Temperatures, Heterogeneous Exporters and Aggregate Trade*

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Abstract

This paper studies exporting firms' reaction to weather shocks in destination countries, and the role played by trade diversion as a shock-coping strategy. Using detailed customs data from France, from 1995 to 2009, I show that the geography of exports across markets both at the firm and the aggregate levels are affected by temperature shocks. At the firm level, temperature shocks have a trade deterring effect, in particular for larger firms. I rationalize this result by trade diversion motives: large firms divert away from countries under heat and reduce their exports to these markets. At the aggregate level, temperature shocks in a destination market generate a change in the set of exporting firms that serve this market, in the favor of smaller firms, while larger firms divert their exports, thus generating an aggregate trade diversion away from destinations under heat.

Keywords: Exports, Firms, Temperatures, Diversion.

JEL Codes: F14, F18

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1 Introduction

Climate and the environment are a major concern of our societies and for our activities. From the latest PWC reports, climate-related concerns are among the most cited for CEO since many years. CEOs across the world are increasingly anxious about climate change effects as well as broader societal threats (such as geopolitical uncertainty, terrorism, ...), rather than direct business risks such as changing consumer behavior or new market entrants.

This paper studies exporting firms' reaction to weather shocks in destination countries, and the role played by trade diversion as the main shock-coping strategy, both at the micro and at the aggregate levels. Weather shocks in foreign countries have an impact on local production, revenues and GDP and thus reduce import demand and foreign firms' exports. Following weather shocks in destination countries, measured by temperatures variations, I identify trade diversion across destinations as the main shock coping strategy for foreign exporting firms. When a destination market is hit by a temperature shock, if the firm is able to divert its exports to other destination markets, the drop in exports to that market – and trade diversion to other destinations – is likely to be important. Yet, all firms cannot divert trade across destinations: most exporting firms only sell to a limited number of export markets, with limited trade diversion possibilities. As this coping strategy is used mainly by large, multi-destination firms, aggregate trade fluctuations are likely to arise after temperatures shocks. My paper provides support in favor of these results.

Measuring the impacts of climate shocks on economic outcomes, and trade in particular, is the subject of a large literature. The effects of weather variations, such as rising temperatures, rainfalls or natural disasters, are extensively documented (Carleton and Hsiang, 2016). A large, quantitative empirical research provides evidence of important effects of climate on health, agriculture, economics, conflict, migration, and demographics and other fields. Among these effects, the trade impact of weather shocks has attracted recent attention. Recent evidence shows that weather shocks tend to influence trade flows, by affecting production in exporting countries, income and demand in importing countries, as well as shipments and trade routes[1]. Most of the existing studies take an aggregate view on the trade effect of weather shocks: analyses are mainly undertaken using aggregate trade data, at the country (both importer or exporter) or at the sectoral level. On the contrary, the firm-level trade effects of weather change are not documented: the present paper fills this gap. I believe this micro-level approach to be informative for many reasons. First, an extensive literature, since Melitz (2003) and Bernard et al. (2006), advocates the central role of firms in trade. Second, aggregate trade elasticities to weather shocks depend upon the aggregated firm-level reactions to these shocks. Assessing the effect of weather shocks on aggregate exports requires to estimate firm-level reactions to weather shocks, as well as an aggregation exercise. My paper provides results in these

[1] Jones and Olken (2010) find an average 2% decrease in export growth in poor countries for each additional degree Celsius of temperature rise, and no effect of precipitation. Li et al. (2015) estimate using Chinese data that exports decrease by 1.1% for every additional degree Celsius of temperature rise and no effect on imports. Dallmann (2019) suggests that temperature shocks have a trade-deterring effect that varies across country-pairs, that may affect economic growth (Dell et al., 2012). Osberghaus (2019) provides an extensive survey of the existing empirical result in this field.

directions.

My analysis is based on firm-level disaggregated export data from the French Customs, from 1995 to 2009. I combine this firm-level data with temperatures data (from the Climatic Research Unit, CRU) (Harris et al., 2014) at the destination-year level, providing an average yearly temperature and other weather variables. I thus consider the full universe of French exporters and use the (exogenous) occurrence of weather shocks in the destinations served by these firms. In a firm-level gravity framework, I estimate the impact of temperatures on the exported values. Beyond the average effect, I estimate the differential impact on trade flows across firms that all face the same weather shock in the destination market. My identification strategy consists in using export variations across firms and relating this result to their trade diversion abilities, i.e. how many destinations they served in the previous year.

The first contribution of my paper is to document and rationalize the heterogeneous effect of weather shocks across exporting firms. My results first indicate a massive drop in exports following weather shocks in destinations, for large, multi-destination firms. These firms tend to reduce much more their exports in hotter countries (over time) than smaller firms. This result is largely documented in the paper and is robust to many robustness checks, including specification matters, measures of firm size, sub-samples issues and other confounders. By contrast, my results show a limited, close to null, effect of temperature shocks on smaller firms' exports. My results imply that market shares are reallocated toward the left tail of the size distribution when temperatures increase. In hotter markets, large, multi-destination firms decrease their exports and simultaneously smaller exporters expand relative to larger firms.

Moreover, my results also provide evidence that the response of trade flows is determined by the firm's ability to divert exports across destinations. A large part of the cross-firm variance is accounted for by the number of destinations served by the firm. When facing temperature shocks in one market, I show that multi-destination firms tend to export relatively more to other, specific destinations, in which they have experience and to which they already sell a lot. I also show that for these firms, total exports (i.e. over all destinations) do not decrease after temperature changes, contrarily to small firms. At the firm level, I thus document that temperature changes have a trade diversion effect, across destinations.

The second contribution of my paper is thus to document a risk-coping strategy used by exporting firms facing temperature shocks. A strand of the trade literature documents how uncertainty shapes trade outcomes. While some recent studies focus on trade policy uncertainty, such as Handley and Limão (2017), several papers study different consequences of demand uncertainty on various definitions of trade margins and firm dynamics (see Alessandria et al. (2010); Iacovone and Javorcik (2010); Békés et al. (2017); Berman et al. (2019), and document a contraction of trade flows when uncertainty increases. In a heterogeneous firms environment, Esposito (2019) and De Sousa et al. (2020) find that highly performing firms reduce more their supply on a given destination when facing increased uncertainty. Héricourt and Nedoncelle (2018) focus on exchange-rate volatility as a specific case of uncertainty, and document an heterogeneous response of exporters depending upon the reallocation possibilities of firms, with substantial aggregate implications. Fontagné and Orefice (2018) also provide evidence of reallocation of exports of multi-destination firms facing technical barriers to trade. My results thus talk to that literature by documenting that these risk-coping strategies are also at play regarding weather shocks and demand uncertainty in foreign markets.

Then, my results allow to provide aggregate implications of weather shocks, explicitly accounting for heterogeneous firm behavior. Analyses of global phenomena may be harmed by aggregation bias as suggested by the empirical literature[2]. On top of this aggregation bias, firm-level shocks may not cancel out in the aggregate and may lead to aggregate fluctuations (Gabaix, 2011). In our context, firm distribution is not uniform and trade is granular. Large, multi-destination firms represent a minority of firms but the bulk of exports. Firms that shape aggregate trade outcomes are firms that are diverting exports under heat. As a result, if we were to hide these firms, we would forget a major part of the aggregate adjustment to weather shocks. Understanding how climate shocks affect global patterns of trade requires a careful aggregation of micro-level exports elasticities to weather shocks[3]. I provide this step in the present paper to address the critical issues of climate shocks. My paper provides the aggregate consequences of these results regarding the effect of weather shocks.

The third contribution of the paper is thus to provide the careful aggregate trade implications of weather shocks. Micro-level trade diversion generates an *aggregate* trade diversion away from destinations with temperature shocks, precisely because diverting firms account for the bulk of exports in those countries. To support this result, I show that the aggregate trade diversion effect would *disappear* if all firms in the economy had the same weight in the aggregate, independently of their individual, heterogeneous response to temperature shocks. On top of that, I show that the trade-deterring effect of temperatures is larger in sectors with a high share of exports made by reallocating firms. Trade diversion at the firm-level has aggregate implications, shaped by the presence of reallocating firms. Overall, I estimate that firm-level trade diversion under temperature shock is a determinant of the geography of exports at the aggregate level. Finally, I show that temperature shocks also affect the composition of exporters within a destination. I estimate that smaller firms account for an increased share of exports in countries with temperature increases: small firms decrease less their exports than larger firms. The average exporter is thus different across years following temperature shocks.

The paper is organized as follows. The next section reviews why temperatures deters aggregate demand. Section 3 describes the French firm-level data at hand. I present in Section 4 the main micro-level results regarding the differential effect of temperatures across firms. Then, Section 5 focuses on trade-diversion at the firm level in light of reallocation possibilities. I finally provide in Section 6 the empirical implications of the micro-level results, before concluding.

[2]Imbs and Mejean (2015) and Ossa (2015) provide evidence of cross-sectional elasticity heterogeneity, that raise prime-order issues in aggregation exercises.

[3]On a different topic, Bas et al. (2017) show that heterogeneity in trade elasticities (arising both from demand and from supply) is crucial to assess the welfare impact of trade policy.

2 Background

The negative impact of temperatures on output and income. Many studies have estimated a large and negative correlation between temperature and aggregate output. Because of agriculture's direct link with atmospheric conditions, that sector's vulnerability to high temperatures has been the focus of many studies estimating the impacts of climate change , see e.g. Mendelsohn et al. (1994); Deschênes and Greenstone (2007); Schlenker and Roberts (2009); Chen et al. (2016). Using aggregate data, many studies have also estimated a large, negative correlation between temperature and industrial output. Dell et al. (2012) examine how variations in temperature and rainfall affect the growth of industrial output, with a sample of 125 counties over the 1950-2003 period. They find that the growth of industrial output declines approximately by 2.4% for a 1C increase in annual average temperature, but only in poor countries. More recently, Burke et al. (2015) analyze a sample of 166 countries from 1960 to 2010 and show that global economic productivity exhibits nonlinear responses to temperatures in all countries. They find that productivity increases with annual average temperature up to 13C and declines sharply at higher temperatures. Cachon et al. (2012) analyze a micro-level data set of weekly production from 64 automobile plants in the US over the 1994-2005 period, and find that a week with six or more days above 32C can reduce that week's production by roughly 8%. Using a sample of 28 Caribbean and Central American countries over the 1970-2006 period, Hsiang (2010) analyzes the effects of temperature and cyclones on economic output (measured by value added per capital). For a 1C increase in surface temperature during the hottest season, national output falls by 2.5%, with output losses in non-agricultural industries significantly exceeding the losses in agricultural industries (2.4%/1C vs. 0.1%/1C).

Main mechanisms. The explanation for agriculture is straightforward. To say it broadly, in the agricultural sector, temperatures decrease yields. Yield losses on the hottest days drive much of this variance in the total effect both in the US (Schlenker and Roberts, 2009), in Europe (Moore and Lobell, 2015) or in less advanced economies (Schlenker and Lobell, 2010). The losses can be attenuated by water storage (Duflo and Pande, 2007) or irrigation technologies (Auffhammer et al., 2012; Aryal et al., 2019; Jones et al., 2019).

Recent empirical evidence supports a negative relationship between temperatures and labor productivity (for a review see Heal and Park (2016)). Heat stress can lower work intensity (Seppanen et al., 2006), reduce cognitive performance (Graff Zivin et al., 2018), lower performance in physical tasks and voluntarily shorten work hours in sectors of the economy most exposed to outdoor temperature, such as construction and agriculture (Graff Zivin and Neidell, 2014). Impacts on manufacturing production have been identified in both high- and low-income contexts (Somanathan et al., 2015; Adhvaryuy et al., 2014). All in all, this may affect labor productivity in both agriculture and the manufacturing sector.

3 Data

I combine 3 main types of data: (i) firm-level trade data on French export flows, (ii) firm size controls and (iii) climate variables.

Firm-level trade data. I use firm-level trade data from the French customs over the period 1995-2009. This database reports exports for each firm, by destination and year over our sample period. It reports the volume (in tons) and value (in Euros) of exports for each CN8 product (European Union Combined Nomenclature at 8 digits) and destination, for each firm located on the French metropolitan territory. Some shipments are excluded from this data collection but these are related to a very small proportion of total exports.[4]

For the econometric exercise, I exclude obvious outliers and winsorize my sample, excluding the top and bottom 1% in export value and in export value growth rate over one year. I aggregate trade flows at the firm-destination-year level and use the product information for a set of robustness checks.

Firm-level controls. I also use firm-level data contained in the dataset called BRN (*Bénéfices Réels Normaux*), which provides balance-sheet data i.e. value added, total sales, employment, capital stock and other variables. The BRN database is constructed from reports of French firms to the tax administration, which are transmitted to INSEE (the French Statistical Institute). The BRN dataset contains between 650,000 and 750,000 firms per year over the period (around 60% of the total number of French firms). Importantly, this dataset is composed of both small and large firms, since no threshold applies on the number of employees. A more detailed description of the database is provided by Berman et al. (2012). Depending on the year, these firms represent between 90% and 95% of French exports contained in the customs data. As it is standard in the literature, I restrict the observations to firms belonging to manufacturing. Balance-sheet and customs data can be merged using the firm identifier (SIREN number) and the year.

Weather variables. Measuring changes in weather conditions is not straightforward[5]. There are many measures available to researchers to capture changes in weather over time. Auffhammer et al. (2013) provide an overview of the most used measures in economics literature and the pros and cons of each measure.

As a baseline measure for weather conditions, I use the country-year temperature data, from the Climatic Research Unit of the University of East Anglia (CRU version v4.02) (Harris et al., 2014). It provides a set of country-year average temperatures for the sample period. I use the "raw" average level of temperatures and do not compute any difference, change or variation by myself. Instead, my empirical strategy will be based upon fixed effects, such that identification comes from variations in temperatures.

[4] A more detailed description of the database is provided by Eaton et al. (2011). Inside the European Union, firms are required to report their shipments by product and destination country only if their annual trade value exceeds the threshold of 150,000 Euros. For exports outside the EU all flows are recorded, unless their value is smaller than 1,000 Euros or one ton.

[5] Note also that there are distinctions for researchers between climate and weather. This research uses variation in weather conditions over years. Assessing whether this research can be used to assess the effect of climate change on the economy is out of the scope of this paper.

As robustness measures of weather shocks, I will use other variables such as the average precipitation level, the daily maximum and minimum temperatures and other weather variables from the same source (CRU).

Other macroeconomic variables. Other macroeconomic variables, such as GDP or exchange rate level come from the Penn World Tables and the IMF's International Financial Statistics. I include proxies of country-specific risks from the World Bank Governance Indicators gathered in Teorell et al. (2019). Finally, I also use the estimates of market potential from Head and Mayer (2004) to measure competition on destination markets.

Descriptive Statistics. Table 1 provides the descriptive statistics of my sample.

– Include Table 1 here. –

Measuring potential trade diversion at the firm level is crucial in my analysis. Table 2 provides the distribution of the number of destinations (in the firm-year dimension). As emphasized by other studies using French customs data, the distribution is highly skewed and the ability to reallocate across destinations is restricted to a small set of firms. All firms do not have a large set of destinations to serve. Crucially, firms that serve many destinations account for a disproportionate share of exports (Héricourt and Nedoncelle, 2018).

– Include Table 2 here. –

4 The heterogeneous impact of temperature shocks on firm-level exports

4.1 Empirical Strategy

Specification. To investigate the effect of temperatures in destination j on export outcomes of firm i in year t, I estimate the general following specification:

$$\text{Trade}_{ijt} = \alpha \text{Temp}_{jt} + \beta \text{Controls}_{jt} + \delta \text{Controls}_{it} + \gamma \left(\text{Temp}_{jt} \times \text{Controls}_{it}\right) + \mathbf{FE} + \varepsilon_{ijt} \quad (1)$$

The main trade outcome I focus on is the value of exports of firm i in year t to destination j in which temperature shocks – denoted Temp_{jt} – occur. I include in Controls_{jt} a set of country-year controls such as GDP and exchange-rate level that are other candidates than temperatures to explain the export patterns. I control for firm size using a set of covariates denoted Controls_{it}. I consider many measures of firm size: my preferred is the number of destinations as it is a size proxy and it also captures the potential reallocation possibilities. I also consider, as alternatives, the size of the assets of the firm as well as total employment, all measured at the end of year $t-1$ to avoid endogeneity.

Both α and γ estimates are of interest to me. While α measures the (average) elasticity of exports to temperatures, γ measures the conditional impact of firm size controls – denoted Controls_{it} – on this elasticity. I expect to estimate a trade-deterring effect of temperatures on trade margins ($\hat{\alpha} < 0$). A negative $\hat{\gamma}$ means that firm size magnifies the negative impact of temperatures on trade flows: the negative impact of rising temperatures on trade flows is increased for large firms compared to small ones.

Discussion about fixed effects and identification. I control for unobserved heterogeneity using sets of fixed effects (**FE**) I now discuss. I detail the econometric consequences of each set of fixed effects In particular, I show that the inclusion of country-year FE does not allow me to identify the unconditional effect of temperatures on exports but is key to assess the differential impact of temperatures changes.

I first include firm x country fixed effects. This set of FE controls for unobserved specific relationship between a firm and a foreign market. For instance, a firm may be related to one market by historical links or by culture. When included, the coefficient is estimated from the time variation within a firm-destination observation. This excludes firms serving a market one year only and then exiting forever on my sample period.

I also include a firm x year fixed effects. This FE controls for time-varying firm characteristics such as size, employment, revenues, ... The counterpart of including this FE is that (i) the effect of firm size cannot be identified unconditionally and (ii) it excludes firms serving only one export market for a given year. I thus restrict the sample here to firms serving at least two destinations. The two restrictions imposed by the exclusion of singletons in these dimensions is not neutral for the exercise. Compared to the full universe of exporters, my estimation sample excludes firms serving 1 destination or being present 1 year only. This creates an upward bias in the firm size compared to the full exporters universe.

Including a country-year fixed effect is not straightforward in my exercise. If included, I cannot identify the unconditional effect of temperatures on exports (which is not the primary parameter of interest to me) and I also cannot disentangle the effect of temperature on exports from other country-specific variables and risks that also affect exports. I first exclude this FE in the first part of my analysis to show that results are in line with existing evidence (Osberghaus, 2019; Dallmann, 2019). In a second step, I however include it because it is crucial to investigate the differential impact of temperatures changes across firms on a given market. When it is included, I absorb the variance across market-year couples and only focus on variation across firms within each couple which is precisely what I want to estimate. In that case, I can only identify the differential impact of size on the trade elasticity to temperatures, controlling for total exports to that market by French exporters. In the limit case, my sample should exclude market-year observations that exhibit only 1 French exporting firm, which is not the case in the present sample[6]. Overall, when the full

[6]As a side remark, I only use export flows from French firms. I do not observe the exports of other countries to each

set of FE is included, identification relies on variation across firm-year observations within a destination market.

All specifications are estimated using a linear estimator, and the dependent export variables are in logs. I thus restrict my sample to positive export flows: my results focus on the intensive margin of exports.

4.2 Results

Baseline estimates. Table 3 presents my baseline results. In column (1), I estimate the average impact of rising temperatures on trade is significantly negative, including firm-country FE and year dummies. I estimate an elasticity around -0.1 which is hardly affected by the inclusion of a firm-year FE in column (2). On average, increases in temperature tend to decrease exports of the average firm across year in a given destination.

In column (3) I add the interaction term between temperature and my preferred measure of firm size, the lagged log number of destinations served by the firm, from the customs dataset. As I include a firm-year FE, the unconditional effect of the number of destinations cannot be estimated. I obtain a significant, negative coefficient to that interaction term. Together with the negative unconditional effect of temperatures changes (in columns (1) and (2)), I estimate a non-linear, magnified effect of temperatures on exported values for larger firms. The number of destinations magnifies the negative impact of temperatures on exports: firms serving many destinations exhibit a larger negative impact of temperature on their exports. For illustration, I find that the trade elasticity to temperatures for firms at the top of the distribution of the number of destinations is of around -0.18 (0+(-0.057*3,21)) while for for firms at the 10th percentile (serving around 2 destinations), the estimated elasticity is close to 0 at best: small firms do not decrease their exports following temperature increases, while large firms do experience a trade-deterring effect.

In column (4), I include the full set of fixed effect and adds a country-year FE. I cannot identify the unconditional effect of temperature changes (as well as other country-year variables) but I still estimate a negative interaction term coefficient. This result is also displayed in columns (5) and (6): the negative impact of temperatures on exports is increasing with firm-level assets size (at the end of year $t-1$, in column (5)) and with firm employment (at the end of year $t-1$). In both columns (5) and (6), I however estimate that the main effect of firm size in captured by the number of destinations served by the firm. This is consistent with the idea that, independently of its size, reallocation of exports across destination may be the main adjustment margin for firm facing temperatures changes in destination countries.

I interpret this result as follows: rising temperatures slightly decreases exports for all firms but the negative effect is increasing with firm size. Large firms' exports are more negatively affected than small firms' exports following rising temperatures. As I include a country-year fixed effect, it holds constant the amount of French exports to that market-year. Coefficients can be thus be interpreted as changes in market

country-year observation. Yet, I believe this is not an important concern because rising temperatures are likely to affect all exporters, independently of their origin country, in the same manner, on the contrary to changes in exchange-rates for instance, which are by nature bilateral.

shares, across all French exporters to that market. I infer that the market share of smaller firms is less reduced that the one of large firms after changes in temperatures. Rising temperatures are associated to a change in the composition of exporters on a given market. In the present case, my results suggest that market shares are reallocated toward the left tail of the size distribution when temperatures increase. Large firms decrease their exports and simultaneously smaller firms expand relative to larger firms. Temperature changes thus generate a composition effect.

– Include Table 3 here. –

Sensitivity analysis. I provide a set of robustness checks to the main results. Instead of providing an extensive set of Tables, I follow Simonsohn et al. (2015) and provide a "specification curve" regarding my main coefficient. I replicate variants of my baseline specification, with the complete set of fixed effects, and alternatively replace the dependent variable, my measure of temperatures, the measure of firm size, and the weather covariates included in the estimation. In formal terms, I estimate variants of the following equation:

$$\begin{aligned} \text{Trade}_{ijt} &= \gamma \left(\text{Temp}_{jt} \times \text{Nb Dest}_{it}\right) && (2) \\ &+ \lambda \left(\text{weatherCovariates}_{jt} \times \text{Nb. Dest}_{it}\right) && (3) \\ &+ \zeta \left(\text{weatherCovariates}_{jt} \times \text{FirmSize}_{it}\right) + \mathbf{FE} + \varepsilon_{ijt} && (4) \end{aligned}$$

From these estimations, I obtain a set of estimates of $\hat{\gamma}$ (N=216) that I then plot in Figure 1. The top panel shows all estimated coefficients and the bottom panel shows the characteristics of the estimation from which the coefficient is obtained. I rank all estimations along their specifications characteristics.

– Include Figure 1 here. –

First, I show that my results are not driven by price effects. On the contrary, I show that the estimated effect of temperatures and firm size on exported quantities are of similar magnitude compared to export values. Most of the impact on export values comes from variation in exported quantities.

Second, I also check the sensitivity of my results with respect to the trade measures. Figure 1 presents the results on the exports of the main HS6 product at the firm level. I identify the main HS6 product (in value) at the firm-destination-year level and aggregate the exports for this product line only. Doing so allows me to assess that the effect I find does not depend upon product churning, because reallocation of exports across products is shut in this exercise. I find that exports of the main HS6 product are deterred by rising temperatures on average and all the more for larger firms. Results are very close to the baseline results presented above.

Third, I check the sensitivity of my results to an alternative measures of country-year temperatures. My baseline measure above was the average temperature at the country-level. In my specification curve, I have used the country-year specific average minimum daily temperature, average maximum daily temperature as well as their lags as dependent variables. I obtain very close results in signs and magnitude.

Fourth, I departed from my baseline estimation by including additional weather covariates, on top of temperatures. Dallmann (2019) provides evidence that both precipitation and temperatures affect trade flows at the aggregate level. Results presented in Figure 1 show that including total precipitations, and average humidity in the specification does not alter the main message.

Fifth, I have also included other proxies of firm size in the estimation. In these estimations, I thus include the log Assets, the log employment, the log value added and the log equity as alternative proxies of firm size (on top of the number of destinations).

All these tests confirm the larger trade-deterring effect of temperatures changes for larger firms, in particular when they serve many destinations. I estimate that all coefficients' point estimates, independently of the specification choice I make, are negative, significantly different from 0 and remain in the interval between -0.05 and -0.15.

Potential omitted variables. I now check that the estimated coefficient in the above specification is not attributable to omitted country-specific variables. I consider here many country-year variables that have been documented to be trade determinants at the firm level. I thus regress an augmented specification in which I include an interaction term between potential omitted variables (denoted Covariates_{jt}) and firm size measures:

$$\text{Trade}_{ijt} = \alpha \text{Temp}_{jt} + \gamma \left(\text{Temp}_{jt} \times \text{Controls}_{it} \right) + \mu (\text{Covariates}_{jt} \times \text{Controls}_{it}) + \mathbf{FE} + \varepsilon_{ijt} \tag{5}$$

– Include Table 4 here. –

Note that the role of omitted variables and the related bias is accounted for in specifications including country-year fixed effects. Yet, this specification allows country-specific variables (such as temperatures or omitted variables) to have (only) a differential effect across firms. I use the full set of fixed effects and standard errors are clustered at the country-year level. Results are presented in Table 4. I consider here many potential omitted variables that are sequentially introduced in the specification. Column (1) controls for the interaction between GDP in the destination and the number of destinations. Changes in destination GDP tend to favor the exports of larger firms, compared to smaller ones. But the main interaction coefficient is still negative and significant. I however note that the point estimate is half its baseline value, suggesting that the effect is likely to be demand-related. Once accounting for changes in aggregate demand on the market, changes in exports across firms are decreased by half.

Column (2) checks that temperature changes are not confounded with other country-specific risks. In particular, countries with increasing temperatures may also be riskier countries (both over time and across countries). I control for that dimension by including a proxy of country-specific risks from the World Bank Governance Indicators gathered in Teorell et al. (2019). I use the country-year measures (point estimates) of "Political Stability and Absence of Violence" indicator. Results in column (2) show (i) that higher quality of institution (lower risk) is associated to higher exports all the more for bigger firms, and (ii) that the magnified effect of temperature along firm size is not affected by this control. I infer that increases in temperatures have something specific to them that cannot be controlled for by other dimensions of country specific risks.

In column (3), I include the time-invariant destination's distance from France in the discussion. I cannot exclude that temperatures variations are likely to be higher for distant countries. If this is the case, the negative coefficient recovered from the interaction between temperatures and firms' size could be driven by different export dynamics in "difficult" destinations, across small and large firms. I show that this explanation is true but does not kill the effect of temperatures. Results in column (3) show that there is a difference between small and large firms in their exports variation under temperature changes both in close and in distant market.

In columns (4) and (5), I control for competition on the destination market. In my baseline specifications, I do not include a specific "multilateral resistance" term, that for instance determines the amount of competition faced by French exporters in the destination, while this has been shown to be an important component of gravity equations. Second, beyond these theoretical considerations, rising temperatures could affect the productivity of local producers and thus the strength of competition in the destination with a positive end-impact of French exporters. I this control for (the differential impact of) competition in the destination markets using two measures. First, I use available data from Head and Mayer (2004), which provides country-year measures of competition. The drawback with using this measure is that it only covers up to 2003 (i.e. half of my sample period). Results are displayed in Column (4). As a robustness check, I use the number of French firms exporting as a proxy for competition in the market. Results using this measure of competition are in column (5). In both columns, I estimate that increases in competition within a destination market over time tend to increase more the exports of large firms. Yet, even when controlling for changes in competition, I estimate a differential effect of temperatures shifts across firms.

All in all, I have shown that the estimated differential effect of temperatures across firms can hardly be attributed to omitted variables, even though the point estimates are slightly affected by the inclusion of competing mechanisms.

5 Trade Diversion

The previous section documents a robust, magnified negative effect of temperatures on exports along many measures of firm size. On average, the share of destination j in any firm's total exports decreased after increases in temperatures in j, and this effect is more at play when firms are big and sell to many markets. I argue that this result can be rationalized by the firm's ability to reallocate exports across destinations. This section shows that the differential effect of temperatures increases on exports across firms can be rationalized by the reallocation of exports across many destinations, i.e. trade diversion.

Suppose that a destination market is hit by a temperature shock: if the firm is able to divert its exports to other destination markets, the decrease in exports to that market – and trade diversion to other destinations – is likely to be important. If the firm is not able to reallocate, changes in exports are likely to be small. I provide empirical support in favor of this trade diversion hypothesis. In this section, I show that when firms face temperature shocks in the whole set of destinations they serve, they tend to export *relatively more* to some destinations at the same time, particularly in countries where the firm has experience and some already sell a lot. This behavior generates a particular pattern of firm-level exports, in which large firms' exports are mainly unaffected by temperatures, because of these reallocations.

5.1 Specification

I assess the reallocation behavior by firms by estimating:

$$\text{Trade}_{ijt} = \alpha Temp_{it} + \beta C_{it} + \delta C_{ijt-1} + \gamma \left(Temp_{it} \times C_{ijt-1} \right) + \mathbf{FE} + \varepsilon_{ijt} \tag{6}$$

in which $Temp_{it}$ is the average temperature faced by firm i in year t. It is defined as a trade-weighted aggregate of temperatures faced by any firm given its export destinations in $t-1$: $Temp_{it} = \sum_j \frac{X_{ijt-1}}{X_{it-1}} Temp_{jt}$. The specification includes lagged firm-destination-year variables (C_{ijt-1}) so as to capture variation across both destinations and firms, as well as the interaction term with the average temperature.

In the previous section, I included an interaction term between temperature and firm characteristics to infer variation across firms. In this exercise, I include an interaction term between average temperature and firm-destination characteristics to identify variations across destinations' characteristics, following temperatures shocks. An estimated positive γ would imply a positive correlation between exports and firm-destination characteristics, for any average temperature over all destinations served by the firm. I finally include the full set of country-year, firm-year and firm-country fixed effects. Including these FE does not prevent from estimating the firm-destination specific characteristics that are correlated with higher exports (i.e. with a positive estimated γ) when temperature shocks occur.

5.2 Results

Table 5 presents the estimation of this specification. Recall that the variance of interest is across destinations in the exercise. In column (1) I estimate that for a given level of average temperature faced by a firm, exports to country j will be higher (relative to other destinations served by the firm) all the more than the firm exported to that destination in year $t-1$ (relative to other destinations served by the firm). The same holds for quantities (column (2)) and experience (column (5)). No effect arises regarding lagged price differentials across markets (column (3)) or market power differential (column (4))[7].

– Include Table 5 here. –

5.3 Total firm exports

I now investigate the effect of temperature changes (aggregated over all destinations) on the total exports of the firms, i.e. over all destinations served by the firm. To do so, I estimate the following equation:

$$X_{it} = \alpha Temp_{it} + \beta C_{it} + \delta(Temp_{it} \times C_{it}) + \lambda_i + \lambda_t + \varepsilon_{it} \tag{7}$$

where X_{it} is the total exports of firm i in year t, over all destinations. While α captures the average trade-deterring effect of exposition to shocks, I allow this effect to vary along the ability of firms to reallocate across destinations, captured by the δ coefficient. It allows me to estimate the impact of temperature changes on total firm level exports and investigate whether multi-destination firms have a significant and different outcome with respect to firms that do not have that ability.

– Include Table 6 here. –

Results are displayed in Table 6. I estimate in column (1) a positive average correlation between firm level exports and aggregate temperatures in all destinations. Columns (2) to (4) provide a positive estimated δ suggesting that the increase in firm-level exports together with the occurrence of increased temperatures is driven primarily by the increased export performance of firms serving many destinations. Larger firms, that are also the ones able to reallocate their exports, exhibit higher increases in exports, over all destinations, than smaller firms that cannot reallocate. This is additional evidence in favor of reallocation as an explanation for the increased firm-destination negative elasticity to temperatures.

Overall, I estimate that following changes in temperatures, firms tend to favor increase exports in destinations in which they have experience and already sell a lot. For these firms, exports over all destinations, do not decrease when temperatures increase. This is suggestive evidence that reallocation of exports across destinations is at play for the firms that have this ability.

6 Aggregate Implications

This section documents the aggregate implications of the micro-level mechanisms documented in the previous sections. In particular, I have shown that reallocation of exports across destinations generates a trade diversion effect at the firm level and a composition effect across exporters in a given market. This section

[7] I estimate market power at the firm-destination-year level using the elasticity of X_{ijt} to changes in real exchange rate, somehow following Asprilla et al. (2019) in this estimation. The higher the estimated pass-through is, the higher is the market power.

documents the aggregate consequences of these patterns, departing from the firm perspective up to a more aggregate level. In particular, I emphasize that the aggregate effect of temperatures on exports is shaped by the presence of multi-destination firms. These firms simultaneously exhibit a particular reaction to temperatures at the micro-level and account for the bulk of exports.

6.1 Aggregate trade diversion under heat

Aggregation exercise Micro evidence suggests that the number of destinations served by the firm increases the negative response of trade flows to a particular destination following a temperature shock in that destination, while it increases the total exports towards other destinations at the firm level. Building on the approach developed by di Giovanni et al. (2018), I now derive the aggregate implications of these firm-level findings at the bilateral level (i.e. for a given destination market, subject to temperature shocks).

I first compute the predicted response of exports flow to each destination j using the micro-level elasticities estimated and presented in Table 3 - for what follows, I use the estimation produced by the benchmark regression reported in column (4) (-0.092). Specifically, this regression coefficient provides, for every firm and destination a predicted change in exports, denoted $\Delta \hat{X_{ijt}}$, following a destination-year change in temperatures depending upon the number of destinations the firm serves.

I then aggregate the firm-specific reactions to changes in temperatures. The predicted change in aggregate French exports to destination j following a given change in temperatures in that destination is thus $\Delta \hat{X_{jt}}$ defined as:

$$\Delta \hat{X_{jt}} = \sum_i \omega_{ijt-1} \times \Delta \hat{X_{ijt}} \tag{8}$$

in which ω_{ijt-1} is the weight of firm i in total exports to j in $t-1$.

In order to assess the implications of the role played by the firm distribution in the economy, I compute a counter factual aggregate exports to j response, denoted $\Delta \tilde{X_{jt}}$, such that every firm accounts for the same share of total exports to each destination.

$$\Delta \tilde{X_{jt}} = \sum_i \omega_{jt-1} \times \Delta \hat{X_{ijt}} \tag{9}$$

in which $\omega_{jt-1} = 1/n_{jt-1}$ and n_{jt-1} is the total number of firms exporting to country j in $t-1$. This weight assumes a uniform distribution of exports across firms in the economy. Doing so allows to assess the effect of the presence of multi-destination firms and the role of firm distribution in the predicted exports response to destination j.

Results of the exercise are displayed in Table 7. I have computed the two predicted changes in aggregate exports at the country level and the observed change in exports in the data (ΔX_{jt}). I have then averaged these values for each quartile of country-year observations in terms of temperature growth. The first row thus displays the changes in exports for countries in the first quartile of temperature growth, and the bottom row for the fourth quartile.

– Include Table 7 here. –

Results confirm the crucial role played by multi-destination firms in shaping aggregate, country-level response of French exports to a temperature shock. Columns (1) and (2) show that, all other things equal, the variation of exports is close to zero for each group of countries only when weights of all firms in aggregate exports are constrained to be equal, whereas it is much larger (in absolute values) when effective, observed (lagged) weights are used. If all firms had the same (and thus close to 0) weight in the aggregate exports, temperatures shocks would have a much smaller effect on exports. On the contrary, when accounting for the effective role of each firm in the aggregate, results confirm a trade diversion with temperatures, in particular in the fourth quartile of the distribution (where the estimated change is larger in value).

This result can be interpreted as follows: the aggregate trade diversion effect would disappear if all firms in the economy had the same weight in the aggregate, independently of their individual response to temperatures.

Further estimations To confirm this result, I perform a set of estimations. As trade diversion is shaped by the presence of reallocating firms, the trade-deterring effect of temperatures should be larger in *sectors* with a high share of exports made by reallocating firms.

To check that, I aggregate firm-level trade flows at the sector-destination-year level and estimate:

$$X_{jst} = \alpha Temp_{jt} + \gamma Controls_{jt} + \beta Share^{x}_{sjt} + \delta(Temp_{jt} \times Share^{x}_{sjt}) + \lambda_{jt} + \lambda_{st} + \varepsilon_{jst} \qquad (10)$$

in which s denote the HS4 sector of interest. I estimate whether sectoral exports (X_{jst}) are affected by temperatures in the destination and by the presence of large firms in that sector $Share^{x}_{sjt}$. By cell, I compute the share of exports realized by firms that serve more than x destinations; x coming from the threshold in the effective distribution of the number of destinations in my sample, see Table 2. I thus compute the respective shares of exports (in values) that are made by firms that serve more than 3 (median), 7 (top 25%), 16 (top 10%), 25 (top 5%) and 50 (top 1%) destinations.

I include a country-year fixed effect in the estimation: it captures the average level of exports to that market, and the remaining variation is across sectors. I control for unobserved shocks to sectors by adding sector-year fixed effects. Identification in that estimation relies on variation across sectors in the presence of large firms, that captures potential trade diversion. In particular, I use the difference in the share of large firms across sectors to show that it shapes the aggregate trade pattern and trade diversion under temperature changes.

Variations across sectors in the share of high performance firms should correlate with high negative impact of temperatures. I thus expect to estimate a negative δ, as it would imply a magnified, negative impact of temperatures on aggregate exports. I cluster the standard errors at the sector-year level.

– Include Table 8 here. –

Table 8 provides the results. Column (1) displays a non significant impact of temperatures on the sectoral exports. In column (2), I however estimate a negative coefficient of the interaction term. I estimate that the negative trade impact of temperature changes is higher (in absolute terms, i.e. more negative) in sectors in which the share of exports made by firms serving more than 3 destinations is higher. I thus estimate a differential effect of temperature changes across sectors, which is directly related to the "sectoral ability" to reallocate. As sectoral exports become more granular, and made by large firms able to reallocate exports, I estimate that trade diversion away from one market is higher, holding the temperatures change constant. Columns (3) to (6) check this result is not affected when using alternative measures of within-sector heterogeneity. Overall, my prediction is confirmed, even though magnitudes of interaction coefficients get closer to 0 when focusing on a very small set of firms, in particular regarding the top 1% of exports.

6.2 Aggregate composition effects

The differential effect of temperature shock across firms in a given market should translate in a change in the composition of exporters in one market. Composition of exporters may change as small firms decrease less their exports than larger firms. I should thus observe changes in the average characteristics of exporting firms to markets under heat. This subsection checks that, at the aggregate level, I observe a change in exporters' characteristics in any market. By a composition effect, I should observe that firms that serve "hotter" destination (over time, not in the cross section of countries) should be smaller on average.

To test that, I regress:

$$Size_{jt} = \alpha Temp_{jt} + \beta Controls_{jt} + \lambda_j + \lambda_t + \varepsilon_{jt} \tag{11}$$

where $Size_{jt}$ is the export-weighted average size of firms serving market j in year t. Average firm size should be negatively correlated with weather shocks if large firms reallocate exports and represent lower export share in total exports to that market. I cluster the standard errors at the country level.

Table 9 provides the results. I investigate the correlation between temperatures and many measures of average firm size. Columns (1) and (2) focus on the average log assets; columns (3) and (4) check the average employment of firms serving market j. In columns (2) and (4), I include the country-specific measures (related to the quality of governance) as additional covariates. I estimate a significant, negative correlation between temperature and these measures of average firm size. This confirms the prediction, suggesting that when temperature shocks occur, the set of exporting firms is affected. On average, the largest firms reduce their presence, to the profit of smaller firms. Columns (5) and (6) however show that the average labor productivity is not affected by temperature.

– Include Table 9 here. –

These shifts rely on the pre-existing heterogeneity of exporting firms. Shifts in composition of exporters would not have any aggregate effects if firms were homogeneous. On the contrary, as firms are heterogeneous, changes in market shares across firms in a given destination have some aggregate counterparts.

7 Conclusion

Using customs data from France, from 1995 to 2009, this paper studies exporting firms' reaction to weather shocks in destination countries. While weather shocks in foreign countries have an impact on aggregate foreign demand, I identify trade diversion across destinations as the main shock coping strategy for foreign exporting firms. When a destination market is hit by a temperature shock, if the firm is able to divert its exports to other destination markets, the drop in exports to that market is large. As this coping strategy is used mainly by large, multi-destination firms, aggregate trade fluctuations arise after temperatures shocks. Temperature shocks thus affect the geography of exports both at the firm level and in the aggregate.

Evidence in this paper calls for additional future research regarding the impact of these temperature-led changes. In particular, composition effects are not neutral for consumers under in hotter markets. The average performance of the firms from which foreign consumer import from is affected by weather shocks. As large firms to reduce their presence in these markets, consumers may be forced to import "lower quality" goods, inputs that may in turn affect aggregate outcomes in the foreign country. These mechanisms deserve additional research, in particular in a climate change context.

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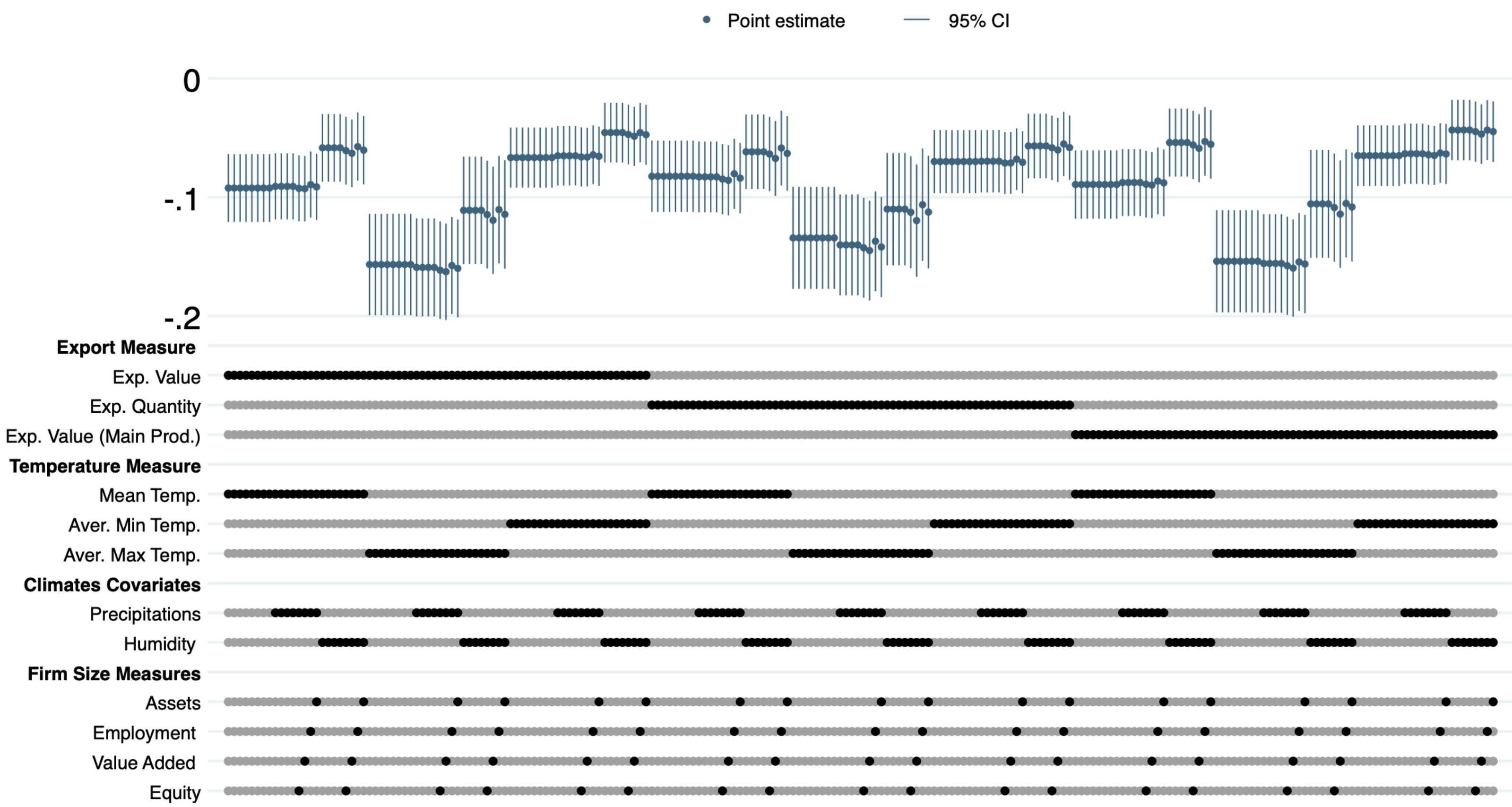
Figure 1: Specification Curve: estimated coefficients for the interaction term $\left(\text{Temp}_{jt} \times \text{Nb. Dest}_{it}\right)$ in Equation 2.



Tables

Table 1: Descriptive Statistics of the Sample

Variable	**Mean**	**SD**	**Min.**	**Max.**	**Obs.**
Firm-country-year Variables					
Export Value x_{ijt}	642163.2	1.23e+07	1	8.56e+09	4431641
Export Quantities q_{ijt}	743797.7	3.00e+07	1	1.32e+10	4431641
Unit Values p_{ijt}	480.5001	98034.7	4.33e-08	1.45e+08	4431641
Firm-year Variables					
Assets	89962.33	4549069	.152449	1.27e+09	466015
Employment	137.6036	2194.549	0	298487	466015
Value Added	22460.88	2389469	-2463507	8.37e+08	457987
Apparent Labor Prod	75.27584	758.0458	-98540.28	194590	448600
Nb Products	4.811787	8.665964	1	568.5	466015
Nb Destinations	15.19543	14.66521	1	182	466015
Country-year Variables					
Mean Temp.	19.39735	7.725181	.325	29.21667	2358
Mean Prec.	93.21857	68.54525	1.816667	409.5917	2358
GDP	275.6463	707.9276	.3319776	8629.17	1788

Note: This table provides the descriptive statistics of the sample used in the baseline regression.

Table 2: Distribution of the Number of Destinations

Percentile	Number of Destinations
25%	1
50%	3
75%	7
90%	16
95%	25
99%	50

Note: This table provides the distribution of the number of destinations, in the firm-year sample (N=448,600).

Table 3: Baseline estimations.

Dependent Variable	Values: ln X_{ijt}					
	(1)	(2)	(3)	(4)	(5)	(6)
Temp_{jt}	-0.099^c	-0.103^c	0.045			
	(0.051)	(0.057)	(0.093)			
Nb Dest_{it-1}	0.830^a					
	(0.012)					
Temp_{jt} × Nb Dest_{it-1}			-0.053^a	-0.092^a	-0.085^a	-0.087^a
			(0.016)	(0.015)	(0.014)	(0.014)
Temp_{jt} × Assets_{it-1}					-0.016^c	
					(0.008)	
Temp_{jt} × Employment_{it-1}						-0.029^a
						(0.006)
Observations	2630675	2630675	2630675	2630675	2630675	2556143
R^2	0.791	0.834	0.833	0.835	0.835	0.835
Country-year Controls	x	x	x			
Firm-year Controls	x					
Firm-country FE	x	x	x	x	x	x
Firm-year FE		x	x	x	x	x
Country-year FE				x	x	x
Year FE	x					

Note: Robust standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All standard errors are clustered at the country-year level. Country-year controls include destination GDP, destination RER with France and market potential.

Table 4: Potential Omitted Variables

Dependent Variable	Values: ln X_{ijt}				
	(1)	(2)	(3)	(4)	(5)
Temp_{jt} × Nb Dest_{it-1}	-0.049^a	-0.074^a	-0.026^c	-0.025^b	-0.031^b
	(0.011)	(0.016)	(0.015)	(0.010)	(0.015)
GDP_{jt} × Nb Dest_{ijt-1}	0.075^a				
	(0.005)				
Political Stability_{jt} × Nb Dest_{it-1}		0.021^a			
		(0.008)			
Distance_{j} × Nb Dest_{it-1}			-0.081^a		
			(0.007)		
Foreign Market Potential_{jt} × Nb Dest_{it-1}				0.060^a	
				(0.003)	
Nb French Exporter_{jt} × Nb Dest_{it-1}					0.147^a
					(0.008)
Observations	2630675	1986162	2630675	1404300	2630675
R^2	0.835	0.842	0.835	0.864	0.835

Note: All specifications include firm-year, firm-country and country-year fixed effects. Robust standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All standard errors are clustered at the country-year level. Country-year controls include destination GDP, destination RER with France and market potential.

Table 5: Reallocation motives.

	(1)	(2)	(3)	(4)	(5)
Ln X_{ijt-1}	0.064^a				
	(0.006)				
$Temp_{it}$ × Ln X_{ijt-1}	0.019^a				
	(0.003)				
Ln Q_{ijt-1}		0.044^a			
		(0.004)			
$Temp_{it}$ × Ln Q_{ijt-1}		0.012^a			
		(0.002)			
Ln P_{ijt-1}			0.019^a		
			(0.006)		
$Temp_{it}$ × Ln P_{ijt-1}			0.001		
			(0.002)		
PTM_{t-1}				9118.344	
				(5.1e+07)	
$Temp_{it}$ × PTM_{t-1}				0.347	
				(0.226)	
Experience in market j					0.231^a
					(0.011)
$Temp_{it}$ × Experience in market j					0.067^a
					(0.004)
Observations	2120393	2120393	2120393	2120393	2120393
R^2	0.856	0.855	0.854	0.854	0.825

Note: All specifications include firm-year, firm-country and country-year fixed effects. Robust standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All standard errors are clustered at the country-year level.

Table 6: Total Exports. Dependent Var: Ln X_{it}

	(1)	(2)	(3)	(4)
Temp_{it}	0.179^a	-0.060^a	-0.048^a	-0.060^a
	(0.027)	(0.017)	(0.014)	(0.017)
Assets_{t-1}	0.454^a	0.456^a	0.440^a	0.456^a
	(0.011)	(0.011)	(0.016)	(0.011)
Employment_{t-1}	0.186^a	0.182^a	0.182^a	0.177^a
	(0.007)	(0.007)	(0.007)	(0.013)
Nb Dest_{it-1}	0.419^a	0.046	0.055	0.049
	(0.038)	(0.049)	(0.049)	(0.049)
$\text{Temp}_{it} \times \text{Nb Dest}_{it-1}$		0.162^a	0.157^a	0.160^a
		(0.009)	(0.009)	(0.009)
$\text{Temp}_{it} \times \text{Assets}_{t-1}$			0.007	
			(0.005)	
$\text{Temp}_{it} \times \text{Employment}_{t-1}$				0.002
				(0.004)
Observations	214114	214114	214114	214114
R^2	0.914	0.915	0.915	0.915

Note: All specifications include firm and year fixed effects. Robust standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All standard errors are clustered at the country-year level.

Table 7: Aggregation Exercise

	(1)	(2)	(3)
Quartile	$\Delta\hat{X}_{jt}$	$\Delta\tilde{X}_{jt}$	ΔX_{jt}
1	-.0282508	-.0117545	.0131799
2	-.0298066	-.0088711	.0131433
3	-.0435549	-.0125484	.016446
4	-.0393971	-.0147894	-.0025287

Note: This table provides the predicted changes in aggregate exports. See text for more details on the methods. "Quartiles" represent quartiles of the yearly temperature growth.

Table 8: Trade Diversion Effect of Large Firms

	(1)	(2)	(3)	(4)	(5)	(6)
Temp_{jt}	-0.002					
	(0.016)					
$Share^{3}_{sjt}$		0.010				
		(0.019)				
$\text{Temp}_{jt} \times Share^{3}_{sjt}$		-0.810^{a}				
		(0.253)				
$Share^{7}_{sjt}$			0.005			
			(0.016)			
$\text{Temp}_{jt} \times Share^{7}_{sjt}$			-0.570^{a}			
			(0.208)			
$Share^{16}_{sjt}$				-0.017		
				(0.013)		
$\text{Temp}_{jt} \times Share^{16}_{sjt}$				-0.522^{a}		
				(0.150)		
$Share^{25}_{sjt}$					-0.027^{b}	
					(0.012)	
$\text{Temp}_{jt} \times Share^{25}_{sjt}$					-0.303^{b}	
					(0.134)	
$Share^{50}_{sjt}$						-0.053^{a}
						(0.011)
$\text{Temp}_{jt} \times Share^{50}_{sjt}$						-0.209
						(0.132)
Observations	355537	748669	748669	748669	748669	748669
R^2	0.884	0.846	0.846	0.846	0.846	0.846
Sector-year FE	x					
Sector-country FE	x	x	x	x	x	x
Country-year FE		x	x	x	x	x
Country-year controls	x					

Note: Robust standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All standard errors are clustered at the sector-country level. Country-year controls include destination GDP, destination RER with France and market potential.

Table 9: Average Firm Size and Temperatures : Correlation

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Var.	Assets		Employment		Labor Prod.	
Temp_{jt}	-0.309^{a}	-0.393^{a}	-0.232^{a}	-0.365^{a}	-0.056	-0.002
	(0.081)	(0.111)	(0.087)	(0.119)	(0.037)	(0.053)
Nb Dest. $_{t-1}$	2.391^{a}	2.167^{a}	2.040^{a}	1.911^{a}	0.365^{a}	0.424^{a}
	(0.088)	(0.115)	(0.094)	(0.124)	(0.040)	(0.056)
Observations	929	571	929	571	929	571
R^2	0.976	0.976	0.954	0.953	0.830	0.804
Governance Variables		x		x		x

Note: All specifications include country and year fixed effects. Robust standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All standard errors are clustered at the country level. Country-year controls include destination GDP, destination RER with France and market potential. All columns include country-year controls.