# Trade costs shocks and lumpiness of imports: Evidence from the Fukushima disaster

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Abstract:

This paper uses a difference-in-differences approach to test the hypothesis that the increase in the per-shipment costs of imports from Japan due to the Fukushima disaster in 2011 lead to an increase in the lumpiness of imports from Japan. Using China and the USA as control groups it is found that the Fukushima trade cost shock reduced the average number of import transactions per year at the firm-good level and, therefore, increased the degree of lumpiness of imports from Japan.



Keywords: Fukushima disaster, trade shock, imports, Germany

JEL Classification: F14



*All computations were done at the Research Data Centre of the Federal Statistical Office in Wiesbaden. I thank Melanie Scheller for preparing the transaction level data and for checking the output of my do-files for the violation of privacy. The micro data used are strictly confidential but not exclusive; see http://www.forschungsdatenzentrum.de/datenzugang.asp for information on how to access the data. To facilitate replications the Stata do-files used are available from the author on request.



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## 1. Motivation

International trade is costly, and these trade costs are in part not proportional to the value of the international transaction. There are fixed costs that come with every shipment including paper work (filling in customs declarations and other forms) and the time and monetary costs related to having the cargo inspected. These fixed costs lead to a trade-off between per-shipment trade costs and shipping frequency. On the one hand, firms would like to economize on per-shipment costs by sending fewer and larger shipments. On the other hand, this comes at a cost due to time-lags related to waiting to fill a larger shipment and because of the need to keep costly inventories between shipment arrivals (see Hornok and Koren (2015a)). At the firm level, shipping frequency can be considered as an additional margin of trade besides the intensive margin (the volume of trade) and the extensive margins made of the number of goods traded and the number of countries traded with (see Békés et al. 2011).

Therefore, per-shipment costs may make it optimal for traders to engage in cross-border transactions infrequently, and trade flows at the level of the firm – imports (exports) by a firm of a specific good from (to) a specific country – are lumpy. Empirical evidence on the lumpiness of international trade has been reported in a small number of recent studies:

Alessandria et al. (2010) use monthly data on the universe of US exports for goods in narrowly defined categories to six destination countries from January 1990 to April 2005 and find that goods are traded infrequently over the course of a year. Exports are lumpy, trade is highly concentrated in a few months. Békés et al. (2015a) explore transaction level data for exports from France in 2007 at the firm-product-destination level and approximate the number of shipments by the number of months within a year in which a transaction is recorded for a given firm-product-destination. A

large number of firms ship their products only in a few months. The authors report a high degree of lumpiness in exports – almost 45 percent of firms ship a given product to a given destination only once a year to EU markets and more that 60 percent do so to extra-EU markets. Hornok and Koren (2015a) examine disaggregated data on exports of the United States and Spain in 2009 and look at the lumpiness of trade transactions by documenting how frequently the same good is exported to the same destination country within a year. Trade transactions for a given product to a given destination show strong signs of lumpiness. Kropf and Sauré (2014) look at transaction level data for Swiss exports from 2007, a subset of which contains a firm identifier so that export data are at the firm-product-destination level. Exports are lumpy; the mean value of shipments per year is 3.5. Wagner (2016a) uses transaction level data for Germany from 2009 to 2012 and documents that imports and exports show a high degree of lumpiness. In a given year about half of all firm-good-country combinations are recorded only once or twice for trade with EU-countries, and this is the case for more than 60 percent of all firm-good-country combinations in trade with non-EU countries.

Two econometric studies look at the link between the degree of lumpiness of trade and indicators of per-shipment costs. Hornok and Koren (2015a) investigate how the frequency of shipments varies with the level of per-shipment costs. They estimate a number of gravity-like regressions (that include variables for GDP and GDP per capita of destination countries, and distance to destination countries of exports, among others, as control variables) for exports of the US and Spain at the product-country level and find that the number of shipments decrease ceteris paribus when the time costs or the monetary costs per shipment are larger. Empirical models in Wagner (2016a) show that in Germany the frequency of transactions at the firm-

good-country level tends to decrease with higher per-shipment costs when unobserved firm and goods characteristics are controlled for.

While a high degree of lumpiness of trade is documented for a number of countries, empirical evidence for the role of trade costs in shaping this lumpiness is scarce. Furthermore, this evidence is based on cross-section regressions only. The reason for this shortcoming is that the indicators used to measure per-shipment trade costs are either constant (like distance to the country of origin or destination) or highly stable (like the time that it takes to have a container inspected by the customs, or the costs related to exporting a container) over time for a single country of destination or origin, and do vary only between countries (see Wagner (2016a)).

This paper contributes to the literature by using an exogenous shock that lead to an increase in the per-shipment costs of imports from one country of origin to Germany to identify the effect of per-shipment costs on the degree of lumpiness of imports. On 11 March 2011, in Japan a tsunami disabled the power supply and cooling of three Fukushima Daiichi reactors, causing a disastrous nuclear accident. As a consequence, imports from Japan were inspected carefully by the customs to detect any radioactivity that might have contaminated the cargo. This lead to an increase of per-shipment costs for imports from Japan due to a delay in time of delivery caused by this inspection.[1] Per-shipment costs for imports from other countries of origin did not change due to the Fukushima disaster.

[1] See contemporaneous newspaper articles, e.g. http://www.focus.de/wissen/natur/katastrophen/tid-21835/atomkatastrophe-strahlende-importe_aid_613820.html, http://www.handelsblatt.com/-panorama/aus-aller-welt/fukushima-verseuchung-des-meeres-weitet-sich-aus/4016560.html, http://www.n-tv.de/wirtschaft/Europas-Haefen-ruesten-sich-article2976226.html

In this paper we use a difference-in-differences approach (discussed in detail in section 3) to test the hypothesis that the increase in the per-shipment costs of imports from Japan between 2010 and 2011due to the Fukushima disaster lead to an increase in the lumpiness of imports from Japan. In doing so, China and the USA, the most important countries of origin for German imports outside the EU in 2011, are used as control groups.

To anticipate the most important result, we find that the increase in the per-shipment costs due to the Fukushima disaster reduced the average number of transactions per year and, therefore, increased the degree of lumpiness of imports from Japan.

The rest of the paper is organized as follows. Section 2 introduces the data used, section 3 presents the empirical investigation, section 4 concludes.

## 2. Data

This paper uses transaction-level data for German imports from Japan, China and the USA. In Germany information on goods traded across borders and on the countries traded with is available from the statistic on foreign trade (*Außenhandelsstatistik*). For trade with non-EU countries the source of information is data collected by the customs (the so-called *Extrahandelsstatistik*). The data used in this paper are based on these raw data at the transaction level. The unit of observation in these raw data is a single transaction between economic agents located in two countries, e.g. the import of X kilogram of good A with a value of Y Euro from Japan to Germany. For a given year, the sum over all transactions is identical to the figures published by the Federal Statistical Office for total imports of Germany.

The record of the transaction usually includes a firm identifier (tax registration number) of the trading German firm.[2] Using this identifier information at the transaction level can be aggregated at the level of the trading firm. These data show which firm trades how much of which good with firms from which country in a given month. Products are distinguished according to very detailed classifications. In the data used for this paper, the Harmonized System at 6-digit level (HS6) is used as the product classification system.

## 3. Empirical investigation

The degree of lumpiness of imports is measured by the number of import transactions at the firm-product-country level. In the German data used here trade frequency is measured by the number of months in a year in which transactions of this firm-good-country combination are recorded. Note that within a month all imports of a specific HS6-good from a specific country by one single firm are aggregated and reported as one data point only. Therefore, the proxy for trade frequency used here may be biased for high frequency traders which import the same good from the same country in (nearly) every month several times. For low frequency traders, however, the number of months with recorded transactions is a reliable approximation (see the discussion in Békés et al. 2015).

That said, information on the lumpiness of German imports from Japan (the country where the Fukushima disaster happened), China and the USA (the countries that are used as control group) in 2010 (the year before the disaster) and 2011 (when on 11 March the nuclear catastrophe happened) is reported in Table 1.

[2] Note that this identifier is missing for several transactions for various reasons including traders that do not have a (German) tax identification number; further details were not revealed to me.

[Table 1 near here]

In line with results (that are summarized in the introductory section) reported for other countries and for Germany before Table 1 shows a high degree of lumpiness of imports for all three countries in both years. About two thirds of all firm-good-country combinations are recorded only once or twice. The frequency of recorded transactions tends to decline with an increase in the number of transactions per year. This is in accordance with the presence of per-shipment fixed costs that provide an incentive for importers to engage in cross-border transactions infrequently. However, there is a remarkable increase in the frequency of the number of transactions when it comes to twelve transactions per year. This might be due to the fact (mentioned above) that within a month all imports of a specific HS6-good from a specific country by one single firm are aggregated and reported as one data point only. Therefore, the proxy for trade frequency used here may be biased for high frequency traders which trade the same good with the same country in (nearly) every month several times.

The big picture is remarkably similar for the three countries considered. The average number of transactions – a summary measure of the degree of lumpiness of imports in trade with a country – does not differ much between the countries, and it is stable over time though it decreased slightly in all three countries from 2010 to 2011 (pointing to a small increase in the degree of lumpiness of imports).

From the results reported in Table 1 one might conclude that the trade cost shock caused by the Fukushima disaster did not have any impact on the degree of lumpiness of imports from Japan. This conclusion, however, might be precipitate. It has been documented for a number of countries that many firm-product-country combinations in international trade are recorded in one year only and do not survive over a longer period (see Wagner (2016b), section 3.3, for a survey of these studies).

Given that the link between per-shipment trade costs and the degree of lumpiness of imports tends to be different for different goods and different firms (see Wagner 2016a) changes in the degree of lumpiness should be investigated for firm-product-country combinations that took place in both years only.

Table 2 documents that this point might be highly relevant for an analysis of German imports from Japan, China and the USA in 2010 – 2011. Only about half of all firm-good-country observations in German imports in this period are observed in both years. The econometric investigation uses only these survivor cases.

[Table 2 near here]

To test for the presence of an impact of the Fukushima trade cost shock on the degree of lumpiness of German imports from Japan, and to estimate the size of this effect, a difference-in-differences approach is applied.[3] Informally stated, for all firm-good combinations in imports from Japan that were observed in 2010 and in 2011 the difference in the number of transactions that took place in 2010 and 2011 is computed, and this difference is compared to the respective difference in the number of transactions in imports from either China or the USA. Formally, the following empirical model is estimated (by OLS) [4]

$$[1] \quad transactions_i = ß0 + ß_1 * year_i + ß_2 * Japan_i + ß_3 * year_i * Japan_i + e_i$$

Here, $tansactions_i$ is the number of import transactions by firm i (the outcome variable), $year_i$ is a dummy variable that has either the value 0 (for 2010, the period before the disaster) or the value 1 (for 2011, the period in which the disaster

[3] A discussion of any details of this method is beyond the scope of this paper; see Angrist and Pischke (2015), ch. 5, for a textbook treatment.

[4] Computations used the Stata command `diff` (Villa 2016)

happened), $Japan_i$ is a dummy variable that has either the value 1 (for imports from Japan, the treatment group) or the value 0 (for imports from the country that serves as a control group, i.e. either China or the USA), and $e_i$ is an error term. $ß_3$, the regression coefficient of the interaction term of the variable year and the variable Japan, is the difference-in-differences estimate of the treatment effect – the import costs shock due to the Fukushima disaster.

Results from the difference-in-differences analysis are reported in Table 3.[5] In line with the hypothesis stated in the introductory section the estimated treatment effect is negative (indicating an increase in the degree of lumpiness of imports due to the increase in per-shipment costs), statistically significant at a usual error level, and of the same size for firms from both control groups.

## 4. Concluding remarks

This paper uses a difference-in-differences approach to test the hypothesis that the increase in the per-shipment costs of imports from Japan due to the Fukushima disaster in 2011 lead to an increase in the lumpiness of imports from Japan. Using China and the USA as control groups it is found that the Fukushima trade cost shock reduced the average number of import transactions per year at the firm-good level and, therefore, increased the degree of lumpiness of imports from Japan.

However, the size of the estimated effect of the Fukushima trade cost shock that points to a reduction of the average number of import transactions per year by 0.06 can be regarded as small compared to the average number of transactions reported in Table 1. This small size of the effect might be due to a small size of the increase in per-shipment costs. While I am not aware of any estimates of this

[5] To economize on space, only the estimated treatment effects and its p-values are reported. The complete results for all coefficients and more statistics are available on request.

increase in trade costs, anecdotal evidence points to an increase of the waiting time for the delivery of imported goods from Japan due to time-lags introduced by additional inspection of containers by the port authorities and customs as the source of increased costs. Maybe, a few days more until the goods can leave the port are considered as a small cost shocks that leads to a small change in import behavior of the firms only.

**References**


Alessandria, George, Joseph P. Kaborski, and Virgiliu Midrigan (2010): Inventories, Lumpy Trade, and Large Devaluations. *American Economic Review* 100 (December), 2304-2339.

Angrist, Joshua D. and Jörn-Steffen Pischke (2015): Mastering 'Metrics. The Path from Cause to Effect. Princeton and Oxford: Princeton University Press.

Békés, Gábor, Lionel Fontagné, Balázs Muraközy, and Vincent Vicard (2011): Frequency of export: an additional margin of trade. Extended abstract, December 9.

Békés, Gábor, Lionel Fontagné, Balázs Muraközy, and Vincent Vicard (2015): Shipment Frequency of Exporters and Demand Uncertainty: An Inventory Management Approach. Centre for Economic Policy Research CEPR Discussion Paper No. 11013, December.

Hornok, Cecília and Miklós Koren (2015a): Per-shipment Costs and the Lumpiness of International Trade. *Review of Economics and Statistics* 97 (2), 525-530.

Hornok, Cecília and Miklós Koren (2015b): Administrative barriers to trade. *Journal of International Economics* 96 , Supplement 1, S110-S122.

Kropf, Andreas and Philip Sauré (2014): Fixed Costs per Shipment. *Journal of International Economics* 92 (1), 166-184.

Mayer, Thierry and Soledad Zignago (2011): Notes on CEPII's distance measures: The GeoDist database. CEPII Document de Travail No 2011-25, December.

Villa, Juan M. (2016): diff: Simplifying the estimation of difference-in-differences treatment effects. *The Stata Journal* 16 (1), 52-71.

Wagner, Joachim (2016a): The Lumpiness of German Exports and Imports of Goods. University of Lüneburg Working Papers in Economics No. 359, April.

Wagner, Joachim (2016b): A survey of empirical studies using transaction level data on exports and imports. *Review of World Economics* 152 (1), 215-225.

Table 1: German import transactions per year by firm-good-country of origin

| County | Japan | | China | | USA | |
|---|---|---|---|---|---|---|
| Year | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 |
| | Share (%) | Share (%) | Share (%) | Share (%) | Share (%) | Share (%) |
| Number of transactions per year | | | | | | |
| 1 | 51.87 | 52.12 | 51.76 | 52.05 | 55.89 | 57.24 |
| 2 | 13.36 | 13.47 | 14.76 | 14.84 | 14.10 | 13.98 |
| 3 | 7.05 | 6.92 | 7.80 | 7.77 | 7.02 | 6.80 |
| 4 | 4.45 | 4.57 | 5.13 | 5.02 | 4.48 | 4.33 |
| 5 | 3.40 | 3.39 | 3.68 | 3.67 | 3.19 | 3.08 |
| 6 | 2.72 | 2.65 | 2.91 | 2.82 | 2.45 | 2.36 |
| 7 | 2.33 | 2.26 | 2.38 | 2.33 | 2.05 | 1.88 |
| 8 | 2.02 | 1.99 | 2.02 | 2.02 | 1.75 | 1.68 |
| 9 | 2.04 | 1.96 | 1.81 | 1.78 | 1.64 | 1.55 |
| 10 | 2.12 | 2.10 | 1.78 | 1.77 | 1.66 | 1.50 |
| 11 | 2.26 | 2.23 | 1.90 | 1.86 | 1.75 | 1.61 |
| 12 | 6.39 | 6.36 | 4.07 | 4.06 | 4.02 | 3.99 |
| Average number of transactions | 3.24 | 3.22 | 2.98 | 2.96 | 2.81 | 2.74 |

Note: Number of transactions refers to months with recorded import transactions at the firm-product-country of origin level; goods refer to categories at the HS6 level.

Table 2: Number of Firm-HS6 good-country of origin observations in German imports

| | 2010 only (share; %) | 2011 only (share; %) | 2010 and 2011 (share; %) |
|---|---|---|---|
| Japan | 47,667 (23.84) | 53,723 (26.87) | 98,544 (49.29) |
| China | 217,217 (23.69) | 270,234 (29.47) | 429,598 (46.85) |
| USA | 167,067 (24.28) | 211,630 (30.75) | 309,500 (44.97) |

Table 3: Effect of Fukushima disaster on lumpiness of German imports from Japan

| | Control group | China | USA |
|---|---|---|---|
| Estimated effect | | -0.060 | -0.063 |
| (p-value) | | (0.030) | (0.027) |

Note: The estimated effect is the regression coefficient of the interaction term between a dummy variable indicating whether a transaction occurred with a firm in Japan (1) or with a firm from the country in the control group (0) and a dummy variable indicating whether the transaction took place in 2010 (0) or in 2011 (1); see text. p-values are based on robust standard errors.