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Trade Conflicts and Credit Supply Spillovers: Evidence From The Nobel Peace Prize Trade Shock*

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Abstract

In this paper, we examine how a trade conflict's impact on the real economy can be amplified by financial intermediaries. After China's implicit ban on the imports of Norwegian salmon in response to the decision on 2010 Nobel Peace Prize, we find that banks that are highly exposed to the salmon industry cut back lending to non-salmon firms and households by 3-6 percent more than other banks. Furthermore, we find that the reduction in lending was not driven by the erosion of bank capital, but rather by the shift in expectations about the performance of loans to salmon producers, which drove highly exposed banks to increase their loan loss provisions and reduce risk-taking.

JEL Classification: F14, G21

Keywords: Trade shock; Bank lending channel; Expectation shock

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1 Introduction

In this paper, we explore a new channel through which trade conflicts affect the real economy, namely via credit supply spillovers. Recent trade wars and trade conflicts between several major economies in the world, such as the US-China and the US-Europe trade wars since 2018, raise the question of how trade conflicts affect real economies. The various trade sanctions imposed after the Russian invasion of Ukraine also highlight the urgency of this question. Existing empirical evidence often focuses on the direct effects of trade conflicts on employment and consumption, usually making the case that trade policies are blunt and only inflict limited damage on rival economies, see, for instance, Bekkers and Schroeter (2020) and Korhonen (2019).[1] The existing estimates of the real consequences of trade conflicts typically ignore the potential propagation of shocks across industries via financial intermediaries. This propagation mechanism can be important since industries affected by trade conflicts are often capital-intensive and rely heavily on bank funding. To address this gap, in this paper, we explore how trade conflicts can via a shock to lenders and credit supply spillovers affect sectors of the real economy that are not directly in the scope of the conflict. More specifically, we examine how banks that are highly exposed to firms affected by trade conflicts change their lending to firms not directly affected by the trade shock and how these shifts in lending generate real effects for the borrowing firms.

Our analysis is focused on a Chinese-Norwegian trade shock induced by a Nobel Peace Prize award. On 8 October, 2010, the Norwegian Nobel Committee announced that the 2010 Nobel Peace Prize is awarded to the Chinese dissident, Liu Xiaobo. This led to what was in practice a trade ban on imports of Norwegian salmon to China, one of Norway's most important exports. The trade ban also specifically targeted one product, as other Norwegian exports to China did not seem to be affected. Such an unexpected trade shock resulted in a sharp drop in salmon prices in Norway, so that salmon producers – about 1,000 salmon farms located along the coast of northern Norway – were expected to suffer losses as, for instance, illustrated by a sharp drop in the stock prices of major salmon producers around the time of the event. We use loan-level credit register data to identify salmon farms and their creditor banks. We document that loans to salmon farms are highly concentrated in a handful of regional savings banks located in municipalities along the coast and a few national banks that serve borrowers throughout Norway. This bank-level variation in exposure to fish farms affected by the trade conflict allows us to identify the impact of the trade shock on bank

[1] This is especially true for those trade conflicts that are centered around certain products, like China's ban on Canadian canola imports in response to the arrest of Huawei's CFO in Vancouver in 2019. According to conventional wisdom, these conflicts are often more symbolic, with little real impact: Although Canadian canola producers may have suffered a loss owing to the trade shock, the loss was probably rather small as a share of Canadian GDP. Furthermore, these producers could sell their products to other countries instead so that their actual losses may have been minimal.

lending using a difference-in-differences approach. We refer to banks that are highly exposed to salmon farms as "high-exposure banks" and other banks as "low-exposure banks".

Theoretically, the transmission of the trade shock through the banking system can go in two directions. On the one hand, when the trade shock starts to affect the sales of salmon farms and impair their credit worthiness or simply when the expectations about the performance of salmon farms shift, the creditor banks might try to reduce the loans to the salmon industry that are perceived to be loans of deteriorating credit quality. As a result, banks might shift lending from salmon farms to other non-salmon producing firms, increasing credit supply to the rest of the economy. We call this a "crowding-in" effect. Empirically, the "crowding-in" effect predicts that the Nobel Peace Prize trade shock should lead to an increase in bank lending to non-salmon producing firms. On the other hand, a potential decrease in the credit quality of salmon farms might materialize as higher losses of high-exposure banks. These losses, in turn, might erode bank capital and force banks to deleverage by cutting back lending to all borrowers. Even for those loans to salmon farms that are not yet non-performing, the shift of expectations about the performance of salmon producers might force banks to put these loans on watch, increasing their risk weights as well as building buffers through increasing loss provisions, which will also reduce the banks' lending capacity to other non-salmon producing firms. Overall, the trade shock might lead to banks' decreasing credit supply to the rest of the economy. We call this a "crowding-out" effect. Empirically, the existence of the "crowding-out" will predict that the Nobel Peace Prize trade shock leads to a decrease in bank lending to non-salmon firms.

Our difference-in-differences analysis allows to empirically evaluate whether the crowding-in or the crowding-out effect is dominant. Exploring data on the full universe of firm-bank lending relations in Norway for the period 2006-2015 we uncover strong evidence for the dominance of the crowding-out effect. In particular, we show that high-exposure banks decrease their lending in all lending categories by 3-6% following the trade shock. We adopt several alternative approaches to show that this decline in credit is unlikely to be driven by a confounding drop in the demand for credit as a result of deteriorating regional economies. These include two placebo tests and a loan-level analysis isolating variation in credit for the same firm borrowing from multiple banks with different exposure to salmon farms. Next, we explore the mechanism behind the reduction in credit. We show that the trade shock does not lead to lower bank capital in high-exposure banks, suggesting that high-exposure banks' cutting back lending is not caused by materialized losses in bank capital. However, during the trade shock, high-exposure banks do increase their loan loss provision and reduce their risk-taking. As such, our results are most consistent with banks' expectations playing an important role for credit provisioning: even without materialized loan losses from the salmon farms, reversed expectations about salmon farms' performance and increasing expectations of deteriorating credit quality for these salmon farms lead banks to respond by building buffers on their balance sheets and reducing risk-taking. These results are in line with a growing body of the literature highlighting the role of banks' expectations in credit supply, e.g. Ma et al. (2021) and Falato and Xiao (2022). Finally, we show that the reduction of credit to non-salmon firms with relations to highly-exposed banks also generates real effects for these firms. In particular, we find that after the trade shock, non-salmon firms borrowing from highly-exposed banks reduce both their investment volumes and their labor costs. The existence of these adverse real effects clearly underlines the potential of trade shocks to spread via the financial system to industries not directly affected by the trade conflict.

Our paper contributes to several strands of the literature. To start with, our paper is related to the literature on the relationship between banking and trade. Existing studies have found that cross-border banking flows follow bilateral trade flows (for example, Aviat and Cœurdacier (2007)), and trade-/FDI-related events can affect domestic bank lending (through, for example, increasing domestic competition from foreign firms, see Federico et al. (2020)). We contribute to this literature by documenting a new channel of how trade flows also affect other sectors in the economy via bank lending. Our paper is also related to the literature on the link between trade conflicts and aggravated macroeconomic outcomes. Existing studies document a limited aggregate effect of trade sanctions on macroeconomic outcomes. For example, Bekkers and Schroeter (2020) estimate that GDP is reduced by approximately 0.1 percent as a result of the 2018 rise of US-China tariffs, while Korhonen (2019), based on a review of studies on the impact of the 2014 sanctions against Russia, limits the range of the impact of the sanctions on GDP to -0.2 to -1.5 percent. We demonstrate that shifts in bank lending can further aggravate the aggregate effect of the sanctions on the economy.

More broadly, our paper contributes to the literature that studies how real economic shocks are transmitted and amplified by the banking system by exploring the salmon import ban as an exogenous shock to the Norwegian salmon industry and by presenting evidence of how this shock affects other industries' access to credit. An aggregate-level strand of this literature suggests that shocks to bank capital caused by the deterioration of some segments of bank lending portfolios can be transmitted to other segments of bank lending and thus generate a broader impact in terms of real economic dynamics (Meh and Moran, 2010; Furlanetto et al., 2019). Studies based on micro-level data also trace the impact of bank-level funding and capital shocks to lending. For instance, De Jonghe et al. (2020) document that when banks are hit by a funding shock, they reallocate credit to low-risk firms mostly in industries they are already specialized in, while Gropp et al. (2019) and Juelsrud and Wold (2020) find a similar reallocation to low-risk borrowers by banks that are hit by higher capital requirements. Some studies also focus on the exact transmission of shocks via the banking industry, e.g. through industrial overlaps, e.g. Paravisini et al. (2015) and Giannetti and Saidi (2019), or via geographic proximity, as in Goetz et al. (2016). Agarwal et al. (2020) is an example of this strand of the literature that is most closely related to our paper: Exploring the 2014 collapse of energy prices, they find that Mexican banks with high exposure to the energy sector were stuck with their big debtors and increased their exposure to these borrowers even more, thus crowding out lending to the other sectors.

Finally, by showing that lending can be reduced even when affected firms remain solvent and there is no significant rise in non-performing loans, we also contribute to the literature on the link between lending dynamics and banks' expectations. In our setup, the Chinese import ban is a shock to high-exposure banks' expectations about salmon farms' credit quality, and our results echo a very recent study by Ma et al. (2021) on the role of banks' expectations in driving their lending decisions. In this paper, banks' pessimistic expectations with regard to the regional economy led to reduced lending to firms. Our results are also in line with Falato and Xiao (2022), who show that in the 2008-2009 financial crisis, the adverse shock to US banks' expectations leads to a persistent credit slump.

The rest of the paper proceeds as follows: In Section 2, we present a brief introduction to the institutional background and our data. In Section 3, we describe our bank-level analysis and report its results, with further checks on potential threats to our identification. Section 4 presents evidence that the observed shifts in lending result from changes in the expectations about the performance of the salmon firms' loans, while Section 5 illustrates that the changes in bank lending generate adverse real effects for non-salmon firms. Section 6 concludes.

2 Institutional Background and Data

2.1 The 2010 Nobel Peace Prize Announcement as a Shock to the Norwegian Salmon Industry

Norway is the world's largest salmon producer, accounting for 52% of the global market for Atlantic salmon in 2017, according to the Food and Agriculture Organization of the United Nations. Most of Norwegian salmon nowadays is produced by salmon farms along the Norwegian coast. The salmon farms employ more than 2% of the labor force in Norway, and 95% of their products are exported. In the late 1990s, Norway became China's main salmon supplier. In 2010, Norway exported 1 million salmon to China, which accounted for 99% of the market share in China. Given the systemic importance of the salmon industry in Norway, the industry became the target of the trade conflict after the Norwegian Nobel Committee announced on October 8 2010 that the 2010 Nobel Peace Prize would be given to the Chinese dissident, Liu Xiaobo. Following the announcement, China Customs started to raise concerns about viruses and parasites spotted in imported Norwegian salmon, and the Chinese authorities imposed extra quarantine and inspection requirements on Norwegian salmon imports. Almost all the fresh salmon exported by Norway to China ended up rotting in Chinese warehouses during time-consuming quarantine and inspection, making it almost impossible for Norwegian exporters to sell salmon to China (Norwegian Seafood Federation Annual Report, 2011). In 2011, Norwegian salmon exports to China fell by about 60% compared with 2010; in June 2012, Norwegian exporters were only able to sell 12 salmon to China. By the end of 2016, Norwegian salmon remained non-existent in China, and the market for salmon in China was mostly taken over by Denmark, the UK, and Chile. The implicit import ban was only lifted after the Norwegian Prime Minister Erna Solberg paid a visit to Beijing in April 2017, emphasizing that her priority was the "normalization of diplomatic and political ties between Norway and China" and promising to raise human rights questions only "at a later date". In addition, the trade ban seemed to specifically target salmon: Other Norwegian exports to China were largely unaffected (Skivenes (2011), Chen and Garcia (2015)).

Before October 2010, Norway was expecting to be the first European country to achieve a free-trade agreement with China in the near future, and eight rounds of negotiations had been successfully completed between the two countries since 2007. Given that the yearly increase in seafood consumption in China alone exceeded Norway's entire annual production in the fishing sector, optimistic salmon farmers in Norway started to aggressively expand their production capacity while the two countries' bilateral negotiations were ongoing, mainly financed by their creditor banks ("high-exposure" banks). As we show in Figure 1, the exposure of these banks to salmon farms (lending to salmon farms as a share of banks' total corporate lending) increased by more than 30% between 2007 and 2010. However, the trade negotiation progress was completely suspended after the Nobel Peace Prize announcement and only resumed in August 2017, after Norwegian Prime Minister Erna Solberg's trip to Beijing to break the ice in April 2017.

The Nobel Peace Prize trade shock was a heavy blow to the Norwegian salmon industry and attracted considerable media attention in 2010-2012. Salmon prices collapsed in both Norwegian and international markets. The average selling price for Norwegian salmon in 2012 fell by more than 25%, compared with 2010 according to statistics by the Norwegian Directorate of Fisheries, and many salmon farmers feared that they would suffer big losses and would not be able to survive. This negative shift in expectations about the performance of Norwegian salmon farms is reflected in Figure 2, which depicts how stock prices for salmon farms listed on the Oslo Stock Exchange collapsed after the shock and only recovered after 2014. As a capital-intensive industry, the salmon industry relies heavily on loans from banks. Given the fragmented structure of the Norwegian banking market, which consists of a few national commercial banks alongside 100 or more small, regional savings banks, most of the loans issued to salmon farms were concentrated in three national commercial banks and a handful of regional savings banks located in salmon-producing areas, mostly coastal municipalities in northern Norway. The reversal of expectations about the salmon farms' performance generated concerns by high-exposure banks about the credit quality of their loans to salmon farms. For example, in its 2012 annual report, the regional bank Helgeland Sparebank acknowledged that "the price decline of aquaculture products and the weak earnings raised concerns about borrowers from the fishing industry". Data from a lending survey (Figure 3) collected by Norges Bank on credit practices of the major Norwegian banks, reveals that a substantial amount of the respondents reported tightening credit standards after the Nobel Peace Prize shock, and that most of the reported tightening of credit standards was due to industry-specific factors. As Figure 1 shows, those high-exposure banks reduced their lending to fish farms from 2011 and onwards. By the end of 2016, their exposure to fish farms had fallen to 2007-levels.

Figure 1: Loans to salmon farms as a share of high-exposure banks' corporate lending, 2005-2016

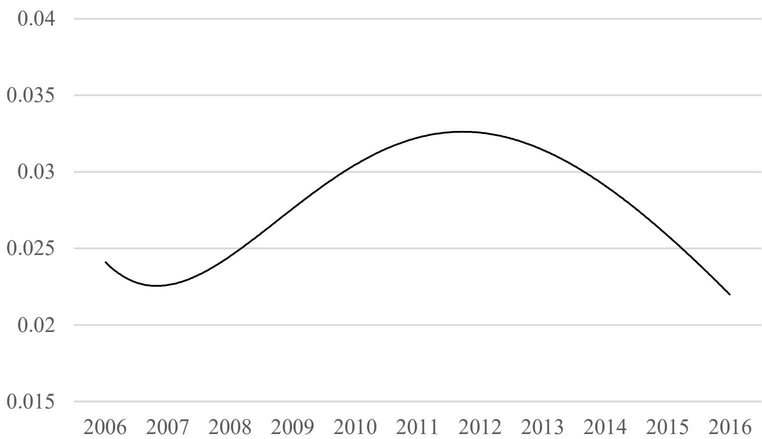


Figure 2: Stock market prices, OSEAX index versus weighted average stock price of salmon farms (July 1 2010 price = 100)

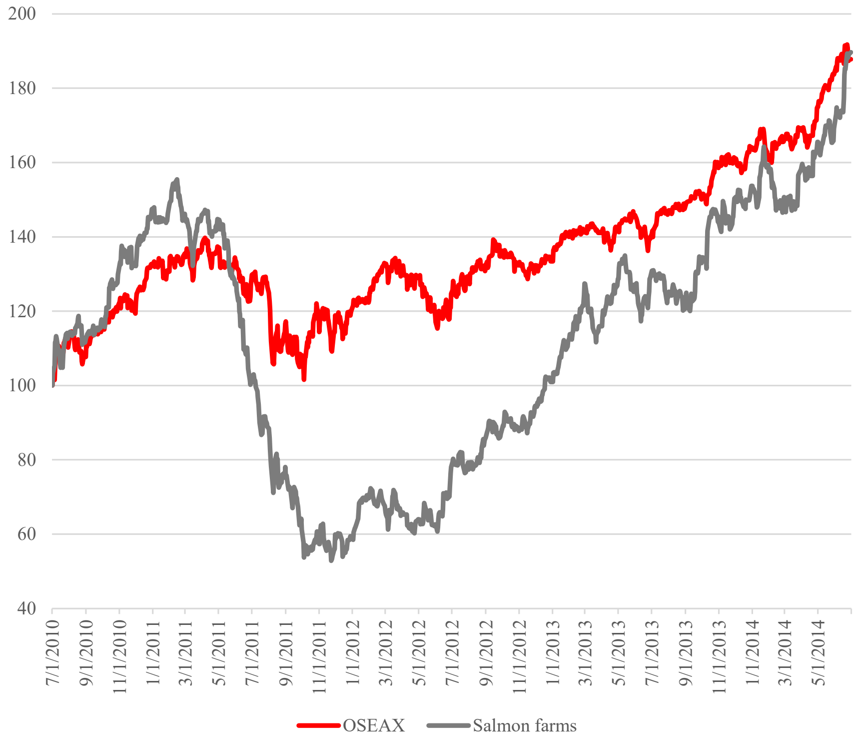
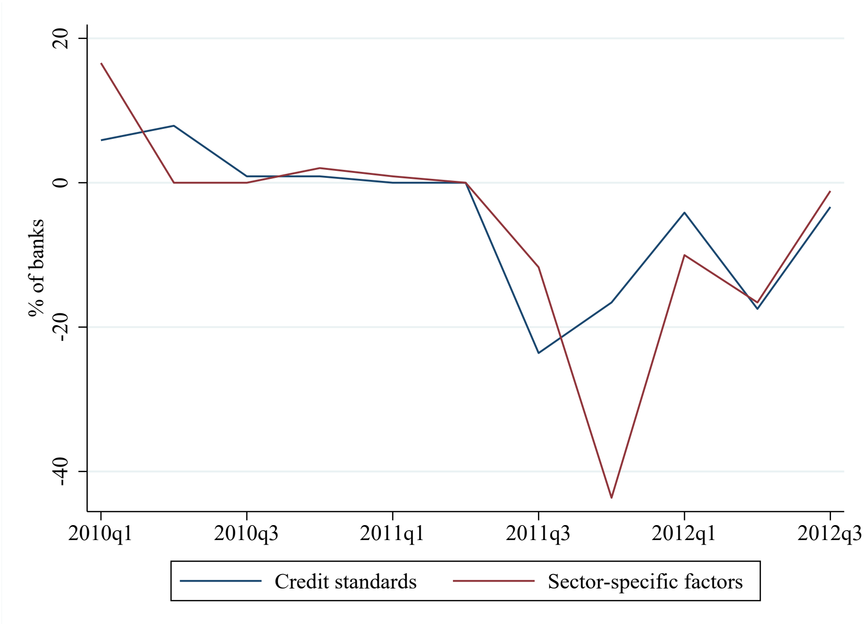


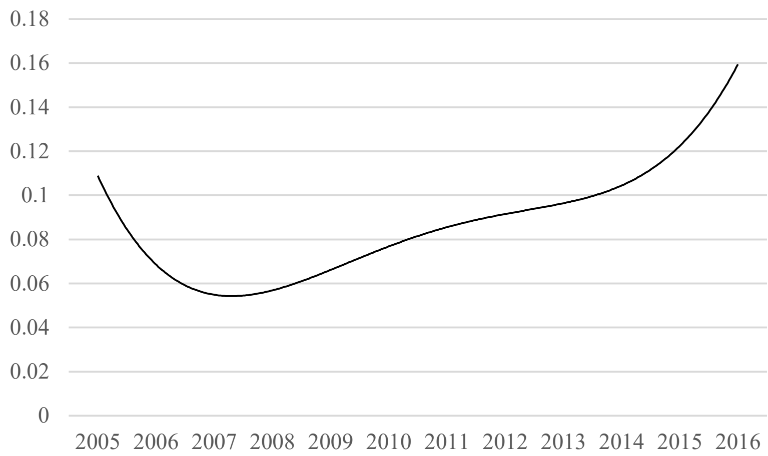
Figure 3: Fraction of banks reporting tightening of credit standard in the *preceeding 3 months* and that this tightening is due to "industry-specific" concerns.



Notes: This figure reports the results from "Norges Bank's Survey of Bank Lending" (https://www.norges-bank.no/en/news-events/news-publications/Reports/Norges-Banks-Survey-of-Bank-Lending/?tab=newslist). The survey asks questions about, among other things, whether banks are tightening credit standards and what the underlying reasons for such changes in credit standards are. Source: Norges Bank

It is interesting to note that from an ex post perspective, the shift in expectations was probably exaggerated as the Norwegian salmon industry did not suffer substantial profit losses during the trade shock. In practice, salmon producers were able to explore other markets as substitutes for China in the longer run. As Figure 4 shows, although the rise in salmon farms' mean return on assets slowed down after 2010 due to the trade shock, their profits did not collapse and the rise in their return on assets picked up again after 2014. The registry of Norwegian firms does not indicate any higher rate of salmon farms' bankruptcy post-2010, either.

Figure 4: Salmon farms' mean return on assets, 2005-2016, based on the firm register data provided by Brønnøysund Register Centre (*Brønnøysundregistrene*)



2.2 Data

We draw data from three different sources. The first source is the yearly balance sheet reports of all banks operating in Norway – including subsidiaries and branches of foreign-owned banks (mostly Swedish and Danish), between 2006 and 2015 from the financial market statistics (ORBOF).[2] As of 2015Q4, there are 105 savings banks and 28 commercial banks in Norway. There are 14 foreign owned banks, including two subsidiaries and 12 branches. The dataset is an unbalanced panel consisting of unique 169 banks and 1,355 bank-year observations.

The second data source is credit register data provided by the Norwegian Tax Administration (*Skatteetaten*). By the end of each year, all banks report all outstanding loan and deposit accounts to the tax administration for tax purposes. We match this dataset with data from our third source, the firm register data provided by Brønnøysund Register Centre (*Brønnøysundregistrene*). By the end of each year, all firms operating in Norway are required to register their balance sheets and financial statements at the Register Centre.

[2] *Offentlig Regnskapsrapportering fra Banker og Finansieringsforetak* (financial reports from banks and financial undertakings)

In the matched dataset, through borrowing firms' 4-digit NACE codes, we are able to identify the salmon farms[3] as well as each salmon farm's volume of outstanding loans from each of its creditor banks. As of 2010, there are about 1,000 salmon farms across Norway, and on average each of them receives about NOK 20 million (about USD 3.3 million) in funding from banks. Furthermore, from the matched dataset, we can also compute each bank's exposure to salmon farms, defined as the ratio of the banks' lending to salmon farms to its CET-1 capital following Agarwal et al. (2020). We define a bank as a high-exposure bank if its exposure to salmon farms exceeds 5% in 2010 (5% seems a natural cutoff in our sample, since the percentage of loans to salmon farms in those banks with lower exposure is close to zero). In our sample, 17 banks are classified as high-exposure banks: Three of them are national commercial banks accessible across Norway, and the rest are regional savings banks located in coastal municipalities. The high-exposure banks hold about 49% of total bank assets in Norway.

Table 1: Summary statistics

	N	Mean	Sd	Min	Max
Bank-level variables					
Natural logarithm of total lending	1,501	15.244	1.541	9.595	20.864
Natural logarithm of mortgage lending	1,417	14.560	1.581	3.839	20.105
Natural logarithm of corporate (excluding fish farms) lending	1,473	13.759	1.806	6.695	19.675
Natural logarithm of corporate (excluding fish farms) lending	1,473	13.759	1.806	6.695	19.675
High-exposure bank in 2010, dummy variable	1,501	0.120	0.325	0	1
Exposure to fish farms in 2010	1,501	0.019	0.077	0	0.602
Natural logarithm of total assets	1,501	15.322	1.491	12.022	21.395
Deposits to total assets ratio	1,501	0.633	0.160	0	0.956
Equity to total assets ratio	1,501	0.096	0.046	-0.083	0.742
Macro-level variables					
GDP growth	1,501	0.013	0.013	-0.017	0.030
CPI growth	1,501	0.020	0.009	0.007	0.038
House price growth	1,501	0.063	0.044	-0.011	0.137

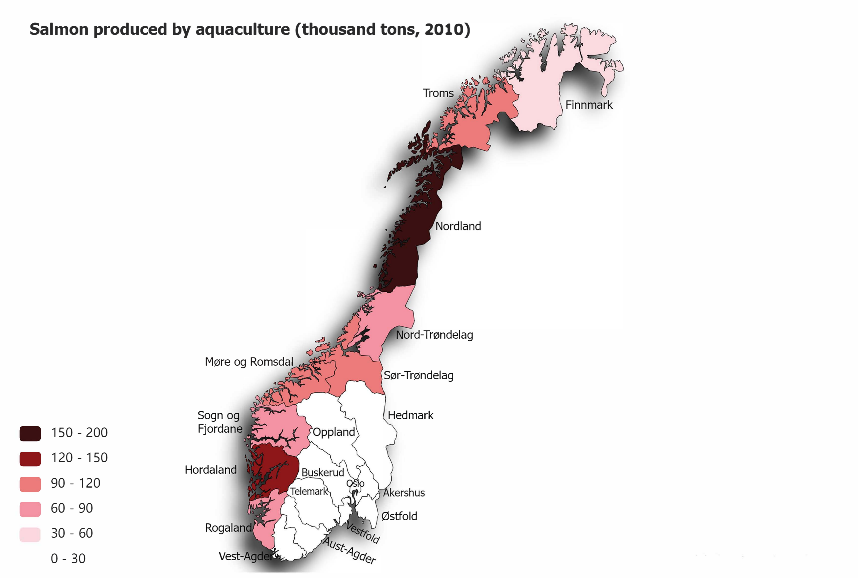
Notes: This table reports summary statistics of bank-level and macro-level variables, 2005-2015. "High-exposure bank in 2010" is a dummy variable that equals 1 if a bank has high exposure to salmon farms (i.e. if the ratio of the banks' lending to salmon farms to its CET-1 capital exceeds 5%) at the end of 2010.

Table 1 provides summary statistics for the variables that are used in our analyses.

[3]We further confirm the identity of the salmon farms via their salmon farming licences issued by the Norwegian Directorate of Fisheries.

Figure 5: Salmon production and number of high-exposure banks by county (2010)

(a) Salmon production by county in thousands of tonnes



(b) Number of high-exposure banks by county

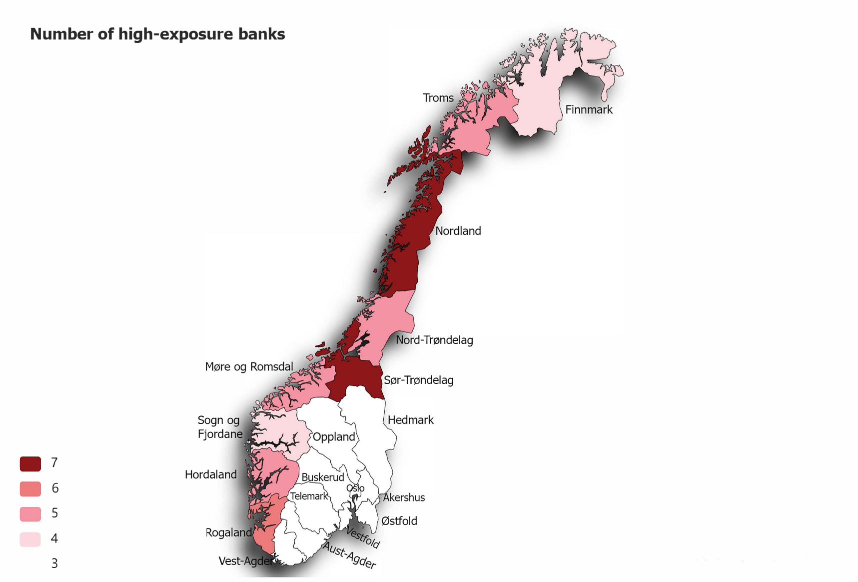
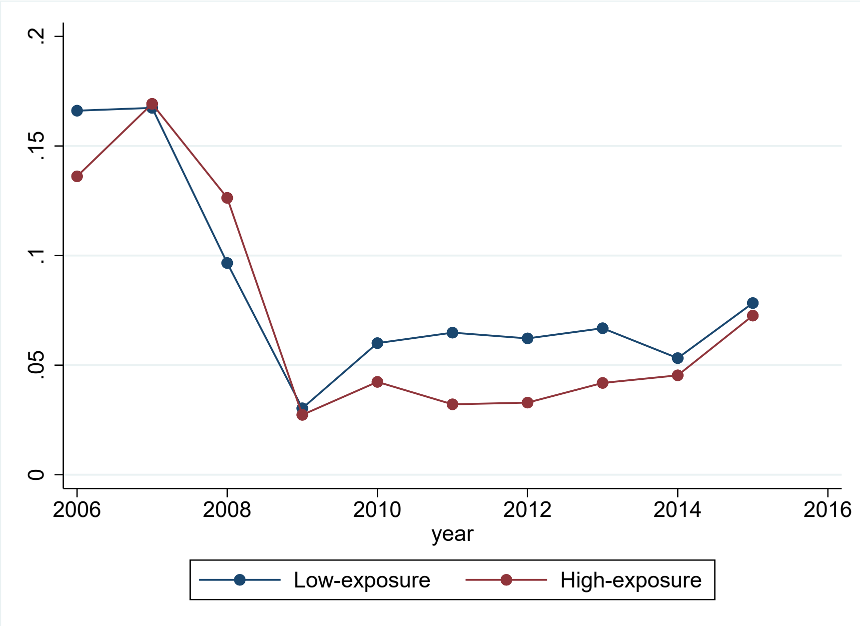


Figure 5 depicts salmon production by county in Norway (Panel (a)) as well as the number of high-exposure banks by county (Panel (b)). The figure shows that high-exposure banks are concentrated in the counties that are more exposed to the salmon industry. Figure 6 depicts average rates of lending growth for both high-exposure banks and low-exposure banks. Before 2010, the trends in lending growth for the two groups are similar, while from 2010, there is a sharp, relative drop in lending growth for high-exposure banks. The observation of the similarity of trends between the two-types of banks justifies the use of the difference-in-differences approach that we introduce in the next section.

Figure 6: Rate of lending growth: High-exposure versus low-exposure banks



3 The Nobel Peace Prize Trade Shock and Bank Lending

In this section, we document how the Nobel Peace Prize trade shock affected bank lending to non-salmon producing firms. We start by investigating the impact of the Nobel Peace Prize trade shock on bank lending both at the bank and loan level, before discussing the validation of the difference-in-differences model.

3.1 Bank-level evidence

Bank-level evidence based on discrete exposure measure. To test how the Nobel Peace Prize trade shock affected bank lending, we estimate the following regression equation:

$$(1)\quad Y_{bt} = \alpha Y_{b,t-1} + \beta Post_t + \gamma Post_t \times High\ exposure_{b,2010} + \eta \mathbf{X_{bt}} + \lambda \mathbf{Z_t} + \delta_b + \epsilon_{bt}$$

in which the dependent variable Y_{bt} is a measure of lending volumes for bank b in year t, dummy variable $Post_t$ equals 1 for any year t after 2010, dummy variable $High\ exposure_{b,2010}$ equals 1 if a bank b has high exposure to salmon farms (i.e. if the ratio of the bank's lending to salmon farms to its CET-1 capital exceeds 5%) at the end of 2010, vector $\mathbf{X_{bt}}$ includes bank-level controls (total bank assets in logarithm form, deposit to total assets ratio, equity ratio), vector $\mathbf{Z_t}$ includes macro-level controls (GDP growth, CPI growth, house price growth), and δ_b captures bank fixed effects.

We start by estimating equation (1) by using as dependent variables a range of indicators measuring banks' lending volumes – i.e. the (log) volumes of banks' total lending, mortgage lending, and lending to non-salmon producing firms. We refer to the latter as "firm lending" for brevity. We look not only at total loans, but also at their main components – firm lending and mortgage loans – in order to trace any differences in the dynamics of these two components. In particular, mortgage loans do not only tie up less capital but are in practice also less risky (during our sample period, the non-performing loan ratio for mortgage loans is 0.62%, compared with 1.04% for corporate loans). This makes mortgage loans an attractive alternative for banks that are interested in reducing their risk exposure and stabilizing risk-weighted capital ratios following (expected) loan losses.

The results from estimating equation (1) are reported in Table 2. These results suggest that, for low-exposure banks in Norway, the Nobel Peace Prize trade shock has a small negative impact in terms of total and mortgage lending (columns (1) and (2)) but does not significantly affect lending to non-salmon producing firms. For high-exposure banks ($Post \times High\ exposure$), the Nobel Peace Prize trade shock has significant and negative effects on both total lending and on lending to non-salmon producing firms (columns (1) and (3)), while the effect on mortgage lending is statistically insignificant. Notably, the lending of high-exposure banks to non-salmon producing firms drops by about 4% after the trade shock, while low-exposure banks' lending to non-salmon producing firms is not significantly affected by the shock. These results are consistent with the existence of a crowding-out effect of the trade shock and suggests a negative spillover through bank lending to the rest of the economy.

Bank-level evidence based on continuous exposure measure. We next re-estimate the same model using the continuous level of a bank's exposure to salmon firms measured by the ratio of loans to salmon firms to CET-1 capital (*Exposure*), instead of a dummy for high salmon-farm exposure. The results which are presented in Table 3 illustrate a very similar impact of the exposure to salmon farms on bank lending. For example, a 10 percentage point increase in the exposure measure corresponds to an approximately 1% drop in total lending (column (1)) and a 0.37% drop in lending to non-salmon producing firms (column (3)) after the trade shock.

More flexible specification. To ensure that our results are not driven by systematic differences between high- and low-exposure banks, at the bank level, we adopt a more flexible version of equation (1) and re-estimate the model by adding as additional controls the key bank characteristics included in the vector $\mathbf{X_{bt}}$ as observed in 2010 interacted with indicators for every year around the trade shock. In other words, we estimate the following regression equation:

Table 2: Effects of the trade shock on bank lending (discrete treatment)

	(1) $\ln Total\ lending$	(2) $\ln Mortgage\ lending$	(3) $\ln Firm\ lending$
Post	-0.0153*	-0.0403***	-0.0235
	(0.0092)	(0.0136)	(0.0161)
Post × *High exposure*	-0.0269**	-0.0216	-0.0398*
	(0.0143)	(0.0205)	(0.0244)
Bank controls	✓	✓	✓
Macro controls	✓	✓	✓
Bank FE	✓	✓	✓
Observations	1,342	1,297	1,320
R^2	0.8474	0.7340	0.7301

*Notes: The table presents the coefficient estimates of regression specification (1), using the logarithms of banks' total lending (column (1)), mortgage lending (column (2)), and lending to firms (column (3), excluding salmon farms), respectively, as dependent variables. Dummy variable Post equals 1 for any year that is after 2010, and dummy variable High exposure equals 1 if a bank has high exposure to salmon farms (i.e. if the ratio of the banks' lending to salmon farms to its CET-1 capital exceeds 5%) at the end of 2010. Bank controls include the logarithm of total bank assets, deposits to total bank assets ratio, equity to total assets ratio; macro controls include GDP growth, CPI growth, and house price growth. Bank fixed effects are included. ***, ** and * denote the 1%, 5% and 10% significance levels. Robust standard errors reported in parentheses, clustered at bank level.*

$$
\begin{aligned}
(2) \qquad Y_{bt} &= \alpha Y_{b,t-1} + \beta Post_t + \gamma Post_t \times High\ exposure_{b,2010} \\
&+ \sum_{\tau=2006,\tau\neq 2010}^{2015} \phi_\tau \left(\mathbf{1}_{t=\tau} \times \mathbf{X}_{b,2010}\right) + \eta \mathbf{X_{bt}} + \lambda \mathbf{Z_t} + \delta_b + \epsilon_{bt}.
\end{aligned}
$$

The results of this estimation are illustrated in Table 4. These results are again very similar to the ones obtained so far and indicate that the drop in lending is still significantly related to the trade shock and banks' salmon farm exposure even when we control for the time-specific effects of observable bank-level characteristics.

Based on regression equation (2), we further investigate the dynamic impact of the trade shock through the dynamic equation (3):

Table 3: Effects of the trade shock on bank lending (continuous treatment)

	(1) $\ln Total\ lending$	(2) $\ln Mortgage\ lending$	(3) $\ln Firm\ lending$
Post	-0.0285***	-0.0389***	-0.0283*
	(0.0079)	(0.0132)	(0.0152)
Post × *Exposure*	-0.1091**	-0.1498	-0.0369***
	(0.0568)	(0.0921)	(0.0126)
Bank controls	✓	✓	✓
Macro controls	✓	✓	✓
Bank FE	✓	✓	✓
Observations	1,342	1,297	1,320
R^2	0.8808	0.7404	0.7446

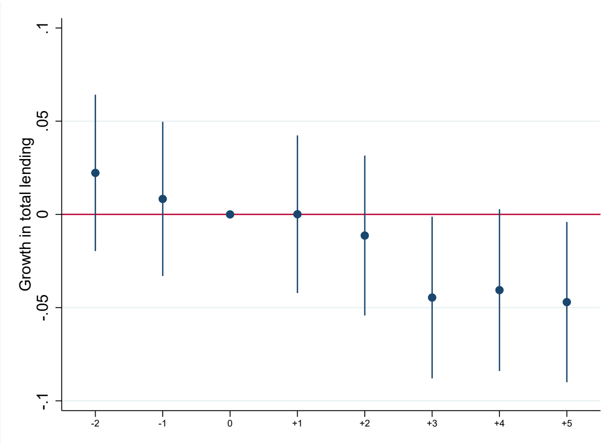
*Notes: The table presents the coefficient estimates of regression specification (1), using the logarithms of banks' total lending (column (1)), mortgage lending (column (2)), and lending to firms (column (3), excluding salmon farms), respectively, as dependent variables. Dummy variable Post equals 1 for any year that is after 2010, and the variable Exposure is a bank's lending to salmon farms as a share of the bank's total corporate lending at the end of 2010. Bank controls include the logarithm of total bank assets, deposits to total bank assets ratio, equity to total assets ratio; macro controls include GDP growth, CPI growth, and house price growth. Bank fixed effects are included. ***, ** and * denote the 1%, 5% and 10% significance levels. Robust standard errors reported in parentheses, clustered at bank level.*

$$(3) \quad Y_{bt} = \alpha Y_{b,t-1} + \sum_{\tau} \delta_{i\tau} \mathbf{1}_{t=\tau} + \sum_{\tau=2008,\tau\neq 2010}^{2015} \gamma_\tau \left(\mathbf{1}_{t=\tau} \times High\ exposure_{b,2010}\right) + \sum_{\tau=2008,\tau\neq 2010}^{2015} \phi_\tau \left(\mathbf{1}_{t=\tau} \times \mathbf{X}_{b,2010}\right) + \eta \mathbf{X_{bt}} + \lambda \mathbf{Z_t} + \delta_b + \epsilon_{bt}.$$

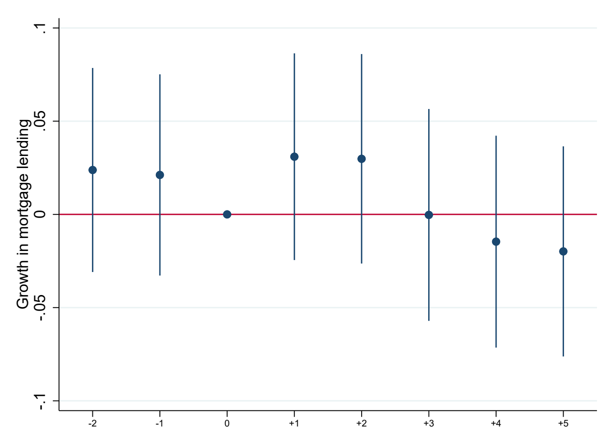
The dynamic effect, which is captured by the estimated coefficients γ_τ, is delineated by Figure 7. The figure suggests that high- and low-exposure banks more or less follow parallel trends in total lending, mortgage lending, and lending to non-salmon producing firms before 2010, in that the difference in the supply of lending between these two types of banks is not significantly different from zero. However, after 2010, growth in total loan supply is significantly lower for high-exposure banks, and such difference is mainly driven by the lending to non-salmon producing firms. The results again confirm previous findings that high-exposure banks reduce their lending to non-salmon producing firms after the trade shock.

Figure 7: The impacts of the trade shock on high-exposure banks, 2006-2015

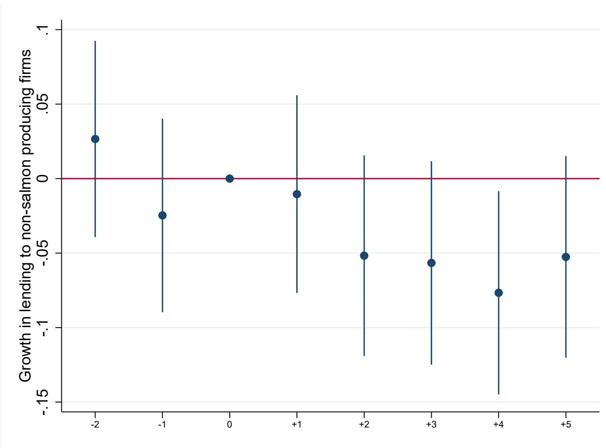
(a) Growth in total lending



(b) Growth in mortgage lending



(c) Growth in lending to non-salmon producing firms



Notes: Panels (a), (b), and (c) delineate the impact that the Nobel Peace Prize trade shock has on high-exposure banks' total lending, mortgage lending, and lending to non-salmon producing firms, respectively. We consider a 8-year window that spans the four years before the trade shock and five years after. The vertical lines represent 90% confidence intervals adjusted for clustering. The figures report estimated coefficients γ_τ *(*$\tau = 2008, ..., 2015$*) from the regression (3), in which* $High\ exposure_{b,2010}$ *equals 1 for high-exposure banks after the trade shock. The regression takes into bank fixed effects, and robust standard errors are clustered at bank level.*

3.2 Loan-level evidence

Next, we use the credit register data to explore the effects of the Nobel Peace Prize trade shock at the loan level. Focusing on loan-level variation in credit growth allows us to further shed light on the extent to which the reduction in credit is supply-driven. This is important, as it is typically challenging to decompose the effects on bank-level credit growth into supply and demand. For instance, as salmon farms in our sample are often located in remote, sparsely populated coastal municipalities and are often important employers in regional economies, the trade shock may force salmon farms to lay off workers, and lower consumption by laid-off workers may cause regional economic growth to slow down, resulting in lower demand of credit from regional borrowers. To demonstrate that our results are not completely driven by such demand-side effects, we take advantage of our firm- and firm-bank level data and exploit the identification strategy developed by Khwaja and Mian (2008): We focus on all non-salmon producing firms that borrow from both high-exposure banks and low-exposure banks, and conduct a regression as follows:

$$Y_{ibt} = \alpha + \gamma Post_t \times High\ exposure_{b,2010} + \delta_{it} + \epsilon_{ibt} \tag{4}$$

in which Y_{ibt} is the volume of firm i's outstanding loan from bank b in year t in logarithm form, and δ_{it} captures $firm \times year$ fixed effects that control for the firm's credit demand. If the estimated coefficient γ is significant, we are able to infer that the impact of the trade shock on high-exposure banks' lending is indeed driven by their credit supply.

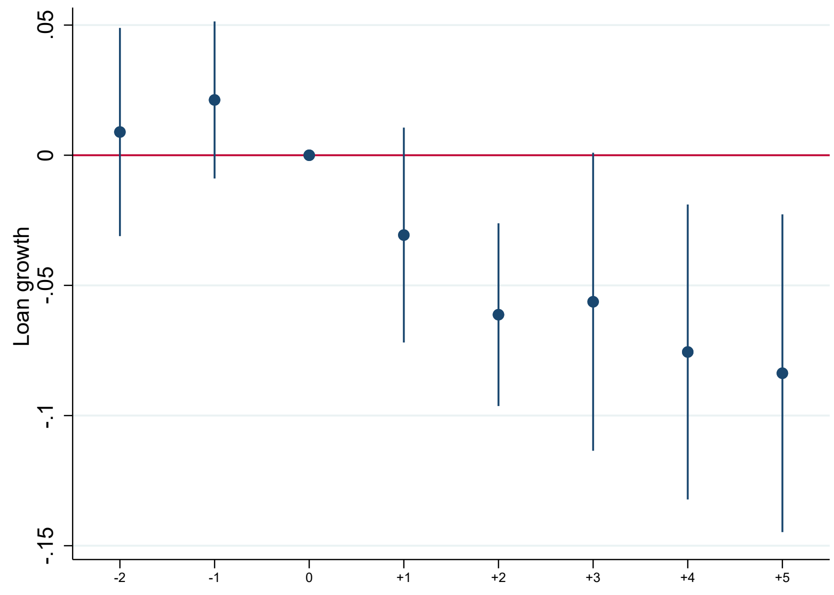
We find that the estimated coefficient γ is about -0.0572 and significant, as Table 5 shows, implying that high-exposure banks' total lending drops by about 5.7% after the trade shock relative to low-exposure banks *for the same firm*. The magnitude is comparable with the estimate in column (1), Table 2. Our result from the Khwaja-Mian approach thus suggests that our key results are indeed driven by the supply of rather than the demand for credit.

Furthermore, we extend the regression equation (4) and estimate the firm-bank level model using the following dynamic equation at the loan level:

$$Y_{ibt} = \alpha + \sum_{\tau} \delta_{i\tau} \mathbf{1}_{t=\tau} + \sum_{\tau=2008,\tau\neq 2010}^{2015} \gamma_\tau\ (\mathbf{1}_{t=\tau} \times High\ exposure_{b,2010}) + \epsilon_{ibt} \tag{5}$$

In this equation, we interact the treatment variable $High\ exposure_{b,2010}$ with indicators for every year except 2010 as the base year. The idea is to establish whether prior to the trade shock non-salmon producing firms were still drawing larger credit volumes from the high-exposure banks (which could be due to some unobservable confounding factors). We present the coefficient plot resulting from the estimation of the coefficient γ in Figure 8. The figure suggests that high- and low-exposure banks more or less follow a parallel trend in lending before 2010, in that the difference in the supply of lending to non-salmon producing firms between these two types of banks is not significantly different from zero. However, after 2010, loan supply to non-salmon producer firms is significantly lower for high-exposure banks. The results again confirm previous findings that high-exposure banks reduce their lending to non-salmon producing firms after the trade shock and provide additional evidence that this is due to a trade shock-driven supply effect.

Figure 8: Changes in lending to non-salmon producing firms, 2008-2015



Notes: The figure delineates the impact of the Nobel Peace Prize trade shock on banks' lending to non-salmon producer firms, 2008-2015, by presenting the point estimates of coefficient γ_τ *(*$\tau = 2008, ..., 2015$ *and* $\tau \neq 2010$*) in regression specification (5), using the growth rate of banks' lending to non-salmon producer firms as the dependent variable. The vertical lines represent 95% confidence intervals and the point estimates, adjusted for clustering at firm*bank level.*

3.3 Model Validation

A key assumption for the validity of our difference in-differences analysis is the existence of parallel ex ante trends of the high-and low exposure banks' lending. As already discussed the validity of this assumption is illustrated in Figure 6. In this section, we perform several additional tests that further strengthen the model validation and enable causality claims.

Propensity score matching To further validate our difference-in-differences approach and explore whether the effect of the post-2010 lending dynamics is indeed driven by the trade shock and salmon-farm exposure, we design an additional test where banks are defined as treated (high-exposure) and non-treated (low-exposure) not by their *de facto* lending exposure to salmon farms but rather by their 2010 balance sheet variables included in $\mathbf{X}_{b,2010}$. For this purpose, we employ these balance sheet characteristics and match high-exposure banks with low-exposure banks by propensity score matching. We then use the matched low-exposure banks as placebo treated group and re-run the regression (1). In other words in this exercise we consider as "treated" not the banks with high exposure to salmon farms but the banks that in 2010 had similar balance sheet characteristics to the high-exposure banks. The results are reported in Table 6. These results indicate no significant impact of the placebo exposure on either the total lending or the lending to non-salmon producer firms. They, therefore, indicate that the statistical significance of the high exposure to the trade shock documented in the previous set of results is not driven by observable bank-level characteristics that might correlate with the bank exposure to the trade shock, but is indeed related to the true exposure of the bank to the salmon industry.

Placebo tests Our results may also be driven by other unobserved confounding factors, for example, other shocks that take place around 2010 (e.g. shocks related to the expectations of stricter capital regulation after the global financial crisis), or other confounding shocks that affect certain groups of banks. To account for the possibility that our results are driven by other confounding shocks that take place around 2010, we conduct a placebo test that is based on the data from 2001-2010: We set an arbitrary year between 2001 and 2010 as the start of the treatment and rerun our regressions. We find no significant result from the exercises, suggesting that our results are not driven by any confounding shocks prior to 2010. Next, to check whether our results are driven by other confounding shocks that affect certain group of banks, we conduct a placebo test as follows: Instead of the 17 high-exposure banks in our sample, we randomly choose 17 banks from the low-exposure banks as our placebo treatment group, take the rest of the low-exposure banks as our control group and rerun our regressions. After repeating the procedure 1,000 times, we find that the estimated coefficient for the interaction term $Post_t \times High\ exposure_{b,2010}$ is not significantly different from zero, implying that our results are indeed driven by those banks with high exposure to salmon farms.

4 What is the Mechanism Behind the Reduction in Loan Volumes?

By showing that lending to non-salmon firms is significantly reduced after the Nobel Prize Shock the results of the previous section clearly support the existence of a crowding-out channel. As already mentioned crowding out can occur both (i) if the high-exposure banks face an increase in non-performing loans (due to the default of salmon firms) and the resulting depletion of capital and (ii) if the high-exposure banks revisit their expectations about the performance of loans to salmon firms even in the absence of salmon firms' defaults and the corresponding increases in non-performing loans. To explore which of these two mechanisms drives the high-exposure banks' lending adjustment under the trade shock, we next examine the changes in a range of bank balance sheet variables that occur over the relevant period. More specifically, we re-estimate Equation (1) using banks' equity ratio, non-performing loan (NPL) ratio, and loan loss provision (in millions of NOK) as dependent variables. The intuition behind the choice of these variables is that if the lending reduction is driven by capital constraints associated with the exhaustion of capital due to non-performing loans to salmon farms, we should observe that high-exposure banks see their non-performing loans rise and their equity ratios decline after the trade shock. An increase in the loan loss provisions not accompanied by lower capital ratio and higher non-performing loan ratio will, on the other hand, suggest that the results are primarily driven by revisions of banks' risk perception and expectations about the performance of loans to the salmon industry. We report the results in Table 7.

First, the results in column (1) suggest that, compared with low-exposure banks, the impact of the trade shock on high-exposure banks' equity ratio is not significantly different from zero. This means, high-exposure banks did not suffer from capital losses after the shock, which is in line with the stylized fact presented in Figure 4 that average salmon farms did not suffer from any substantial drop in their profitability, and also in line with our observation that the post-2010 bankruptcy rate among fish farms is not significantly higher than the pre-2010 period. This assumption is also confirmed by the coefficients reported in column (2), which suggest that the NPLs of high-exposure banks do not increase more than those of low-exposure banks after the trade shock. However, although from the *ex post* perspective the trade shock did not materialize as a disaster for salmon farms, during the trade shock, high-exposure banks were indeed concerned about their on-balance sheet exposure to salmon farms. As column (3), Table 7 shows, while the trade shock has an insignificant impact on low-exposure banks' loan loss provision, high-exposure banks on average increase their loan loss provision by about NOK 92 million (about USD 16 million). This is plausibly driven by high-exposure banks' revised expectations about the health of salmon farms, i.e. they build buffers on the expectation that the credit quality of salmon farms will deteriorate. Such perception of increasing credit risk in their on-balance sheet exposure makes the high-exposure banks reluctant to take further risks; this is in line with our results in Table 2 that high-exposure banks deleverage and cut back lending under the trade shock. *Ex post*, such reluctance in risk-taking might even explain the lower ratio of non-performing loans for high-exposure banks shown in column (2). These results are consistent with the presumption that the reversal of bank expectations about the performance of loans to salmon firms served as the main channel that led to an amplification of the trade shock via the banking system. They are also consistent with the observations illustrated in Figure 3 that highlighted industry-specific factors as a main factor explaining the tightening of credit standards after the Nobel Peace Prize shock.

5 Does the Reduction of Loans to Non-Salmon Producing Firms Generate Any Real Effects?

So far we have documented that high-exposure banks reduce their lending to non-salmon producing firms following the trade shock. We now explore whether the reduction in credit for non-salmon producing firms has real economic implications. If that is the case, the results will suggest that the trade shock not only affects the salmon industry but, via the shock to high-exposure banks, also a much wider range of firms from other largely unrelated industries. In this section, we therefore explore three dimensions of potential real effects: investments (measured by the natural logarithm of firms' fixed assets), employment (measured by the natural logarithm of the number of employees) and labor costs, which are a proxy for labor income (measured by the natural logarithm of firms' labor costs). We examine the real effects by estimating a model that is similar to equation (1) but at the firm rather than the bank level, as equation (6)

$$(6) \quad Y_{it} = \alpha Y_{i,t-1} + \beta Post_t + \gamma Post_t \times High\ exposure_{b,2010} + \eta \mathbf{X_{bt}} + \lambda \mathbf{Z_t} + \delta_b + \epsilon_{bt}$$

in which dependent variable Y_{it} is the measure of firm-level outcomes. The high-exposure indicator $High\ exposure_{b,2010}$ is generated at the firm level based on the number of banks the firm has exposure to (if the bank from which the majority of a firm's loan is borrowed in 2010 is a high-exposure bank, we assign a value of 1 to the high-exposure dummy; the value is zero, otherwise). In unreported tests, we have generated similar results by defining the high exposure at the firm level if more than 50% of the firm's loan volume is from high-exposure bank(s). In order to control for relevant macroeconomic factors, we include GDP growth, CPI growth, and house price growth as controls. We estimate the model using firm-level fixed effects.

The results of the estimation that are presented in Table 8 illustrate that the reduction of lending indeed has real economic consequences. For example, the coefficients depicted in column (1) suggest that the fixed assets of those firms borrowing from high-exposure banks are lower following the trade shock, compared to other firms, suggesting that the reduction in credit at the bank level lowers investment at the firm level. Column (2) indicates no significant impact on these firms' employment, a result that is probably due to strong labor protection that does not allow quick adjustment of payroll numbers in Norway. The coefficients presented in column (3) indicate firms borrowing from high-exposure banks still have relatively lower expenditure on labor, suggesting that they do not keep up with the wage dynamics of peers borrowing from low-exposure banks.

In sum, we show that the trade shock might generate real effects that go well beyond the affected (salmon) industry by significantly depressing investments and labor incomes. Existing studies on the aggregate impact of a trade shock that ignore the spillovers via the financial system may, therefore, significantly underestimate the deterioration in aggregate real economic outcomes.

6 Conclusion

Exploring China's implicit trade ban on Norwegian salmon after the announcement of the 2010 Nobel Peace Prize as a trade shock to the Norwegian salmon industry, we find that banks that are more exposed to salmon farms cut back their lending to the other sectors so that the trade shock generates an adverse spillover to the rest of the economy through reduced bank lending that results in impaired access to credit for firms. We find that such a crowding-out effect is not driven by materialized losses in banks' capital, as a result of salmon farms' poor performance, it is rather driven by banks' expectations with regard to salmon farms' deteriorating credit quality. Given the high on-balance sheet exposure, the perception of increased risk related to lending to salmon farms forces banks to increase the buffers on their balance sheets, avoid excessive risk-taking, and hence limit their new loan issuance. Most importantly, we show that the reduction of credit supply, faced by firms borrowing from high-exposure banks, generates a significant deterioration of their investment and labor costs, thus suggesting that the adverse effects of the trade shock on aggregate outcomes are reinforced by the shock's transmission via the banking system.

Our results raise further questions about how to reduce the spillover of trade shocks to the other sectors through bank lending, as well as what to do to increase the resilience of the banking sector under unexpected trade shocks. In a more fragmented banking sector, the potential is higher that exposure to trade risks is concentrated in some of the banks, making the borrowers of these banks more vulnerable to trade shocks. However, this does not necessarily mean that a banking sector needs to be more concentrated, as regional banks may be better at collecting information from regional borrowers, hence they may provide better financial intermediation services for the regional economy. It may be necessary to introduce policies to induce banks to better diversify their exposure to trade risk.

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Table 4: Effects of the trade shock on bank lending (controlling for pre-trend)

	(1) ln *Total lending*	(2) ln *Mortgage lending*	(3) ln *Firm lending*
Post	-0.0207	-0.2496***	-0.0225
	(0.0170)	(0.0491)	(0.0535)
Post × *High exposure*	-0.0259**	-0.0068	-0.0666***
	(0.0145)	(0.0204)	(0.0245)
Bank controls	✓	✓	✓
Macro controls	✓	✓	✓
Bank FE	✓	✓	✓
Observations	1,342	1,297	1,320
R^2	0.8533	0.7600	0.7490

Notes: The table presents the coefficient estimates of regression specification (2), using the logarithms of banks' total lending (column (1)), mortgage lending (column (2)), and lending to firms (column (3), excluding salmon farms), respectively, as dependent variables. Dummy variable Post equals 1 for any year that is after 2010, and dummy variable High exposure equals 1 if a bank has high exposure to salmon farms (i.e. if the ratio of the bank's lending to salmon farms to its CET-1 capital exceeds 5%) at the end of 2010. Bank controls include the logarithm of total bank assets, deposits to total bank assets ratio, equity to total assets ratio; macro controls include GDP growth, CPI growth, and house price growth. Vector $\mathbf{X}_{b,2010}$ *includes the logarithm of total bank assets, deposits to total bank assets ratio, and equity to total assets ratio in the end of 2010. Bank fixed effects are included. ***, ** and * denote the 1%, 5% and 10% significance levels. Robust standard errors reported in parentheses, clustered at bank level.*

Table 5: Estimating effects of the trade shock on bank lending, using the Khwaja-Mian approach

	$\ln Total\ lending$
$Post \times High\ exposure$	-0.0572***
	(0.0088)
Firm*year FE	✓
Observations	312,081
R^2	0.1671

*Notes: The table presents the coefficient estimates of regression specification (4), using the logarithm of banks' total lending as dependent variables. Dummy variable $Post$ equals 1 for any year that is after 2010, and dummy variable $High\ exposure$ equals 1 if a bank has high exposure to salmon farms (i.e. if the ratio of the bank's lending to salmon farms to its CET-1 capital exceeds 5%) at the end of 2010. Firm*year fixed effects are included. ***, ** and * denote the 1%, 5% and 10% significance levels. Robust standard errors reported in parentheses, clustered at firm*bank level.*

Table 6: Effects of the trade shock on bank lending (placebo test using propensity score matching)

	(1) ln *Total lending*	(2) ln *Mortgage lending*	(3) ln *Firm lending*
Post	-0.0149	-0.0369**	-0.0230
	(0.0101)	(0.0143)	(0.0177)
Post × *High exposure*	-0.0071	-0.0133	0.0214
	(0.0203)	(0.0276)	(0.0349)
Bank controls	✓	✓	✓
Macro controls	✓	✓	✓
Bank FE	✓	✓	✓
Observations	1,161	1,116	1,139
R^2	0.8415	0.7342	0.7222

*Notes: The table presents the coefficient estimates of regression specification (1), using the logarithms of banks' total lending (column (1)), mortgage lending (column (2)), and lending to firms (column (3), excluding salmon farms), respectively, as dependent variables. The estimates are based on pseudo treated banks that are low-exposure banks matched to the high-exposure banks via propensity score matching. Dummy variable Post equals 1 for any year that is after 2010, and dummy variable High exposure equals 1 if a bank has high exposure to salmon farms (i.e. if the ratio of the bank's lending to salmon farms to its CET-1 capital exceeds 5%) at the end of 2010. Bank controls include the logarithm of total bank assets, deposits to total bank assets ratio, equity to total assets ratio; macro controls include GDP growth, CPI growth, and house price growth. Bank fixed effects are included. ***, ** and * denote the 1%, 5% and 10% significance levels. Robust standard errors reported in parentheses, clustered at bank level.*

Table 7: Effects of the trade shock on bank balance sheets

	(1) *Equity ratio*	(2) *NPL ratio*	(3) *Loan loss provision*
Post	0.0241***	0.2964***	-3.9989
	(0.0019)	(0.1125)	(11.0428)
Post × *High exposure*	0.0024	-0.3088*	92.6294***
	(0.0032)	(0.1739)	(17.0403)
Bank controls	✓	✓	✓
Macro controls	✓	✓	✓
Bank FE	✓	✓	✓
Observations	1,342	1,342	1,342
R^2	0.7434	0.6581	0.4369

*Notes: The table presents the coefficient estimates of regression specification (1), using banks' equity ratio (column (1)), NPL ratio (column (2)), and loan loss provision (column (3)), respectively, as dependent variables. Dummy variable Post equals 1 for any year that is after 2010, and dummy variable High exposure equals 1 if a bank has high exposure to salmon farms (i.e. if the ratio of the bank's lending to salmon farms to its CET-1 capital exceeds 5%) at the end of 2010. Bank controls include the logarithm of total bank assets, deposits to total bank assets ratio, equity to total assets ratio (except the regression for column (1)); macro controls include GDP growth, CPI growth, and house price growth. Bank fixed effects are included. ***, ** and * denote the 1%, 5% and 10% significance levels. Robust standard errors reported in parentheses, clustered at bank level.*

Table 8: Real effects of the Nobel Peace Prize trade shock

	(1) ln *Fixed assets*	(2) ln *Employment*	(3) ln *Labor cost*
Post	-0.1057***	0.0567***	-0.1513***
	(0.0041)	(0.0030)	(0.0062)
Post × *High exposure*	-0.0836***	-0.0018	-0.1462***
	(0.0065)	(0.0034)	(0.0097)
Bank controls	✓	✓	✓
Macro controls	✓	✓	✓
Bank FE	✓	✓	✓
Firm FE	✓	✓	✓
Observations	341,827	341,827	341,827
R^2	0.0204	0.0078	0.0036

*Notes: The table presents the coefficient estimates of regression specification (6), using the logarithms of borrower firms' fixed assets (column (1)), employment (column (2)), and labor expenditure (column (3)), respectively, as dependent variables. Dummy variable Post equals 1 for any year that is after 2010. The high-exposure indicator High exposure is generated at the firm level based on the number of banks the firm has exposure to (if the bank from which the majority of a firm's loan is borrowed in 2010 is a high-exposure bank, we assign a value of 1 to the high-exposure dummy; the value is zero, otherwise). Bank controls include the logarithm of total bank assets, deposits to total bank assets ratio, equity to total assets ratio; macro controls include GDP growth, CPI growth, and house price growth. Bank and firm fixed effects are included. ***, ** and * denote the 1%, 5% and 10% significance levels. Robust standard errors reported in parentheses, clustered at firm level.*