

Birg, Laura

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Parallel imports under a manufacturer rebate and a price freeze: Evidence from Germany

Laura Birg 

Ruhr-University Bochum, Bochum,
Germany

Correspondence

Laura Birg, Ruhr-University Bochum,
Bochum, Germany.

Email: laura.birg@ruhr-uni-bochum.de

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Abstract

I study the effect of a change in the mandatory manufacturer rebate and a price freeze on wholesale prices for pharmaceuticals on competition by parallel imports. First, I analyze the effect of a manufacturer rebate on competition by parallel imports in a two-country model. Second, I exploit a policy reform in Germany in 2010 that increased the manufacturer rebate by 10 percentage points. Using a data set with prescription drugs with competition from parallel imports, I estimate the effect of the change in the manufacturer rebate on competition by parallel imports. The model predicts that an increase in the manufacturer rebate increases the market share of parallel imports. The rebate decreases the manufacturer's revenues from domestic distribution. In response, the manufacturer lowers the wholesale price for a foreign distributor, resulting in a competitive advantage for and an increase in the market share of parallel imports. The estimation shows that the increase in the manufacturer rebate by 10 percentage points has increased the market share of parallel imports by approximately 18%–35% and has increased the number of importers by up to 17%.

KEYWORDS

manufacturer rebate, parallel imports, pharmaceuticals, regulation

JEL CLASSIFICATION

F12, I11, I18

1 | INTRODUCTION

I study the effect of a change in the mandatory manufacturer rebate on competition by parallel imports in the German pharmaceutical market. First, I analyze the effect of a mandatory manufacturer rebate and a price freeze on competition by parallel imports in a two-country model with a vertical control structure following Ganslandt and Maskus (2007) and Birg (2017). A pharmaceutical manufacturer sells a drug in two countries through independent intermediaries. Parallel trade occurs as the intermediary in the foreign country may resell the drug in the manufacturer's home country. The government in the home country requires the pharmaceutical manufacturers and wholesalers to provide a mandatory rebate for prescription drugs to the third party-payer, the statutory health insurance. I find that an increase in the manufacturer rebate increases the market share of parallel imports. Second, I exploit a policy reform in Germany in 2010 that increased the mandatory manufacturer rebate by 10 percentage points, complemented by a price freeze. Using a data set with prescription drugs with competition from parallel imports (INSIGHT HEALTH GmbH, 2016), I estimate the effect of the change in the manufacturer rebate on competition by

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parallel imports. Estimation results suggest that an increase in the manufacturer rebate by 10 percentage points has increased the market share of parallel imports by approximately 18%–35% and has increased the number of importers by up to 17%.

In many states, governments try to curb the high level of expenditure for pharmaceuticals. In principle, there are two strategies available to governments to reduce third party-payer expenditure: Stronger competition or stricter regulation.

After patent expiration, brand-name drugs compete with generics, but even before, on-patent drugs may be exposed to competition from parallel imports. Parallel imports are drugs that are imported from another country without the authorization of the manufacturer (Maskus, 2000). Wholesalers or parallel traders may resell goods that were placed on the market in one country in another country (Maskus, 2000). Pharmaceutical regulation may either target monopolistic pricing behavior on the supply side through price caps or aim at increasing price sensitivity on the demand side through reimbursement limits. There may be a conflict between the two strategies, when stricter regulation, for example, reduces profits and thus limits the incentives for market entry.

I analyze this potential conflict by studying the effect of a mandatory manufacturer rebate on competition from parallel imports in Germany. Germany applies a mandatory manufacturer rebate on wholesale prices for pharmaceuticals. This is, pharmaceutical manufacturers and wholesalers must provide a mandatory rebate for prescription drugs to the third party-payer, the statutory health insurance. In 2010, a policy reform increased the mandatory manufacturer rebate by 10 percentage points from 6% to 16%. This change in the manufacturer rebate was expected to affect the retail-wholesale margin and thus affect competition between locally sourced drugs and parallel imports. In the European Economic Area, parallel trade is legal and a common phenomenon. The volume of pharmaceutical parallel trade in the EU was 5.2 bn. Euro in 2018 (EFPIA, 2020). Parallel trade is profitable if price differences between countries are sufficiently high to cover the cost of parallel trading, for example, distribution cost, license cost, repackaging cost, etc. For pharmaceuticals, price differences in the European Union may reach up to 100%–300% (Kanavos & Costa-Font, 2005). Main reasons for price differences are manufacturers' price discrimination, vertical control structures and/or differences in pharmaceutical regulation. Pharmaceutical manufacturers regularly price discriminate between countries based on differences in income, insurance coverage, etc (Danzon & Chao, 2000; Danzon & Furukawa, 2003).

Pharmaceutical markets are characterized by numerous government interventions. In the European Union, health policy, including pharmaceutical regulation, is within the national competence of EU member states (Art. 168 TFEU) and accordingly, regulatory instruments and the strictness of regulation differ across countries (see e.g., Espin & Rovira, 2007 or Carone et al., 2012 for an overview). Typically, pharmaceutical manufacturers do not sell directly but through independent wholesalers (Taylor et al., 2004). Consequently, parallel trade in pharmaceuticals is a common phenomenon in the European Union.¹

Competition by parallel imports in destination countries is affected by pharmaceutical regulation through three channels. First, regulatory differences between countries drive drug price differences. This is, regulatory differences determine the volume and direction of parallel imports. Second, pharmaceutical regulation in destination countries may change copayments and accordingly the choice between locally sourced versions and parallel imports. Higher copayments may make patients more sensitive to prices and price differences and therefore more likely to choose (less expensive) parallel imports. The design of the cost-sharing system, rules of copayment and reimbursement, seems to be an important factor in determining the competition by parallel imports (Birg, 2018; Enemark et al., 2006, Kanavos et al., 2004). Third, regulatory instruments in destination countries may also affect competition between locally sourced version and parallel imports. For instance, Brekke et al. (2015) show that stricter price caps may reduce competition from parallel imports. Also regulation in pharmaceutical supply chains or the regulation of wholesale prices may drive competition, as it affects the difference between retail and wholesale prices and thus the profitability of parallel trade. Compared to direct regulation of retail prices, regulation at the wholesale level in the context of parallel imports is different: First, the agents directly affected by regulation at the retail level, and regulation at the wholesale level are different and also their options to adapt their behavior might be different. Second, under regulation at the wholesale level, not all parts of the distribution chain are subject to the regulatory instrument. While regulation at the retail level applies to all domestic sales, wholesale regulation only affects domestic wholesale sales. Sales to foreign wholesalers (and their reimports) may not be subject to wholesale regulation. Almost all European countries regulate wholesale margins or pharmacy margins (Carone et al., 2012).

The literature on pharmaceutical regulation and parallel trade has mainly focused on the effect of parallel trade on regulatory choices at the retail level, suggesting that parallel trade may distort regulatory decisions (e.g., Bennato & Valletti, 2014; Grossman & Lai, 2008; Pecorino, 2002). Brekke et al. (2015) study the effect of pharmaceutical regulation on competition by parallel imports, showing that stricter regulation (lower price caps) reduces competition from parallel imports. Similarly, Birg (2019) suggests that lower reimbursement for drugs (lower reference prices) may reduce competition from parallel imports. The effect of wholesale level regulation, however, has received rather little attention in the literature. Costa-Font (2016) shows that parallel imports are not only driven by price differences but also by cross-country differences in distribution margins. He

concludes that parallel trade can be regarded as “regulatory arbitrage”. Birg (2017) studies externalities of different wholesale level regulation instruments which also affect the manufacturer's possibilities to limit competition from parallel trade. Brekke et al. (2013) show how product margins determine pharmacies' incentives to promote generic substitution, suggesting that generic and brand-name margins determine competition between brand-names and generics.

My estimation results suggest that, in Germany an increase in the manufacturer rebate by 10 percentage points has increased the market share of parallel imports by approximately 18%–35% and has increased the number of importers by up to 17%. As in many countries, wholesale prices and/or pharmacy margins are regulated, my results point beyond the case in Germany: Stricter wholesale price regulation may enhance competition from parallel imports. This implies that there is not necessarily a conflict between the two approaches to curbing third party-payer expenditure to pharmaceuticals, at least for regulation at the wholesale level.

The rest of the paper is organized as follows. In the next section, a model is presented that outlines the underlying incentive structure of manufacturer rebates for manufacturers and wholesalers. Section 3 describes the institutional background. Section 4 presents the data set and Section 5 studies the effect of a change in manufacturer rebates on competition by parallel imports. Section 6 concludes.

2 | MODEL

Consider the pharmaceutical market for an on-patent drug b . A pharmaceutical manufacturer M sells the drug in two countries $j, j = D, S$, with D for destination, S for source country. In both countries, the manufacturer does not sell directly but through independent intermediaries I_j .² The manufacturer charges each intermediary a wholesale price w_j per unit and a fixed fee ϕ_j . Two-part tariffs between pharmaceutical manufacturers and wholesalers are well established in the literature (see, e.g., Chen & Maskus, 2005; Maskus & Chen, 2004). In addition, they may play an important role in the contract negotiations between pharmaceutical manufacturers and wholesalers (e.g., in the form of volume discounts) (Vogler & Martikainen, 2015).

The intermediary I_D sells the authorized version b in country D ; the intermediary I_S sells the authorized version b in country S and, in addition, may resell the drug b in D as a parallel import (hereafter denoted by β). This implies that S is the source country and D is the destination country of the parallel import.

The locally sourced version of the drug b and the parallel import β are de facto identical but differ in sourcing. Differences in appearance and packaging between the locally sourced version of the drug and the parallel import (Maskus, 2000) may induce consumers to associate a lower quality with the parallel import. This perception is captured by a discount factor τ in consumer valuation.³

Consumers in both countries are heterogeneous with respect to the gross valuation of the drug θ which is uniformly distributed on the interval $[0,1]$. Consumer heterogeneity can be interpreted as differences in income, the severity of the condition or prescription practices (see e.g., Brekke et al., 2011). The total mass of consumers is given by one in both countries.

In both countries, consumers pay a fraction γ_j , with $\gamma_j \in (0, 1)$, of the drug price (coinsurance). This is, the drug copayment is $c_{ij} = \gamma_j p_{i,j}$ and third-party payer reimbursement is $r_{ij} = (1 - \gamma_j) p_{i,j}$.

Each consumer demands either one or zero units of the most preferred drug. The utility derived from no drug consumption is zero, while consumer k with valuation θ_k who buys one unit of drug i obtains a net utility of

$$U(\theta_{k,j}, \tau, c_{i,j}) = \begin{cases} \theta_k - \gamma_j p_{i,j} & \text{if } i = b \\ \theta_k(1 - \tau) - \gamma_j p_{i,j} & \text{if } i = \beta. \end{cases} \quad (1)$$

In country D , the marginal consumer indifferent between buying the locally sourced version b and the parallel import β has a gross valuation $\theta_D^{b,\beta} = \frac{\gamma_D(p_{b,D} - p_{\beta,D})}{\tau}$; the marginal consumer indifferent between the parallel import β and not buying (0) has a gross valuation $\theta_D^{\beta,0} = \frac{\gamma_D p_{\beta,D}}{1 - \tau}$. Demand for the locally sourced version b and for the parallel import β is given by $q_{b,D} = 1 - \theta_D^{b,\beta}$ and $q_{\beta,D} = \theta_D^{b,\beta} - \theta_D^{\beta,0}$. In country S , the marginal consumer indifferent between buying the locally sourced version b and not buying (0) has a gross valuation $\theta_S^{b,0} = \gamma_S p_{b,S}$. Demand for the drug b is given by $q_{b,S} = 1 - \theta_S^{b,0}$.

Assume that the coinsurance rate in the source country is sufficiently low to guarantee non-negative quantities:

$$\gamma_S < \frac{4\gamma_D}{(1 - 3\tau)(1 - \tau)}. \quad (2)$$

The firm produces at constant marginal cost, which is normalized to zero. Profits are

$$\pi_M = w_D q_{b,D} + w_S q_{\beta,D} + w_S q_{b,S} + \phi_D + \phi_S, \quad (3)$$

$$\pi_{I_D} = (p_{b,D} - w_D) q_{b,D} - \phi_D, \quad (4)$$

$$\pi_{I_S} = (p_{\beta,D} - w_S) q_{\beta,D} + (p_{b,S} - w_S) q_{b,S} - \phi_S. \quad (5)$$

Consider a two-stage game after the potential introduction of a manufacturer rebate by the regulator in D : In the first stage, the manufacturer M charges each intermediary a wholesale price w_j per unit and a fixed fee ϕ_j . In the second stage, intermediaries I_D and I_S set prices. The game is solved by backward induction.

2.1 | Benchmark case

Consider a system with coinsurance as a benchmark.

In the second stage, intermediaries compete in prices. In country D , intermediaries I_D and I_S maximize (4) and (5) with respect to $p_{b,D}$ and $p_{\beta,D}$. The profit-maximizing prices are

$$\begin{aligned} p_{b,D} &= \frac{2\tau + \gamma_D(w_S + 2w_D)}{\gamma_D(3 + \tau)}, \\ p_{\beta,D} &= \frac{\tau(1 - \tau) + \gamma_D(2w_S + w_D(1 - \tau))}{\gamma_D(3 + \tau)}. \end{aligned} \quad (6)$$

In country S , the intermediary I_S maximizes (5) with respect to $p_{b,S}$. The profit-maximizing price is

$$p_{b,S} = \frac{1 + \gamma_S w_S}{2\gamma_S}. \quad (7)$$

In the first stage, the manufacturer sets ϕ_D and ϕ_S (see Appendix A.1).

He maximizes (3) with respect to w_D and w_S . Equilibrium wholesale prices are

$$w_D = \frac{2(1 - \tau)(\gamma_D + \tau\gamma_S(1 - \tau))}{\gamma_D\Omega} \quad (8)$$

$$w_S = \frac{2(1 - \tau)}{\Omega}, \quad (9)$$

with $\Omega = 4\gamma_D + \gamma_S(3\tau + 1)(1 - \tau)$.

Equilibrium prices and quantities are

$$\begin{aligned} p_{b,D} &= \frac{2(\gamma_D + \tau\gamma_S(1 - \tau))}{\gamma_D\Omega}, \\ p_{\beta,D} &= \frac{(1 - \tau)(2\gamma_D + \tau\gamma_S(1 - \tau))}{\gamma_D\Omega}, \\ p_{b,S} &= \frac{4\gamma_D + 3\gamma_S(1 - \tau^2)}{2\gamma_S\Omega} \end{aligned} \quad (10)$$

and

$$\begin{aligned} q_{b,D} &= \frac{2(\gamma_D + \tau\gamma_S(1 - \tau))}{\Omega}, \\ q_{\beta,D} &= \frac{\gamma_S(1 - \tau)}{\Omega}, \\ q_{b,S} &= \frac{4\gamma_D - \gamma_S(1 - 3\tau)(1 - \tau)}{2\Omega}. \end{aligned} \quad (11)$$

The market share of the parallel import is

$$\chi = \frac{q_{D,\beta}}{q_{D,\beta} + q_{D,b}} = \frac{(1-\tau)\gamma_S}{2\gamma_D + \gamma_S(2\tau+1)(1-\tau)}. \quad (12)$$

2.2 | Manufacturer rebate and price freeze

Consider now that the government in country D applies a manufacturer rebate ξ , with $\xi \in (0, 1)$. Both intermediaries are subject to the rebate with their sales in country D .

Assume that the rebate is sufficiently low to guarantee non-negative quantities and prices:

$$\xi \leq \frac{1}{\Omega\gamma_D} \left(\sqrt{(\gamma_D + \tau\gamma_S(1-\tau))(\gamma_S^2(1-\tau)^2(\gamma_D + \tau\gamma_S(1-\tau)) + \Omega\gamma_D(3\gamma_S(1-\tau^2) + 4\gamma_D))} - \gamma_S(\gamma_D(1-\tau) - 2\tau^2\gamma_S) - \tau\gamma_S^2(\tau^2 + 1) \right). \quad (13)$$

To prevent strategic price increases, the manufacturer rebate is combined with a price freeze in country D : $p_D^\xi = p_D$. The price for the parallel import is not regulated.

From the perspective of the intermediaries, the rebate is similar to a tax; it increases the wholesale price to be paid. Due to the price freeze, the domestic intermediary cannot increase the retail price accordingly.

Profits are

$$\pi_M^\xi = w_D^\xi q_{b,D}^\xi + w_S^\xi q_{\beta,D}^\xi + w_S^\xi q_{b,S}^\xi + \phi_D^\xi + \phi_S^\xi, \quad (14)$$

$$\pi_{I_D}^\xi = (p_{b,D}^\xi - w_D^\xi(1+\xi))q_{b,D}^\xi - \phi_D^\xi, \quad (15)$$

$$\pi_{I_{S,b}}^\xi = (p_{\beta,D}^\xi - w_S^\xi(1+\xi))q_{\beta,D}^\xi + (p_{b,S}^\xi - w_S^\xi)q_{b,S}^\xi - \phi_S^\xi. \quad (16)$$

In the second stage, intermediaries set prices. In country D , the price for the locally sourced version is subject to the price freeze and set to $p_D^\xi = p_D = \frac{2(\gamma_D + \tau\gamma_S(1-\tau))}{\gamma_D\Omega}$. Intermediary I_S maximizes (16) with respect to $p_{\beta,D}^\xi$. The profit-maximizing price is $p_{\beta,D}^\xi = \frac{p_D^\xi(1-\tau) + w_S^\xi(1+\xi)}{2} = \frac{2(1-\tau)(\gamma_D + \tau\gamma_S(1-\tau))}{2\gamma_D\Omega} + \frac{1}{2}w_S^\xi(1+\xi)$.

In country S , the intermediary I_S maximizes (16) with respect to $p_{b,S}$. The profit-maximizing price is $p_{b,S}^\xi = \frac{1+\gamma_S w_S}{2\gamma_S}$.

In the first stage, the manufacturer sets the wholesale prices and the fixed fee, with which he extracts the wholesalers' profit. He sets the fixed fees ϕ_D^ξ and ϕ_S^ξ (see Appendix A1).

When setting wholesale prices, the manufacturer balances three effects: First, an increase in the wholesale price increases the revenue per unit sold to the intermediary. Second, the resulting higher retail price reduces the quantity. Third, the intermediary's margin and thus his extractable profit is reduced.

Under the manufacturer rebate and the price freeze, the manufacturer sets the wholesale price w_D^ξ to maximize (14):

$$\frac{\partial \pi_M^\xi}{\partial w_D^\xi} = \underbrace{q_{b,D}^\xi}_A + \underbrace{w_D^\xi \frac{\partial q_{b,D}^\xi}{\partial p_{b,D}^\xi} \frac{\partial p_{b,D}^\xi}{\partial w_D^\xi}}_B + \underbrace{\left(\frac{\partial p_{b,D}^\xi}{\partial w_D^\xi} - (1+\xi) \right) q_{b,D}^\xi + (p_{b,D}^\xi - w_D^\xi(1+\xi)) \frac{\partial q_{b,D}^\xi}{\partial p_{b,D}^\xi} \frac{\partial p_{b,D}^\xi}{\partial w_D^\xi}}_C. \quad (17)$$

A reflects the effect of a wholesale price increase for a given quantity. B and C include the effect of quantity changes. C captures the effect on the extractable profit. A is positive. B is zero. Due to the price freeze, quantities do not respond to wholesale prices. The first part of C is negative because of the price freeze. The second part of C is zero. The quantity depends on the retail price which remains unchanged due to the price freeze. This leaves two opposing effects on the producer's profit. The first effect is larger than the latter if the wholesale price w_S^ξ is sufficiently small ($w_S^\xi < \widehat{w}_S^\xi$, see Appendix A.1). Thus, the

manufacturer maximizes his profit by setting the wholesale price w_D^ξ to extract the intermediary's profit, that is, $w_D^\xi = \frac{p_{b,D}}{(1+\xi)}$. The absence of quantity effects leads to a corner solution.

The manufacturer maximizes (14) with respect to w_S^ξ . Equilibrium wholesale prices are

$$w_D^\xi = \frac{p_{b,D}}{(1+\xi)} = \frac{2(\gamma_D + \tau\gamma_S(1-\tau))}{(1+\xi)\gamma_D\Omega}, \quad (18)$$

$$w_S^\xi = \frac{2(1-\xi)(1-\tau)(\gamma_D + \tau\gamma_S(1-\tau))}{(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))\Omega}. \quad (19)$$

Compared to the benchmark case, the wholesale price for domestic distribution w_D^ξ is higher if the manufacturer rebate is sufficiently small and the wholesale price for foreign distribution w_S^ξ is lower (see Appendix A.1). The regulated price $p_{b,D}^\xi$ and the higher marginal cost w_D^ξ give intermediary I_D a competitive disadvantage.

Equilibrium prices and quantities are

$$\begin{aligned} p_{b,D}^\xi &= \frac{2(\gamma_D + \tau\gamma_S(1-\tau))}{\gamma_D\Omega} = p_{b,D}, \\ p_{\beta,D}^\xi &= \frac{(1-\tau)(\gamma_D + \tau\gamma_S(1-\tau))(2\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))}{\gamma_D(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))\Omega} < p_{\beta,D}, \\ p_{b,S}^\xi &= \frac{4\gamma_D^2 + 3\tau\gamma_S^2(1+\tau)(1-\tau)^2 + \gamma_S\gamma_D(7\tau+3)(1-\tau) - 2\xi\gamma_S(1-\tau)(\gamma_D + \tau\gamma_S(1-\tau)) - \xi^2\gamma_D\Omega}{2\gamma_S(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))\Omega} \\ &< p_{b,S} \end{aligned} \quad (20)$$

and

$$\begin{aligned} q_{b,D}^\xi &= \frac{2\gamma_D^2 + 2\tau^2\gamma_S^2(1-\tau)^2 + 4\tau\gamma_S\gamma_D(1-\tau) - \xi^2\gamma_D(2\gamma_D + \gamma_S(1-\tau^2))}{(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))\Omega} < q_{b,D}, \\ q_{\beta,D}^\xi &= \frac{\gamma_S(1-\tau)(\gamma_D + \gamma_S\tau(1-\tau))}{(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))\Omega} > q_{\beta,D}, \\ q_{b,S}^\xi &= \frac{4\gamma_D^2 - \tau\gamma_S^2(1-3\tau)(1-\tau)^2 - \gamma_S\gamma_D(1-7\tau)(1-\tau) + 2\xi\gamma_S(1-\tau)(\gamma_D + \tau\gamma_S(1-\tau)) - \xi^2\gamma_D\Omega}{2(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))\Omega} \\ &> q_{b,S}. \end{aligned} \quad (21)$$

The price of the locally sourced version, $p_{b,D}^\xi$, is fixed due to the price freeze. Both the price of the parallel import $p_{\beta,D}^\xi$ and the price of the drug in country S , $p_{b,S}^\xi$, are lower due to the lower wholesale price w_S^ξ (see Appendix A.1).

The quantity of the originally sourced drug, $q_{b,D}^\xi$, is lower, the quantity of the parallel import, $q_{\beta,D}^\xi$, is higher (see Appendix A.1). The total quantity in the destination country is higher. The quantity of drug in country S , $q_{b,S}^\xi$, is higher.

The market share of the parallel import is

$$\begin{aligned} \chi^\xi &= \frac{q_{\beta,D}^\xi}{q_{\beta,D}^\xi + q_{b,D}^\xi} \\ &= \frac{\gamma_S(1-\tau)(\gamma_D + \gamma_S\tau(1-\tau))}{2\gamma_D^2 + \tau\gamma_S^2(2\tau+1)(1-\tau)^2 + \gamma_S\gamma_D(4\tau+1)(1-\tau) - \xi^2\gamma_D(2\gamma_D + \gamma_S(1-\tau^2))} \\ &> \chi. \end{aligned} \quad (22)$$

For the manufacturer, the rebate in combination with the price freeze in D results in a rebalancing of distribution channels. Revenues from the domestic distribution channel decline due to the rebate and the price freeze and the manufacturer has an incentive to shift a part of his economic activity to S . Thus, he decreases the wholesale price w_S . This provides intermediary I_S with a competitive advantage compared to I_D . As a result, the market share of parallel imports increases.

Proposition 1 summarizes the effect of a change in the manufacturer rebate ξ on competition by parallel trade:

Proposition 1 *An increase in the manufacturer rebate ξ increases the market share of the parallel import: $\frac{\partial \gamma^\xi}{\partial \xi} > 0$.*

2.3 | Welfare

In country D , consumer surplus increases with the rebate. The total quantity is higher, the average price is lower (the price of the locally sourced version is unchanged, the price of the parallel import is lower). As the quantity of the original product decreases, some consumers switch from the locally sourced version b to the parallel import β . While these consumers benefit from the price reduction, they receive a product with (subjectively) lower quality. But also for them, consumer surplus increases by a revealed preferences argument.

Third party-payer reimbursement is lower under the rebate. Although total quantity is higher, the lower average price dominates the effect.

Profits of the intermediaries are extracted by the manufacturer. Therefore, profits (after extraction) are not affected by the rebate. The profit of the manufacturer π_M^ξ decreases compared to the benchmark case. The wholesale price in the destination country increases, but also the extractable profit of the intermediary decreases due to the rebate. The wholesale price in the source country decreases and the quantity increases.

Welfare in the destination country is given by consumer surplus (CS_D) plus the manufacturer's profit (π_M) less third party-payer expenditure (E_D): $W_D = CS_D + \pi_M - E_D$. The specific welfare consequences of the rebate depend on the copayment rates γ_D and γ_S , the discount factor for parallel imports τ , and the size of the rebate ξ . Table 1 shows a numerical example to illustrate the welfare consequences of introducing a rebate and increasing it. Assume the following parameters: $\gamma_D = 0.1$, $\gamma_S = 0.05$, $\tau = 0.2$. Compared to the benchmark case (first row), welfare decreases both by introducing the rebate (second row, left) and by increasing it (second row, right).

Therefore, the introduction of the rebate and its increase cannot easily be justified by welfare maximization. The rebate seems to have the essential function of limiting third-party expenditure.

3 | INSTITUTIONAL BACKGROUND

The German pharmaceutical market had a volume of € 31 bn. in 2019 (German Pharmaceutical Industry Association, 2020). Third party-payer expenditure (borne by the Statutory Health Insurance) for pharmaceuticals had a volume of € 41 bn (German Pharmaceutical Industry Association, 2020). The share of parallel imports in pharmacy market sales was 8.5% in 2018 (EFPIA, 2020).

In order to reduce expenditure borne by the statutory health insurance, pharmaceutical manufacturers, wholesalers, and pharmacists must provide a mandatory rebates for prescription drugs to the statutory health insurance.

In 2010, the Statutory Health Insurance Amendment Act (GKV-ÄndG) increased the mandatory manufacturer rebate from 6% to 16% (§ 130a (1) SGB (Sozialgesetzbuch, Social Insurance Code) V). At the same time, a price moratorium (price freeze) came into force. Specifically, pharmacies must provide a discount to health insurers. Pharmaceutical firms, in turn, must reimburse pharmacies for this discount (§ 130a, para. 1 SGB V). The price freeze was designed so that a manufacturer price increase after a cut-off date resulted in a corresponding increase in the discount to be granted (and refunded) (§ 130a, para. 3a SGB V).

The price freeze at the manufacturer level in combination with regulated wholesale margins (§ 2 drug price regulation (Arzneimittelpreisverordnung)) (and pharmacy margins, § 3) had de facto the effect of a price freeze at the (pharmacy) retail level for domestically sourced drugs.

The reform was in force for 3 years from August 2010 onwards. The German Parliament passed the law in June 2010. The legislative draft of the Federal Government is from March 2010. In the run-up, there were press reports about the plans of the federal government in early March 2010.

	$\xi = 0.06$	$\xi = 0.16$
W	5.24	5.24
W^ξ	5.19	4.94

TABLE 1 Numerical example

The reform only affected pharmaceuticals that were not subject to reference pricing. For all other pharmaceuticals, the mandatory rebate of 6%, which was already in force before the reform, was retained.

Reference prices constitute maximum reimbursement limits for pharmaceuticals by the statutory health insurance funds. In Germany, reference prices are formed in a two-step process (§ 35 SGB V). In the first step, the Federal Joint Committee (Gemeinsamer Bundesausschuss) decides on the definition of reference price groups. Groups can be defined for drugs with the same active substance, drugs with pharmacologically and therapeutically comparable active substances, and drugs with therapeutically comparable effects (§ 35 para 1, SGB V). In the second step, the National Association of Statutory Health Insurance Funds (GKV-Spitzenverband) sets the reference prices. In the context of the analysis in this paper, it appears important that the formation of reference price groups and the exemption from reference prices is independent of distribution channels (domestic or foreign) and prices. New patent-protected drugs with measurably improved efficacy are exempted from reference prices. Generally, a drug is subject to reference pricing when alternatives (with same or pharmacologically and therapeutically comparable active substances or with therapeutically comparable effects) exist. In the other case, it is not. Therefore, even on-patent drugs can be subject to reference prices if alternatives—in the sense described above—exist. An on-patent drug that is exempted from reference pricing may be subject to reference pricing after patent expiry or when alternatives become apparent (Giulini-Limbach et al., 2021).

4 | DATA AND DESCRIPTIVE STATISTICS

In this paper, I use a panel data set from Insight Health that covers all prescription drugs with competition from parallel imports sold in Germany for the period from January 2008 to December 2011 (INSIGHT HEALTH GmbH, 2016). For each drug, the data set contains information on the central pharmaceutical number, 3-digit Anatomical Therapeutic Chemical Classification System code (ATC code), trade name, active ingredient, administration form, package size, defined daily dose, strength, manufacturer, launch date, dispensing requirements, and the status as import or locally sourced version.

The data set comprises monthly data on sales by pharmacies to consumers (in units and in Euro, at the pharmaceutical manufacturer price), sales by wholesalers to pharmacies (in units), returns from pharmacies to wholesalers (in units), pharmaceutical manufacturer price, pharmacy retail price, and reference price.

An observation is identified by the central pharmaceutical number, representing a product with a particular active ingredient, administration, form, strength, and package size sold by a particular firm in a particular month.

The data set contains no information on source countries of parallel imports or purchase prices of wholesalers.

The analysis is based on a market definition where a market is defined by the active ingredient, package size, and dose strength. This maps substitution patterns at pharmacies, where locally sourced drugs may be substituted by parallel imports of the same active substance, package size, and dose strength. These markets are more narrowly defined than reference price groups, which could also be defined by pharmacologically-therapeutically comparable active ingredients or drugs with therapeutically comparable effects.

I restrict my data set to markets that face competition from parallel imports before the reform was announced. Thereby I exclude markets that exhibit peculiar barriers to parallel imports or where those barriers have changed after the introduction of the reform.

For some markets in my data set, reference prices apply. No market switches back from having a reference price to not having one. I exclude markets for which a reference price is introduced after the reform. For the empirical identification of the reform effect on parallel imports, I only consider markets belonging to the treatment group that are never subject to reference pricing in all observed periods. All other markets are in the comparison group.

Before the reform came into effect, markets with and without a reference price to not exhibit a different trend (see Figures 1 and 2).

Table 2 shows the summary statistics for all products.

Table 3 shows summary statistics for treated and not treated markets.

I use observations of all months between January 2008 and December 2011 in 811 markets, of which 643 are affected by the reform.

The summary statistics show that the average market share of parallel imports is higher in the treatment group than in the control group when market shares are measured by units sold. If market shares are weighted by prices, however, the average market share of imports is lower in the treatment group than in the control group. The number of importers is lower in the treatment group than in the control group. The competitive situation, as measured by the average Herfindahl-Hirschman index (HHI) 12 months before the reform announcement, is similar in treatment and control groups.

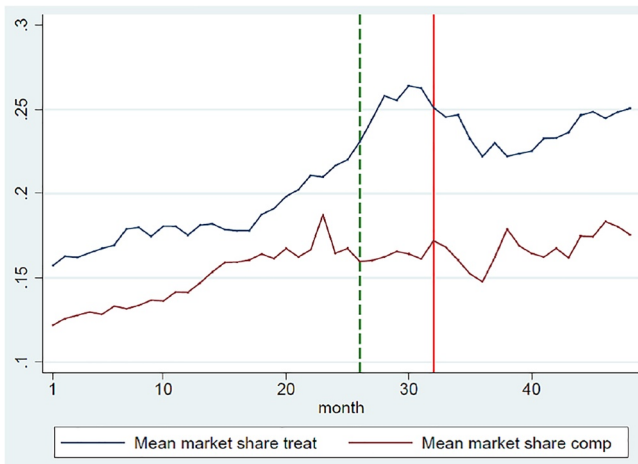


FIGURE 1 Average market share of parallel imports in treatment and comparison group [Colour figure can be viewed at wileyonlinelibrary.com]

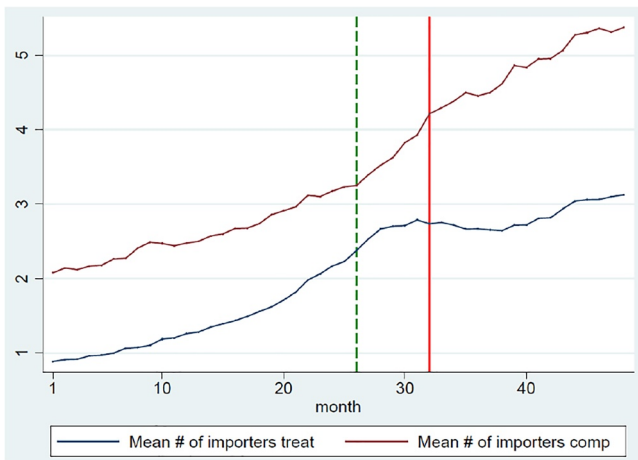


FIGURE 2 Average number of importers in treatment and comparison group [Colour figure can be viewed at wileyonlinelibrary.com]

5 | EMPIRICAL ANALYSIS

5.1 | Empirical strategy

The aim is to identify the effect of the reform described above on competition by parallel imports. Therefore, I estimate the effect of the reform on the market share of parallel imports and the number of importers. Since the reform only affects products that are not subject to a reference price (are not part of a reference price group), the empirical strategy is to identify the difference in market dynamics for products that are subject to the reform and those that are not by using a difference-in-differences approach.

I estimate the following random effects model

$$y_{it} = \alpha + \beta_1 T_i + \beta_2 R_t + \beta_3 D_{it} + \rho X_{it} + \delta_t + \varepsilon_{it}, \quad (23)$$

where y_{it} is the (log) market share of imported products (in packages or turnover) or the number of importers in a market i in month t . T is a dummy indicating treated markets, R is a dummy indicating post-reform periods, D is a dummy indicating the reform effect ($T \times R$), X_{it} contains a set of characteristics that vary over time (market size measured in number of packages of the same active ingredient sold, the number of products in the same ATC3 group, and the average HHI-Index for the last 12 months before announcement of the reform), δ_t is a month fixed effect, and ε_{it} is a robust error term.

All markets in the estimation have faced competition by imports prior to the reform. Only tablets are included for the estimation. Thereby I avoid difficulties arising from potentially limited substitutability between tablet and non-tablet products. The estimation is restricted to prescription drugs because only these drugs are possibly subject to reference prices.

The empirical strategy relies on the assumption that the evolution of treated and untreated markets does not differ systematically before the reform. To test this assumption, a pre-reform test similar to Brekke et al. (2015) is used (see Table A1 in the Appendix A.2.1). The fixed effects regression contains only pre-reform observations. Interaction effects of monthly dummies

TABLE 2 Summary statistics all markets

Variable	Mean	Std. Dev.	Min.	Max.	N
Reference price	56.138	30.307	10.79	148.48	6903
Sales originals	4024.752	8364.669	1	241,989	26,877
Sales imports	512.612	955.835	0	13,286	18,241
Market share imports	0.202	0.275	0	1	28,307
Market share imports weighted by prices	0.198	0.225	0	1	26,877
Number of importers	2.356	3.785	0	30	38,564
Number of products in ATC3 group	289.551	237.634	2	663	38,564
Avr. HHI before reform	0.533	0.377	0	1	38,564

Abbreviation: HHI, Herfindahl-Hirschman index.

TABLE 3 Summary statistics markets in treatment and control group

Variable	Mean	Std. Dev.	Min.	Max.	N
Markets in treatment group					
Sales originals	3734.46	8107.425	1	241,989	19,880
Sales imports	513.599	988.375	0	13,286	13,145
Market share imports	0.215	0.293	0	1	21,214
Market share imports weighted by prices	0.163	0.214	0	1	19,880
Number of importers	2.054	3.533	0	30	30,809
Number of products in ATC3 group	265.918	224.678	2	663	30,809
Avr. HHI before reform	0.525	0.395	0	1	30,809
Markets in control group					
Reference price	56.138	30.307	10.79	148.48	6903
Sales originals	4849.536	9005.451	1	73,045	6997
Sales imports	510.066	866.362	0	8000	5096
Market share imports	0.161	0.207	0	1	7093
Market share imports weighted by prices	0.3	0.223	0	0.999	6997
Number of importers	3.556	4.456	0	28	7755
Number of products in ATC3 group	383.439	263.135	24	663	7755
Avr. HHI before reform	0.563	0.294	0	1	7755

Abbreviation: HHI, Herfindahl-Hirschman index.

with a dummy for markets affected by the reform are included. If these interactions are not statistically significant at usual levels, a similar trend of treated and untreated markets prior to the reform may be assumed. If a dummy indicating affected markets after the reform has a significant effect, this effect may be interpreted as the effect of the reform of treated markets compared to untreated markets.

It turns out that the interaction term is statistically insignificant in nearly all months (see Appendix A.2.1). Six months prior to the reform, the interaction term starts to be significant at least at the five percent level. The legislative proposal of the German Federal Parliament dates to 4 months before the reform. Press coverage begins about 1 month earlier. It is not unlikely that hints about reform details were disclosed shortly before the legislative proposal and that this may have affected treated markets prior to the reform.

The development of average market shares of imported drugs for treated markets and untreated markets is shown in Figure 1. The red vertical line indicates the month where the reform came into effect. The green dashed line marks 6 months before the reform came into effect. This is the month with a significant interaction effect in the pre-reform test 1 month before press coverage. I cannot rule out the possibility that details of the reform plan have been disclosed to market participants before the general public was informed.

Figure 2 shows the development of the average number of importers for treated and untreated markets.

In both figures, the trend of treated and untreated markets is not different prior to the reform.

5.2 | Empirical results

5.2.1 | Market share of imports

The main empirical results for the market share of imports are shown in Table 4. In this specification, the market share is calculated by referring to units.

Since log values for market shares are used, the coefficients measure (semi) elasticities. The estimations suggest that the reform has increased the market share of imported products by approximately 18%–35%. Compared to the products not affected by the reform, the market share of imports in affected markets is considerably higher.

Four different sets of controls are applied. Market size is measured by the (log of the) number of packages of the same active ingredient sold per market in each month. The effect of the market size on the market share of imports is negative with an elasticity of about -0.31 to -0.32 . The number of products within the same ATC3 group, which may be considered as therapeutic alternatives, has a positive effect on the market share of imported products with an elasticity of about 0.325 – 0.36 . As described in Section 4, the average HHI before the reform is similar in treatment and control group. In the fourth column, the average HHI for the period 12 months before the reform announcement is included for each market as a control variable for the post-reform period. The coefficient is positive, that is, the higher the market concentration (the larger the HHI) before the reform is, the larger is the market share of parallel imports after the reform.

However, this control variable should be interpreted with caution. A high market concentration is typically present in the data set when the market share of the locally sourced product is large. If the HHI is large (and the market share of imports small), then the same absolute increase in imports will result in a larger growth rate of import market shares (note that this estimation uses the log of market shares) than if the HHI was small (and the market share of imports large). The coefficient could thus indicate that new imports emerge in markets (in treatment and control group) with high market concentration before the reform.

TABLE 4 Market shares

	(1)	(2)	(3)	(4)
	M.S. Imports	M.S. Imports	M.S. Imports	M.S. Imports
Treatment group	0.0725 (0.649)	−0.339 (0.053)	−0.162 (0.343)	−0.0974 (0.573)
Post reform	−0.240* (0.022)	−0.243* (0.018)	−0.245* (0.017)	−0.855*** (0.000)
Reform effect	0.267** (0.007)	0.347*** (0.000)	0.351*** (0.000)	0.181* (0.048)
Market size		−0.306*** (0.000)	−0.319*** (0.000)	−0.318*** (0.000)
Number of products in ATC3 group			0.325*** (0.000)	0.359*** (0.000)
Avr. HHI before reform				1.227*** (0.000)
Constant	−2.148*** (0.000)	1.064 (0.101)	−0.652 (0.315)	−0.855 (0.184)
<i>N</i>	18,217	18,217	18,217	18,217
R^2_{overall}	0.00284	0.0231	0.0319	0.00191
R^2_{within}	0.0446	0.0639	0.0641	0.0955
R^2_{between}	0.0198	0.00812	0.0294	0.000552

Note: *p*-values in parentheses.

Abbreviation: HHI, Herfindahl-Hirschman index.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The interaction dummy capturing the reform effect is statistically significant at least at the five percent level in all specifications.

5.2.2 | Number of importers

The main empirical results for the number of importers in each market are shown in Table 5.

The log of the number of importers in each market is the dependent variable, so that the coefficients can be interpreted as (semi) elasticities. The regression indicates that the reform had a positive impact on the number of importers in affected markets. The reform coefficient indicates that reform has increased the number of importers by about 14%–17% compared to non-affected markets in regression specifications 1–3. In these specifications, the reform coefficient is statistically significant at least at the five percent level. The market size (measured by the log of packages with the same active ingredient sold) has a positive effect on the number of importers with an elasticity of about 0.10–0.11. The number of products in the same ATC3 group has a positive effect on the number of importers with an elasticity of 0.15–0.17.

For consistency with estimating the effect of the reform on market share, the result of the effect of the average HHI before the reform is also reported here. The effect of the average pre-reform HHI on the number of importers is positive, that is, the higher the pre-reform market concentration, the higher the post-reform importer growth rate of the number of importers in all markets.

If the HHI is large (and the number of importers small) then the addition of one more importer will result in a larger growth rate than if the HHI is small (and the number of importers already large). The coefficient could thus indicate that additional importers have entered markets with a high degree of market concentration. This specification should therefore be interpreted with particular caution. The inclusion of this control variable results in the coefficient for the reform effect no longer being statistically significant. The positive sign is retained though.

TABLE 5 Number of importers

	(1)	(2)	(3)	(4)
	N Importers (log)	N Importers (log)	N Importers (log)	N Importers (log)
Treatment group	−0.413*** (0.000)	−0.257** (0.003)	−0.170* (0.045)	−0.153 (0.072)
Post reform	0.156* (0.014)	0.157* (0.012)	0.156* (0.012)	−0.0225 (0.765)
Reform effect	0.176** (0.006)	0.146* (0.019)	0.148* (0.018)	0.0988 (0.115)
Market size		0.115*** (0.000)	0.108*** (0.000)	0.107*** (0.000)
Number of products in ATC3 group			0.158*** (0.000)	0.168*** (0.000)
Avr. HHI before reform				0.359*** (0.000)
Constant	1.292*** (0.000)	0.0911 (0.736)	−0.738** (0.006)	−0.785** (0.004)
<i>N</i>	18,241	18,236	18,236	18,236
R^2_{overall}	0.0166	0.0501	0.0788	0.0504
R^2_{within}	0.286	0.294	0.295	0.304
R^2_{between}	0.0812	0.000196	0.0172	0.00901

Note: *p*-values in parentheses.

Abbreviation: HHI, Herfindahl-Hirschman index.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

6 | ROBUSTNESS

6.1 | Alternative definition of market share

In my main regression, market shares refer to units sold. If market shares are measured by units weighted by prices, the results do not change considerably. The magnitude of coefficients is very similar with a semi-elasticity of 27%–36%, and coefficients remain statistically significant. Taking into account the average HHI before the reform also has an effect similar to the estimate in the main part. Table A2 shows regression results (see Appendix A.2.2).

6.2 | Matching strategy

In addition to the difference-in-differences model in the main part, I also examine the effect of the reform using a matching approach. The effect of the reform is identified by comparing similar markets before the reform. The matching strategy follows Imai et al. (2022) (see Appendix A.2.3 for more details on the matching strategy employed and the effectiveness of matching).

The estimated coefficient for the effect of the reform on the (log) market share of imports is 0.05. The coefficient is positive but close to zero. In addition, with a standard error of 0.038 it is not statistically significant at usual levels.

The same matching procedure was followed to identify the effect of the reform on the number of importers. The estimated coefficient for the effect of the reform on the (log) number of importers is 0.09. The coefficient is positive. With a standard error of 0.021 it is statistically significant at the 0.001 level.

7 | CONCLUSION

In this paper, I study the effect of a change in the manufacturer rebate and a price freeze on competition by parallel imports. First, I analyze the effect of a manufacturer rebate on competition by parallel imports in a two-country model. Second, the paper exploits a policy reform in Germany in 2010, which increased the manufacturer rebate by 10 percentage points. Using a data set with prescription drugs with competition from parallel imports, I estimate the effect of the change in the manufacturer rebate on competition by parallel imports.

The model predicts that an increase in the manufacturer rebate increases the market share of parallel imports. The estimation shows that the increase in the manufacturer rebate has increased the market share of parallel imports by approximately 18%–35% and has increased the number of importers by up to 17%.

My results concerning the market share of parallel imports suggests that stricter wholesale regulation, unlike stricter retail regulation (Birg, 2019; Brekke et al., 2015), could enhance competition by parallel imports.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from INSIGHT Health GmbH. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from INSIGHT Health GmbH at <http://www.insight-health.de/#/en> with the permission of INSIGHT Health GmbH.

ORCID

Laura Birg  <https://orcid.org/0000-0001-8294-6243>

ENDNOTES

- ¹ Source countries of parallel imports are countries with rather low drug prices, such as Greece, Italy, Portugal, and Spain, destination countries are characterized by rather high drug prices, for example, Denmark, Germany, the Netherlands, and Sweden (Kanavos & Costa-Font, 2005). In the destination countries of parallel trade, the share of parallel imports in pharmacy market sales ranged between 8.2% in the Netherlands, 8.5% in Germany, 12.9% in Sweden, and 25.5% in Denmark in 2018 (EFPIA, 2020).
- ² The model set-up follows Ganslandt and Maskus (2007) and Birg (2017).
- ³ The interpretation of the drug price as a quality indicator (Waber et al., 2008) may result in consumers perceiving the parallel import to be of lower quality.

REFERENCES

- Bennato, A. R., & Valletti, T. (2014). Pharmaceutical innovation and parallel trade. *International Journal of Industrial Organization*, 33, 83–92. <https://doi.org/10.1016/j.ijindorg.2014.02.009>
- Birg, L. (2017). Pharmaceutical regulation at the wholesale level and parallel trade. *Economics Bulletin*, 37(3), 2260–2273.
- Birg, L. (2018). Pharmaceutical cost-sharing systems and savings for health care systems from parallel trade. *The World Economy*, 41(6), 1664–1694. <https://doi.org/10.1111/twec.12616>
- Birg, L. (2019). *Reference pricing and parallel imports: Evidence from Germany*. CEGE Working Paper No. 362.
- Brekke, K. R., Holmas, T., & Straume, O. R. (2013). Margins and market shares: Pharmacy incentives for generic substitution. *European Economic Review*, 61, 116–131. <https://doi.org/10.1016/j.euroecorev.2013.02.005>
- Brekke, K. R., Holmas, T. H., & Straume, O. R. (2011). Reference pricing, competition, and pharmaceutical expenditures: Theory and evidence from a natural experiment. *Journal of Public Economics*, 95(7–8), 624–638. <https://doi.org/10.1016/j.jpubeco.2010.11.015>
- Brekke, K. R., Holmas, T. H., & Straume, O. R. (2015). Price regulation and parallel imports of pharmaceuticals. *Journal of Public Economics*, 129, 92–105. <https://doi.org/10.1016/j.jpubeco.2015.08.002>
- Carone, G., Schwierz, C., & Xavier, A. (2012). *Cost-containment policies in public pharmaceutical spending in the EU*. European Commission Economic Paper 461. http://ec.europa.eu/economy_finance/publications/economic%20paper/2012/pdf/ecp_461_en.pdf
- Chen, Y., & Maskus, K. E. (2005). Vertical pricing and parallel imports. *Journal of International Trade & Economic Development*, 14(1), 1–18. <https://doi.org/10.1080/0963819042000333225>
- Costa-Font, J. (2016). Is medicines parallel trade regulatory arbitrage. *International Journal of Health Economics and Management*, 16(4), 321–336. <https://doi.org/10.1007/s10754-016-9199-z>
- Danzon, P. M., & Chao, L. (2000). Cross-national price differences for pharmaceuticals: How large and why? *Journal of Health Economics*, 19(2), 159–195. [https://doi.org/10.1016/s0167-6296\(99\)00039-9](https://doi.org/10.1016/s0167-6296(99)00039-9)
- Danzon, P. M., & Furukawa, M. (2003). Prices and availability of pharmaceuticals: Evidence from nine countries. *Health Affairs*, 22(Suppl 1), 521–536. <https://doi.org/10.1377/hlthaff.w3.521>
- EFPIA. (2020). The pharmaceutical industry in figures—edition. Retrieved from https://efpia.eu/media/554521/efpia_pharmafigures_2020_web.pdf
- Enemark, U., Møller Pedersen, K., & Sørensen, J. (2006). *The economic impact of parallel imports of pharmaceuticals*. University of Odense.
- Espin, J., & Rovira, J. (2007). Analysis of differences and commonalities in pricing and reimbursement systems in Europe. Retrieved from https://ppri.goeg.at/Downloads/Publications/andalusian_school_public%20health_report_pricing_2007_incl_annexes.pdf
- Ganslandt, M., & Maskus, K. E. (2007). Vertical distribution, parallel trade, and price divergence in integrated markets. *European Economic Review*, 51(4), 943–970. <https://doi.org/10.1016/j.euroecorev.2006.06.004>
- German Pharmaceutical Industry Association. (2020). Pharma-data 2020. Retrieved from https://www.bpi.de/fileadmin/user_upload/Downloads/Publikationen/Pharma-Daten/Pharma-Daten_2020_DE.pdf
- Giulini-Limbach, C., Bauer, C., & May, U. (2021). *Arzneimittelmarkt-Steuerung unter dem Einfluss von AMNOG und Festbeträ gen: Forschungsprojekt im Auftrag der Bristol-Myers Squibb GmbH & Co. KGaA (No. 232)*. IBES Diskussionsbeitrag.
- Grossman, G. M., & Lai, E. L.-C. (2008). Parallel imports and price controls. *The RAND Journal of Economics*, 39(2), 378–402. <https://doi.org/10.1111/j.0741-6261.2008.00019.x>
- Imai, K., Kim, I. S., & Wang, E. H. (2022). Matching methods for causal inference with time-series cross-sectional data. *American Journal of Political Science* forthcoming. <https://doi.org/10.1111/ajps.12685>
- INSIGHT HEALTH GmbH. (2016). Prescription drugs sold in Germany from January 2004 to December 2011. Retrieved from <http://www.insight-health.de/#!/en>
- Kanavos, P., & Costa-Font, J. (2005). Pharmaceutical parallel trade in Europe: Stakeholders and competition effects. *Economic Policy*, 20(44), 751–798. <https://doi.org/10.1111/j.1468-0327.2005.00150.x>
- Kanavos, P., Costa-Font, J., Merkur, S., & Gemmill, M. (2004). *The economic impact of pharmaceutical parallel trade in European Union member states: A stakeholder analysis*. LSE Health and Social Care Special Research Paper.
- King, G., & Nielsen, R. (2019). Why propensity scores should not be used for matching. *Political Analysis*, 27(4), 435–454. <https://doi.org/10.1017/pan.2019.11>
- Maskus, K. E. (2000). Parallel imports. *The World Economy*, 23(9), 1269–1284. <https://doi.org/10.1111/1467-9701.00329>

- Maskus, K. E., & Chen, Y. (2004). Vertical price control and parallel imports: Theory and evidence. *Review of International Economics*, 12(4), 551–570. <https://doi.org/10.1111/j.1467-9396.2004.00467.x>
- Pecorino, P. (2002). Should the US allow prescription drug reimports from Canada? *Journal of Health Economics*, 21(4), 699–708. [https://doi.org/10.1016/s0167-6296\(02\)00035-8](https://doi.org/10.1016/s0167-6296(02)00035-8)
- Taylor, D., Mrazek, M., & Mossialos, E. (2004). Regulating pharmaceutical distribution and retail pharmacy in Europe. In E. Mossialos, M. Mrazek, & T. Walley (Eds.), *Regulating pharmaceuticals in Europe: Striving for efficiency, equity and quality* (pp. 55–79).
- Vogler, S., & Martikainen, J. E. (2015). Pharmaceutical pricing in Europe. In Z. -U. -D. Babar (Ed.), *Pharmaceutical prices in the 21st century* (pp. 343–370).
- Waber, R. L., Shiv, B., Carmon, Z., & Ariely, D. (2008). Commercial features of placebo and therapeutic. *JAMA*, 299(9), 1016–1017.

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APPENDIX

A.1 | Model

Benchmark case:

In the first stage, the manufacturer sets

$$\phi_D = (p_{b,D} - w_D) q_{b,D} = \frac{(\gamma_D w_D (1 + \tau) - \gamma_D w_S - 2\tau)^2}{\gamma_D (3 + \tau)^2 \tau} \quad (24)$$

and

$$\begin{aligned} \phi_S &= (p_{\beta,D} - w_S) q_{\beta,D} + (p_{b,S} - w_S) q_{b,S} \\ &= \frac{(\gamma_D (w_S (1 + \tau) - w_D (1 - \tau)) - \tau (1 - \tau))^2}{\tau \gamma_D (1 - \tau) (\tau + 3)^2} + \frac{(1 - \gamma_S w_S)^2}{4\gamma_S}. \end{aligned} \quad (25)$$

Manufacturer rebate and price freeze:

In the first stage, the manufacturer sets the wholesale prices and the fixed fee, with which he extracts the wholesalers' profit. He sets the fixed fee according to

$$\begin{aligned} \phi_D^\xi &= (p_{b,D}^\xi - w_D^\xi (1 + \xi)) q_{b,D}^\xi \\ &= \frac{(2\gamma_D (3\tau - 1) + 4\tau^2 \gamma_S (1 - \tau) + \gamma_D w_S \Omega (\xi + 1)) (2\gamma_D + 2\tau \gamma_S (1 - \tau) - \gamma_D w_D \Omega (\xi + 1))}{2\gamma_D \tau \Omega^2} \end{aligned} \quad (26)$$

and

$$\begin{aligned} \phi_S^\xi &= (p_{\beta,D}^\xi - w_S^\xi (1 + \xi)) q_{\beta,D}^\xi + (p_{b,S}^\xi - w_S^\xi) q_{b,S}^\xi \\ &= \frac{(2\gamma_D (1 - \tau) + 2\tau \gamma_S (1 - \tau)^2 - \gamma_D w_S^\xi \Omega (\xi + 1))^2}{4\tau \gamma_D (1 - \tau) \Omega^2} + \frac{(1 - \gamma_S w_S^\xi)^2}{4\gamma_S}. \end{aligned} \quad (27)$$

Manufacturer's profit from country D under manufacturer rebate:

$$\begin{aligned} \pi_M^\xi(D) &= w_D^\xi (1 - q_{b,D}^\xi) + \phi_D^\xi \\ &= -\frac{(2\gamma_D + 2\tau \gamma_S (1 - \tau) - \xi \gamma_D w_D (4\gamma_D + \gamma_S (3\tau + 1)(1 - \tau))) (2\gamma_D (1 - 3\tau) - 4\tau^2 \gamma_S (1 - \tau) - \gamma_D w_S (4\gamma_D + \gamma_S (3\tau + 1)(1 - \tau))) (\xi + 1)}{2\tau \gamma_D (4\gamma_D + \gamma_S (3\tau + 1)(1 - \tau))^2} \end{aligned}$$

Manufacturer's profit from country D increases in w_D for w_S^ξ sufficiently low:

$$\frac{\partial \pi_M(D)}{\partial w_D} = \frac{\xi (2\gamma_D (1 - 3\tau) - 4\tau^2 \gamma_S (1 - \tau) - \gamma_D w_S^\xi (4\gamma_D + \gamma_S (3\tau + 1)(1 - \tau))) (\xi + 1)}{2\tau (4\gamma_D + \gamma_S (3\tau + 1)(1 - \tau))} > 0 \text{ if } w_S^\xi < \widehat{w_S^\xi} = \frac{2\gamma_D (1 - 3\tau) + 4\tau^2 \gamma_S (\tau - 1)}{\gamma_D (\xi + 1) (4\gamma_D - \gamma_S (\tau - 1) (3\tau + 1))}.$$

Comparison of wholesale prices under manufacturer rebate and in the benchmark case:

$$w_D^\xi - w_D = \frac{2(\gamma_D + \tau\gamma_S(1-\tau))(\tau - \xi(1-\tau))}{\gamma_D(\xi+1)(4\gamma_D + \gamma_S(3\tau+1)(1-\tau)) + \gamma_D(1-\xi) + \tau\gamma_S(1-\tau)} > 0 \text{ if } \xi < \hat{\xi}_{w_D} = \frac{\tau}{(1-\tau)},$$

$$w_S^\xi - w_S = -2\xi(1-\tau) \frac{\tau\xi^2\gamma_S(1-\tau)^2}{(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))(4\gamma_D + \gamma_S(3\tau+1)(1-\tau))} < 0.$$

Comparison of intermediaries' prices under manufacturer rebate and in the benchmark case:

$$p_{b,D}^\xi - p_{b,D} = 0$$

$$p_{\beta,D}^\xi - p_{\beta,D} = -\frac{\tau\xi^2\gamma_S(1-\tau)^2}{(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))(4\gamma_D + \gamma_S(3\tau+1)(1-\tau))} < 0$$

$$p_{b,S}^\xi - p_{b,S} = -\frac{\xi(1-\tau)(\gamma_D(1-\xi) + \gamma_S\tau(1-\tau))}{(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))(4\gamma_D + \gamma_S(3\tau+1)(1-\tau))} < 0.$$

Comparison of the market share of the locally sourced drug under manufacturer rebate and in the benchmark case:

$$\chi^\xi - \chi = \frac{\xi^2\gamma_S\gamma_D(1-\tau)(2\gamma_D + \gamma_S(1-\tau^2))}{(2\gamma_D + \gamma_S(2\tau+1)(1-\tau))(2\gamma_D^2 + \tau\gamma_S^2(2\tau+1)(1-\tau)^2 + \gamma_S\gamma_D(4\tau+1)(1-\tau) - \xi^2\gamma_D(2\gamma_D + \gamma_S(1-\tau^2)))} > 0$$

$$\frac{\partial \chi^\xi}{\partial \xi} = \frac{2\xi\gamma_S\gamma_D(1-\tau)(2\gamma_D + \gamma_S(1-\tau^2))(\gamma_D + \gamma_S\tau(1-\tau))}{(2\gamma_D^2 + \tau\gamma_S^2(2\tau+1)(1-\tau)^2 + \gamma_S\gamma_D(4\tau+1)(1-\tau) - \xi^2\gamma_D(2\gamma_D + \gamma_S(1-\tau^2)))^2} > 0$$

Comparison of quantities under manufacturer rebate and in the benchmark case:

$$q_{b,D}^\xi - q_{b,D} = -\frac{\xi^2\gamma_S\gamma_D(1-\tau)^2}{(4\gamma_D + \gamma_S(3\tau+1)(1-\tau))(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))} < 0$$

$$q_{\beta,D}^\xi - q_{\beta,D} = \frac{\xi^2\gamma_S\gamma_D(1-\tau)}{(4\gamma_D + \gamma_S(3\tau+1)(1-\tau))(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))} > 0$$

$$q_{b,S}^\xi - q_{b,S} = \frac{\xi\gamma_S(1-\tau)(\gamma_D(1-\xi) + \tau\gamma_S(1-\tau))}{(4\gamma_D + \gamma_S(3\tau+1)(1-\tau))(\gamma_D(1-\xi^2) + \tau\gamma_S(1-\tau))} > 0$$

Welfare

$$W_D = CS_D + \pi_M - E_D$$

$$= \int_{\theta_D^{\beta,\beta}}^1 (\theta - \gamma_D p_{b,D}) d\theta + \int_{\theta_D^{\beta,0}}^{\theta_D^{b,\beta}} (\theta(1-\tau) - \gamma_D p_{\beta,D}) d\theta + w_D q_{b,D} + w_S q_{\beta,D} + w_S q_{b,S}$$

$$+ \phi_D + \phi_S - (1-\gamma_D)(p_{b,D} q_{b,D} + p_{\beta,D} q_{\beta,D})$$

A.2 | Empirical analysis

A.2.1 | Pre-reform test

TABLE A1 Pre-reform test

	Market shares imports
Interaction 1	-0.136 (0.436)
Interaction 2	0.0851 (0.593)
Interaction 3	0.0844 (0.573)

(Continues)

TABLE A1 (Continued)

	Market shares imports
Interaction 4	0.0266 (0.838)
Interaction 5	0.157 (0.261)
Interaction 6	0.0383 (0.788)
Interaction 7	0.0201 (0.878)
Interaction 8	0.0141 (0.910)
Interaction 9	0.0879 (0.460)
Interaction 10	0.103 (0.426)
Interaction 11	0.129 (0.367)
Interaction 12	0.0235 (0.864)
Interaction 13	-0.0615 (0.634)
Interaction 14	0.0844 (0.525)
Interaction 15	-0.105 (0.393)
Interaction 16	-0.0877 (0.491)
Interaction 17	-0.167 (0.146)
Interaction 18	-0.144 (0.186)
Interaction 19	-0.201 (0.065)
Interaction 20	-0.116 (0.317)
Interaction 21	-0.123 (0.227)
Interaction 22	-0.00952 (0.934)
Interaction 23	-0.0857 (0.395)
Interaction 24	-0.0235 (0.797)
Interaction 25	0.0301 (0.748)

TABLE A1 (Continued)

	Market shares imports
Interaction 26	0.177* (0.041)
Interaction 27	0.176* (0.029)
Interaction 28	0.141 (0.090)
Interaction 29	0.177* (0.022)
Interaction 30	0.154* (0.035)
Interaction 31	0.0940 (0.100)
Constant	-2.361 (0.578)
<i>N</i>	10,156
<i>R</i> ²	0.204

Note: *p*-values in parentheses.

p* < 0.05, *p* < 0.01, ****p* < 0.001.

A.2.2 | Definition of market shares

TABLE A2 Market shares weighted by prices

	(1)	(2)	(3)	(4)
	M.S. Imports	M.S. Imports	M.S. Imports	M.S. Imports
Treatment group	0.0771 (0.626)	-0.326 (0.063)	-0.152 (0.374)	-0.0878 (0.612)
Post reform	-0.246* (0.021)	-0.249* (0.017)	-0.250* (0.016)	-0.857*** (0.000)
Reform effect	0.278** (0.005)	0.356*** (0.000)	0.360*** (0.000)	0.192* (0.037)
Market size		-0.301*** (0.000)	-0.313*** (0.000)	-0.312*** (0.000)
Number of products in ATC3 group			0.320*** (0.000)	0.355*** (0.000)
Avr. HHI before reform				1.220*** (0.000)
Constant	-2.195*** (0.000)	0.957 (0.147)	-0.737 (0.261)	-0.937 (0.150)
<i>N</i>	18,217	18,217	18,217	18,217
<i>R</i> ² _{overall}	0.00334	0.0250	0.0343	0.00228
<i>R</i> ² _{within}	0.0448	0.0631	0.0633	0.0946
<i>R</i> ² _{between}	0.0182	0.00910	0.0307	0.000586

Note: *p*-values in parentheses.

Abbreviation: HHI, Herfindahl-Hirschman index.

p* < 0.05, *p* < 0.01, ****p* < 0.001.

A.2.3 | Matching

In addition to the difference-in-differences model in the main part, I also examine the effect of the reform using a matching approach. The effect of the reform is identified by comparing similar markets before the reform. The matching strategy follows Imai et al. (2022).

The treatment starts for all markets in the same period. Similar markets are identified by using a time span of 6 month before the reform is announced. Similar to the regression in the main part of the paper, market size, the number of products in the same ATC3 group and HHI are considered as covariates. 250 markets from the treatment group are used for matching. Each of these markets is assigned 112 markets from the control group. Taking into account King and Nielsen's (2019) criticism of propensity score matching, Mahalanobi's distance matching was chosen as the refinement method. The covariate balance as used by King and Nielsen (2019) is close to zero (see Table A3).

Figures A1 and A2 show the covariate balance before and after refinement, respectively, indicating that the refinement method was effective in bringing the covariate balance closer to zero.

Figure A5 also shows the effectiveness of the chosen refinement method. It compares the absolute value of the standardized mean difference for each covariate before and after the refinement. Most of the observations are below the diagonal line, again indicating the effectiveness of the refinement.

Based on the matched sets, the effect of the reform on the market share of imports is estimated by using the difference-in-differences approach as in Imai et al. (2019). Standard errors are computed with 1000 weighted bootstrap samples. The estimated coefficient for the effect of the reform on the (log) market share of imports is 0.05. The coefficient is positive but close to zero. In addition, with a standard error of 0.038 it is not statistically significant different from zero at usual levels.

Decreasing the time span for the identification of similar markets increases the number of matched markets in the treatment group to 311. But this does not alter the regression outcome considerably.

Therefore, using a matching approach does not allow to identify a significant effect of the reform on the market share of parallel imports.

The same matching procedure was followed to identify the effect of the reform on the number of importers. 312 markets from the treatment group are used for the matching. Each of these markets is assigned 112 markets from the control group. Again, Mahalanobi's distance matching was chosen as the refinement method. Compared to examining market shares, the covariate balance is larger, even after refinement, indicating less effective matching (see Table A4 and Figures A4–A6).

Based on this matched sets, the effect of the reform on the number of importers is estimated in the same way as for market shares. The estimated coefficient for the effect of the reform on the (log) number of importers is 0.09. The coefficient is positive. With a standard error of 0.021 it is statistically significant different from zero at the 0.001 level.

TABLE A3 Covariate balance

	M.S. Imports	Market size	N Prod in ATC3 group	HHI
t_6	−0.244	−0.246	−0.029	0.141
t_5	0.000	−0.230	−0.025	0.167
t_4	−0.041	−0.191	−0.028	0.172
t_3	0.091	−0.177	−0.027	0.119
t_2	0.058	−0.129	−0.029	0.110
t_1	0.159	−0.076	−0.031	0.058
t_0	0.205	−0.069	−0.033	0.032

Abbreviation: HHI, Herfindahl-Hirschman index.

FIGURE A1 Covariate balance before refinement [Colour figure can be viewed at wileyonlinelibrary.com]

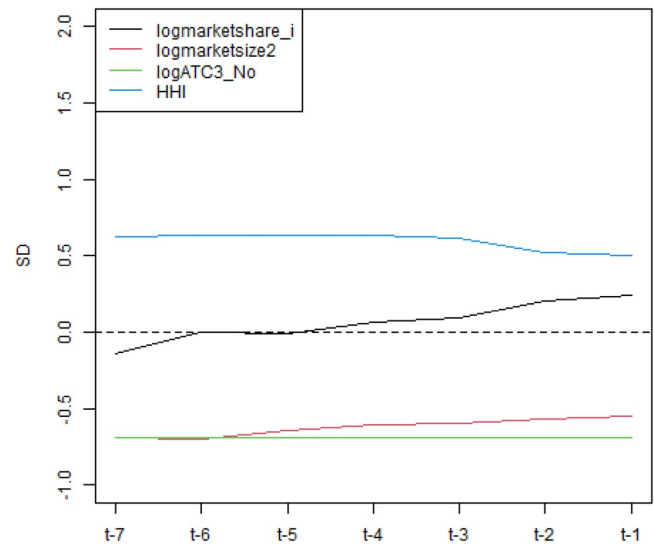


FIGURE A2 Covariate balance after refinement [Colour figure can be viewed at wileyonlinelibrary.com]

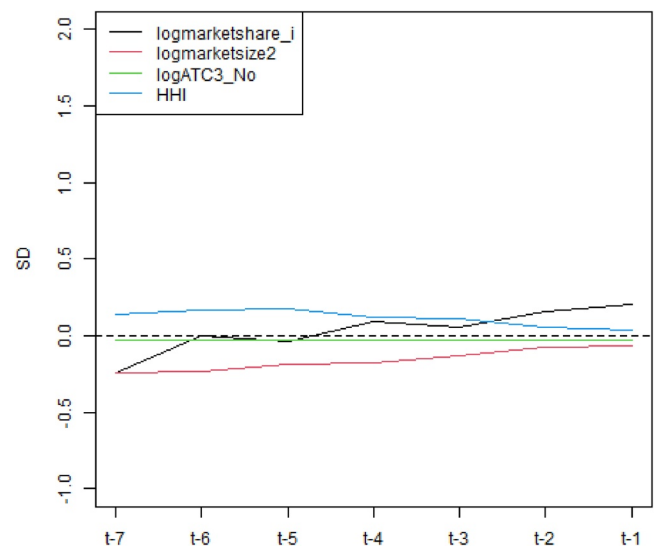


TABLE A4 Covariate balance

	N of importers (log)	Market size	N Prod in ATC3 group	HHI
t_6	0.138	-0.246	-0.029	0.141
t_5	0.170	-0.230	-0.026	0.167
t_4	0.191	-0.191	-0.028	0.172
t_3	0.241	-0.176	-0.028	0.119
t_2	0.265	-0.129	-0.030	0.111
t_1	0.301	-0.076	-0.032	0.059
t_0	0.409	-0.068	-0.033	0.033

Abbreviation: HHI, Herfindahl-Hirschman index.

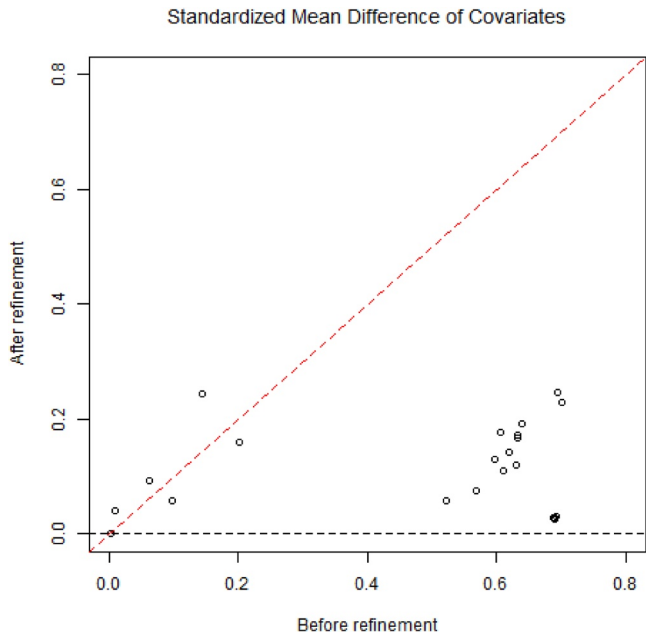


FIGURE A3 Scatter plot refinement effectiveness [Colour figure can be viewed at wileyonlinelibrary.com]

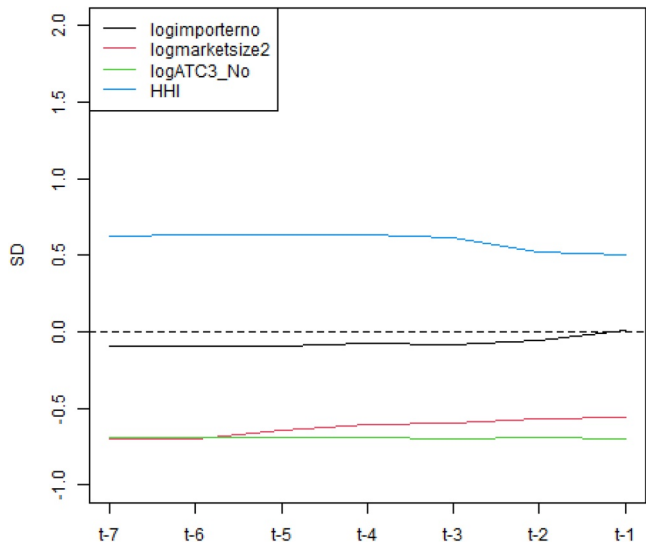


FIGURE A4 Covariate balance before refinement [Colour figure can be viewed at wileyonlinelibrary.com]

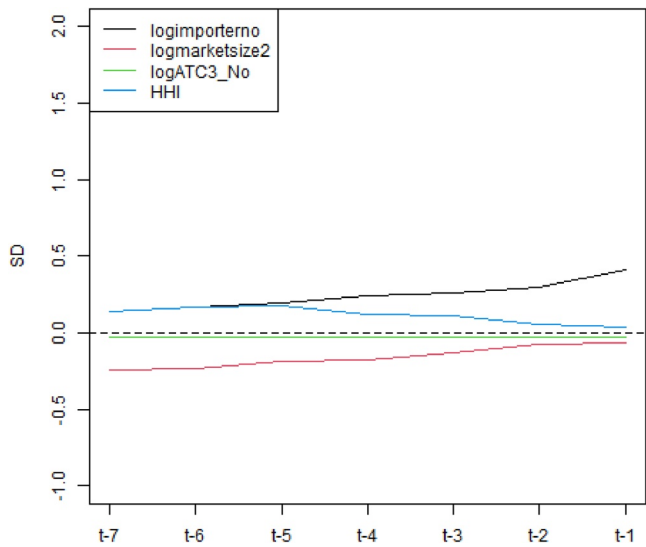


FIGURE A5 Covariate balance after refinement [Colour figure can be viewed at wileyonlinelibrary.com]

FIGURE A6 Scatter plot refinement effectiveness [Colour figure can be viewed at wileyonlinelibrary.com]

