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Published in:
Journal of International Economics

DOI:
10.1016/j.jinteco.2023.103831

Publication date:
2023

Journal of International Economics 145 (2023) 103831

Contents lists available at ScienceDirect

Journal of International Economics

journal homepage: www.elsevier.com/locate/jie

Full length articles

Mitigating information frictions in trade: Evidence from export credit guarantees

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ARTICLE INFO

JEL classification:
D22
D82
F14
G28
G32
H81
L25

Keywords:
Information frictions
Buyer default
Liquidity constraints
Export credit guarantees
Trade
Firm performance

ABSTRACT

Information frictions make foreign trade risky. In particular, the risk of buyer default deters firms from selling abroad. To address this issue, many countries offer export credit guarantees to provide insurance to exporters. In this paper, we investigate the causal effects of guarantees by exploiting a quasi-natural experiment in Sweden and rich register data on guarantees, firms and trade. Estimates from a fuzzy regression discontinuity design show large positive effects on the probability of exporting and the value of exports to the destination for which the guarantees are issued. These results are robust to an alternative approach using a difference-in-differences matching estimator. Further findings suggest that guarantees impact firms heterogeneously and play an important role in resolving buyer default risk and easing liquidity constraints. Larger impacts are observed in non-OECD countries, on smaller, liquidity constrained exporters and for firms selling products that face a relatively high cost of buyer default.

1. Introduction

Information frictions constitute substantial barriers to foreign trade that are on par with transport costs or tariffs (e.g., Rauch and Trindade, 2002; Head and Mayer, 2013; Allen, 2014; Steinwender, 2018). In particular, with imperfect contract enforcement, exporters face uncertainty about their buyer's ability or likelihood of payment, which ultimately is private information (Schmidt-Eisenlohr, 2013). Thus, there is a risk that the buyer does not pay the agreed price after receiving the goods. This default risk lowers exporters' expected profits and impedes international trade.[1] While firms can seek trade financing from banks, these private

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[1] At the local level, communities can reduce the risk of strategic default by monitoring and punishing opportunistic behaviour (Ostrom, 1990; Dixit, 2003). Meanwhile, within the domestic market, legal systems discourage such behaviour. However, contract enforcement mechanisms at the international level are

https://doi.org/10.1016/j.jinteco.2023.103831
Received 19 November 2020; Received in revised form 17 October 2023; Accepted 25 October 2023
Available online 31 October 2023

institutions may not provide the necessary financing if the risk from selling to the intended destination or buyer is deemed too high. In the event that the firm cannot secure trade financing from banks or other private institutions, it may instead turn to government institutions for support. Specifically, a firm that expects to close a deal may seek to obtain an export credit guarantee. By addressing the problem of default risk, the guarantee alleviates the information frictions present in cross-border trade to promote export activity.

This paper utilises a uniquely rich micro-level dataset from Sweden during the period of 2000–2017 to investigate whether government-backed guarantees reduce information frictions in trade by estimating the causal effects of guarantees on exports. We rely on two empirical approaches. First, by exploiting a quasi-natural experiment from the marketing campaigns of the Swedish Export Credit Agency, we employ a fuzzy regression discontinuity approach to provide causal evidence for the positive effects of export credit guarantees at both the extensive and intensive margins of exports. This empirical strategy is feasible because the campaigns were directed only at firms with fewer than 250 employees, thus generating a clear discontinuity threshold. Second, we estimate the impact of guarantees using a difference-in-differences propensity score matching estimator, where we meticulously match firm-destination dyads that acquire guarantees (treated) with very similar firm-destination dyads that do not acquire guarantees (controls). We then compare the difference in their outcomes relative to the year prior to guarantee use. Importantly, with an expanded sample, we demonstrate that the guarantees have heterogeneous effects across firms, with a larger impact observed for smaller, liquidity-constrained firms that have greater difficulties meeting their debt obligations. Moreover, we find that the guarantees have a more pronounced effect for exporters selling products that face a relatively high cost of buyer default (e.g., differentiated goods).

To our knowledge, this is the first study to directly address the challenge of self-selection in estimating the causal effects of guarantees, and we do so with a fuzzy regression discontinuity design (FRDD).[2] In 2012, the Swedish Export Credit Agency began to regularly approach firms *en masse* through surface mail. These direct marketing campaigns were designed to increase firms' awareness about the government institution's guarantees. A specific feature of the campaigns was that they targeted goods-exporting firms with a workforce below the threshold of 250 employees, i.e., small- and medium-sized enterprises (SMEs). As a result, these exporters, which mainly operated in manufacturing industries and wholesale and retail trade, were more likely to adopt the promoted instruments. The broad nature of the campaigns meant that they were non-discriminatory among goods-exporting SMEs in those industries, eliminating concerns about particular firms being selected to receive the mail. Our empirical analysis indicates a sharp (roughly 17 percentage-point) increase in the likelihood of acquiring a guarantee to a destination when an exporter's employment falls below the discontinuity threshold, and we exploit this gap to estimate the causal effects of guarantees. Importantly, our unique dataset provides information on the destinations of the guarantees issued, and we conduct our analysis at the firm-destination level.

Our FRDD results show a large and significant causal effect of guarantees on exports. At the extensive margin, the probability of entering a foreign market is approximately 10 percentage points higher for firm-destinations that use a guarantee than for firm-destinations without a guarantee. At the intensive margin, the value of exports in the destination market is more than three times larger. Because the guarantees are generally issued for riskier destinations outside the EU and OECD, we find that in their absence, many firms either do not export or sell only small amounts to these countries. However, by adopting the guarantees, firms have insurance against buyer default and very large sales growth is observed in the targeted destinations. Thus, our results suggest that export credit guarantees play an important role in overcoming the information frictions associated with default risk to promote international trade. This main finding using the FRDD is robust to alternative bandwidths around the discontinuity, alternative specifications and a non-parametric estimator.

On the other hand, we do not find any significant effects on performance at the firm level in terms of employment or value added. This contrasts with the commonly advanced aims of government-backed guarantees to promote not only exports but also jobs and overall economic growth. Again, given that the guarantees are typically issued for countries outside the EU and OECD, trade flows to these foreign markets tend to be small. On average, exports to the destinations for which the guarantees are issued account for less than 6% of firms' total sales. Therefore, while the guarantees are important with respect to their targeted destinations, they have a limited impact on firm size.

Results from our second approach using the difference-in-differences (DD) matching estimator corroborate the aforementioned findings. The results also survive a series of robustness checks, including an estimator that addresses the concern for the staggered treatment (Borusyak et al., 2021), and a "placebo-in-time" analysis that shifts the treatment to earlier years. Importantly, further analysis reveals substantial heterogeneity with regards to the impact of the guarantees. These results improve our understanding of the underlying mechanisms involved. First, firms face liquidity constraints in funding exports (e.g., Minetti and Zhu, 2011; Manova, 2013). In resolving the default risk of buyers, the guarantees generate higher expected revenues, thereby lowering the costs of external financing and potentially easing the exporters' liquidity constraints. Hence, we expect more pronounced effects for credit-constrained exporters. Our results show that the guarantees have a larger impact, at both at the extensive and intensive margins, for exporters that depend more on external financing (e.g., Rajan and Zingales, 1998). These results are also robust to alternative measures of financial health, such as liquidity and solvency ratios. Moreover, we exploit the variation across product characteristics. Without a guarantee, the relative cost of buyer default is higher for exporters of, for example, differentiated goods with lower resale value and products with less bank financing available. We find evidence that these exporters indeed benefit more from the guarantees, further demonstrating their role in addressing buyer default risk.

weaker and political risks also add to the default risk. Therefore, throughout most of human history, traders themselves have often travelled to trade (Greif, 2006).

[2] This research design has recently been applied in, e.g., Asher and Novosad (2020), Cohodes (2020), and is included in the RDD survey of Villamizar-Villegas et al. (2022).

While the global financial crisis highlighted the importance of trade finance and government-backed support, the history of government-backed export credit guarantees dates back to the time after World War I, when several countries independently established export credit agencies (Dietrich, 1935). By acting as the "guarantor of last resort", the institution's purpose was to facilitate trade, with the ultimate goal of promoting exports and creating jobs. These policy instruments are now very prevalent. It is estimated that in 2017, approximately 1 trillion USD of new guarantees were provided globally by government agencies (Berne Union, 2018). However, despite the substantial amounts involved, research on their effects is scarce. In fact, fewer than a dozen countries have been studied.[3]

Our paper contributes most directly to the literature on export credit guarantees. Due to a lack of micro-level data, the prior empirical research has mainly relied on more aggregated data at the country or industry level, which are susceptible to the influence of confounding channels at a more granular level (e.g., Abraham and Dewit, 2000; Egger and Url, 2006; Felbermayr and Yalcin, 2013; Auboin and Engemann, 2014; Freund, 2016; Agarwal and Wang, 2018). This literature finds a positive impact of guarantees on exports, in particular, for industries that are more dependent on external financing and for trade with riskier or less financially developed countries. The few micro-level studies include Jäkel (2022), Felbermayr et al. (2012), Heiland and Yalcin (2021) and Badinger and Url (2013), with the latter two using survey data. They examine the countries of Denmark, Germany and Austria, and generally find a positive association between guarantees and exports, sales and jobs. The main limitations of the prior literature on export credit guarantees are the use of aggregate or, at best, firm-level data and, most importantly, difficulty in establishing causality when treatment is self-selected — firms typically seek guarantees, which are deal specific, only if they expect to close these deals. By contrast, our work combines transaction-level data on the universe of government-backed guarantees with register data on firms as well as customs data. This allows us to investigate the effects of guarantees at the *firm-destination level*. Therefore, for the first time in this literature, we study the detailed linkages among guarantees, firm export destinations and firm performance while controlling for confounders at multiple levels. At the same time, we address the primary challenge of self-selection in the use of guarantees by exploiting a quasi-natural experiment (i.e., using a fuzzy RD design), while also employing a DD matching estimator.

This paper relates to a broader literature on information frictions in trade and their mitigation. This includes both theories featuring imperfect information (e.g., Rauch and Casella, 2003; Allen, 2014; Steinwender, 2018) and empirical studies on counter-measures beyond guarantees, such as technology (e.g., Steinwender, 2018), networks (e.g., Rauch and Trindade, 2002; Parsons and Vézina, 2018), and export promotion or subsidies (e.g., Alvarez, 2004; Görg et al., 2008; Ferguson and Forslid, 2019). Despite their similarity to export promotion policies and grants as a public measure for encouraging exports, guarantees are distinct in that they are to be fully paid by firms, are transaction specific, and work as government-backed insurance against the buyers' default risk. Our paper adds to this literature by providing evidence on guarantees and firm performances that is robust to self-selection.[4]

Finally, our paper also speaks to a growing literature in trade finance. While open account and cash-in-advance transactions do not rely on bank intermediation, exporters and importers may also seek trade finance from banks, for example, through letters of credit. Schmidt-Eisenlohr (2013) theoretically demonstrates the trade-offs for each payment contract. In his model, information frictions arise as firm types are private information, and "bad" types deviate from their contractual obligations when profitable. With imperfect contract enforcement, this commitment problem generates a default risk from the importer (or exporter). Evidence suggests that bank trade finance is important for promoting trade (e.g., Niepmann and Schmidt-Eisenlohr, 2017a; Demir and Javorcik, 2018). However, as illustrated during the global financial crisis, the deterioration of bank health in times of crisis dries up the supply of liquidity and bank financing, including letters of credit, which depresses trade volumes (e.g., Amiti and Weinstein, 2011; Ahn et al., 2011; Paravisini et al., 2014; Niepmann and Schmidt-Eisenlohr, 2017b; Crozet et al., 2022). This is clearly a concern of policy-makers and suggests an important role for policy intervention in the form of export credit guarantees. Indeed, our data indicates that the use of guarantees rose significantly during the global financial crisis, mitigating the downturn in trade.

The remainder of this paper is organised as follows. Section 2 describes our conceptual framework. In Section 3, we introduce our data and portray the exporters that adopt the guarantees. Section 4 explains the quasi-natural experiment and our identification strategy with the FRDD and presents evidence for the casual effects of guarantees. In Section 5, we employ the DD matching estimator and demonstrate that guarantees have heterogeneous effects across destination, firm and product characteristics. Lastly, in Section 6, we conclude. (We provide additional results and details in the Online Appendix.)

2. Conceptual framework

In this section, we describe the problem of default risk that firms face and introduce a stylised model to demonstrate the role of export credit guarantees in resolving this problem. In general, trade involves risks and is impeded by information asymmetries about the counter-party. In this setting, *"honesty is self-enforcing only between pairs of sufficiently close neighbors"* (Dixit, 2003, p. 1293).

[3] Empirical studies have covered, e.g., Australia, Austria, Belgium, Czech Republic, Denmark, Germany, Japan, Turkey and the US. In addition, there are a few multi-country studies on various aspects of export financing, e.g., on the guarantees of OECD countries (Baltensperger and Herger, 2009) and on the export financing of four eastern European countries (Janda et al., 2013).

[4] Recently, a few studies have emerged on export promotion that also directly address self-selection, e.g., by adopting a randomised controlled trial design for a sample of apparel and textile firms in Vietnam (Kim et al., 2018) or for a sample of SMEs in UK manufacturing (Breinlich et al., 2017).

When trade takes place across international borders, exporters, for example, lack information about their buyer's ability or likelihood of payment. This default risk is exacerbated by the incomplete nature of contracts, weaker cross-border contract enforcement, as well as political risks such as currency transfer restrictions (e.g., Ellingsen and Vlachos, 2009). Meanwhile, importers face the uncertainty that even with payment, the products delivered are sub-standard, late to arrive, or worse, not delivered at all.

Trade financing is important in determining the risks associated with cross-border transactions. Because cash-in-advance payments are uncommon, exporters are often exposed to the risk that their buyer may default on payment (e.g., Demir and Javorcik, 2018). Exporters that offer trade credit through open account financing are more competitive, and this financing mode mitigates the information asymmetries that importers face since they only pay for the delivered products after inspection. However, exporters that extend credit may require external funds to increase their liquidity and working capital. This inevitably raises costs, especially because trade across borders occurs over longer distances and is time consuming.

To lower the risk of default, exporters can acquire more information about their buyer and the political-economic environment of the country that it operates in. This helps to reduce information asymmetry but does not eliminate it entirely. Alternatively, exporters may involve an intermediary such as a private bank or government guarantor. Larger, more productive firms generally have more financial resources to pay the costs associated with the services of these third-parties. Here, we focus on the role of the government-backed export credit guarantee as an instrument to alleviate the problems that exporters encounter. In exchange for a premium, the guarantee transfers the default risk that exporters face to the government. Through this channel, the exporters' trade credit effectively rises, thereby easing their liquidity constraints. We next illustrate these ideas using a simple stylised framework, which mainly follows Heiland and Yalcin (2021).

Consider a setting with a representative consumer in each country j. The demand q for variety a produced in Sweden is $q_j[a] = p_j[a]^{-\varepsilon} A_j$, where $p_j[a]$ is the price, A_j is the demand shifter, and $\varepsilon > 1$ is the elasticity of substitution. Sweden has an exogenous number of heterogeneous risk-neutral firms that randomly draw their unit costs of production (equivalently, variety) a. To capture the problem of information asymmetry, assume the Swedish exporters face a risk of default from their buyer and are paid with probability $\lambda < 1$. Firms have liquid funds k, which are used to finance fixed costs $f > k$. For each country j, the firm's maximisation problem, subject to the demand function, is

$$\max_p \ \lambda pq - \bar{R}k - \lambda R^o(aq + f - k), \quad o \in [B, G]. \tag{1}$$

Expected profits are equal to expected revenues minus the opportunity cost of investing k at the risk-free rate of return $\bar{R}$ and the costs of financing production. The latter consists of variable costs and the part of fixed costs that cannot be financed internally. The interest rate R^o depends on whether the firm obtains additional liquidity only through the bank (B) or with the support of an export credit guarantee (G). The firm sets the price $p[a] = \frac{R^o a}{\theta}$, where $\frac{1}{\theta} \equiv \frac{\varepsilon}{\varepsilon - 1}$, and the productivity threshold for entry into exporting is determined by:

$$\frac{\lambda A}{\varepsilon}\left(\frac{R^o a}{\theta}\right)^{1-\varepsilon} = \lambda R^o(f - k) + \bar{R}k. \tag{2}$$

Next, we introduce the bank's problem. The bank makes loan H to the firm given the following no-arbitrage condition:

$$\lambda R^B H + (1 - \lambda) b^B R^B H = \bar{R}H, \tag{3}$$

where $b^B \in [0, 1]$ is the bank's recovery rate from pursuing the buyer in the destination country in the event that the borrower (i.e., the exporting firm) defaults on the bank.[5] Then, the bank's interest rate is $R^B = \frac{\bar{R}}{\lambda + (1 - \lambda) b^B}$.

Firms can also choose to use a government-backed export credit guarantee. As the "guarantor of last resort", the government offers the guarantee for a fee that is proportional to the size of the amount covered. Hence, suppose that the guarantee pays out the amount $G \leq pq$ in the event of buyer default. To use the guarantee, firms pay a premium γG to the government. They also pay a fixed cost f^G. The premium charged is then determined by the no-arbitrage condition:

$$\gamma G \bar{R} + (1 - \lambda) b^G G = (1 - \lambda) G \Rightarrow \gamma = \frac{(1 - \lambda)(1 - b^G)}{\bar{R}}, \tag{4}$$

where $b^G \in [0, 1]$ is the government's recovery rate against the buyer. Upon purchasing the guarantee, the firm ensures a payment G in the event of buyer default, which further eliminates the bank's own risk that the firm will not repay its loan. The bank can therefore charge the risk-free rate $\bar{R}$. The firm borrows the amount of $H = aq + f - k + f^G + \gamma G$ from the bank to cover externally financed fixed costs and the premium paid to the government for using the guarantee. We set the guaranteed amount G equal to $\bar{R}H$ because the firm must also pay the interest payments associated with the loan. Thus, we obtain $G = \frac{\bar{R}}{1 - \bar{R}\gamma}(aq + f - k + f^G)$. When using the guarantee, we can rewrite the firm's maximisation problem as:

$$\max_p \ \lambda pq + (1 - \lambda)G - \bar{R}k - \bar{R}H = \lambda pq - \bar{R}k - \lambda R^G(aq + f - k + f^G), \tag{5}$$

where $R^G = \frac{\bar{R}}{1 - \bar{R}\gamma} = \frac{\bar{R}}{1 - (1 - \lambda)(1 - b^G)}$.

[5] For simplicity, we assume that the bank and government can hedge their balance sheets at zero cost (i.e., $c^B = c^G = 0$ in Heiland and Yalcin (2021)). Additionally, the firm's recovery rate is implicitly set to zero, though the same results hold as long as it is less than the recovery rate of the bank and government.

2.1. Default risk

To focus on the problem of default risk, we first assume that $k = f$ to abstract away from liquidity constraints. From Eq. (2), we see that the potential for buyer default (i.e., $\lambda < 1$) lowers expected revenues and raises the productivity cut-off into exporting. Ultimately, this reduces bilateral trade. How does government intervention address this problem? Denote a^G and a^B as the cut-offs with and without the guarantee, respectively. These are determined by:

$$\frac{\lambda A}{\varepsilon}\left(\frac{R^G a^G}{\theta}\right)^{1-\varepsilon} = \lambda R^G f^G + \bar{R}k \quad \text{and} \quad \frac{\lambda A}{\varepsilon}\left(\frac{R^B a^B}{\theta}\right)^{1-\varepsilon} = \bar{R}k. \tag{6}$$

Assuming that the government has a higher recovery than the bank, i.e., $b^G > b^B$, implies that $R^G < R^B$. A comparison of the two cut-offs reveals the trade-off in using the guarantee: the firm pays a higher fixed cost due to $\lambda R^G f^G$ but earns higher expected revenues (or equivalently, pays lower variable costs) because $R^G < R^B$. More productive firms that can afford the guarantee earn higher profits from exporting to foreign countries.[6] The guarantee resolves the problem of default risk because the guarantor has a higher recovery rate than the bank (and the private firm). The firm is essentially paying the government to gain access to this facility. By contrast, in a setting with perfect information where $\lambda = 1$, there is no role for the guarantee and both the amount of exports and the set of exporters are at their first-best levels.

There are a number of reasons why a government institution can insure foreign transactions that private financial intermediaries hardly underwrite and do so at competitive fees.[7] If the government provides the guarantees, then it takes on the fixed costs of information collection, including the acquisition of specialised knowledge about political risks and channels for assessing commercial risks in foreign trade. The government can also diversify risks beyond the scope of many firms and utilise its taxation authority and endowments as collateral to ensure contract fulfilment, even for highly risky or large transactions. Moreover, it can more easily reinsure export credit risks and employ its public and diplomatic channels to pursue claims against defaulting parties. Finally, in practice, the government seems to be advantaged vis-à-vis private banks in providing competitively-priced guarantees since only banks were subject to new regulations, such as increased capital requirements, in the aftermath of the global financial crisis.

2.2. Liquidity constraints

We now study the case of $k < f$ to understand the guarantee's role in alleviating exporters' liquidity constraints. Eq. (6) is modified as:

$$\frac{\lambda A}{\varepsilon}\left(\frac{R^G a^G}{\theta}\right)^{1-\varepsilon} = \lambda R^G(f-k) + \lambda R^G f^G + \bar{R}k \quad \text{and} \quad \frac{\lambda A}{\varepsilon}\left(\frac{R^B a^B}{\theta}\right)^{1-\varepsilon} = \lambda R^B(f-k) + \bar{R}k. \tag{7}$$

Again, there is a trade-off between fixed and variable costs in using the guarantee. Furthermore, when using the guarantee, the firm obtains a lower interest rate $R^G < R^B$ for the loan used to finance the fixed costs of production. The difference $f - k$ captures precisely the lack of working capital due to exporting activities. Thus, the export credit guarantee addresses the default risk from exporting, thereby easing liquidity constraints. Because firms can more easily secure trade financing, this reduces the productivity threshold required for foreign entry and they are more likely to sell to the foreign market as a result. Further examination of Eq. (7) reveals that the effect is more pronounced for liquidity-constrained firms with a larger difference between f and k.[8]

Based on this framework, we derive three predictions:

Conjecture 1. *By using an export credit guarantee to a destination, the firm is more likely to export to that market and the value of exports is expected to increase.*

Conjecture 2. *By using an export credit guarantee, a firm's size (as measured by value added or employment) is expected to increase.*

Conjecture 3. *The impacts of an export credit guarantee are expected to be stronger for liquidity-constrained firms.*

3. Data and a portrait of the firms involved

We begin this section with a primer on our data source for export credit guarantees — the Swedish Export Credit Agency, *Exportkreditnämnden* (EKN). We then present our data on the guarantees and provide a portrait of the firms that use them.

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[6] The sufficient condition for $a^G < a^B$ is $f^G > \frac{k}{\lambda}(1-\bar{R}\gamma)\left[\left(\frac{1-\bar{R}\gamma}{\lambda+(1-\lambda)b^B}\right)^{\varepsilon-1} - 1\right]$.

[7] Banks may face similar problems of information asymmetry with the foreign buyer as private firms, making them non-competitive in underwriting the risks of the transaction (Smith, 1987; Brennan et al., 1988). This may lead to adverse selection into using underwriters, and in turn limits underwriters to financing relatively safer deals with a short maturity or to entire customer portfolios.

[8] We can rewrite Eq. (2) as $\frac{\lambda A}{\varepsilon}\left(\frac{a}{\theta}\right)^{1-\varepsilon} = (R^o)^{\varepsilon-1}\left[\lambda R^o(f-k) + \bar{R}k\right]$. Then, $\frac{\partial a^{1-\varepsilon}}{\partial R^o} \propto \varepsilon\lambda(f-k) + (\varepsilon-1)(R^o)^{-1}\bar{R}k > 0$. Moreover, we interpret the tightening of liquidity constraints as an increase in f as opposed to a decrease in k. Then, we have $\frac{\partial^2 a^{1-\varepsilon}}{\partial R^o \partial f} \propto \varepsilon\lambda > 0$. Because a decrease in k also reduces the return from the risk-free investment $\bar{R}k$, one would need to impose additional assumptions to sign the second derivative. Note that the left-hand sides of Eq. (7) are proportional to the export values, so we obtain the same qualitative predictions at the intensive margin.

3.1. The Swedish export credit agency

In Sweden, export credit guarantees are provided by the EKN, an administratively independent governmental agency under the Foreign Ministry established in 1933. In recent years, the agency has provided new guarantees worth approximately 5 billion USD annually. However, it has the authority to provide substantially larger amounts, and benefits from unlimited credit from the Swedish National Debt Office. In 2017, the agency had around 400 clients and covered approximately 2,100 business transactions to over 130 foreign countries, with the value of new guarantees totalling 4.7 billion USD.[9]

The Export Credit Guarantee Ordinance states that the agency may issue export credit guarantees to promote Swedish exports, internationalisation and competitiveness *"if the operation that is to be guaranteed is of Swedish public interest, or otherwise beneficial for the financial development in Sweden"*. According to the same ordinance, the agency is expected to increase knowledge of its services among SMEs and reduce their export thresholds. The EKN guarantees should complement privately available, i.e., marketable, guarantees and act as the guarantor of last resort.[10] Moreover, the agency is expected to break even in the long run. Therefore, the fees paid by its clients — the so-called premiums — are generally set such that they finance the business of the agency to cover both expected losses and overhead costs. If the EKN fails to cover its losses, which occurred only once in the 1980s, then it can access the necessary funding from the Swedish National Debt Office. A final restriction is that the agency may not issue short-term guarantees (<24 months) for exports to countries considered to be very safe in terms of credit risk, such as high-income OECD countries.

Application for a guarantee is free of charge, open to any firm, and can be done online, while usage is associated with a fee (the premium). When applying, the exporting firm, its foreign buyer and the export transaction are screened. The agency assesses if the parties to the deal can fulfil their contractual obligations. It also assesses the risk of losses so that the guarantee would be needed. Denials occur but are very rare. If *offered* a guarantee, then the firm may choose whether or not to use it. Most of the firms that receive an offer accept it, which results in the agency *issuing* the guarantee.

The premium is transaction specific and expressed as a percentage of the guaranteed export value. It is higher when there is a greater default probability, the risk duration is longer and the guaranteed amount is larger, as assessed by the EKN. Default risk is based not only on the country credit risk, which is endogenously and annually set cooperatively by the OECD, but also on the commercial risk of the buyer. The premium is also higher the larger the share of the political and commercial risk that the exporter wishes to cover.[11] The guaranteed amount cannot exceed a set limit in terms of the share of the export transaction; this is the so-called coverage ratio.[12] The remaining transaction share — the deductible — is retained by the firm for its own account. In summary, the premium is set to reflect the risk of the transaction that both the private firm and the EKN would face. While transactions to riskier destinations and buyers may benefit more from the guarantees, firms are also charged a higher premium and thus pay a higher cost of using them.

3.2. Data

3.2.1. Data on export credit guarantees

We have accessed novel and exhaustive panel data from the EKN on offered and issued guarantees that insure export transactions against buyers' default, which are so-called loss on claim guarantees (LOCGs; henceforth, export credit guarantees or guarantees).[13] The loss on claim guarantees include guarantees for exporters, letters of credit and guarantees for lenders, with guarantees for exporters accounting for the vast majority (over two-thirds) of the offered LOCGs. The data cover the period between 2000 and 2017. Our highly detailed data on guarantees from the EKN enable us to explore seller-contract-destination-buyer variation over almost two decades. (Online Appendix B provides more information about the data construction.)

The picture that emerges is that a limited number of firms account for a large number of guarantees and/or highly valued export contracts (see Online Appendix Table A1). At least half of the firms have only one guarantee per year, while the mean number of guarantees per firm in a given year is six. The average (median) value of an export contract is 10.7 (0.562) million USD. The total number of unique firms that receive guarantees in the years that we cover (2000–2017) is 617, with 97% (598) of these firms being registered in Sweden. To date, the EKN has issued guarantees to 180 destination countries. However, the distribution is highly

[9] As in many EU countries, but unlike in, for example, the US, the Swedish export financing system is divided into two parts. The EKN issues guarantees to all firms, while the Swedish Export Credit Corporation (SEK AB) provides large firms with export credits for medium- to long-term and large export contracts.

[10] In Sweden, there are some private insurers. However, they mainly cover all turnover or customer portfolios, which ensures that risks are spread out and thereby lowers premiums and overhead costs.

[11] The exporter can opt to cover political risk and no commercial risk, but not vice versa. Indicative premium rates are provided by the EKN on their website for most non-OECD countries. These rates are highly negatively correlated with GDP per capita. However, the consideration of other factors may impact the premium calculation. These other factors include, for instance, the size of the transaction and risk assessment of the specific buyer. The agency classifies the commercial risk of the buyer on an A-F scale, with an A corresponding to a government buyer and an F representing a newly established firm/weak firm/highly uncertain project.

[12] This ratio is the guaranteed transaction value over the potential loss on the claim as stipulated by the firm. The latter is defined by the sum of the contract value and the firm's associated foreign market costs.

[13] LOCGs are typical products of export credit agencies, see, e.g., the survey of Growth Analysis (2015). LOCGs account for approximately 75% of the number of EKN guarantee transactions and 55% of the guarantees. The remaining guarantees concern (a) bills of exchange, (b) claims against exporters, (c) investment credits, and (d) working capital. Although (a) is not directly tied to an export event, (b) is, but it concerns exporters' rather than buyers' default. The latter two types of guarantees (c) and (d) are not directly tied to an export contract.

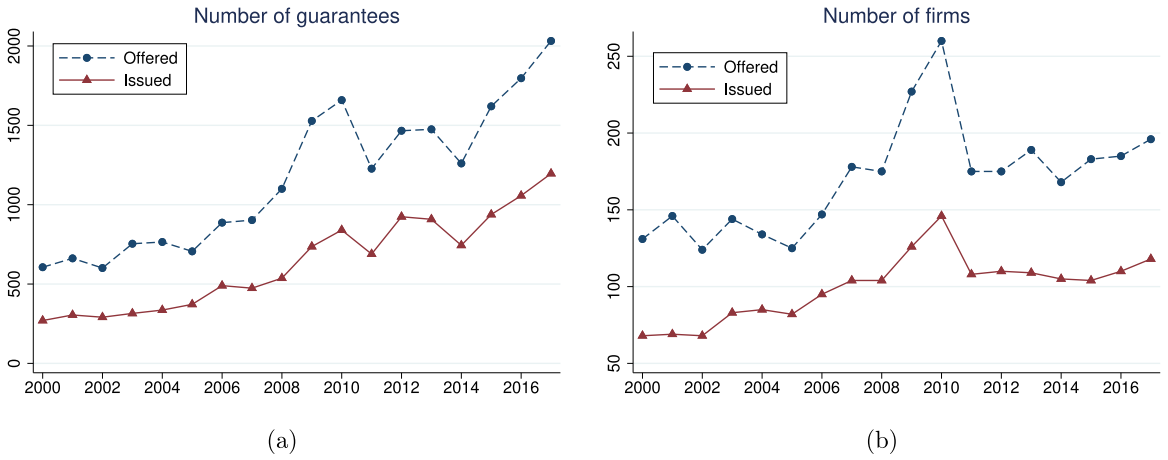

Fig. 1. Number of guarantees and the firms using guarantees over time.
Notes: The figure plots (a) the number of guarantees, and (b) the number of firms using guarantees in the years from 2000–2017. The dotted lines count the guarantees that firms applied for and were subsequently offered. The continuous lines count the guarantees that firms were offered and then acquired, i.e., the issued guarantees. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

skewed towards exports to the regions of Latin America, Eastern Europe and Central Asia and the Middle East (see Online Appendix Table A2). Because the destinations in these regions tend to be riskier, the EKN plays a larger role. Indeed, in accordance with EU regulations, short-term guarantees (<24 months) by the EKN to other EU countries and to OECD members such as the US and Canada are disallowed.

Figs. 1(a) and (b) display the trends, respectively, in the number of guarantees and in the number of firms that use them between 2000 and 2017. The number of guarantees increased substantially, while the number of users rose more moderately. We observe upward trends before the global financial crisis, and in the subsequent years, a marked increase in both the number of EKN guarantees used and the user base. In the post-crisis period, the former remains at high levels, but the latter gravitated towards the lower pre-crisis level. Overall, these patterns indicate an increase over time in the number of guarantees per firm. From the Swedish customs data, we find that the average value of exports, number of destinations and number of products per firm generally have a stronger recovery than the number of exporters post-2008.[14] This may in part explain why a larger rise in the use per firm is observed compared to the number of using firms after 2010. The majority of international trade is financed via an open account, while only small minorities are financed via financial intermediaries or cash-in-advance payments (e.g., Chauffour and Malouche, 2011; Niepmann and Schmidt-Eisenlohr, 2017a; Demir and Javorcik, 2018). In particular, letters of credit and documentary collections account for 13% and 1.8% of world trade in goods (Niepmann and Schmidt-Eisenlohr, 2017a). Acting only as the guarantor of last resort, the EKN has a contribution of comparable magnitude. Focusing on LOCGs alone, the EKN's guarantees account for an average of 2.3% of total exports (goods and services) from Sweden annually, reaching a peak of 9.9% in 2009. More importantly, this average statistic does not reflect the substantial heterogeneity in the importance of the guarantees across countries. Table 1 Panel A shows that the bulk (over 80%) of Sweden's exports is sold to the EU and other OECD countries. However, only 0.4 to 1.9% of the trade is covered by export credit guarantees. For the vast majority of transactions to these countries, guarantees are not used because the destinations are deemed low-risk and finance would be provided by the private credit market. By contrast, the share of Swedish exports to the five regions of Eastern Europe and Central Asia, Africa, Middle East, Latin America and Southern Asia is much smaller at a *combined* 11.8%. However, guarantees account for an average of 10.5 to 31.3% of exports to these geographic regions. Likewise, the share of exporters with guarantees, while on average low, is roughly an order of magnitude higher in non-OECD countries. In column 4, we focus on larger exporters by imposing a threshold of 1 million USD in annual exports to a destination, and the difference in the adoption of guarantees across regions is further magnified.

In Panel B, we find similar patterns when countries are divided according to the EKN country risk categorisation. Countries in the lowest risk class (i.e., zero) are generally in the EU or in the rest of the OECD. Thus, they account for the predominant share of exports, but only 0.6% of the trade is covered by the guarantees. Meanwhile, for more risky destinations between classes 3 and 7, the guarantees contribute to around 13%–15% of the export value. In these risky non-OECD destination countries, the level of uncertainty in the transactions is too high and the private credit market is unwilling to finance them as a result. Yet, it is precisely these countries for which the EKN is relied upon, and state intervention is arguably necessary to attenuate the information frictions and promote trade.

[14] Similar patterns are observed for other small European countries, e.g., Denmark, Belgium and Norway.

Table 1
Issue of guarantees as a share of exports.

	Panel A: By region			
	Share of total exports	Share of exports guaranteed	Share of exporters with guarantees	
			All	>1 mn USD
Region	(1)	(2)	(3)	(4)
EU and EEA	0.682	0.004	0.001	0.004
Rest of OECD	0.154	0.019	0.001	0.007
Eastern Pacific	0.047	0.028	0.001	0.014
Eastern Europe and Central Asia	0.038	0.130	0.003	0.025
Africa	0.025	0.105	0.004	0.039
Middle East	0.025	0.176	0.008	0.070
Latin America	0.018	0.313	0.008	0.053
Southern Asia	0.012	0.141	0.005	0.044
	Panel B: By country risk			
	Share of total exports	Share of exports guaranteed	Share of exporters with guarantees	
			All	>1 mn USD
Risk class	(1)	(2)	(3)	(4)
0	0.797	0.006	0.004	0.003
1–2	0.083	0.003	0.003	0.030
3–4	0.064	0.152	0.006	0.035
5–7	0.056	0.133	0.006	0.047

Notes: Annual averages computed from 2000 to 2017. Column 3 includes all exporter-destination pairs, while column 4 includes only exporter-destination pairs where the annual export value is greater than 1 million USD. See Online Appendix A11 for region definitions.

3.2.2. Data on firms and foreign trade

To identify the causal effects of guarantees, we must carefully consider the selection into the use of guarantees and control for confounding factors when estimating their effects on firm performance. Therefore, we must complement the previously mentioned EKN data with detailed information on firm performance and characteristics. We access this information from the administrative registers of Statistics Sweden for the same period between 2000 and 2017. Using the unique identifiers of establishments and firms, we merge the EKN data with these registers. Additionally, we include macro-level data on, for example, production, access to foreign markets, financial development and trade flows. Our variables and data sources are summarised in Online Appendix Table A3.

Specifically, we use five key registers from Statistics Sweden. First, for information about firms' worker composition, we use the Longitudinal Integrated Database for Health Insurance and Labour Market Studies (LISA). LISA includes very detailed information about the characteristics of all individuals (from 15 years of age). Second, the Structural Business Statistics (SBS) provide granular data on the input and output of all active firms, including information from income statements, balance sheets, business and earnings statistics and register-based labour market statistics. Third, we obtain data on foreign ownership and multinational status from the Enterprise Group Register. Fourth, industry affiliation is drawn from the Business Register. Lastly, the Foreign Trade Statistics (FTS) contain firm-country-product-level longitudinal data that cover firms' trade. Comprehensive data for intra-EU and non-EU trade in goods are gathered from Statistics Sweden and the Swedish Customs, respectively. The former includes trade transactions above a certain threshold but covers 96% of all intra-EU trade. Service trade data are obtained from a survey that captures 80% of total service trade. In summary, we have access to information on the population of workers, establishments, firms and enterprise groups in Sweden, as well as firms' bilateral trade and their transaction-level use of guarantees.

To construct our dataset for the analysis, we focus on the users of guarantees and aggregate the transaction-level data to the levels of our subsequent analyses, namely, the firm-destination and firm levels. By aggregating the data, for example, in 2017, we arrive at 517 firm-destination observations with 1,196 guarantees held by 118 unique firms (see Online Appendix Table B2). By combining information on the guarantees with the customs data, we see that these firms' exports to the destinations of the issued guarantees amounted to roughly 2 billion USD in 2017 (i.e., Table 2 column 2). Meanwhile, the aggregate guaranteed value (i.e., column 3) is approximately 40% larger than that of the value of exports. This difference in the values recorded by customs and the EKN is explained by the fact that the guaranteed value is the value of the contract that is covered by the EKN and that the contract may not be fully executed within the calendar year. Instead, some deals have future deliveries, and these exports show up in the customs data later on. In 2017, the exports covered by the agency reached 96 countries. Close to 1,400 CN 8-digit products were sold to these destinations by the firms with guarantees.

3.3. A portrait of the firms with guarantees

Finally, in this section, we describe the firms with export credit guarantees in our matched longitudinal dataset and their foreign buyers. For comparison, we provide statistics for the universe of Swedish firms, denoted by "U" below, in parentheses.

Table 2
Overview of Swedish exports and exports under guarantees.

	Export value (million USD)			No. of destinations		No. of products	
Year	Total (1)	Firm-destinations with guarantees (2)	Guaranteed value (3)	Total (4)	With guarantees (5)	Total (6)	Firm-destinations with guarantees (7)
2000	85,396	561	508	210	62	8,797	636
2001	76,377	1,168	925	212	64	8,780	866
2002	80,989	1,700	1,117	212	68	9,006	844
2003	99,292	1,285	1,067	227	74	9,031	991
2004	119,706	2,522	1,723	229	78	8,828	900
2005	126,097	1,554	2,249	232	79	8,633	864
2006	142,449	1,739	1,574	233	81	8,436	873
2007	162,144	1,627	2,059	237	73	8,338	891
2008	174,451	3,661	5,301	233	77	8,310	919
2009	124,827	3,300	12,299	236	83	8,247	911
2010	151,164	3,083	4,034	235	101	8,172	1,112
2011	176,822	2,517	2,563	238	85	8,026	988
2012	163,225	3,626	6,100	239	86	8,055	1,031
2013	158,895	2,922	3,902	242	82	8,045	1,056
2014	157,059	2,782	2,585	242	91	8,085	1,067
2015	133,421	2,028	4,099	241	92	8,140	1,038
2016	132,833	1,318	2,061	245	95	8,169	1,093
2017	145,441	1,992	2,888	247	96	8,324	1,380

Notes: The table presents an overview of Swedish exports. Column 1 is the total value of Swedish exports in a given year. Column 2 is the exports of firms with guarantees to the destinations of the issued guarantees in their year of issuance. Column 3 is the guaranteed value of issued guarantees from the EKN data. Column 4 is the total number of export destinations for all Swedish firms. Column 5 is the number of export destinations with issued guarantees. Column 6 is the total number of products exported at the Combined Nomenclature (CN) 8-digit level. Column 7 is the number of products exported by firms with guarantees to the destinations of the issued guarantees.

There are 598 unique exporting firms that use guarantees in the merged dataset. According to Table 3, 72% of these firms are SMEs, with a median of 49 employees (U:1).[15] However, large firms clearly dominate in terms of employment and turnover, with the average firm having 706 employees (U:6) and a turnover of USD 519 million (U:2). Most firms that use guarantees are multinational, contrary to most Swedish firms, but are not foreign owned, similar to Swedish firms in general. Most firms export but not intensively. The average *total* export intensity is 8.7%, and the bilateral export intensity is 3% (U:8 and 0.1, respectively).

Regarding the sectoral distribution of the firms that use the guarantees, manufacturing and wholesale jointly dominate to capture an 82% share of the firms and 93% of the value (Online Appendix Table A4). These are also major industries in Sweden that are the most active in international trade. Overall, they account for approximately one-quarter of employment and one-fifth of the number of private firms (excluding primary industries). In particular, within manufacturing, the production of machinery and equipment (NACE Rev. 2 sector 28) and transport equipment (sectors 29–30) dominate, with a combined 69% of guarantee usage. Using the identification numbers of the foreign buyers in the guarantees provided by the EKN data, we can match a subset of these firms to the Dun and Bradstreet Global Reference Solution database to obtain some information about them. In general, the sectoral distribution of the buyers is also concentrated in manufacturing and wholesale.[16]

4. Empirical analysis with FRDD

4.1. Empirical strategy

In this section, we outline our main empirical strategy of using a fuzzy regression discontinuity design (FRDD) to estimate the causal effects of export credit guarantees on firm performance. Researchers generally face two major challenges with regards to identification. First, firms may self select into using export credit guarantees, leading to a non-random treatment. In particular, firms are more likely to apply and adopt guarantees if they expect to close their deals with their import partners. Moreover, large firms are traditionally more established users, so that firm size may confound the effects of guarantees on the outcomes of interest. Second, outcomes for using and not using the export credit guarantee cannot be simultaneously observed for the same firm.

Our key strategy of the FRDD addresses both of these problems by exploiting a quasi-natural experimental setting. Between 2012 and 2016, the Swedish EKN ran several large-scale marketing campaigns to increase awareness of its export credit guarantees and to attract clients among SMEs. The EKN sent only information to exporting firms with fewer than 250 employees. Because of

[15] In general, we observe an increased usage among SMEs. Industry representatives report that a likely contributor to this trend is the increased costs and constraints that SMEs have faced for using private financial intermediaries since the late 2000s, which have induced them to consider the agency instead. New laws and regulations to prevent money laundering and terrorist financing have meant higher compliance costs for financial intermediaries, and these costs have trickled down to their customers, with some banks even divesting in risky countries.

[16] Summary statistics on some key financial variables of the foreign buyers are available upon request.

Table 3
Summary statistics of Swedish firms with guarantees, 2000–2017.

	Panel A: Firm-level variables			
Variables	N	Mean	Median	S.D.
SME (dummy)	1,843	0.72	1	0.45
Turnover*	1,843	518.81	23.38	1,973.36
Value added*	1,843	97.10	4.74	390.60
Employment	1,843	706.01	49	2,417.91
Wage bill*	1,843	41.52	2.52	160.25
Physical capital stock*	1,843	153.27	5.64	712.96
Cost of raw materials*	1,843	152.45	4.18	601.36
Cost of intermediate goods*	1,843	152.58	0.59	713.72
Cost of intermediate services*	1,843	121.73	3.45	606.43
Share post-sec. educ.	1,843	0.83	0.89	0.21
Firm age	1,843	10.41	8	10.38
Multinational status (dummy)	1,843	0.70	1	0.46
Foreign ownership (dummy)	1,843	0.26	0	0.44
Export status (dummy)	1,843	0.94	1	0.24
Import status (dummy)	1,843	0.89	1	0.31
	Panel B: Firm-destination-level variables			
Variables	N	Mean	Median	S.D.
Export intensity	4,958	0.03	0	0.12
Import intensity	4,958	0.02	0	0.42

Notes: The table presents statistics for exporting firms with guarantees between 2000 and 2017. The variables marked with an asterisk are measured in millions of USD.

the cut-off rule adopted to assign firms to treatment, it is possible to assess the effects of guarantees by using the FRDD where the assigned treatment through the cut-off is an instrument for the use of the guarantees (Hahn et al., 2001; Imbens and Lemieux, 2008). Importantly, it was the EKN that approached the firms, and not the other way around. The research design thus addresses both of the aforementioned problems, namely, self-selection and the construction of a valid counterfactual. We discuss details of the marketing campaign next, followed by the estimating equations.

4.1.1. Marketing campaigns

Through the marketing campaigns, the EKN sought to attract clients for its export credit guarantees. The global financial crisis and deterioration of trade, especially for SMEs, raised the importance of the guarantees as a policy tool, which the government emphasised in its communication with the agency. SMEs had relatively poor knowledge about the EKN, particularly on its offers and means of assistance. Therefore, the campaigns designated a cut-off of 250 employees.

The marketing campaigns were designed as follows. The agency approached a firm's chief executive, financial officer, marketing manager or export manager through surface mail. This mail contained a signed cover letter from the regional contact person of the agency and a brochure with both real-world examples of Swedish companies using the guarantees and some information about the guarantees. The letter would typically start with some statistic on the development of SME exports or a quote from an SME using the guarantees and then discuss the role and importance of the EKN. It concluded with an offer of more information via e-mail, phone or a personal visit by the agency.

For identification purposes, it is encouraging that these marketing campaigns were general in nature.[17] Using information on firms' exports and industry, the EKN targeted approximately 15,000 goods-exporters below the threshold of 250 employees (i.e., SMEs) each year between 2012 and 2016. This number constituted virtually all goods-exporting SMEs in the manufacturing industries and wholesale and retail trade (NACE Rev. 2 sectors 10–33 and 45–47), which were the main focus of the EKN's marketing campaigns. In other words, the campaign was both intended to be and was *de facto* non-discriminatory among goods-exporters in those industries below the employment cut-off. Nevertheless, to account for the possibility that firms outside of manufacturing and wholesale and retail trade were also contacted, our FRDD estimation sample includes goods-exporting firms in these other industries as well. However, they contribute only to a small fraction of the sample and we demonstrate in Section 4.2.1 below that our results are quantitatively similar when excluding them. Therefore, our empirical approach with the FRDD identifies the effects of guarantees by comparing outcomes of goods-exporting SMEs against another group of goods-exporting firms, namely, those with employment just above 250. As a share of the total number of SMEs, the number contacted by the EKN is small (roughly 5%), since the vast majority of SMEs operate in service industries without exporting goods. Moreover, while all of the approached firms had some prior sales activity abroad, most were only marginal exporters. Their median bilateral export intensity was 0.03%, and the median number of destinations was one.

[17] The EKN consciously chose to go out on the market broadly, according to discussions with the agency. A potentially more effective marketing design could have targeted the likeliest prospects, such as the firms that were most likely to become new clients based on, e.g., their size and export profile or the firms that had the largest export potential based on, e.g., the foreign market demand growth in their detailed industry.

A potential threat to identification in the FRDD arises if firms above the cut-off also learn about the EKN's export credit guarantees after the campaigns are launched. For example, this can occur through media coverage or knowledge spillovers between firms. We argue that both channels play a limited role in spreading information about the guarantees. First, we do not find any spikes in content related to the campaigns in print, broadcast or online media over this period (see Online Appendix Figure A1). While media interest in the EKN does show an upward trend, any spikes observed are generally related to its jobs, contracts in foreign markets and the release of reports.[18] Second, the diffusion of guarantee usage appears weak. In Online Appendix Figure A2, we divide Sweden into its 21 counties and plot the number of guarantees used in each county against its lag. Many observations lie off and below the 45-degree line. Hence, there is no indication that within-region information spillovers contributed to the widespread use of guarantees. Given that Sweden is the second least densely populated country in the EU, there is also limited scope for cross-regional diffusion. Lastly, as Section 4.2 below shows, employment is a strong predictor for guarantee use even with such potential spillovers. This implies that there is clearly differential treatment, though it might also suggest that our estimates are likely to be lower bounds for the effects of the guarantees.

To the best of our knowledge, we are not aware of any other wide large-scale promotions implemented over this same period targeted towards SMEs. Nonetheless, there are two other institutions that are involved with state-funded export finance activities, the Swedish Export Credit Corporation (SEK) and Almi, with both of them offering non-marketable export credits. Our estimates of the effects of guarantees may therefore be biased if firms benefit from the financial assistance of these other institutions, leading to underestimation (overestimation) if the assistance is mainly provided to firms just above (below) the cut-off of 250 employees. However, the credits of SEK are directed towards large firms with at least 500 million SEK in turnover, mitigating the concern for underestimation. Meanwhile, Almi offers support to small firms (<50 employees), and especially to micro firms (<10 employees). This in turn suggests that overestimation is unlikely. In addition, there are three other state-funded institutions (Business Sweden, the Swedish Agency for Economic and Regional Growth and the Enterprise Europe Network) that provide non-financial assistance, but they also generally target micro and small firms and their assistance is limited in scale.

4.1.2. *Fuzzy regression discontinuity design*

We exploit the quasi-natural experiment from the EKN by employing a fuzzy RD design. Because the agency only contacted firms below the employment cut-off, there exists a clear discontinuity in the use of guarantees and the intent to treat is randomised.[19] This approach is closer to a randomised controlled trial compared to most other non-experimental designs and provides cleaner identification (Lee and Lemieux, 2010; Cook and Wong, 2008). Here, the treatment is the use of an export credit guarantee, and the probability of treatment jumps discontinuously at the cut-off point of $L^* = 250$ employees. Fig. 2 displays how the cut-off works in practice among Swedish exporters. As expected, there is imperfect compliance as not all firms below the cut-off use guarantees. Nonetheless, we find a discontinuity around the firm size threshold. We argue that precise manipulation of employment around the threshold seems implausible. Both the low awareness of the guarantees among SMEs and the relatively low pay-off of receiving the EKN's information mail make it unlikely that firms would fire employees to qualify for being contacted by the agency. Reassuringly, we also find the distribution of employment to be smooth around the threshold.

Thus, the assignment (i.e., forcing) variable is the number of employees L_{it} of firm i at time t. In this analysis, we drop all firms that have used guarantees in the past. For these firms, we are less certain that the mailing campaign is responsible for their current use of a guarantee. The treatment effect is estimated using two-stage least-squares (2SLS), specifically, from the following two-equation system:

$$D_{ijt} = \alpha_0 + \alpha_1 T_{it} + g(L_{it} - L^*) + \varphi_{st} + \varphi_{jt} + \nu_{ijt}, \tag{8a}$$

$$Y_{ijt} = \beta_0 + \beta_1 D_{ijt} + f(L_{it} - L^*) + \varphi_{st} + \varphi_{jt} + \varepsilon_{ijt}. \tag{8b}$$

To investigate whether the use of a guarantee affects export outcomes in a particular destination, we conduct our first set of estimations at the firm-destination level. Thus, the treatment dummy D_{ijt} is the adoption of an export credit guarantee by firm i for destination j at time t. Note that the guarantee is issued for a particular transaction, which specifies the product as well as buyer. For treated firms, we only have (limited) information on the buyers for which a guarantee was used; for control firms, it is not possible to identify their buyers from the customs trade data. This means that we must reduce the dimensionality of the analysis and examine destination countries instead. Hence, we conduct our analysis at the firm-destination level despite treatment being at the product-buyer level. The indicator variable $T_{it} = 1[L_{it} \leq L^*]$ determines whether the assignment variable L_{it} is below the threshold L^*. Therefore, we use the exogenous assignment to treatment as an instrument for the usage of guarantees to address the potential endogeneity issues that arise from partial compliance. In other words, the treatment status is probabilistically determined as a discontinuous function of firm size (Lee and Lemieux, 2010). In the second stage, Y_{ijt} is the outcome of interest. Standard errors are clustered at the firm-destination level. For the main analysis, we follow much of the prior literature to employ a parametric approach and consider linear functions of $g(\cdot)$ and $f(\cdot)$. We also verify that our results are robust to a non-parametric FRDD.

[18] Two illustrative cases of such media interest spikes relate to foreign market openings and losses in Iran (2015 3rd quarter) and Spain (2016 1st quarter), respectively. In the former, the EKN was mentioned in relation to significant media interest in foreign trade implications for Swedish firms of a deal-in-the-making between Iran and six countries on a non-uranium enrichment deal. The deal would reduce sanctions on Iran and on individuals, firms and banks based on their business with Iran. In the latter, the EKN was frequently mentioned by the media as an important creditor that would likely incur heavy losses if the large Spanish energy company Abengoa, which was having financial difficulties, would file for bankruptcy.

[19] While we *de facto* have information on which firms are contacted through the marketing campaign, this is not relied upon in the estimation. Instead, firm size as measured by employment determines whether they receive the intent to treat.

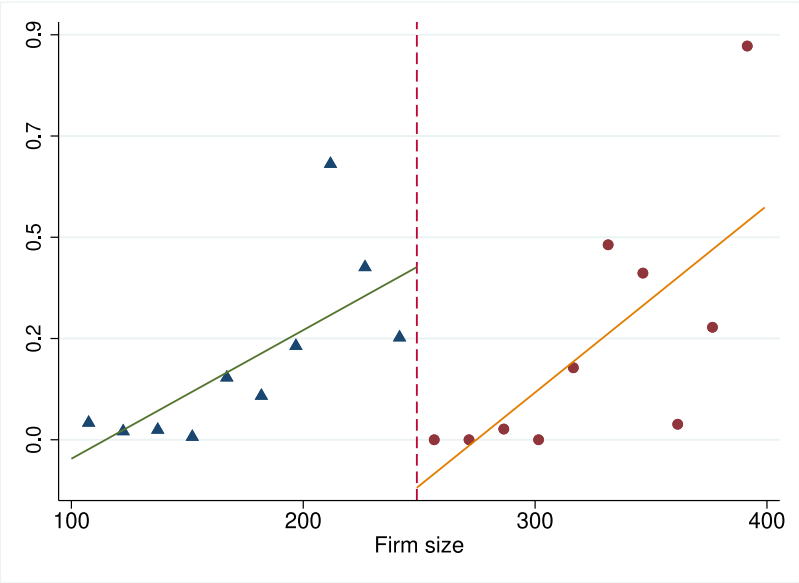

Fig. 2. The use of guarantees around the firm size threshold.
Notes: The figure displays guarantee usage according to the assignment variable (firm size) for firms, with the discontinuity at the threshold being 0.23 and within the bandwidth of 150. A linear fit is imposed on both sides of the cut-off. The dots correspond to the average use of the guarantees for a bin width of 10.

The outcomes of interest Y_{ijt} include the change in export status (goods and services) $\Delta \Pr(Exports > 0)_{ijt}$ and the log change in export values (goods and services) $\Delta \ln(Exports)_{ijt}$ between t and $t-1$. The former can alternatively be interpreted as the change in the probability of exporting. Thus, the estimations capture the effects of the guarantees as the difference-in-differences (DD) response of the extensive and intensive margins of trade for a given destination. Eqs. (8a) and (8b) also include industry-year and destination-year fixed effects (i.e., φ_{st} and φ_{jt}) to capture any industry-specific time trends and time-varying country characteristics, respectively.

The validity of the FRDD relies on the continuity assumption that the outcome of the second stage in Eq. (8b) is a continuous function of employment. As we have argued above, we find it implausible for firms to have precise control over their employment for the purpose of using the guarantees and thus sorting into treatment. Then, any jump in the response variable in proximity to the cut-off can be interpreted as a causal response. This local average treatment effect (LATE) is captured by parameter

$$\beta_1 = E[Y_{ijt}(1) - Y_{ijt}(0) | L_{it} = L^*], \tag{9}$$

where $Y_{ijt}(1)$ ($Y_{ijt}(0)$) denotes that the unit is exposed (not exposed) to treatment. Although the analysis focuses on a relatively narrow range of firm size for identification, the discontinuity gap in an regression discontinuity design can be interpreted as a weighted average treatment effect across all firms (Lee and Lemieux, 2010).

To address the potential for other covariates to be imbalanced across the cut-off, we combine the FRDD with covariate matching, using inverse propensity score weights.[20] Specifically, we estimate propensity scores (p) using a logit regression to predict the use of guarantees on a vector of baseline covariates, $\mathbf{X}_{ijt}$ (excluding the assignment variable of firm employment), along with industry and year fixed effects. Each observation at the firm-destination-year level receives an inverse probability of treatment weight (IPTW) to achieve balance in the distribution of covariates between two groups. In particular, treated (control) units are weighted $\frac{1}{p}$ ($\frac{1}{1-p}$). The IPTW is then multiplied by the kernel weight, and these new weights are used in the 2SLS estimation. In this way, the IPTW removes any remaining association between the baseline covariates and treatment.

The baseline covariates include measures at the firm and destination levels and are listed in Online Appendix Table A5. A full description is provided in Online Appendix B. Specifically, we use measures of firm output, inputs and their costs, trade intensities, the number of export destinations, and other firm characteristics related to their credit constraints as well as multinational status and foreign ownership. By accounting for the lag of key trade, output and input characteristics, we control for initial firm productivity while avoiding a range of assumptions and pitfalls associated with measuring total factor productivity (see, e.g., Hummels et al., 2014). At the destination level, we include standard gravity variables, financial development indicators from the Economic Freedom of the World database (Gwartney et al., 2022) to capture countries' capacity to provide external financing, as well as country credit

[20] RDD covariate matching or adjustment methods have been recently proposed, e.g., in Calonico et al. (2019), Frölich and Huber (2019), Angrist and Rokkanen (2015); and Linden and Adams (2012).

risk from the EKN to reflect both the risk of a government imposing barriers to transfer funds abroad and the risk of force majeure, such as natural or political disasters (e.g., war).

Additionally, we add a number of first-differenced variables (turnover, human and physical capital, wages and trade) and measures of foreign demand and supply shocks for firms' existing trade portfolio. Our underlying conjecture is that firms' intention to export, their realised exports and interest in backing from the EKN are all related to both foreign demand shocks and the firm's trajectory, with growing (shrinking) firms being more (less) prone to expand abroad, while the expected relation to seeking EKN backing is not as clear cut.[21] Our foreign trade shock variables draw on Hummels et al. (2014) and Munch and Schaur (2018), with details provided in Online Appendix B. Lastly, we employ industry and year fixed effects to control for industry-specific characteristics and macroeconomic shocks.

For these baseline covariates, we confirm their balance for firms just above and below the cut-off point, implying that there are no significant differences between the two groups of firms for the various characteristics considered. In Online Appendix Table A5, we use each of the baseline covariates as the response variable in a discontinuity regression, and the results are generally consistent with a pattern of random assignment around the discontinuity (Imbens and Lemieux, 2008). Out of the wide range of variables that we test, only a handful are associated with the treatment.[22] Thus, we observe no indication that there are systematic differences between firms above and below the cut-off.

Meanwhile, we also examine firm-level outcomes by estimating

$$D_{it} = a_0 + a_1 T_{it} + g(L_{it} - L^*) + \varphi_{st} + n_{it}, \tag{10a}$$

$$Y_{it} = b_0 + b_1 D_{it} + f(L_{it} - L^*) + \varphi_{st} + e_{it}. \tag{10b}$$

Here, the outcomes include changes in firm-level value added and employment. In these regressions, treatment D_{it} is defined as the use of a guarantee to any country, i.e., $D_{it} = \max_{c \in C} D_{ijt}$, where C is the set of countries.[23] To be consistent with the firm-destination-level regressions, industry-year fixed effects (i.e., φ_{st}) are also included.

4.2. Empirical results

In Table 4, we present our FRDD results from the quasi-natural experiment in Sweden. In this section, we examine the effects at both time t, the year in which the guarantee is issued, and also at $t+1$. Analogously, the outcome at $t+1$ is defined as the difference with $t-1$ and accounts for the situation in which the dispatch of exports occurs in the following calendar year. The EKN distinguishes between two dates: (i) the date of request for the export credit guarantee by the firm and (ii) the date of risk, i.e., when the exporter delivers the exports and the likelihood of non-payment arises. For the issued guarantees in our FRDD estimation sample, the average difference between the dates of request and risk is 5.2 months, which is quite close to the mean of the entire sample (6.7 months). Meanwhile, the difference in the year of the dates is zero (i.e., within the same calendar year) for 54% of the guarantees in the estimation sample and one for 43%, which justifies the focus on the immediate effects of the guarantees. To cleanly identify the impact of a single guarantee obtained by the firm, we exclude from the sample firms that use a guarantee in the same destination at $t+1$.

Panel A displays the 2SLS regression results from estimating equation (8) at the firm-destination level, and Panel B shows the results from estimating equation (10) at the firm level. We estimate the mean squared error optimal bandwidths for each of the firm-destination outcomes following Calonico et al. (2017). For consistency, average bandwidths for the outcome variables at t and $t+1$ are used, such that we have the same estimation sample across the different regressions. We repeat this process at the firm level. Starting with results for the first stage at the firm-destination level, we encouragingly find evidence for a discontinuity in the use of export credit guarantees around the threshold of 250 employees. The probability of using a guarantee in a destination for firms just below the cut-off that are exposed to the treatment is roughly 17 percentage points higher than that for firms just above the cut-off, which were not contacted by the EKN through the mailing campaign. This estimate is both statistically and economically significant and suggests that the EKN's marketing campaign was effective in promoting the use of its export credit guarantees. The Kleibergen–Paap test statistics strongly suggest that the first-stage instrument is relevant. We obtain the same qualitative finding in Panel B at the firm level, but the magnitude is higher, given that treatment is defined as any use of a guarantee across destinations.

Next, we turn to the second-stage results on firm performance. The sample consists of firms (both treated and control) that have never used a guarantee before, so these estimated effects capture the impacts for the first-time use of a guarantee. In Panel A, we analyse the causal effects of the guarantees on firms' export performance. Our findings provide strong support for Conjecture 1, namely, the positive effects of guarantees on exports. The use of an export credit guarantee increases both the probability of exporting and the value of exports to the targeted destination relative to the control group. Thus, the government guarantee is successful in promoting exports at both the extensive and intensive margin. The baseline estimates imply that the probability of exporting to a country for firms that acquire a guarantee is 9.1 percentage points higher (relative to the prior year) compared to those that do not.

[21] A growing firm may be receptive to means to assist its expansion abroad, but it is also feasible that shrinking firms are under even stronger pressure to find such means.

[22] Our results are robust to including these variables in estimation (see Online Appendix Table A6).

[23] To estimate propensity scores, we aggregate destination-specific variables up to the firm-level using the share of exports by the firm to a destination at time t as weights.

Table 4
Baseline results with FRDD.

	Panel A: Firm-destination-level outcomes				
		Outcomes at t		Outcomes at t+1	
Dependent variable	Guarantee use	Δ1(Exports > 0)	Δln (Exports)	Δ1(Exports > 0)	Δln (Exports)
	(1)	(2)	(3)	(4)	(5)
Employment<250	**0.171**				
	(22.46)				
Guarantee use		**0.091**	**1.211**	**0.102**	**1.620**
		(2.12)	(2.56)	(2.26)	(2.79)
Industry-year FE	Y	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y	Y
1st stage F-statistic	254.07				
Kleibergen–Paap rk LM (p-value)	< 0.01				
Kleibergen–Paap Wald rk F-statistic	504.28				
Bandwidth estimate	95	95	95	95	95
Observations	34,080	34,080	34,080	34,080	34,080
	Panel B: Firm-level outcomes				
		Outcomes at t		Outcomes at t+1	
Dependent variable	Guarantee use	Δln(Value added)	Δln(Employment)	Δln(Value added)	Δln(Employment)
	(1)	(2)	(3)	(4)	(5)
Employment<250	**0.668**				
	(10.22)				
Guarantee use		−0.147	−0.117	−0.826	0.019
		(−0.37)	(−0.75)	(−1.73)	(0.04)
Industry-year FE	Y	Y	Y	Y	Y
1st stage F-statistic	58.27				
Kleibergen–Paap rk LM (p-value)	< 0.01				
Kleibergen–Paap Wald rk F-statistic	104.52				
Bandwidth estimate	86	86	86	86	86
Observations	1,221	1,221	1,221	1,221	1,221

Notes: The table displays our FRDD estimates of the local average treatment effects ($LATE$) of guarantees. Regressions include industry-year and destination-year fixed effects for firm-destination responses and industry-year fixed effects for firm responses. All continuous variables are in logarithms, with 1e−6 added to export values to avoid truncation. Mean squared error optimal bandwidths are employed following (Calonico et al., 2017), with a triangle kernel weight. IPTW is applied in both stages of the 2SLS estimation. t-statistics from standard errors clustered at the firm-destination (firm) level are displayed in parentheses in Panel A (B). Coefficients in bold denote $p < 0.05$.

At the intensive margin, the use of a guarantee raises the value of exports to a destination by more than a factor of three (i.e., $\exp(1.211) \approx 3.357$). This suggests that the export credit guarantee increases the value of sales to the destination for which the guarantee is issued by a large positive amount. Admittedly, our results are based on a restricted sample of firms for which the EKN's marketing campaigns were relevant (i.e., around the employment threshold and with previous export experience). As mentioned, we also excluded firms that have used guarantees in the past. The number of firms, share of trade and use of guarantees represented by this sample are small and caution is warranted in interpreting the magnitudes of the effects. However, there are potential reasons for the large responses observed. Given that the EKN acts as the guarantor of last resort, the firm is unlikely to secure financing without the guarantee for exports to its intended destination. Both the firm itself and banks are unwilling to provide financing due to the risk of buyer default. Indeed, many firms are not exporting to the destination of the issued guarantee in the year prior. In our estimation sample, close to 20% of the treated observations (i.e., firm-destinations that use a guarantee) have strictly positive exports after zero exports in the year before. For the remaining treated observations, the raw growth rates are also extremely large at an average of 172%. Consistent with the overall decline in Swedish exports over this sample period, the mean growth rate for the untreated observations is negative at approximately −8%. Therefore, the raw statistics alone reveal a substantial difference in the outcomes of the treated and untreated observations. The magnitudes of the estimates obtained from the regression results are consistent with these statistics.

In Panel B, we test Conjecture 2 by analysing the effects of the treatment on other measures of firm performance, specifically, value added and employment. Here, treatment is defined as the use of a guarantee to any country. We do not find evidence in support of Conjecture 2, as the estimated effects of the export credit guarantees are statistically insignificant. In fact, the baseline results show a negative impact of the guarantees in columns 2 to 4, though the coefficients are imprecisely estimated. Nonetheless, our insignificant results on employment contrasts with the results of a German study on a sample of predominantly larger firms that finds a positive and statistically significant firm-level job impact of guarantees (Felbermayr et al., 2012). These different findings could potentially be explained by the size of the firms that are in the samples of interest. Our empirical strategy relies on the analysis of SMEs. As mentioned in Section 3.2, these firms are mostly marginal exporters, so domestic sales still account for the vast majority (over 90%) of total sales.

Moreover, from Table 1, we know that exports to the destination countries for which the guarantees are issued constitute a small fraction of Swedish sales abroad. Instead, the EU and other OECD countries account for the vast majority of exports. At the firm

level, the average shares of total sales and exports sold in the destination of the guarantee in the FRDD sample are only 5.5 and 17.9%, respectively. The median values are even smaller at 0.7 and 3.1%, respectively. Hence, the effects of the guarantee, while large and pronounced in foreign markets, do not appear to be important for increasing the overall size of firms. Our results suggest that at least in the short-run, firms appear to be capable of producing the exports backed by the export credit guarantee without having to significantly expand their workforce.

4.2.1. Robustness

We test the robustness of our FRDD results using alternative bandwidths and specifications as well as a non-parametric estimator. Reassuringly, these additional results at the firm-destination level are qualitatively consistent with our baseline findings above and are also statistically significant. Our baseline parametric FRDD estimator employs a data-driven method for choosing the optimal bandwidth. In Online Appendix Table A6, we vary the bandwidth by 50 and 200%, i.e., half and double, respectively (McCrary, 2008). Results from the former are similar to the baseline, while estimates at the intensive margin for the latter are smaller but still sizeable.

We also perform robustness checks using a non-parametric FRDD estimator and alternative specifications and samples. As before, the aim is to estimate the LATE around the discontinuity of 250 employees. Due to the high dimensions involved at the destination and firm margins, we can no longer include fixed effects when employing the non-parametric FRDD estimator. Thus, to make a valid comparison, Online Appendix Table A6 presents results from using the parametric and non-parametric estimators excluding any fixed effects. In both cases, being just below the threshold increases exports to the country of the guarantee at both the extensive and intensive margins. Although the estimated effects are smaller compared to our baseline estimates, they remain statistically significant. Additionally, our main findings are robust to including imperfectly balanced baseline covariates in the estimation and to exclude industries outside of manufacturing and wholesale and retail trade for both the sample of firms below and above the 250 threshold.

5. Empirical analysis with DD matching estimator

5.1. Empirical strategy

As a complementary strategy to our FRDD, we employ a difference-in-differences (DD) propensity score matching (PSM) estimator (e.g., Rosenbaum and Rubin, 1983; Heckman et al., 1997), which relies on the matching of time-varying observable characteristics to control for the potential non-random selection of guarantee users. This complementary approach serves two purposes. First, we establish the robustness of our FRDD results using an alternative estimation method. Second, and perhaps more importantly, we expand on the sample of firms that are medium sized or just above the cut-off in the FRDD analysis to a larger sample that allows us to more fully conduct a heterogeneity analysis. We estimate propensity scores using a large number of characteristics in addition to employment, which makes the DD estimator especially suitable because of our uniquely rich population data (e.g., Heckman et al., 1999; Smith and Todd, 2005). By controlling for common support, we ensure that firm-destination pairs that use guarantees (treated) and those that do not use guarantees (controls) have similar pre-treatment distributions for the selection variables.[24] This approach thereby mimics a comparison of the de facto outcome with its counterfactual.

We implement this DD matching estimator by first estimating the propensity scores with a logit model based on observables $\mathbf{W}_{ijt}$ along with industry and year fixed effects. To more closely align with our FRDD setting, the observables include firm employment. The richness of the data presented in Section 3 allows us to condition the analysis on an unusually large number of observable pre-treatment characteristics of firms, industries and countries. For identification, we select the variables that affect both the selection into using export credit guarantees and the outcome (De Luna et al., 2011). Thus, we substantially limit the risk that unobserved heterogeneity between the treated and controls may affect the response variables. Next, we employ a matching procedure with replacement, where a treated firm-destination dyad is matched with its three closest non-treated matches in terms of the propensity score in the same year.[25] The matching performs well, with the percentage bias being low overall, also individually for each variable, and generally statistically non-significant (see Online Appendix Table A7).

The estimated propensity scores capture the conditional *ex ante* probability ($p(\mathbf{W}_{ijt})$) of using guarantees for exports to foreign destination j. Now, we estimate the average treatment effect on the treated (ATT), which captures the mean changes in the outcomes of the treated and untreated groups:

$$\delta = \left[Y_{ijt}(1) - Y_{ijt}(0) | D_{ijt} = 1, p(\mathbf{W}_{ijt})\right]. \tag{11}$$

Treatment is the use of a guarantee, as before, and we drop observations where the firm-destination pair has previously used a guarantee. The (matched) control group comprises firm-destinations that share similar characteristics $\mathbf{W}_{ijt}$ without a guarantee. The DD matching estimator further assumes that conditional independence holds, i.e., treatment is randomly assigned conditional on

[24] The DD matching estimator also offers flexibility in the form of fewer parametric assumptions than if we use, for example, OLS regression as a complementary strategy. An additional advantage relative to, e.g., within regressions is that we can abstain from assuming that past outcomes (e.g., exports and employment) do not affect the selection into treatment (Imai and Kim, 2017).

[25] After matching, for the treated, we are left with 703 firm-destination observations and 329 firms, while for the matched controls, we have 2,101 firm-destination observations and 1,192 firms. Note that the dyads are not allowed to be their own controls in the years when they did not acquire guarantees since matching is at the firm-destination-year level.

Table 5
Baseline results with DD matching estimator.

	Panel A: Firm-destination-level outcomes			
	Outcomes at t		Outcomes at $t+1$	
Dependent variable	ΔPr (Exports > 0)	Δln (Exports)	ΔPr (Exports > 0)	Δln (Exports)
	(1)	(2)	(3)	(4)
Guarantee use	**0.164**	**2.454**	**0.043**	**0.797**
	(9.99)	(11.51)	(2.47)	(3.53)
Industry-year FE	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y
Observations	2,804	2,804	2,804	2,804
	Panel B: Firm-level outcomes			
	Outcomes at t		Outcomes at $t+1$	
Dependent variable	Δln(Value added)	Δln(Employment)	Δln(Value added)	Δln(Employment)
	(1)	(2)	(3)	(4)
Guarantee use	−0.086	0.086	0.479	0.206
	(−0.37)	(0.70)	(1.39)	(1.52)
Industry-year FE	Y	Y	Y	Y
Observations	1,819	1,819	1,819	1,819

Notes: The table displays our DD matching estimates of the average treatment effects on the treated (ATT) of guarantees. Regressions include industry-year and destination-year fixed effects for firm-destination responses and industry-year fixed effects for firm responses. All continuous variables are in logarithms, with 1e−6 added to export values to avoid truncation. A common support restriction is imposed. t-statistics from robust standard errors are displayed in parentheses in Panel A (B). Coefficients in bold denote $p < 0.05$.

observables. Moreover, the estimator is unbiased even in the presence of systematic differences in the unobserved time-invariant characteristics (between the treated and controls) as such characteristics are differenced out. We further add industry-year and destination-year fixed effects when examining firm-destination level outcomes to control for any remaining unobserved *time-varying* industry and destination heterogeneity that could bias the results.

Although our interest is in the effects of guarantees, we identify several patterns with respect to the factors that are strongly correlated with using them. *Ceteris paribus*, greater trade activity as captured by the number of export destinations is associated with a higher likelihood of guarantee use. The probability of adopting guarantees is also higher for domestic as opposed to foreign-owned firms and for firms with a higher share of skilled workers (as measured by post-secondary education). At the destination level, we find increased guarantee use in riskier destination countries.

5.2. Empirical results

Table 5 presents the DD matching estimator results on the impact of export credit guarantees. The coefficients represent the average treatment effects on the treated (ATT), where we match firm-destination dyads that have guarantees (treated) at time t to similar dyads without guarantees (controls). Results are shown for outcomes at times t and t+1; as before, we drop firms that use guarantees in both years. For this estimation sample, the mean difference between the dates of request and risk is 5.1 months, which again is similar to the average of all guarantees. Roughly two-thirds of the guarantees' dates of request and risk occur in same calendar year, and the remaining one-third have a one year gap.

In Panel A, we find qualitatively similar effects from the use of guarantees at the firm-destination level compared to the FRDD results around the employment threshold.[26] The results strongly support Conjecture 1 that guarantees promote sales into foreign markets. At the extensive margin, our estimates of the ATT suggest that the use of guarantees increases the probability of exporting in the same (following) year by 16.4 (4.3) percentage points. Meanwhile, we find large effects at the intensive margin at time t and a smaller but still statistically significant effect at time $t+1$. For this sample, the share of firms that have strictly positive exports to the destination of the issued guarantee after zero exports is approximately 19%, which is similar to the FRDD sample. The average growth rate for the remaining treated observations is even larger than that of the FRDD sample at 276%. Overall, these statistics confirm the idea that in the absence of guarantees, firms have a very low level of exports to the destination countries for which the guarantees are issued.

The firm-level regressions are shown in Panel B. The evidence presented also suggests that the responses in firm performance as measured by value added and total employment are small. This is consistent with our FRDD findings, even though the sample here includes treated firms that are not necessarily SMEs with around 250 employees. We obtain positive coefficient estimates on

[26] We also compared our results on export values at the firm-level with the findings of two other micro-level studies on the subject, with our estimates being in between them (Badinger and Url, 2013; Heiland and Yalcin, 2021). We note that our empirical setting is quite different from these studies, as it employs firm-destination-year panel data (18 years) for the population of firms, matches on a uniquely wide range of pre-treatment characteristics at several levels, and estimates the DD matching results of the guarantee treatment for all the treated firms.

Table 6
Heterogeneity by first time use of guarantee in region.

	Panel A: Outcomes at t					
Dependent variable	ΔPr (Exports > 0)			Δln (Exports)		
First time use in	Destination	Same region	Other regions	Destination	Same region	Other regions
	(1)	(2)	(3)	(4)	(5)	(6)
Guarantee use	**0.164**	0.010	−0.004	**2.454**	0.134	−0.024
	(9.99)	(0.04)	(−0.91)	(11.51)	(1.12)	(−0.45)
Industry-year FE	Y	Y	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y	Y	Y
Observations	2,804	9,282	42,412	2,804	9,282	42,450
	Panel B: Outcomes at $t+1$					
Dependent variable	ΔPr (Exports > 0)			Δln (Exports)		
First time use in	Destination	Same region	Other regions	Destination	Same region	Other regions
	(1)	(2)	(3)	(4)	(5)	(6)
Guarantee use	**0.043**	**0.012**	**0.009**	**0.797**	**0.028**	**0.004**
	(2.47)	(2.26)	(2.46)	(3.53)	(2.22)	(2.45)
Industry-year FE	Y	Y	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y	Y	Y
Observations	2,804	9,282	42,412	2,804	9,282	42,450

Notes: The table displays our DD matching estimates of the average treatment effects on the treated (ATT) of guarantees. Regressions include industry-year and destination-year fixed effects for firm-destination responses and industry-year fixed effects for firm responses. All continuous variables are in logarithms, with 1e−6 added to export values to avoid truncation. A common support restriction is imposed. See Online Appendix Table A11 for region definitions. t-statistics from robust standard errors displayed in parentheses. Coefficients in bold denote $p < 0.05$.

employment, but they are not statistically significant in either year. Therefore, even with this alternative estimation method, the impact of the guarantees on overall firm-level outcomes appears weak. Similar to the FRDD sample, exports to the destination of the issued guarantee only contribute to a small fraction of total firm-level sales. The average (median) shares of total sales and exports accounted for by the destination of the guarantee are 5.5 and 12.2% (1.3 and 2.7%), respectively.

Next, we also examine whether there are spillover effects to other countries. Table 6 estimates the impact of the guarantees on exports to other countries in the same region as the destination of the issued guarantee and on exports to any other region in the world. The baseline DD matching estimates from Table 5 are included for ease of comparison. These are consistently the largest and suggest that by addressing the problem of buyer default risk, guarantees have the strongest direct effects in their targeted destination. We also find a positive but weaker impact in neighbouring countries of the same region, and the weakest impact is observed in the rest of the world. One potential explanation for this pattern is that guarantees ease liquidity constraints to facilitate firms' entry into neighbouring markets. Alternatively, by entering the destination of the issued guarantee, firms may establish networks to these other countries or learn about them through knowledge spillovers, i.e., due to extended gravity forces (e.g., Chaney, 2014; Albornoz et al., 2012; Morales et al., 2019). We provide evidence in Section 5.3 below that is consistent with former explanation, but we cannot rule out the latter. Nonetheless, the positive spillovers estimated in Table 6 have important policy implications. Given that guarantees are usually issued for exports to regions with higher risk, government credit agencies should understand that their instruments have potential positive externalities within the region.

5.2.1. Robustness

Here, we demonstrate that our DD matching estimates survive a battery of robustness checks. First, in Online Appendix A8, we exclude the largest transactions from the observations of the treatment group to show that our results are not driven by any outliers of firms with very large guarantee deals. Specifically, we drop either the top 10 largest transactions or those above 500 million SEK. Second, we divide the sample into three time periods: before (2000–2007), during (2008–2012) and after (2013–2017) the global financial crisis. In general, we find positive impacts across all three periods, However, larger estimates are obtained during the global financial crisis, especially at the intensive margin. The results imply that transactions benefit more from the guarantees when firms are faced with negative macroeconomic shocks, in particular, in financial markets.

Third, our findings remain robust to alternative matching methods. Specifically, we instead match to the first nearest neighbour and separately, employ a kernel matching estimator. We also estimate a "naive" model that only matches treated and control firm-destination dyads on a subset of $\mathbf{W}_{ijt}$, namely, turnover, employment, physical capital stock, firm age, export and import status and intensities. Comparisons with the baseline results suggests that omitting a wide range of firm, industry and country characteristics may lead to bias and overestimation.[27]

[27] Compared to the naive model, both the AIC and BIC values are much smaller in the main DD matching specification, which indicates the preference for the main DD specification in terms of both goodness of fit and the avoidance of overfitting.

Fourth, we conduct placebo tests by demonstrating that "pseudo-treatments" do not affect firms' bilateral exports. In essence, this means testing the so-called unconfoundedness assumption — namely, that the treatment is exogenous (Imbens and Wooldridge, 2009). We construct a pseudo-treatment by re-coding the data such that the treatment appears to occur in destination-years when there was, in fact, no treatment. We then apply the DD matching estimator. If identification holds, then we should observe no impact. Reassuringly, the difference in the estimated outcomes of the pseudo-treatment between treated and non-treated firms are not statistically significant. The coefficients are much smaller in magnitude or even have the opposite sign compared to those of the main estimations.

Finally, there is a potential concern that the staggered timing of the treatment (i.e., guarantee use) may bias our DD matching estimates in the presence of effect heterogeneity (e.g., Callaway and Sant'Anna, 2021; Baker et al., 2022). To address this issue, we employ the "imputation" estimator from Borusyak et al. (2021).[28] Compared to the baseline results, we obtain quantitatively similar estimates using this alternative estimation method (see Online Appendix Table A9). Importantly, we do not find evidence for any pre-trends that would violate the parallel trends assumption, either in terms of the export probability or values.

5.3. Heterogeneity analysis

In this section, we exploit the variation across destination, firm and product characteristics to further understand the role of the export credit guarantees in promoting trade. Unfortunately, we do not have access to direct measures of credit constraints (see, e.g., Minetti and Zhu, 2011 and Muûls, 2015) and must rely on indirect measures to infer the extent of financial distress that firms face. Nonetheless, our results using these indirect measures are consistent with the mechanisms discussed in our conceptual framework. The results below suggest that guarantees alleviate the liquidity constraints that firms face and also benefit exporters that sell certain types of products for which the relative cost of buyer default risk is higher. As mentioned, for two-thirds of the guarantees in the estimation sample, exports are delivered in the same year as when the guarantees are requested. Therefore, we focus on the immediate effects at time t, when variation across guarantee and non-guarantee use is the largest.[29]

5.3.1. Destination heterogeneity

From Conjecture 3, we expect the impact of guarantees to be more pronounced when liquidity constraints are tighter. In Table 7, we first consider the heterogeneity of destinations at a broad level to examine this hypothesis. In particular, OECD countries tend to have stronger legal institutions in terms of their rule of law and contract enforcement.[30] Hence, exporters generally face greater risks in non-OECD countries, including that of buyer default. In our conceptual framework, this lowers expected revenues and raises the costs of external financing, which further implies that the guarantees are expected to have a larger impact. We find evidence consistent with this idea in Table 7 Panel A. The positive effects of guarantees are mainly driven by sales abroad to non-OECD countries, which suggests that they are more effective in promoting trade towards riskier destinations. The probability of exporting to these destinations is more than twice as large as that of OECD countries after adopting the guarantees. Likewise, export value growth is also substantially larger.

In Table 7 Panels B and C, we instead split destinations by their risk classifications. The EKN makes assessments for the risk of payment problems in each country. In Panel B, the country risk categorisation depends on various political, economic and financial factors in the nation, and also considers of the risks of action by its public authorities and how its business environment may affect individual transactions. Meanwhile, debtor risk categories in Panel C capture the foreign debtor's creditworthiness, with lower categories representing governments, banks and well-established companies, and higher categories representing weak companies or companies with certain project risks. Compared to Panel A, we obtain findings that are qualitatively similar at both the extensive and intensive margins.

5.3.2. Firm heterogeneity

Next, we investigate the heterogeneous effects of the guarantees across firms, in particular, with regards to the liquidity constraints that they face. Because industries vary in their liquidity and working capital requirements, we exploit the *within-industry* variation to compare firms operating in the same industry. Hence, for each measure of credit constraint that we employ, we compute the median across exporters that receive a guarantee in a given 2-digit industry and year. We use this median value to split the sample of treated firms. In doing so, we contrast exporters that face tight liquidity constraints against those that are less credit constrained. We then perform propensity score matching separately for the groups of firms above and below the median. This means that the matched control group is similar not only in the same set of characteristics as before but also in their relative level of credit constraints. Lastly, we run separate regressions for the samples above and below the median to compare the impact of the guarantees on exporter performance across the two groups.

In Table 8, we begin with the standard measure of external finance dependence, defined by the share of firm investment that is not financed via internal cash flows. This is computed at the firm-level using the information provided by the Swedish register data following the methodology in Rajan and Zingales (1998). Table 8 displays the differential average treatment effects on the treated for the samples above and below the median. The results strongly support Conjecture 3, demonstrating that the guarantees have

[28] This estimator is constructed using the estimated fixed effects from the subsample of untreated observations to impute the untreated potential outcomes and hence, the estimated treatment effect for each treated observation (Borusyak et al., 2021).

[29] Results for $t+1$ are generally qualitatively similar and available upon request.

[30] We account for all EU and OECD countries under the heading of the OECD, although a handful of the EU countries are not yet members of the OECD.

Table 7
Heterogeneity across destinations.

	Panel A: OECD vs. other countries			
Dependent variable	Δ Pr (Exports > 0)		Δ ln (Exports)	
Destination	OECD	Other countries	OECD	Other countries
	(1)	(2)	(3)	(4)
Guarantee use	**0.088**	**0.191**	**1.423**	**2.812**
	(3.52)	(9.23)	(4.40)	(10.51)
Industry-year FE	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y
Observations	846	1,960	846	1,960
	Panel B: Destination country risk			
Dependent variable	Δ Pr (Exports > 0)		Δ ln (Exports)	
Country risk category	0–2	3–7	0–2	3–7
	(1)	(2)	(3)	(4)
Guarantee use	**0.140**	**0.183**	**2.447**	**2.618**
	(5.56)	(8.51)	(7.61)	(9.93)
Industry-year FE	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y
Observations	1,008	1,772	1,008	1,772
	Panel C: Destination debtor risk			
Dependent variable	Δ Pr (Exports > 0)		Δ ln (Exports)	
Debtor risk category	1–4	5–6	1–4	5–6
	(1)	(2)	(3)	(4)
Guarantee use	**0.160**	**0.257**	**2.471**	**2.794**
	(9.48)	(3.31)	(11.17)	(3.29)
Industry-year FE	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y
Observations	2,644	156	2,644	156

Notes: The table displays our DD matching estimates of the average treatment effects on the treated (ATT) of guarantees. Regressions include industry-year and destination-year fixed effects. All continuous variables are in logarithms, with 1e−6 added to export values to avoid truncation. A common support restriction is imposed. In Panel B, country risk is measured on a scale of 0 to 7, with 0 being the lowest risk. In Panel C, debtor risk is measured on a scale of 1 to 6, with 1 being the lowest risk. A risk of 1 to 4 is associated with government debtors, banks, other public debtors and well-established companies. A risk of 5 to 6 is associated with weak companies and companies with certain project risks. t-statistics from robust standard errors are displayed in parentheses. Coefficients in bold denote $p < 0.05$.

larger effects on exporters that require more outside capital. Comparing the performance of treated firms against control firms with a similar level of credit constraints, we find that the probability of exporting and the value of exports are both higher for the group of liquidity constrained firms. Next, in Panel B, we instead directly apply the industry-level external finance dependence measures from Rajan and Zingales (1998). In order to accommodate firms in service industries, which were not covered by Rajan and Zingales (1998), we first convert the HS 6-digit codes of exported products into the ISIC Rev. 2 industry classification. For each firm, we then compute the weighted average over exported products. Compared to our previous results, we obtain qualitatively similar findings at both the extensive and intensive margins using this alternative measure.

The remainder of Table 8 shows corroborating evidence for Conjecture 3 even when we examine other firm-level measures of financial health. Specifically, we employ the quick ratio and the EBIT-interest coverage ratio to capture the liquidity and solvency of the firm, respectively. The quick ratio is the share of current assets other than inventory to current liabilities, indicating whether the firm's short-term assets are sufficient to meet its short-term liabilities.[31] Meanwhile, the EBIT-interest coverage ratio is the share of earnings before interest and taxes to interest expenses, capturing the firm's ability to comply with the interest obligations to its creditors. Generally, export credit guarantees have a stronger impact on the export performance of firms with relatively poor financial health. This result has important policy implications. If firms that struggle to meet their short and long term debt obligations also have difficulties in securing trade finance, for example, from banks, then the EKN's role as the guarantor of last resort becomes even more significant. Without this government credit agency, firms that are less financially sound may be unable to reach foreign markets.

In Table 9, we examine the heterogeneity with respect to firm size, which serves as an alternative proxy for financing constraints (Heiland and Yalcin, 2021). The results shows that micro and small firms experience the largest effects, again, both

[31] The quick ratio is more stringent a measure of liquidity than, e.g., the current ratio, which includes the less liquid assets of inventory in the numerator.

Table 8
Heterogeneity by liquidity constraints.

	Panel A: External finance dependence (firm)			
Dependent variable	Δ1Pr (Exports > 0)		Δln (Exports)	
Sample split by median	Below	Above	Below	Above
	(1)	(2)	(3)	(4)
Guarantee use	**0.159**	**0.251**	**2.427**	**3.823**
	(9.72)	(2.78)	(11.41)	(3.29)
Industry-year FE	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y
Observations	1,847	1,122	1,847	1,122
	Panel B: External finance dependence (industry)			
Dependent variable	Δ1Pr (Exports > 0)		Δln (Exports)	
Sample split by median	Below	Above	Below	Above
	(1)	(2)	(3)	(4)
Guarantee use	**0.153**	**0.208**	**2.378**	**2.948**
	(9.02)	(3.98)	(10.67)	(4.55)
Industry-year FE	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y
Observations	2,666	294	2,666	294
	Panel C: Quick ratio			
Dependent variable	Δ1Pr (Exports > 0)		Δln (Exports)	
Sample split by median	Below	Above	Below	Above
	(1)	(2)	(3)	(4)
Guarantee use	**0.167**	**0.153**	**2.707**	**2.193**
	(7.37)	(6.56)	(9.14)	(7.39)
Industry-year FE	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y
Observations	1,524	1,425	1,524	1,425
	Panel D: EBIT-interest coverage			
Dependent variable	Δ1Pr (Exports > 0)		Δln (Exports)	
Sample split by median	Below	Above	Below	Above
	(1)	(2)	(3)	(4)
Guarantee use	**0.205**	**0.117**	**2.947**	**1.955**
	(9.77)	(4.64)	(10.95)	(5.72)
Industry-year FE	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y
Observations	1,915	1,039	1,915	1,039

Notes: The table displays our DD matching estimates of the average treatment effects on the treated (*ATT*) of guarantees. Regressions include industry-year and destination-year fixed effects. All continuous variables are in logarithms, with 1e−6 added to export values to avoid truncation. A common support restriction is imposed. *t*-statistics from robust standard errors are displayed in parentheses. Coefficients in bold denote $p < 0.05$.

for the likelihood of exporting and the value of exports.[32] This inverse relation between the impact on export performance and firm size suggests that guarantees facilitate the entry of smaller, more liquidity-constrained firms into foreign markets. The estimated coefficients for large firms with 250 or more employees are substantially smaller than those for medium-sized firms with 50 to 249 employees, by roughly a factor of three. Comparisons to the micro and small firms are even more striking, as the effects of large firms at both the extensive and intensive margins are only approximately one-fifth of the impact observed on this group of small firms.

5.3.3. Product heterogeneity

In addition, we exploit the variation of product characteristics that influence the relative cost of buyer default to the exporting firm. Our results provide additional evidence that the guarantees play an important role in addressing buyer default risk. First, when the products are produced and the contracted buyer defaults, the exporter can try to find secondary buyers to recover some portion of its costs. Because markets for differentiated products are thinner compared to those of homogeneous and reference-priced products, exporters of differentiated products have fewer alternative buyers. In the conceptual framework, the equivalent interpretation for this

[32] The guarantees also have a larger impact on exporters in service industries compared to manufacturing (Online Appendix Table A10). This is consistent with the fact that, in the data, we find service firms in Sweden to be on average substantially smaller than their manufacturing peers.

Table 9
Heterogeneity by firm size.

Dependent variable	Δ Pr (Exports > 0)			Δ ln (Exports)		
Sample	Micro and small firms	Medium firms	Large firms	Micro and small firms	Medium firms	Large firms
	(1)	(2)	(3)	(4)	(5)	(6)
Guarantee use	**0.266**	**0.157**	**0.049**	**3.812**	**2.585**	**0.827**
	(8.71)	(5.19)	(2.42)	(9.97)	(6.27)	(3.02)
Industry-year FE	Y	Y	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y	Y	Y
Observations	1,101	753	928	1,101	753	928

Notes: The table displays our DD matching estimates of the average treatment effects on the treated (ATT) of guarantees. Regressions include industry-year and destination-year fixed effects. All continuous variables are in logarithms, with 1e−6 added to export values to avoid truncation. A common support restriction is imposed. Firm (workforce) size categories are: micro and small, <50; medium, 50–249; large, ≥250 employees. t-statistics from robust standard errors are displayed in parentheses. Coefficients in bold denote $p < 0.05$.

Table 10
Heterogeneity by product characteristics.

	Panel A: Differentiated products			
Dependent variable	Δ Pr (Exports > 0)		Δ ln (Exports)	
Sample split by median	Below	Above	Below	Above
	(1)	(2)	(3)	(4)
Guarantee use	**0.154**	**0.194**	**2.195**	**2.871**
	(7.45)	(7.63)	(8.08)	(8.88)
Industry-year FE	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y
Observations	1,726	1,240	1,726	1,240
	Panel B: Letter-of-credit intensity			
Dependent variable	Δ Pr (Exports > 0)		Δ ln (Exports)	
Sample split by median	Below	Above	Below	Above
	(1)	(2)	(3)	(4)
Guarantee use	**0.175**	**0.164**	**2.556**	**2.422**
	(7.00)	(7.57)	(8.14)	(8.56)
Industry-year FE	Y	Y	Y	Y
Destination-year FE	Y	Y	Y	Y
Observations	1,292	1,652	1,292	1,652

Notes: The table displays our DD matching estimates of the average treatment effects on the treated (ATT) of guarantees. Regressions include industry-year and destination-year fixed effects. All continuous variables are in logarithms, with 1e−6 added to export values to avoid truncation. A common support restriction is imposed. t-statistics from robust standard errors are displayed in parentheses. Coefficients in bold denote $p < 0.05$.

difference in recovery rates is a decrease in the probability of payment and lower expected revenues for differentiated as opposed to non-differentiated products. Without a guarantee, the relative cost of buyer default is higher for exporters of differentiated products; hence, the guarantees are expected to have a larger impact.[33] Accordingly, we employ the Rauch (1999) classification to distinguish differentiated and non-differentiated products. First, HS 6-digit products are converted to the SITC Rev. 2 classification of goods. We then compute the firm's share of differentiated products exported across global markets. Again, we split the treated firms by the median of this measure and implement the DD matching estimator separately for each sample. In Table 10 Panel A, we indeed find larger estimated coefficients in the sample of exporters that sell more differentiated products, suggesting that the guarantees are more important when the relative cost of buyer default is higher.

Finally, we employ the "letter of credit-intensity" measure from Crozet et al. (2022). This variable captures the average use of letters of credit by exporters at the HS 4-digit product level and is constructed using information on firms' financing mode from the Turkish customs trade data. On the one hand, firms that do not use letters of credit intensively may be less reliant on trade financing and thus may also experience smaller gains from adopting export credit guarantees. On the other hand, they may be more dependent on the guarantees given that other sources of financing are unavailable. In other words, without the guarantee, the costs of external financing (i.e., R^B in the conceptual framework) and equivalently, the relative cost of buyer default, are both higher. Empirically, the results in Table 10 Panel B suggest that this latter channel dominates. The export credit guarantees have stronger effects on exporters of products for which bank financing is less abundant.

[33] For simplicity, consider the version of the conceptual framework without liquidity constraints. Then, we have $\frac{\partial^2 a^{1-\varepsilon}}{\partial R^o \partial \lambda} \propto (\varepsilon - 2)(R^o)^{\varepsilon-3} \frac{\partial R^o}{\partial \lambda} \lambda - (R^o)^{\varepsilon-2} < 0$. Therefore, the guarantees have a more pronounced effect for products with lower recovery rates.

6. Concluding remarks

International trade involves significant risks, especially across long distances. With imperfect contract enforcement, exporters face uncertainty about their foreign buyers' ability or likelihood of payment, which is private information (Schmidt-Eisenlohr, 2013). Historically, traders, kin or middlemen have carried out trade, and arrangements have been made for protection and contract enforcement. With the development of institutions such as the community responsibility system in European communes and subsequent national courts, domestic trade has flourished (Greif, 2006). However, only a century ago, governments established an institution to facilitate foreign trade – specifically, government-backed export credit guarantees. Since the onset of the global financial crisis, the provision of export credit guarantees has doubled. In this paper, we investigate the role of this institution. In particular, we present novel and robust causal evidence on the effects of guarantees on firm performance, using the most granular and exhaustive longitudinal data to date in the literature.

Our results from the first quasi-natural experiment in the literature demonstrate that guarantees have a large, positive causal effect on export performance. Using a fuzzy regression discontinuity approach, we show that the probability of exporting and value of exports both rise significantly in the destination of the issued guarantee. On the other hand, the effects on jobs and value added, if any, are weak. We show that these results are robust to a difference-in-differences matching estimator. To further investigate the role of guarantees in resolving the information frictions associated with buyer default risk and in easing firms' liquidity constraints, we conduct a thorough heterogeneity analysis using the difference-in-differences matching estimator. Guarantees disproportionately assist exports to non-OECD countries, and for smaller, more liquidity-constrained exporters. In addition, they have a larger impact on firms selling products with a relatively higher cost of buyer default, such as differentiated goods. Overall, our results suggest that export credit guarantees mitigate information frictions to promote international trade.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We thank the editor, Matilde Bombardini, and two anonymous referees for their comments. We also thank Mårten Blix, Holger Breinlich, Holger Görg, Daniel Halvarsson, Dan Johansson, Henrik Jordahl, Anders Kärnä, Hildegunn Kyvik-Nordås, Patrick Nimander, Håkan Nordström, Maria Persson, Natália Pimenta Monteiro, Johanna Rickne, Fredrik Sjöholm and Maurizio Zanardi for their insightful feedback. We are also grateful to the numerous participants in reference groups, seminars, workshops and conferences for their helpful comments and the Swedish Export Credit Agency for supplying export credit guarantee data. We are responsible for all views expressed and any remaining errors. Lodefalk and Tang acknowledge financial support from Growth Analysis (grant no. 2016-149) and the Torsten Söderberg Research Foundation (grant no. E38-16).

Appendix A. Online appendix

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jinteco.2023.103831.

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