

Home Bias in Multimarket Cournot Games*

Catherine Roux[†] Luís Santos-Pinto[‡] Christian Thöni[§]

July 13, 2016

Abstract

We explore the role of 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 trade 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. Tacit collusion contributes to the home bias observed in our experiment but does not offer a full explanation for the phenomenon.

JEL Classification: F12, L13, C91

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

*We thank the Editor and three anonymous referees for helpful comments and suggestions. We are particularly grateful to Pablo Brañas Garza, Marius Brülhart, Jaromír Kovářík, Kala Krishna, Praveen Kujal, Rosemary Nagel, Alberto Salvo, Christian Zehnder and Ro'i Zultan for valuable comments and discussions. We would also like to thank participants at various conferences and seminars. Financial support from HEC, University of Lausanne and the Economic Policy profile area of the University of St. Gallen is gratefully acknowledged. The usual disclaimer applies.

[†]University of Basel. E-mail: catherine.roux@unibas.ch

[‡]University of Lausanne. E-mail: LuisPedro.SantosPinto@unil.ch, corresponding author

[§]University of Lausanne. E-mail: christian.thoeni@unil.ch

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, Treffer (1995), Combes et al. (2005) and Brühlhart and Trionfetti (2009)) or that elasticities of substitution between domestic and foreign goods are large

¹While the home bias in trade 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 the expression ‘home bias’ according to Obstfeld and Rogoff (2001) to designate the supply-side imbalance of trade flows in international goods markets.

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 five, 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.

(see, for example, Evans (2003)). Alternatively, the home bias may be due to trade barriers. On the one hand, international trade costs - tariffs, transport costs, sunk costs of entering foreign markets - provide an intuitive explanation for the effect of national borders on trade volume (see, for example, Obstfeld and Rogoff (2001); Wolf (2000); 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. Anderson and van Wincoop (2004), for example, note that differences in preferences are impossible to distinguish from trade costs. In addition, Anderson and Marcouiller (2002) argue that a substantial part of the effective trade costs might be difficult to measure. Examples for such hidden trade costs comprise unenforceability of contracts across jurisdictional boundaries, bribes extorted by custom officials, or hijacking of shipments.

Shedding light on the causes of the home bias is important, because its economic implications and welfare consequences depend on the channel that generates it. In particular, if the home bias mostly reflects consumer preferences or transport costs, there is no reason for governmental market intervention. If, however, the source of the bias is tariffs, hidden trade costs, or collusion, then an intervention may be welfare enhancing and thus be warranted.

In this paper, we run a series of repeated Cournot duopoly experiments based on Brander (1981)'s model of international trade with a home and an export market. Two firms simultaneously choose their quantities for both markets. The home market of the first firm is the export market of the second firm and vice versa. We compare firms' output choices in the two markets for different levels of trade costs, namely, high, low, and zero trade costs. In contrast to studies using field data, the laboratory environment allows us to have full control over consumer preferences, production and trade costs. Exogenously manipulating trade costs allows us to identify the causal effect of trade costs on home bias. Furthermore, we can directly compare the theoretical predictions from Brander (1981) to the trade flows observed in our experimental markets. To our knowledge, this is the first experimental study of the home bias in trade.⁴

⁴For a discussion of the contribution that the experimental approach can bring to the field

We have five main results. First, we find qualitative support for Brander (1981), 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 the theoretical model. Third, the home bias is present even without trade costs, and thus, trade costs alone cannot explain the home bias 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.⁵ Fifth, while tacit collusion is an important driver of the home bias, it does not offer a full explanation for the phenomenon.

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).⁶ 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.

A more recent and prominent cartel employing a home-market principle was the gas insulated switchgear cartel where “[t]he companies agreed that the Japanese

of international economics in general see Duffy (2014), who writes: “The justifications for an experimental approach to international economics are [...]: the available field data does not allow for precise tests of theoretical predictions nor is it possible to abstract away from complicating factors, for example, transport costs or multi-lateral as opposed to bilateral two-country trade (most theoretical models assume the latter).”

⁵Salvo (2010) provides a similar suggestion based on an empirical analysis of the Brazilian cement industry.

⁶Recent empirical work on spatial cartels suggests that the home-market principle occurs in many different industries. See, for example, Strand (2002) and Röller and Steen (2006).

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

companies would not sell in Europe, and the European companies would not sell in Japan”.⁸ In the methionine industry, the home-market principle was even the instigating factor for the cartel agreement.⁹ 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. 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 Sørsgard, 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

⁸IP/07/80 January 2007, p.2.

⁹OJ L 255/1, 8.10.2003, 82-3, 91 and Harrington (2006).

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 (2015a) find quantities between the Nash and collusive levels in finitely repeated duopoly games (see Engel (2007) or Haan et al. (2009) for reviews of the experimental literature on collusion). Our findings for multimarket Cournot duopolies are 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)).

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 in the export market is c/g , where $0 \leq g \leq 1$. The difference between the latter and the former is the marginal trade cost ($\frac{c}{g} - c$). 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

$$p = a - b(x + y) \quad \text{and} \quad p^* = a - b(x^* + y^*), \quad (1)$$

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

$$\begin{aligned} \pi &= [a - b(x + y)]x - cx + [a - b(x^* + y^*)]x^* - cx^*/g - F \\ \pi^* &= [a - b(x + y)]y - cy/g + [a - b(x^* + y^*)]y^* - cy^* - F^* \end{aligned} \quad (2)$$

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.

For sufficiently low fixed costs, 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

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

It follows from these two equations that $x^{ne} \geq y^{ne}$, 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

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

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

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

must have

$$g > \frac{2c}{a+c}. \quad (3)$$

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

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

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. We apply a between-subjects design, i.e., each subject participates only in one treatment. A 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. In the beginning of the experiment, subjects are randomly allocated to groups of two, and the group composition remains constant across the 20 periods (partner matching). In each period, 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 prices in the domestic and foreign market, respectively, are determined by the market demand functions as given in equation (1), with $a = 74$ and $b = 1$. We impose a lower bound of zero to rule out negative prices.

Profits are calculated according to equation (2). For all treatments, we set $c = 2$, and there are no fixed costs ($F = F^* = 0$). The treatments vary only in g . In HighTC, we set $g = 0.2$, such that the marginal cost in the export market is equal to 10 (trade cost of 8); in LowTC, we set $g = 0.5$, resulting in marginal cost of 4 in the export market (trade cost of 2). In NoTC, we set $g = 1$, such that the marginal cost is the same in the home and export market (zero trade cost). For

$a = 74$ and $c = 2$, we have $g > \frac{2c}{a+c} = \frac{1}{19}$, i.e., the condition discussed in equation (3) is satisfied in all treatments.

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.¹¹

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 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 common knowledge.

We also consider a fourth treatment, NoTCEnd, to check the influence 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 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 online appendix A.2). Similar to other studies on experimental Cournot games, we used an economic framing (see,

¹¹These are the equilibria calculated with the expressions derived above. In the main article, we will contrast the experimental results to these numbers. For two reasons, the experimental game has many other Nash equilibria in pure strategies in the neighborhood of these quantities. First, subjects choose the quantities from a finite grid, and second, we round the profits to integer numbers. In online appendix A.1, we describe the additional equilibria and show that our main results hold also if we consider all Nash equilibria in pure strategies.

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 questions 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.¹²

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.¹³ 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 results and then discuss whether the home bias is caused by trade costs and whether tacit collusion plays a role.

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 the groups of two subjects). Horizontal lines indicate the quantities predicted by the Nash equilibrium.

¹²For the control questions, we follow the design of Roux and Thöni (2015b) and let subjects calculate their profit for a randomly generated combination of x and y . In accordance with their results, we also do not find evidence for a significant influence of the control questions on quantity choices.

¹³For all but one treatment, we conducted one session with 36 participants. For NoTCEnd,

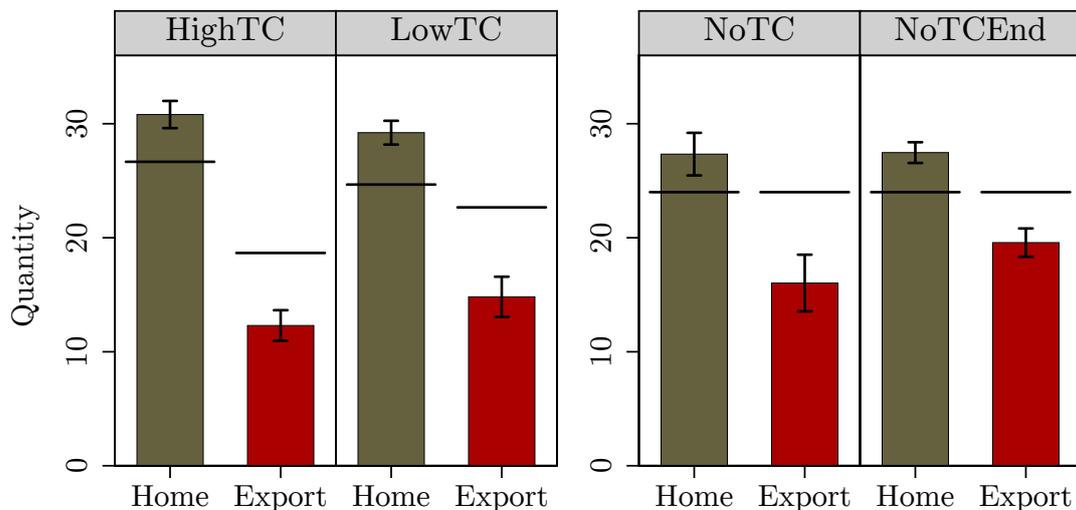


Figure 1: Average quantity in home and export markets for HighTC and LowTC (left panel) and the two treatments without trade costs (right panel). Spikes indicate standard errors, clustered on groups. Horizontal lines indicate Nash-equilibrium quantities.

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 being highly significant. Consequently, there is less trade than 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.¹⁴ 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

the first session had only 16 subjects, so we conducted a second session with 36 subjects.

¹⁴All tests are based on independent group averages. We test the null hypothesis that mean quantities are equal to the predicted quantities. We report two-sided p -values throughout the text. Non-parametric tests (Wilcoxon signed-ranks test) result in similar p -values: For all treatments in Table 1, differences are significant at $p < .01$, except for total quantity.

Table 1: Average quantities in the home and export market

	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

Notes. Average quantities as observed (*obs*), and predicted by the Nash equilibrium (*ne*), *p* indicates two-sided *p*-values of one-sample t-tests comparing the observed and predicted.

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 home bias is of 8 (26.7 – 18.7) units in HighTC and of 2 (24.7 – 22.7) units in LowTC. For the part of the home bias not accounted for by the prediction we will use the term *residual home bias*, i.e., in HighTC, we subtract the predicted home bias (8) from the observed home bias (18.5) to get a residual home bias of 10.5. We observe a residual home bias 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

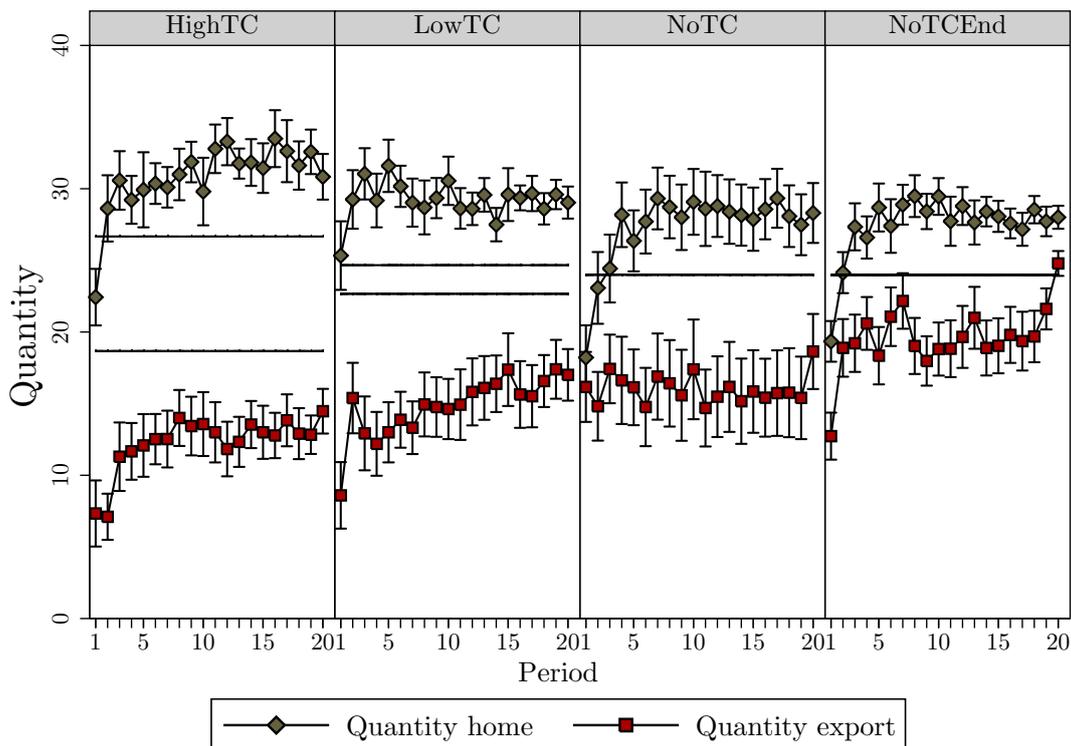


Figure 2: Average quantities in home and export market across the 20 periods. Horizontal lines indicate Nash-equilibrium quantities. Spikes indicate standard errors, clustered on groups.

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.¹⁵

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

¹⁵For example, calculating the same tests as reported in Table 1 using only the average quantities of the last five periods of HighTC or LowTC results in $p < .005$ in all cases (Wilcoxon signed ranks tests: $p < .007$).

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.¹⁶ 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.

In NoTCEnd, the two markets do not have a color and are just 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 two panels on the right of Figure 2 show the home and export quantities over time for the additional treatments. Like in the left panels, there is no indication for a convergence towards the Nash equilibrium in NoTC and NoTCEnd.

Considering all four treatments in Figure 1, we see that the difference between the home and export quantities gradually increases across the four treatments. We use a one-way analysis of variance to test the null hypothesis that the home bias is the same across all four treatments. We find that the home bias is significantly different across treatment ($p = .030$, two-sided), whereas the residual home bias,

¹⁶This result is in line with the empirical findings by Wolf (2000) indicating a home bias on the subnational level in the U.S. even in the absence of any kind of trade barriers.

that is, the part of the difference in quantities not accounted for by the Nash equilibrium, is fairly stable ($p = .614$).¹⁷

4.3 Tacit Collusion and the Home Bias

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 tacitly collude on the joint-profit maximizing outcome.¹⁸ 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 which results in monopoly quantities in both markets 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.

A first indication for collusion stems from the fact that total quantities are lower than predicted. As shown in Table 1, this holds for all four treatments, although significant only in LowTC and NoTC. We can compare the strength of collusion in our experiment with the literature on Cournot duopolies. Huck et al. (2004) report a ratio of the observed quantity to the Nash equilibrium quantity of 0.89 for symmetric duopolies. The closest comparison are the duopoly results in Roux and Thöni (2015a), who—using the same demand function and marginal cost as in the present paper—find a ratio of 0.95. For NoTC, we observe a ratio close to the first study (0.90), while in NoTCEnd, total quantity is much closer to the Nash equilibrium (0.98). In duopolies with asymmetric costs, the literature finds less collusion (Mason et al., 1992; Fonseca et al., 2005). The latter study finds a ratio of 0.99. We find that the ratio of observed to predicted quantity increases in the cost asymmetry with 0.93 for LowTC and 0.95 for HighTC.

But even if the overall quantities are not substantially below Nash quantities, collusive attempts might well be a main driver of the home bias. One way to

¹⁷As a non-parametric alternative, we use Kruskal-Wallis tests. The results are very similar with $p = .011$ for the home bias and $p = .450$ for the residual home bias.

¹⁸Observing collusion in finitely repeated prisoner’s dilemmas and Cournot duopolies is quite common, see, for example, Andreoni and Miller (1993); Huck et al. (2004); Dal Bó (2005); Normann and Wallace (2012).

identify attempts to tacitly collude is by looking at a firm's decision not to enter the competitor's market, and thus forgo short run profits on that market.¹⁹ In 28.1 percent of all quantity periods, firms do not sell in the competitor's market. In 15.8 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 (28.9 percent) than in the treatments with trade costs (9.7 in HighTC and 13.3 percent LowTC). A test over all treatments is not significant. However, if we pool the observations from the two treatments with trade costs and compare them to NoTC then the difference is significant ($p = .044$, two sided t-test). This is somewhat puzzling, given that autarky is the unique joint-profit maximizing solution with trade costs, but not without trade costs. On the other hand, in NoTCEnd we observe autarky in 12.7 percent of the cases, which is very close to the frequency of the treatments with trade costs. It would be interesting to see whether this strong differences in the frequency of autarky are replicable.

Apart from autarky, we also consider a more general measure to identify collusive quantity choices. We use the rival's 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.²⁰ 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 in all treatments. Apparently, firms maximize their short run profits in the home market. In 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

¹⁹In 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).

²⁰These are not best-reply functions of the repeated game, but of the stage game only. Given that best-responses are a function of the competitor's quantities, beliefs play an important role. We did not elicit beliefs, and, therefore, we cannot investigate in the data whether deviations are due to false beliefs or collusion. However, given the persistence over time it seems highly unlikely that systematic belief errors cause the deviations in Figure 3.

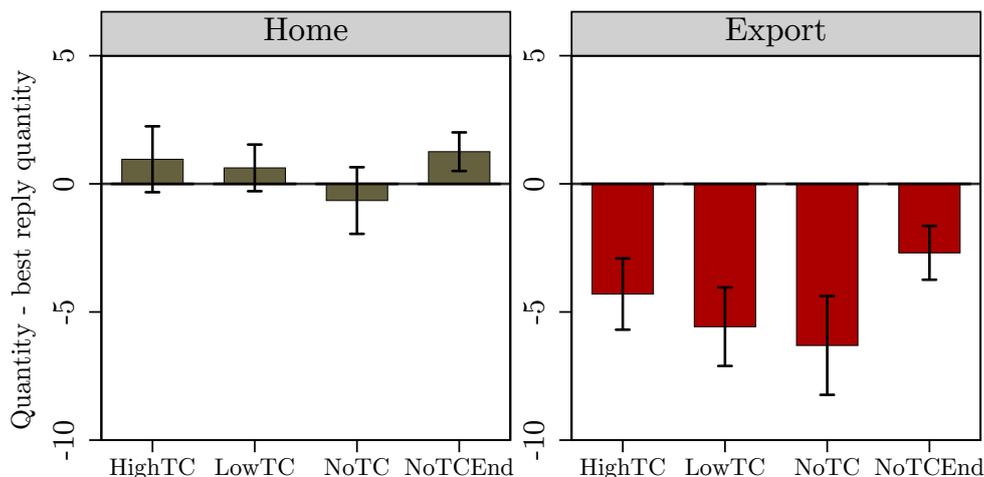


Figure 3: Difference between observed and best-reply quantities for the home and export market and the four treatments. Spikes indicate standard errors, clustered on groups.

market quantity of its rival. We use one-sample t-tests to test whether the observed quantities systematically differ from the best-reply quantities. The null hypothesis is that the difference between observed quantities and best-reply quantities is zero (two sided tests, based on independent group averages). In all treatments, the difference between observed quantities and best reply is insignificant for the home market ($p \geq .108$), while all tests are significant for the export market ($p \leq .017$).²¹ This is a clear indication that, on average, firms offer collusive quantities in the export market.²²

If collusive strategies produce a home bias, then we should observe a close relationship between the profits earned by the two firms and the residual home bias. We perform a median split according to the joint profit to divide the outcomes in collusive and non-collusive market periods. Table 2 shows the results. In all treatments, the residual home bias is substantially larger in collusive situations than in non-collusive situations. However, it is also clear that even in the non-

²¹Wilcoxon signed-ranks tests result in $p \geq .124$ for the home market and $p \leq .041$ for the export market.

²²Observing only one of the two firms playing best-response is akin to Stackelberg games. If we assumed that firms play Stackelberg leader quantities in the home market and follower quantities in export market, then we would observe quantities above best-response in the home market, and at best-response in the export market. However, the results in Figure 3 suggest the opposite.

Table 2: Home bias and collusion

Treatment	Residual home bias	
	Non-collusive	Collusive
HighTC	5.7	15.5
LowTC	8.3	16.4
NoTC	7.5	15.1
NoTCEnd	4.7	11.1

Notes. Residual home bias is the difference between the observed and the predicted home bias. To divide the observations into collusive and non-collusive we perform a median split according to joint profits for each treatment.

collusive outcomes a substantial residual home bias remains.²³ Consequently, while tacit collusion is an important driver of the home bias, it does not offer a full explanation for the phenomenon.

In a final step, we use OLS estimates to explain the residual home bias. In Model (1) in Table 3, 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 due to 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 confirm the observation from Table 2 that 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

²³Even for non-collusive outcomes, the residual home bias is significantly larger than predicted in all four treatments, $p < .004$ ($p < .002$ for non-parametric tests).

Table 3: 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)
<i>F</i> -test	0.8	3.3	2.5	4.4
Prob > <i>F</i>	0.501	0.010	0.020	0.000
<i>R</i> ²	0.012	0.014	0.014	0.061
<i>N</i>	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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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 successfully colluding groups tend to have a strong residual home bias in their quantity choices.²⁴

²⁴Instead 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

5 Conclusion

In this paper, we report results from an experiment based on Brander (1981) to analyze the role of trade costs for the home bias in trade. We vary the level of trade costs to study their impact on the occurrence and size of the home bias. In our experiment, subjects choose quantities supplied on their home and export market, while demand is exogenous and indiscriminate towards domestic and foreign producers. Thus, our experimental design rules out demand side explanations for the home bias. The controlled laboratory setting also allows us to eliminate alternative explanations such as trade barriers, sunk costs of entering foreign markets, or transaction costs. We have five main results. First, we find qualitative support for the theory: there is two-way trade in identical products and each firm has a majority market share in its domestic market. Second, we find a larger home bias than predicted by theory. Third, we find that a home bias exists even in the absence of trade costs. Fourth, we find evidence that tacit collusive outcomes contribute to the home bias. The latter result provides support for an alternative explanation for the home bias: collusive division of geographic markets. Fifth, tacit collusion does not offer a full explanation for the phenomenon since we observe a home bias even in the absence of collusive outcomes.

In our experiment, we modelled a situation where entering the foreign market is particularly easy, because there are neither fixed costs nor sunk costs of exporting. In reality, exporting firms typically face such costs when entering new markets (see, for example, Melitz (2003)). An interesting extension of our setup would be to include these type of costs and investigate their effect on the home bias. Our experimental approach could also be used to study dynamic changes in the environment, such as the introduction or elimination of trade barriers. Historically, many countries moved from fairly closed markets to open ones. In the experiment, this could be modelled with an initial number of rounds with closed markets, where players would learn to play the monopoly output. Then, one could study the adjustment processes that follow trade liberalization and investigate whether there are persistent effects on the home bias.

The economic implications and the welfare consequences of the home bias depend on its origin. In particular, if it is consumer preferences or transport costs

a strong home bias can only be profitable if both firms in the group adhere to this strategy.

that generates it, there is no reason for governmental intervention. If, however, the source of the bias is collusion, an intervention may be welfare enhancing and thus be warranted. Our findings suggest that the home bias may be a sign of a collusive market sharing agreement such as the home-market principle, especially if trade costs are very low.

References

- Aker, J. C., M. W. Klein, S. A. O’Connell, and M. Yang (2014). Borders, ethnicity and trade. *Journal of Development Economics* 107(C), 1–16.
- Anderson, J. E. and D. Marcouiller (2002). Insecurity and the pattern of trade: an empirical investigation. *Review of Economics and Statistics* 84(2), 342–352.
- Anderson, J. E. and E. van Wincoop (2003). Gravity with gravitas: a solution to the border puzzle. *American Economic Review* 93(1), 170–192.
- Anderson, J. E. and E. van Wincoop (2004). Trade costs. *Journal of Economic Literature* 42(3), 691–751.
- Anderson, M. A. and S. L. Smith (1999). Do national borders really matter? Canada–US regional trade revisited. *Review of International Economics* 7(2), 219–227.
- Andreoni, J. and J. H. Miller (1993). Rational cooperation in the finitely repeated prisoner’s dilemma: experimental evidence. *Economic Journal* 103(418), 570–585.
- Baake, P. and H.-T. Normann (2002). Collusive intra-industry trade in identical commodities. *Weltwirtschaftliches Archiv* 138(3), 482–492.
- Bernheim, B. D. and M. D. Whinston (1990). Multimarket contact and collusive behavior. *RAND Journal of Economics* 21(1), 1–26.
- Bock, O., I. Baetge, and A. Nicklisch (2014). hroot: Hamburg registration and organization online tool. *European Economic Review* 71, 117–120.
- Bond, E. W. and C. Syropoulos (2008). Trade costs and multimarket collusion. *RAND Journal of Economics* 39(4), 1080–1104.
- Brander, J. and P. Krugman (1983). A ‘reciprocal dumping’ model of international trade. *Journal of International Economics* 15(3/4), 313–321.
- Brander, J. A. (1981). Intra-industry trade in identical commodities. *Journal of International Economics* 11(1), 1–14.
- Brühlhart, M. and F. Trionfetti (2009). A test of trade theories when expenditure is home biased. *European Economic Review* 53(7), 830–845.

- Byford, M. C. and J. S. Gans (2014). Collusion at the extensive margin. *International Journal of Industrial Organization* 37, 75–83.
- Colonescu, C. and N. Schmitt (2003). Market segmentation, market integration, and tacit collusion. *Review of International Economics* 11(1), 175–192.
- Combes, P.-P., M. Lafourcade, and T. Mayer (2005). The trade-creating effects of business and social networks: evidence from France. *Journal of International Economics* 66(1), 1–29.
- Dal Bó, P. (2005). Cooperation under the shadow of the future: experimental evidence from infinitely repeated games. *American Economic Review* 95(5), 1591–1604.
- Davidson, C. (1984). Cartel stability and tariff policy. *Journal of International Economics* 17(3-4), 219–237.
- Duffy, J. (2014). Macroeconomics: a survey of laboratory research. *Handbook of experimental economics* 2, 1 – 97.
- Engel, C. (2007). How much collusion? A meta-analysis of oligopoly experiments. *Journal of Competition Law and Economics* 3(4), 491–549.
- Engel, C. and J. H. Rogers (1996). How wide is the border? *American Economic Review* 86(5), 1112–1125.
- Engelmann, D. and H.-T. Normann (2007). An experimental test of strategic trade policy. *Journal of Economic Behavior & Organization* 64(1), 144–156.
- Evans, C. L. (2003). The economic significance of national border effects. *American Economic Review* 93(4), 1291–1312.
- Fischbacher, U. (2007). z-Tree - Zurich toolbox for readymade economic experiments. *Experimental Economics* 10(2), 171–178.
- Fonseca, M. A., S. Huck, and H. T. Normann (2005). Playing Cournot although they shouldn't: endogenous timing in experimental duopolies with asymmetric cost. *Economic Theory* 25(3), 669–677.
- Fung, K. C. (1992). Economic integration as competitive discipline. *International Economic Review* 33(4), 837–847.
- Gorodnichenko, Y. and L. L. Tesar (2009). Border effect or country effect? Seattle may not be so far from Vancouver after all. *American Economic Journal: Macroeconomics* 1(1), 219–241.
- Haan, M. A., L. Schoonbeek, and B. M. Winkel (2009). Experimental results on collusion. In J. Hinlopen and H.-T. Normann (Eds.), *Experiments and Competition Policy*, pp. 9–33. Cambridge: Cambridge University Press.
- Harrington, J. E. (2006). How do cartels operate? *Foundations and Trends in Microe-*

- economics* 2(1), 1–105.
- Hillberry, R. and D. Hummels (2008). Trade responses to geographic frictions: a decomposition using micro-data. *European Economic Review* 52(3), 527–550.
- Holt, C. (1985). An experimental test of the consistent conjectures hypothesis. *American Economic Review* 75(3), 314–325.
- Huck, S., H.-T. Normann, and J. Oechssler (2004). Two are few and four are many: number effects in experimental oligopolies. *Journal of Economic Behavior & Organization* 53(4), 435–446.
- Johnson, P. (2010). An international economics classroom experiment. *Southern Economic Journal* 77(2), 501–513.
- Krishna, K. (1989). Trade restrictions as facilitating practices. *Journal of International Economics* 26(3-4), 251–270.
- Lommerud, K. E. and L. Sørgaard (2001). Trade liberalization and cartel stability. *Review of International Economics* 9(2), 343–355.
- Mason, C. F., O. R. Phillips, and C. Nowell (1992). Duopoly behavior in asymmetric markets: an experimental evaluation. *Review of Economics and Statistics* 74(4), 662–670.
- McCallum, J. (1995). National borders matter: Canada–U.S. regional trade patterns. *American Economic Review* 85(3), 615–623.
- Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica* 71(6), 1695–1725.
- Normann, H. T. and B. Wallace (2012). The impact of the termination rule on cooperation in a prisoner’s dilemma experiment. *International Journal of Game Theory* 41, 707–718.
- Noussair, C. N., C. R. Plott, and R. G. Riezman (1995). An experimental investigation of the patterns of international trade. *American Economic Review* 85(3), 462–491.
- Noussair, C. N., C. R. Plott, and R. G. Riezman (2007). Production, trade, prices, exchange rates and equilibration in large experimental economies. *European Economic Review* 51(1), 49–76.
- Obstfeld, M. and K. Rogoff (2001). The six major puzzles in international macroeconomics: is there a common cause? In B. S. Bernanke and K. Rogoff (Eds.), *NBER Macroeconomics Annual 2000*, pp. 339–389. Cambridge, MA: MIT Press.
- Parsley, D. C. and S.-J. Wei (2001). Explaining the border effect: the role of exchange rate variability, shipping costs, and geography. *Journal of International Economics* 55(1), 87–105.

- Pinto, B. R. (1986). Repeated games and the reciprocal dumping model of trade. *Journal of International Economics* 20(3-4), 357–366.
- Rauch, J. E. (2001). Business and social networks in international trade. *Journal of Economic Literature* 39(4), 1177–1203.
- Röller, L.-H. and F. Steen (2006). On the workings of a cartel: evidence from the Norwegian cement industry. *American Economic Review* 96(1), 321–338.
- Rotemberg, J. J. and G. Saloner (1989). Tariffs vs quotas with implicit collusion. *Canadian Journal of Economics* 22(2), 237–244.
- Roux, C. and C. Thöni (2015a). Collusion among many firms: the disciplinary power of targeted punishment. *Journal of Economic Behavior & Organization* 116, 83–93.
- Roux, C. and C. Thöni (2015b). Do control questions influence behavior in experiments? *Experimental Economics* 18(2), 185–194.
- Salvo, A. (2010). Trade flows in a spatial oligopoly: gravity fits well, but what does it explain? *Canadian Journal of Economics* 43(1), 63–96.
- Strand, N. (2002). Tacit collusion in the EU sugar markets. Mimeo, Swedish Competition Authority.
- Trefler, D. (1995). The case of the missing trade and other mysteries. *American Economic Review* 85(5), 1029–1046.
- Wolf, H. (2000). International home bias in trade. *Review of Economics and Statistics* 82(4), 555–563.
- Yi, K.-M. (2010). Can multistage production explain home bias in trade? *American Economic Review* 100(1), 364–393.

A Appendix (to be made available online)

A.1 Multiple Equilibria

Due to the discrete strategy space and rounding of the payoffs to integers, the equilibria mentioned in the main text are not unique. Figure A1 shows the best response correspondences of the two firms for the three levels of trade costs. The black dots in the intersection indicate Nash equilibria.

For HighTC, the predictions for the home market range from 25.0 to 28.2, and from 17.0 to 20.3 for the export market. In LowTC, the corresponding ranges are 23.1 to 26.3 for home and 21 to 24.2 for export. Finally, for the two treatments without trade costs, the range is from 22.6 to 25.4 for both markets.

In the main article, we tested whether the observed behavior is significantly different from the equilibrium closest to the equilibrium of the game with a continuous strategy space. In the following, we reproduce the analysis displayed in Table 1 to show that most of the significant differences remain if we use the Nash equilibrium most favorable to a strong home bias, i.e., we use the Nash equilibrium with the highest home quantity and the lowest export quantity. The results are reported in Table A1. In all but one case, the home (export) quantities are significantly higher (lower) than predicted (at five percent). The exception is the home quantity in NoTC. Furthermore, in all four treatments, the observed home bias is significantly larger than the highest home bias which constitutes a Nash equilibrium.

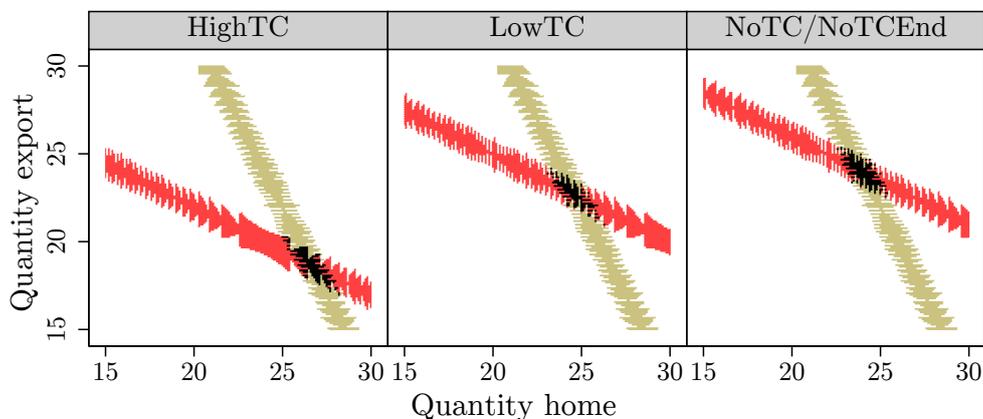


Figure A1: Best response correspondences for the home firm (steeper curve) and the export firm (flatter curve). Black dots indicate Nash equilibria.

Table A1: Average quantities in the home and export market

	HighTC			LowTC		
	<i>obs</i>	<i>ne</i>	<i>p</i>	<i>obs</i>	<i>ne</i>	<i>p</i>
Quantity home	30.8	28.2	.043	29.2	26.3	.012
Quantity export	12.3	17.0	.003	14.8	21.0	.003
Total quantity	43.1	45.3	.201	44.0	47.3	.037
Home bias	18.5	11.2	.001	14.4	5.3	.002
Residual home bias	7.3	0.0	.001	9.1	0.0	.002
	NoTC			NoTCEnd		
	<i>obs</i>	<i>ne</i>	<i>p</i>	<i>obs</i>	<i>ne</i>	<i>p</i>
Quantity home	27.3	25.4	.314	27.5	25.4	.032
Quantity export	16.0	22.6	.017	19.6	22.6	.022
Total quantity	43.4	48.0	.016	47.0	48.0	.365
Home bias	11.3	2.8	.051	7.9	2.8	.013
Residual home bias	8.5	0.0	.051	5.1	0.0	.013

Notes. Average quantities as observed (*obs*), and predicted by the Nash equilibrium (*ne*), *p* indicates the *p*-values of one-sample t-tests comparing the observed and predicted.

A.2 Instructions

[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 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

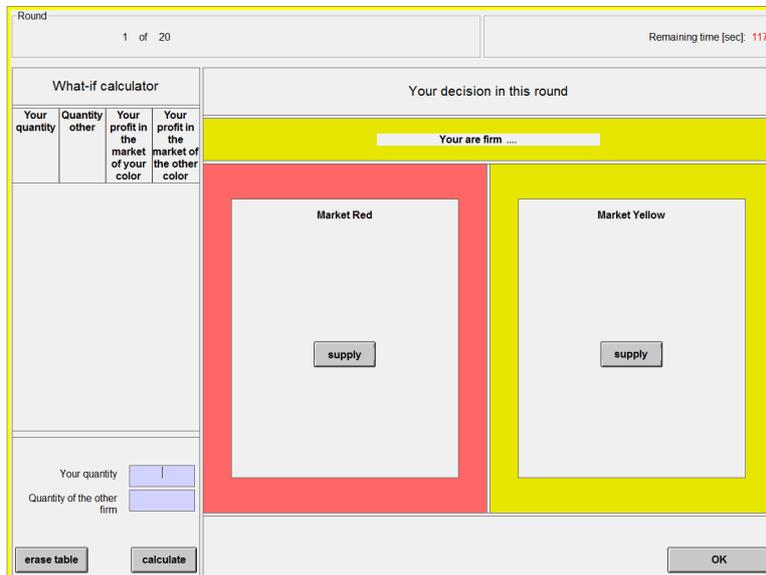
At the beginning of each round, each manager has to decide which of the markets to serve and how many units of the good to supply. In each of the two markets, the firms face the same market demand which is

$$P = 74 - Q.$$

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:



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 make your output decision.

You can use the “What-if-calculator” to determine your per-market profits from different combinations of your quantity and the quantity of the other firm. 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 quantities, you must click on the OK-button. You can then no longer revise your decisions for that round.

After both firms have made their decisions, 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 Quantity 70 60 50 40 30 20 10 0 _____ Your profit 0		Market Yellow Quantity 70 60 50 40 30 20 10 0 _____ Your profit 0	
				Your profit in the previous round			
				Your decision in this round			
				You are firm			
Your quantity <input type="text"/> Quantity of the other firm <input type="text"/> <input type="button" value="erase table"/> <input type="button" value="calculate"/>				Market Red <input type="button" value="supply"/>		Market Yellow <input type="button" value="supply"/>	
				<input type="button" value="OK"/>			

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?