.3	0.0	.012	7.9	0.0	.000
Residual home bias	11.3	0.0	.012	7.9	0.0	.000

Table 1: Average quantities in the home and export market.

being highly significant. Consequently, there is less trade than what is predicted by theory.

The first two lines in Table 1 show the observed quantities (*obs*) and the predicted quantities (*ne*), as well as the *p*-values from one-sample t-tests, comparing the observed quantities to the theoretical prediction (tests are based on independent group averages). The first line reports an oversupply of the quantity in the home market of 4.1 (30.8 – 26.7) units in HighTC and of 4.5 (29.2 – 24.7) units in LowTC. The second line reports an undersupply of the export quantity of 6.4 (18.7 – 12.3) units in HighTC and of 7.9 (22.7 – 14.8) units in LowTC. The deviations from the predicted quantities are highly significant both for the home and export quantities. Thus, while we find qualitative support for the Nash-equilibrium prediction, the asymmetry in the data is much stronger than predicted.

The third line in Table 1 reports the observed total quantity. There is an undersupply of total quantity of 2.2 (45.3 – 43.1) units in HighTC and of 3.3 (47.3 – 44.0) units in LowTC. Finally, the fourth and fifth lines report the observed and predicted home bias, respectively. The observed home bias is of 18.5 (30.8 – 12.3) units in HighTC and of 14.4 (29.2 – 14.8) units in LowTC. The predicted

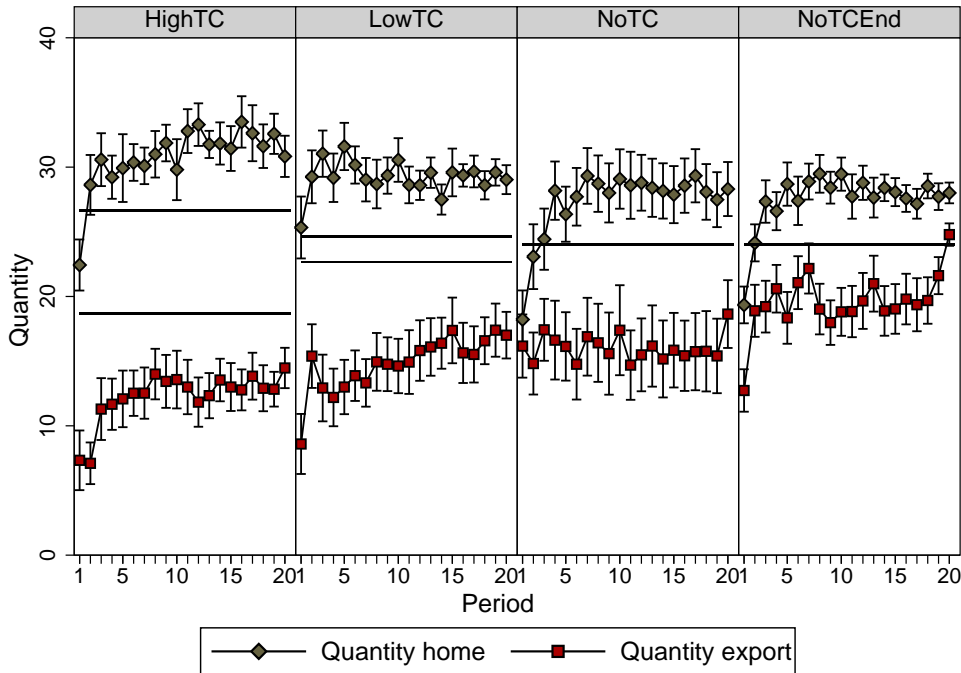


Figure 2: Average quantities in home and export market across the 20 periods. Horizontal lines indicate Nash-equilibrium quantities. Spikes indicate standard errors, clustered on pairs of subjects.

home bias is of 8 ($26.7 - 18.7$) units in HighTC and of 2 ($24.7 - 22.7$) units in LowTC. Hence, we observe a residual home bias, that is, the difference between the observed and predicted home bias, of 10.5 units in HighTC and of 12.4 units in LowTC.

The deviations from the Nash predictions are fairly stable over the course of the 20 periods. Figure 2 shows for each treatment a line plot of the home and export quantities over time. In both HighTC and LowTC, we observe relatively low quantities in both markets in the beginning of the game. The export quantity increases somewhat over time, but the deviations from the predicted quantities remain significant throughout the game.¹²

¹²For example, calculating the t-tests using only the last five periods of HighTC or LowTC results in $p < .005$ in all cases.

4.2 Is the home bias caused by trade costs?

Both treatments studied so far involve trade costs. While this might be a natural assumption in terms of the model it is an open question whether the home bias observed in the two treatments is caused by the asymmetric marginal costs, or simply by the fact that our color framing in the experiment saliently identifies one of the two markets as ‘belonging’ to the respective firm. In order to investigate the causal relationship between trade costs, framing, and the observed home bias we conducted two additional treatments, NoTC and NoTCEnd. The right panel of Figure 1 shows the average home and export quantities for the two additional treatments. In NoTC, the marginal costs in the home and export market are identical. This treatment demonstrates that trade costs are not a necessary condition for a home bias. Although the Nash equilibrium predicts identical quantities in the two markets, observed quantities are clearly different. This results in a home bias of 11.3, which is very close to the residual home bias in the two treatments with trade costs (10.5 and 12.4). Still, the home bias in NoTC might be caused by our strong color framing, giving subjects a clear coordination device to focus on the market of their color.

To investigate the role of the color framing, we conducted a fourth treatment, in which the two markets do not have a color (NoTCEnd). In this treatment, the two markets are called market 1 and market 2, while the firms still have colors. Consequently, the experimental design provides no association whatsoever between firm and market. Calculating the home bias in this treatment is not as straightforward as before because we do not experimentally induce a home market. Instead, we determine the home market and the export market within a pair of firms endogenously from the observed quantities. In particular, we calculate the average market share of a firm in both markets throughout the 20 periods, and we define the market with the higher market share as the home market. Figure 1 shows that, even in the absence of an externally induced home market, we observe a considerable and highly significant deviation from the symmetric Nash equilibrium. The resulting home bias is 7.9.

The right part of Figure 2 shows the home and export quantities over time for the two additional treatments. Like in the left panel, there is no indication for

a convergence towards the Nash equilibrium in NoTC. In case of NoTCEnd, we observe an increase in the quantities in the export market towards the equilibrium quantities in the final two periods. This is presumably due to end-game effects rather than convergence to equilibrium play, because we do not see any indication of lower quantities in the home market.

Considering all four treatments in Figure 1, we see that the difference between the home and export quantities gradually increases across the four treatments ($p = .030$ one-way analysis of variance), whereas the residual home bias, that is, the part of the difference in quantities not accounted for by the Nash equilibrium, is fairly stable ($p = .614$).

4.3 Is the home bias caused by collusion?

We have established the existence of a home bias independently of whether there are trade costs. A potential explanation for this result is that firms collude on the joint-profit maximizing outcome. In the two treatments with trade costs, there is a unique joint-profit maximizing outcome, in which both firms sell the monopoly quantity in their home market and do not serve at all the export market (autarky). In the two treatments without trade costs, any allocation of quantities to the two markets in which one firm produces the monopoly quantity in one market and the other firm produces the monopoly quantity in the other market is joint-profit maximizing. In particular, apart from autarky there is a second prominent symmetric solution, namely that both firms offer half of the monopoly quantity in both markets.

One way to identify attempts to collude is by looking at a firm's decision not to enter the competitor's home market, and thus forgo short run profits on that market.¹³ In 24.8 percent of all quantity choices, firms do not sell in the export market, while in 13.5 percent of all the market outcomes, this holds for both firms, resulting in an autarky situation. Looking at the treatments separately, it is somewhat surprising that the frequency of autarky outcomes is considerably higher in NoTC (21.9 percent) than in the treatments with trade cost (9.4 in HighTC

¹³In principle, it could be a best response not to enter. This is the case if the other firm chooses a very large quantity to drive the profit margin below zero. We observe such large quantities extremely rarely (about 0.1 percent of the cases).

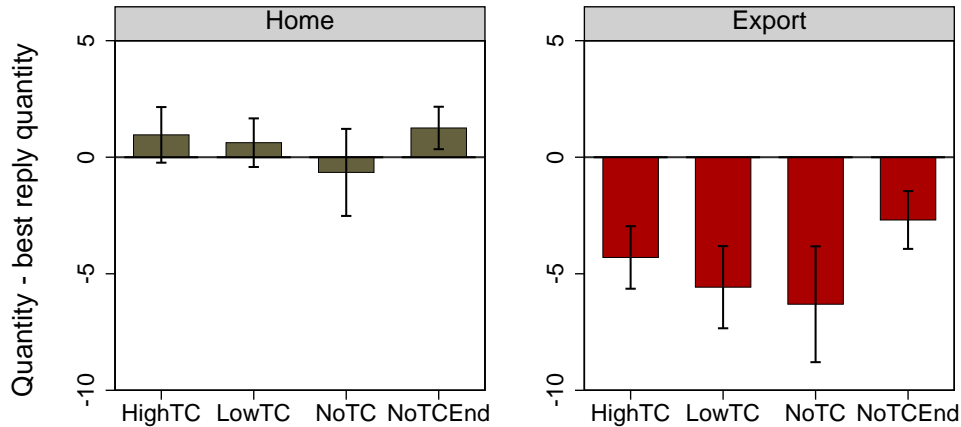


Figure 3: Difference between observed and best-reply quantities for the home and export market and the four treatments. Spikes indicate standard errors, clustered on pairs of subjects.

and 13.3 percent LowTC).¹⁴ The differences are, however, not significant. Still it is surprising, given that autarky is the unique joint-profit maximizing solution with trade costs, but not without trade costs.

Apart from autarky, we also consider a more general measure to identify collusive quantity choices. In particular, we use the rivals' decisions to calculate the best-reply quantity in both the home and export markets for a given firm. We relate this best-reply quantity to the actual quantity of the firm. Differences around zero indicate that the firms maximize their profit in the given period, while we interpret negative differences as an indication of collusive actions. Figure 3 shows the results for the home and export markets in the four treatments. In the home market, we observe quantities which are very close to the best reply, and, in none of the treatments, we find evidence for a systematic deviation. In other words, on average, a firm in its home market was able to best respond to a low export quantity of its rival. On the export market, however, quantities tend to be around five units below the best reply quantities. In other words, on average, a firm exports less than what it should have exported if it was best responding to the home

¹⁴The percentage of NoTC is even higher if we take into account that there was one group in which the two firms played autarky with opposed signs, that is, only sold in the market with the other color. If we include these as autarky situations the percentage increases to 28.9 for NoTC, while the other percentages remain basically unchanged.

market quantity of its rival. We calculate one-sample t -tests for the differences between quantities and best-reply quantities relative to zero (based on independent group averages). In all treatments, the difference between observed quantities and best reply is insignificant for the home market ($p \geq .180$). On the other hand, all tests are significant for the export market ($p \leq .040$). This is a clear indication that, on average, firms offer collusive quantities in the export market.

In a final step, we use OLS estimates to explain the residual home bias. In Model (1) in Table 2, we include treatment dummies and confirm the observation made above that the residual home bias is not substantially different across treatments.

Model (2) introduces two variables controlling for time effects, the period number and a dummy for the final period. Overall, there is no indication for a time trend in the residual home bias, but there seems to be a substantial and significant end-game effect reducing it in the final period. This again supports the argument that the residual home bias is caused by collusive behavior.

In Model (3), we add two additional controls for details in the experimental design which might affect quantity choices. *Red firm* is a dummy identifying whether the subject was assigned to the color red (as opposed to yellow); *Home left* indicates whether the market with the same color as the firm is located on the left part of the screen, as opposed to the right. We do not find any indication that these subtle design features systematically affect the quantities.

Finally, in Model (4), we investigate whether the residual home bias is related to the firms' profits. While so far all the covariates were clearly exogenous, this is of course no longer the case for profits. We add a variable for the sum of the two firms' profits in a given period (measured in percentage of the Nash-equilibrium profit). We find that this measure is strongly positively correlated with the residual home bias, indicating that successful groups tend to have a strong residual home bias in their quantity choices.¹⁵

¹⁵Instead of group profits, we also investigated the effect of individual profits on the home bias. In such an estimate (not reported in the table), we do not find significant effects, because a strong home bias can only be profitable if both firms in the group adhere to this strategy.

Table 2: OLS estimates for the residual home bias

	Dependent variable: Residual home bias			
	(1)	(2)	(3)	(4)
LowTC	1.893 (3.083)	1.893 (3.084)	1.893 (3.085)	1.504 (2.883)
NoTC	0.805 (4.377)	0.805 (4.378)	0.805 (4.380)	0.586 (4.265)
NoTCEnd	-2.608 (2.659)	-2.608 (2.660)	-2.679 (2.762)	-1.965 (2.732)
Period		0.052 (0.104)	0.052 (0.104)	-0.028 (0.098)
Final period		-3.572*** (1.237)	-3.572*** (1.238)	-2.769** (1.075)
Red firm			-0.787 (0.624)	-0.787 (0.625)
Home left			-0.141 (0.832)	-0.141 (0.832)
Group profit				15.215*** (4.332)
Constant	10.504*** (1.872)	10.141*** (2.023)	10.606*** (2.128)	-2.746 (4.526)
F -test	0.8	3.3	2.5	4.4
Prob > F	0.501	0.010	0.020	0.000
R^2	0.012	0.014	0.014	0.061
N	3200	3200	3200	3200

Notes: OLS estimates. Dependent variable is residual home bias, independent variables are the treatment dummies (with HighTC as omitted category), period and a dummy for the final period identify time effects, red firm is a dummy for the subjects color, and home left indicates whether the home market is the market displayed on the left part of the input screen. Group profit measures the sum of both firm's profit in percentage of Nash profits. Robust standard errors, clustered on group, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5 Conclusion

In this paper, we have used an experiment based on Brander and Krugman (1983) to analyze the role played by trade costs in the home bias. We vary the level of trade costs to observe how these costs impact the occurrence and size of the home bias. Our experimental design rules out explanations based on differences in

consumer preferences, sunk export market entry costs, and transaction costs. We have four main results. First, we find qualitative support for the theory. Second, we find a larger home bias than that predicted by theory. Third, we find that a home bias exists even in the absence of trade costs. Fourth, we find evidence that collusive outcomes contribute to the home bias. The last result provides support for an alternative explanation for the home bias: collusive division of geographic markets.

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Appendix

Instructions for LowTC

[Instructions for the LowTC treatment, translated from German. The parts that are different in the instructions for the NoTC treatment are reported in *italics*. For the HighTC treatment, the only difference is the unit cost which is ten instead of four. In the instructions for the NoTCEnd treatment, we leave out any information and screenshots referring to the colors of the markets.]

Instructions

You are taking part in an economic study financed by various research foundations. You can, depending on your decisions, earn a fair amount of money. It is therefore important that you read these instructions carefully.

These instructions are solely for your private use. You are not allowed to communicate with the other participants during the entire study. If you have any questions, please contact the supervisors.

During the study, we will not speak of Swiss francs (CHF) but of Guilders. Your earnings will first be calculated in Guilders. The total amount of Guilders you earn during the study will be converted to Swiss francs at the end of the study. The following conversion rate applies:

$$1250 \text{ Guilders} = 1 \text{ CHF}$$

At the end of today's session, you will receive your earnings from the study in cash. You remain anonymous during and also after the study.

The study is divided into 20 separate rounds. The participants are divided into groups. Each group consists of two participants. The composition of the groups remains the same for all 20 rounds. Hence, you are in a group with the same participant for all 20 rounds.

Each participant is the manager of a firm. Both firms in the same group can serve two identical markets. In each round, you decide which of the markets to serve and how many units of the goods to supply. The other firm in your group does exactly the same thing. The following rule applies: the larger the total quantity supplied in a market, the lower is the market price of the good. *The unit cost amounts to 2 and 4 Guilders*

respectively (depending on the market), and thus, the per-unit profit equals the market price minus 2 and 4 Guilders respectively.

We will explain the exact procedure of the study in the next pages

Information on the Exact Procedure of the Study

At the beginning of each round, each manager has to decide which of the markets to serve and how many units of the good to supply. In each of the two markets, the firms face the same market demand which is

$$P = 74 - Q.$$

P is the market price and Q is the total quantity supplied. For example, if both your firm and the other firm in your group supply the good in the same market, Q is the sum of the quantity supplied by your firm and the quantity supplied by the other firm.

In each group, there is a firm Yellow and a firm Red. The two colors are randomly assigned to the participants. You are informed about the color of your firm on the decision screen. One of the two colors is also randomly assigned to each of the markets. Thus, there is a market Yellow and a market Red. The colors of the firms and the markets stay the same throughout all 20 rounds.

In the first round, you see the following decision screen:

What-if calculator			
Your quantity	Quantity other	Your profit in the market of your color	Your profit in the market of the other color

Round: 1 of 20 Remaining time [sec]: 117

Your decision in this round

Your are firm

Market Red

supply

Market Yellow

supply

Your quantity:

Quantity of the other firm:

Buttons: erase table, calculate, OK

The round number appears in the upper left corner of the screen. In the upper right corner, you can see how many more seconds you have to enter your quantity.

You can use the What-if-calculator to determine your profits from different combinations of your quantity and the quantity of the other firm in one single market. These calculations are purely hypothetical and do not influence your payments. They only serve an informational purpose.

If you want to supply in one particular market, you need to click on the supply-button first. If you do, an input field appears. You set your quantity by entering a number in the input field (maximum one decimal). Once you have entered your quantity, you must click on the OK-button. You can then no longer revise your decision for that round.

After both firms have made their decision, your profit in each market will be determined for this round. *The unit cost is 2 in the market of your color and 4 in the market of the other color.*

Your profit in the market of your color is determined as follows:

$$\begin{aligned} & [74 - (\text{your quantity} + \text{the quantity of the other firm})] \cdot (\text{your quantity}) \\ & - 2 \cdot (\text{your quantity}). \end{aligned}$$

Your profit in the market of the other color is determined as follows:

$$\begin{aligned} & [74 - (\text{your quantity} + \text{the quantity of the other firm})] \cdot (\text{your quantity}) \\ & - 4 \cdot (\text{your quantity}). \end{aligned}$$

The profit of the other firm is determined in the same way. The above expressions show that, given your quantity in a market, the larger the quantity of the other firm in this market, the smaller your profit. The same is true for the other firm. The larger the quantity you choose, the smaller the profit of the other firm in this market. The expression in the brackets is the market price. If the total quantity supplied in one market exceeds 74 units, the market price is zero. You can also incur losses.

In all subsequent rounds, the outcome of the previous round is displayed in the upper half of the screen.

In the rounds 2–20, you see the following decision screen:

Round				2 of 20		Remaining time [sec]: 77	
What-if calculator				Result of the previous round			
Your quantity	Quantity other	Your profit in the market of your color	Your profit in the market of the other color	You are firm			
				Market Red		Market Yellow	
				Quantity 70 60 50 40 30 20 10 0		Quantity 70 60 50 40 30 20 10 0	
				Your profit 0		Your profit 0	
				Your profit in the previous round			
				Your decision in this round			
				You are firm			
				Market Red		Market Yellow	
				supply		supply	
Your quantity <input type="text"/>				OK			
Quantity of the other firm <input type="text"/>				calculate			
erase table							

Bars (not displayed in the above screenshot) show the outcome of the previous round in each market. The length of a bar shows the total quantity supplied in the particular market. The parts in yellow and red inform you about how much of the total quantity each firm supplies in this market. If one firm alone served the whole market, the bar shows the color of that firm only. Your profit earned in the particular round and market is written in the line below the bars.

In the lower half of the screen, you can enter your quantity for the current round, exactly as you did in the previous rounds.

Do you have any questions?