

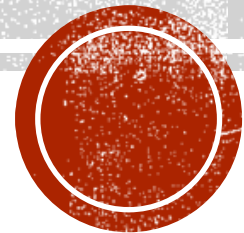
CORRELATION AVERSION IN MULTINATIONALS: INDUSTRY AND FIRM-LEVEL EVIDENCE

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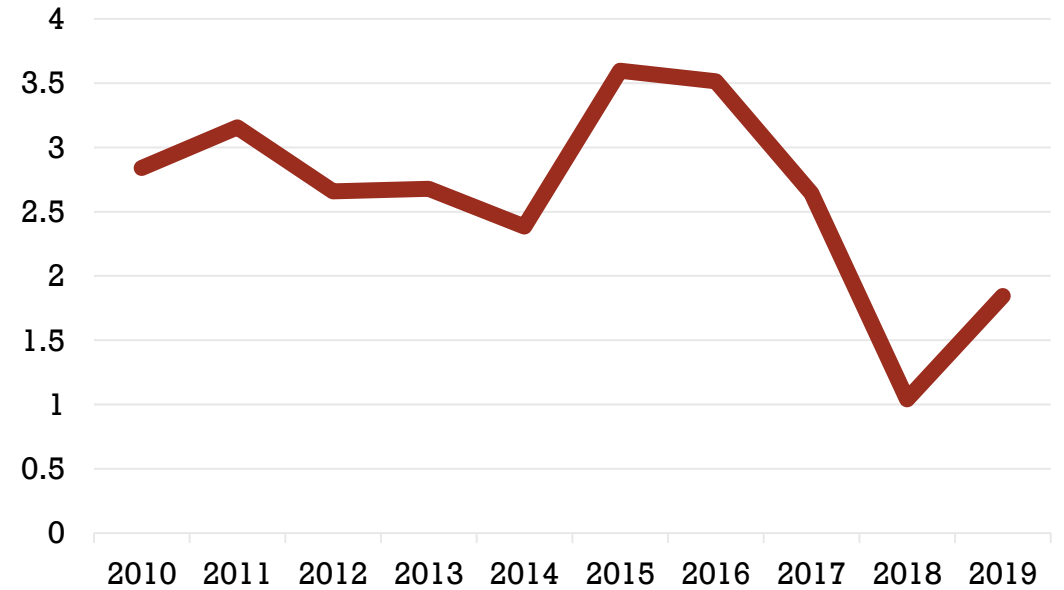


CONTENTS

- Background
- Motivation
- Summary
- Hypothesis development
- Construction of uncertainty measures
- Industry-level analysis
- Firm-level analysis
- Conclusion

BACKGROUND

- World flows of foreign direct investment (FDI) have decreased over the last 6 years
- Even though usual forces were supportive:
 - economic growth was robust, equity prices were high, and interest rates in the core financial centers of the US, UK, EU, and Japan were low
- Jardet et al. (2022) discuss this “puzzle” and link it to growing uncertainty.
- Multinational firms have had to cope with several major “uncertainty shocks”
 - Brexit, the United States (US) presidential election, the China-US trade tensions, Covid-19, and the Ukraine war



World foreign direct investment inflows

Figure 1. World foreign direct investment inflows (as % of GDP)
Source: World Bank.

BACKGROUND

- **negative** and significant effects of both **demand uncertainty** and **exchange rate uncertainty** on FDI investments
 - (Lewis (2014); Fillat and Garreto, (2015); Jeanneret (2016); Conteduca and Kazakova (2018) among others).
- the resolution of this “puzzle” might also lie in high levels of demand and exchange rate volatility in the world.
- However, consider figure 2.

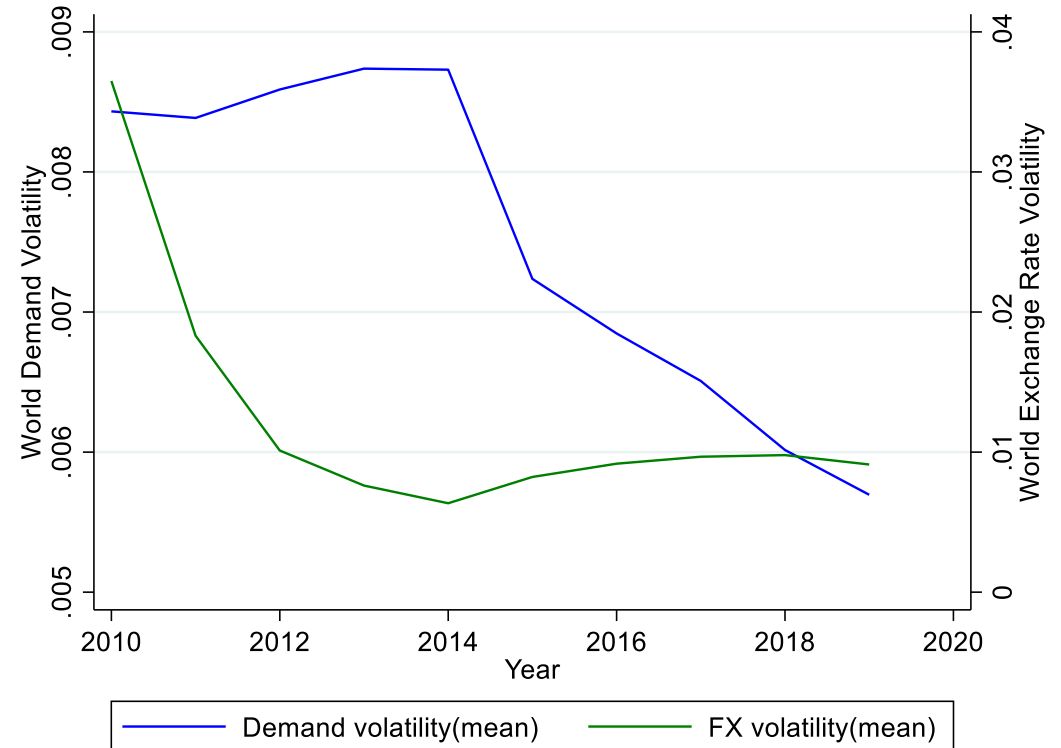


Figure 2. Global demand volatility and global exchange rate volatility. Notes: The lines show the mean measure of demand and exchange rate volatilities for a sample of 182 countries. Source: author calculations based on absorption and exchange rate data from Penn World Table (PWT) 10.1.

MOTIVATION

- Attempt to examine this “puzzle” – different perspective
- The existing studies, at large, focus on the case of a single source of uncertainty
- Investment decisions often have **multidimensional** consequences, with most of them being risky
- Studies should incorporate **multivariate risk-taking** by multinationals.
- In the presence of multiple sources of risk, the **correlation** between these risks matters to the investors.
- On average, the demand and exchange rate volatilities in the world are not increasing separately (Figure 2), however, the correlation between these two risks is a different story.

CORRELATION OF SHOCKS

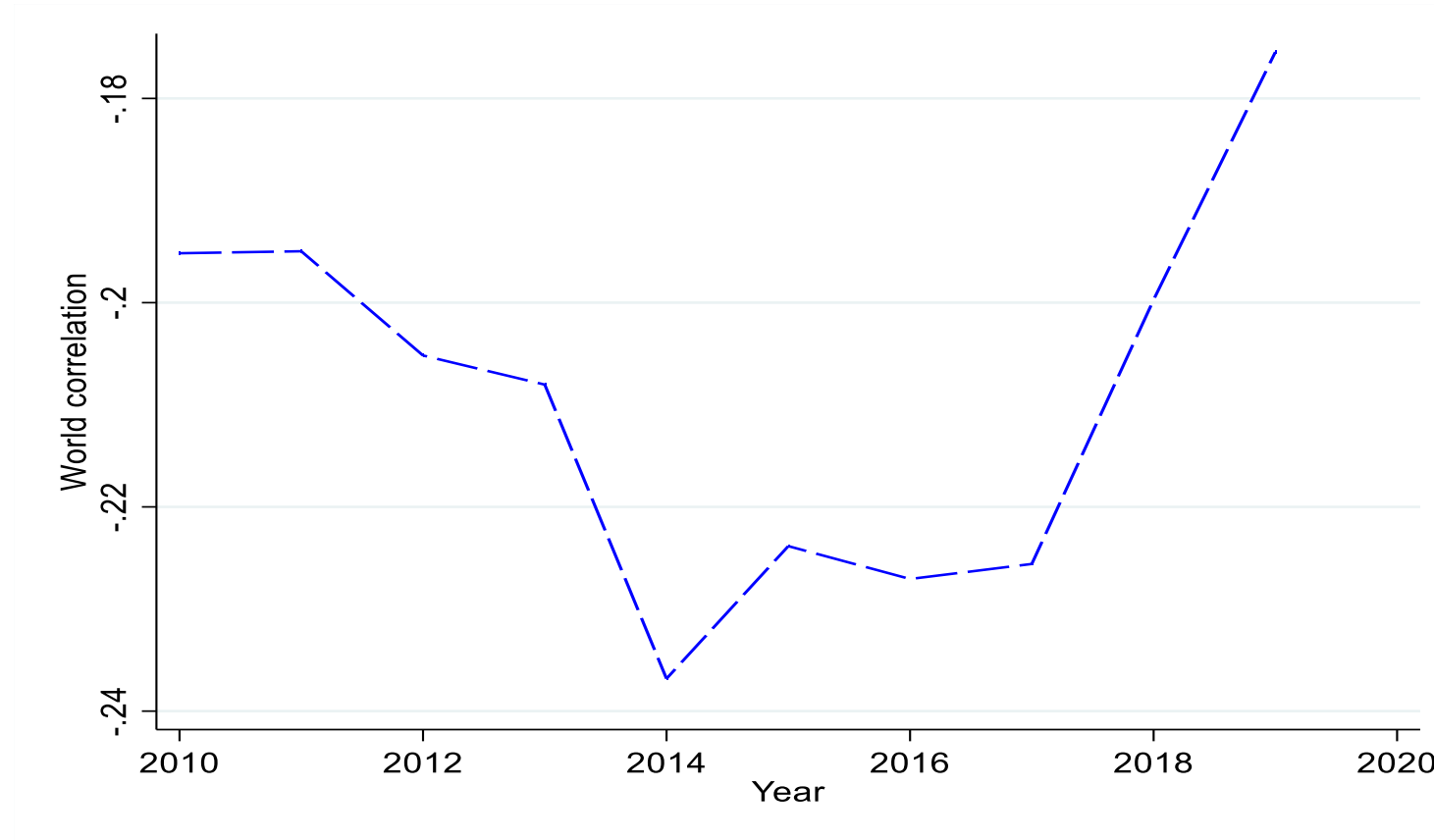


Figure 3. Global correlation of demand and exchange rate shocks (mean measure of the correlation of demand and exchange rate shocks for a sample of 182 countries).

SUMMARY - I

- **Objective:**
 - analyze the FDI investment under multi-variate shocks in a foreign country
 - Demand shocks
 - Exchange rate shocks
 - explore the effects of the correlation between two shocks
- **Research question:**
 - whether risk correlation explains the geographic variation in FDI?
 - whether the multinational enterprises (MNEs) exhibit correlation aversion in the presence of two shocks
- **Approach:**
 - Estimate industry-level FDI investment in the host economy in presence of two shocks and their correlation.
 - Use data on the activities of Japanese Multinationals for firm-level correlation aversion estimations.

SUMMARY - II

- **Key findings:**
 - Less FDI investments in countries where the demand and exchange rate shocks are more correlated
 - Japanese multinationals exhibit correlation aversion: they invest more in destination countries with less correlated shocks
- **Main contributions:**
 - contributes to the literature investment under uncertainty
 - multivariate shocks
 - improves our understanding of the activities of multinationals
 - correlation aversion traits
 - contributes to the literature on time-varying uncertainty
 - time-varying correlation measure

HYPOTHESIS DEVELOPMENT - I

- Derived from the results of existing research in international economics, portfolio maximization theory, the capital asset pricing model (CAPM)
- **Correlation aversion** - generalization of risk aversion.
 - Investors prefer uncorrelated (or even negatively correlated) risks
- First defined by Richard (1975)
 - A correlation-averse agent would prefer a lottery with two perfectly negatively correlated attributes than a lottery with two perfectly positively correlated attributes
- CAPM has stressed the attractiveness of assets whose returns are negatively correlated with the market return

HYPOTHESIS DEVELOPMENT - II

- Goldberg and Kolstad (1995) – analyze exchange rate shocks and export demand
 - under a positive correlation between export demand and exchange rate shocks, the multinational optimally locates some productive capacity abroad. (Theory)
 - do not find support for the effect of correlation on the empirical part
- Riano (2011)
 - analyzes the correlation between domestic and foreign demand shocks and shows that a **negative correlation** between demand shocks induces more firms to start exporting.
- Fillat et al. (2015)
 - study multinational production in the presence of country-specific shock. Show that MNEs with affiliates in countries with less correlated shocks tend to have lower risk premia
- Esposito (2022)
 - risk-averse entrepreneurs exploit the spatial correlation of demand across countries to lower the variance in their global sales. Trade more with **less correlated** countries to diversify the risk.

HYPOTHESIS DEVELOPMENT

- **Hypotheses**

- *1 - destination countries with **more correlated** demand and exchange rate shocks attract **fewer FDI***
- *2 - there is significant **correlation aversion** in multinationals' FDI activities*

- **Approach**

- Use industry-level estimation for the first hypothesis
- Use firm-level estimation for the second hypothesis

UNCERTAINTY MEASURES

- Country demand uncertainty - Penn.World. Table 10.1. country-level absorption (CDA).

- The volatility was computed in two steps:

- First, calculate the growth rate of absorption.

- $\tilde{D}_{i,t} = \ln\left(\frac{D_{i,t}}{D_{i,t-1}}\right)$ (1)

- where $D_{i,t}$ is the aggregate country-level absorption in country i at time t .

- Second, country-level demand volatility is then calculated as the variance of the yearly growth rates over the last 15-year rolling period.

- $\sigma_{i,t}^2 = \frac{1}{N-1} \sum_{n=1}^{15} (\tilde{D}_{i,t-n} - \bar{D}_i)^2$ (2)

- Exchange rate uncertainty is calculated in a similar way.

- Time-varying correlation of these two measures is constructed as the correlation of yearly growth rates of absorption and exchange rate over the last 15-year rolling period.

INDUSTRY-LEVEL ESTIMATION

$$\text{Log}R_{it}^k = \beta_1 \mathbb{V}(\tilde{D}_{it}) + \beta_2 \mathbb{V}(\tilde{EX}_{iUt}) + \beta_3 \mathbb{P}(\tilde{D}_{it}, \tilde{EX}_{iUt}) + \Phi_{it} + f_k + f_i + \varepsilon_{it}^k \quad (3)$$

- $\text{Log}R_{it}^k$ - number of foreign enterprises operating in the host country i at year t and industry k .
- $\mathbb{V}(\tilde{D}_{it})$ - the variance of demand shocks
- $\mathbb{V}(\tilde{EX}_{iUt})$ - the variance of host country exchange rate shocks
- $\mathbb{P}(\tilde{D}_{it}, \tilde{EX}_{iUt})$ - the correlation between these two shocks
- Φ_{it} - set of host country control variables

INDUSTRY-LEVEL DATA SUMMARY

- Source: OECD Activity of Multinational Enterprises (AMNE) database
- Dependent variable - number of foreign enterprises in the declaring country
- Declaring countries - 29 OECD countries
- 65 industries at 3-digit ISEC Rev.4 classification
- Period - 2010-2016

Table 1. Descriptive statistics for variables used in industry-level estimations.

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|-------|--------|-----------|--------|---------|
| Number of firms(log) | 9473 | 4.358 | 1.599 | 0 | 10.093 |
| $\log(Y_{it})$ | 10359 | 13.127 | 1.566 | 10.366 | 16.819 |
| EX_{itU} | 10359 | .568 | 1.473 | -.498 | 5.64 |
| $\mathbb{P}(\tilde{D}_{it}, \tilde{EX}_{itU})_{t-15}$ | 10359 | -.164 | .274 | -.797 | .418 |
| $\mathbb{P}(\tilde{D}_{it}, \tilde{EX}_{itU})_{t-10}$ | 10359 | -.331 | .262 | -.902 | .411 |
| inflation | 10359 | 1.528 | 1.697 | -1.736 | 8.892 |
| $\mathbb{V}(\tilde{D}_{it})$ | 10359 | .002 | .003 | 0 | .013 |
| $\mathbb{V}(\tilde{EX}_{itU})$ | 10359 | .075 | .304 | .003 | 1.765 |
| Inflation volatility | 10359 | 19.421 | 51.03 | .096 | 575.406 |
| Financial development index | 10359 | .632 | .185 | .239 | .978 |

INDUSTRY-LEVEL RESULTS

Table 2. Industry-level estimations, number of foreign affiliates

| Dependent variable: Number of foreign affiliates (log), industry-level | | | |
|--|------------------------|------------------------|------------------------|
| | 1 | 2 | 3 |
| $\mathbb{P}(\tilde{D}_{it}, EX_{itU})_{t-15}$ | -0.286 | -0.253 | |
| | (0.032) ^{***} | (0.032) ^{***} | |
| $V(\tilde{D}_{it})$ | 10.814 | -0.461 | -0.241 |
| | (15.312) | (15.576) | (15.533) |
| $V(EX_{itU})$ | -0.122 | -0.117 | -0.196 |
| | (0.025) ^{***} | (0.026) ^{***} | (0.027) ^{***} |
| $\mathbb{P}(\tilde{D}_{it}, EX_{itU})_{t-10}$ | | | -0.060 |
| | | | (0.022) ^{***} |
| Country FE | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes |
| Additional controls | No | Yes | Yes |
| N | 9473 | 9473 | 9473 |

Notes: (a) Constant terms are included in estimations. (b) Additional controls are FDI host-country control variables such as per capita GDP, exchange rate, inflation, capital stock, Financial Development Index (IMF), and inflation volatility. (c) Values in parentheses are robust standard errors. (d) “***”, “**”, and “*” indicate statistical significance at the 1, 5, and 10% levels, respectively., constant term.

ROBUSTNESS

- **Two robustness checks:**

- *Alternative uncertainty and correlation measures*

- As a robustness check, I estimate with uncertainty and correlation measures which include the information of the past 10 years.

- *Alternative measures for the dependent variable*

- use Inward Foreign Direct Investment flows from OECD database. This data includes 35 OECD countries as FDI host countries, in 45 industries for the period 2010-2019.

Table 5. Industry-level estimations, FDI inflows.

| | Dependent variable: Industry-level FDI Inflow (log) | | |
|-------------------------------------|---|------------|------------|
| | 1 | 2 | 3 |
| $\rho(\tilde{D}_i, EX_{iU})_{t-15}$ | -0.458 | -0.566 | |
| | (0.237)* | (0.243)** | |
| $V(\tilde{D}_i)$ | 27.664 | 26.407 | 18.163 |
| | (28.990) | (29.300) | (29.026) |
| $V(EX_{iU})$ | -0.712 | -0.997 | -1.285 |
| | (0.210)*** | (0.315)*** | (0.347)*** |
| $\rho(\tilde{D}_i, EX_{iU})_{t-10}$ | | | -0.310 |
| | | | (0.181)* |
| Country FE | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes |
| Additional controls | No | Yes | Yes |
| N | 4621 | 4621 | 4621 |

Notes: (a) Constant terms are included in estimations. (b) Additional controls are FDI host-country control variables such as per capita GDP, exchange rate, inflation, capital stock, Financial Development Index (IMF), and inflation volatility. (c) Values in parentheses are robust standard errors. (d) “***”, “**”, and “*” indicate statistical significance at the 1, 5, and 10% levels, respectively, constant term.

FIRM-LEVEL ESTIMATION

$$EMP_{plit} = \beta_1 \mathbb{V}(\tilde{D}_{it}) + \beta_2 \mathbb{V}(\tilde{EX}_{ijt}) + \beta_3 \mathbb{P}(\tilde{D}_{it}, \tilde{EX}_{ijt}) + \mathbf{Z}_{it} + \Phi_{jt} + \Phi_{it} + f_k + f_i + \varepsilon_{it} \quad (4)$$

where,

- EMP_{plit} - number of employees working in the foreign affiliate.
 - AFF_EMP_{plit} - number of employees of the affiliate company l in destination country i at time t owned by Japanese parent company p .
 - PAR_EMP_{pit} - the number of total employees of all affiliate companies in destination country i at time t owned by Japanese parent company p .
- \mathbf{Z}_{it} - a set of parent firm controls (revenue, number of employees)
- Φ_{jt} - a set of controls for Japan
- Φ_{it} - a set of controls for the host country
- \tilde{EX}_{ijt} - the shocks to “relative exchange rate”, i.e., the exchange rate between the host country and Japan.

FIRM-LEVEL DATA SUMMARY

- Source: Toyo Keizai's *Overseas Japanese Companies* database
- Dependent variable - number of employees in foreign affiliates
- Period - 2010-2019

Table 3. Descriptive statistics for variables used in firm-level estimations

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|--|--------|-----------|-----------|--------|-----------|
| Parent_ID | 280062 | 4068.571 | 1734.743 | 1 | 6210 |
| Affiliate ID | 280062 | 20178.197 | 12146.984 | 1 | 41806 |
| Host country ID | 280062 | 73.986 | 46.947 | 1 | 145 |
| Affiliate employment(log) | 151513 | 3.939 | 1.861 | 0 | 11.277 |
| $\mathbb{P}(\tilde{D}_{it}, \tilde{E}X_{ijt})$ | 279485 | -.015 | .35 | -.832 | .66 |
| Parent revenue | 280062 | 2553372.1 | 11559114 | 0 | 1.381e+08 |
| Parent employment | 280062 | 7323.123 | 20250.644 | 0 | 307063 |
| $V(\tilde{D}_{it})(\log)$ | 279485 | -6.664 | .792 | -8.298 | -1.116 |
| Inflation | 268763 | 8.799 | 575.828 | -3.753 | 65374.08 |
| Inflation volatility | 268763 | 48592.03 | 4033611.2 | .354 | 3.414e+08 |
| $V(\tilde{E}X_{ijt})(\log)$ | 279485 | -4.599 | .497 | -5.748 | 10.578 |

JAPANESE MULTINATIONALS – DESCRIPTIVE STATISTICS

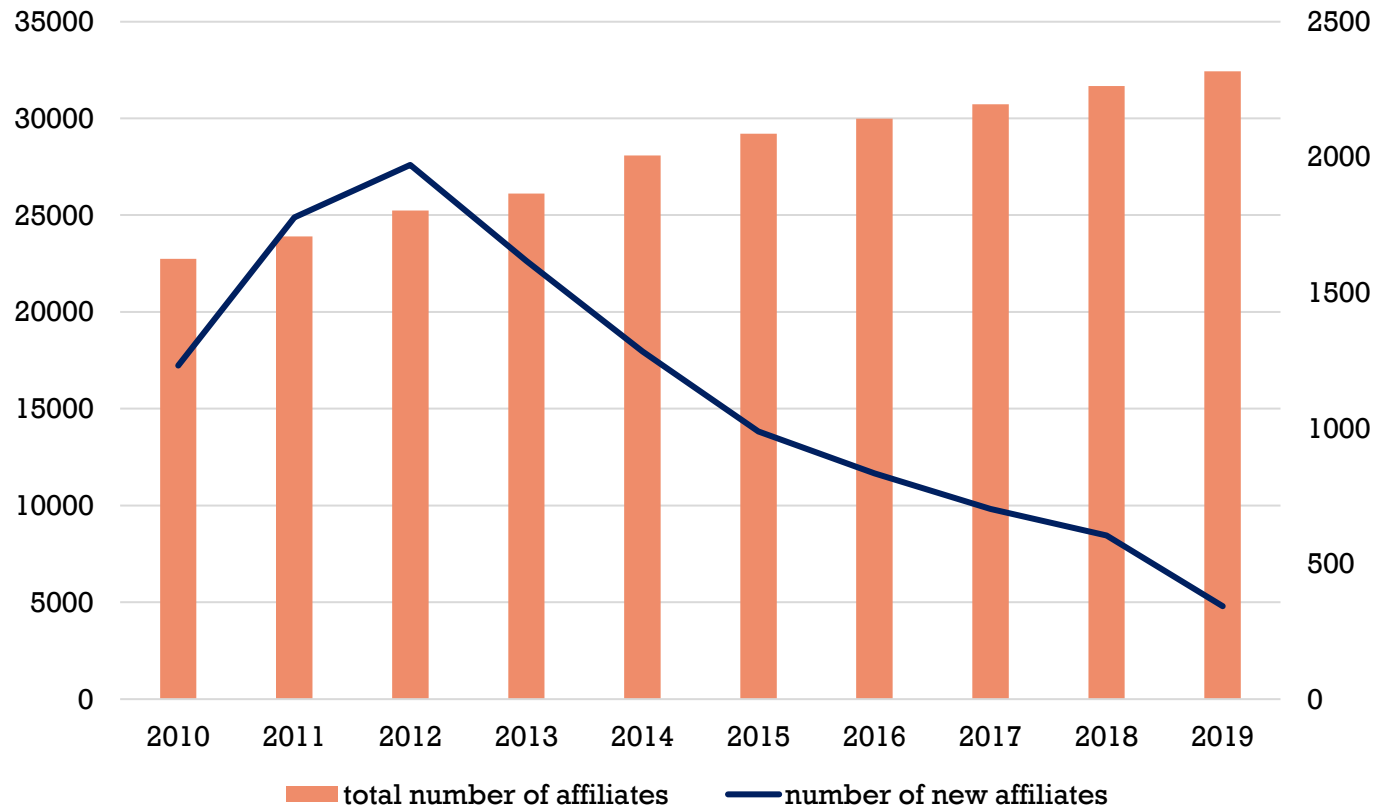


Figure 4. Dynamics of affiliates of Japanese Multinationals.

Notes: Left axis shows the number of total affiliates for each year, and the right axis shows the number of new affiliates established each year.

Source: author calculations based on data from Toyo Keizai

JAPANESE MULTINATIONALS – DESCRIPTIVE STATISTICS

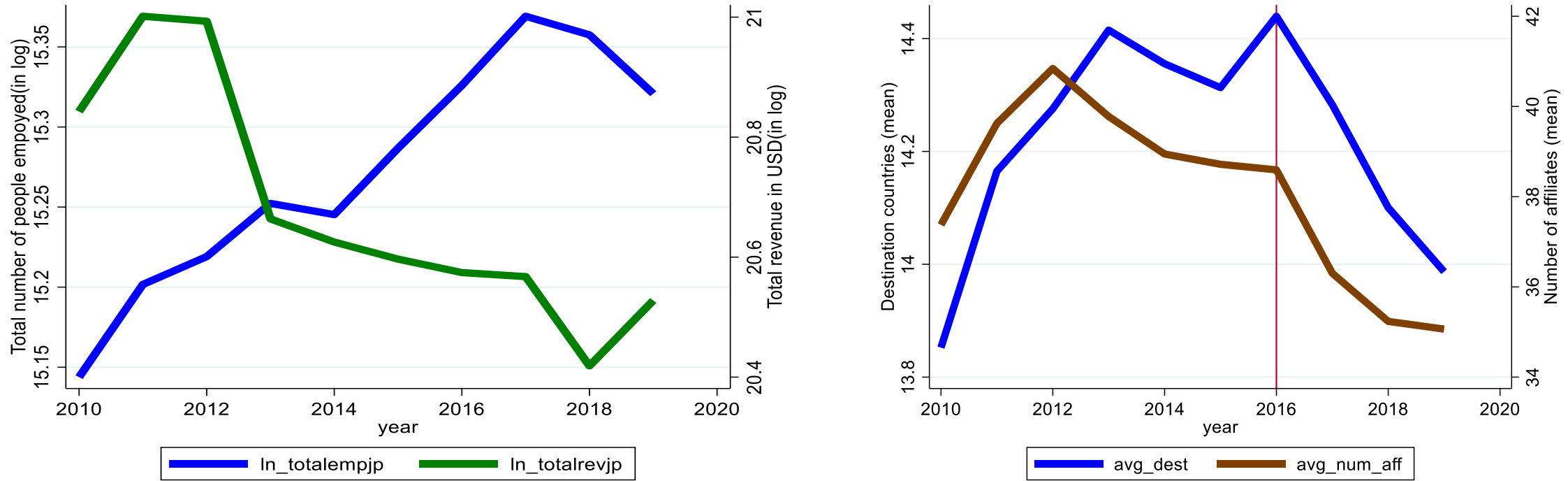


Figure 5. Descriptive statistics for Japanese Multinationals.

Notes: The left panel shows total employment (blue line) and total revenue (green line) dynamics for affiliates of Japanese MNEs. The right panel shows the characteristics of an average Japanese MNE. The blue line shows the average number of destinations served by a Japanese multinational; the brown line shows the average number of affiliates owned by a Japanese MNE. Source: author calculations based on data from Toyo Keizai

JAPANESE MULTINATIONALS – CORRELATION OF SHOCKS

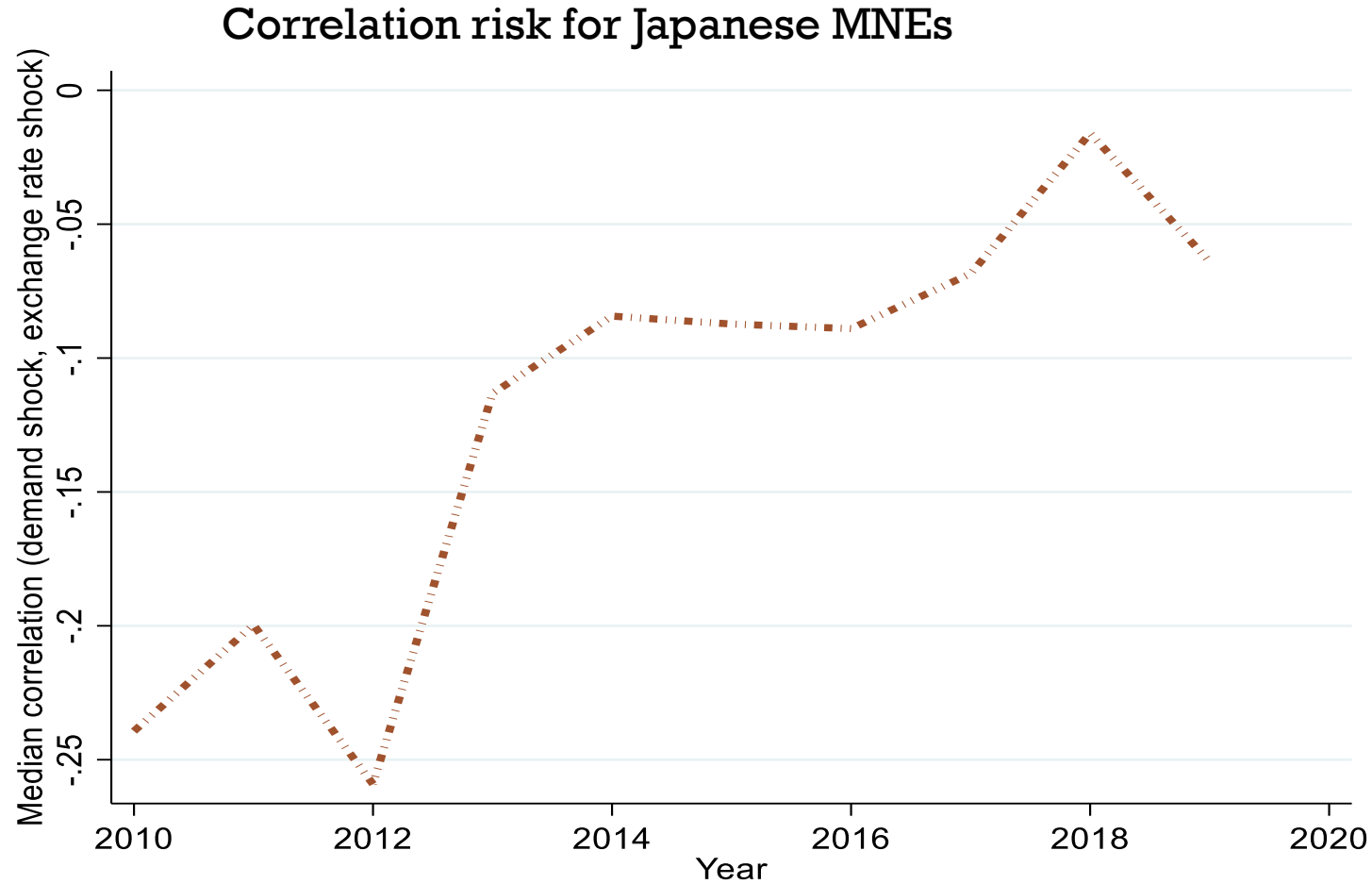


Figure 6. Median correlation of demand and relative exchange rate shocks. Notes: The line shows the median correlation measure for a sample of 145 countries. Source: author calculations based on data from PWT.

FIRM-LEVEL RESULTS

Table 4. Firm-level estimations, number of employees

| Dependent variable | AFF_EMP_{plit} | PAR_EMP_{pit} |
|--|---------------------|----------------------|
| | 1 | 2 |
| $\mathbb{P}(\tilde{D}_{it}, \tilde{EX}_{ijt})$ | -0.066 (0.033)** | -0.107 (0.033)*** |
| $\mathbb{V}(\tilde{D}_{it})$ | -0.057 (0.025)** | -0.066 (0.025)*** |
| $\mathbb{V}(\tilde{EX}_{ijt})$ | 0.037 (0.023) | 0.020 (0.024) |
| Affiliate FE | Yes | Yes |
| Parent controls | Yes | Yes |
| Host country controls | Yes | Yes |
| Japan controls | Yes | Yes |
| Number of parent companies | 4687 | 4687 |
| Number of affiliates | 24132 | 28804 |
| N | 145149 | 170650 |

Notes: (a) Constant terms are included in estimations. (b) parent firm controls variables are revenue and employment. (c) Host country controls are per capita GDP, exchange rate, exchange rate growth, absorption, absorption growth, population, inflation, capital stock, Financial Development Index (IMF), and inflation volatility. (d) Japan control variables are absorption, absorption growth, and per capita GDP. (e) Values in parentheses are robust standard errors. (d) “***”, “**”, and “*” indicate statistical significance at the 1, 5, and 10% levels, respectively.

CONCLUSION

- Take a multivariate risk approach to FDI under uncertainty
- In a multivariate risk setting, the correlation of the risk plays an important role, hence we analyze correlation aversion
- Show
 - the correlation of shocks explains the variation in geographic allocation of FDI inflows
 - Japanese multinationals exhibit significant correlation aversion, they invest more in countries with less correlated shocks
- **Future work**
 - Two other important questions
 - *to what extent do multinationals diversify their demand and exchange rate risk?*
 - *whether diversification benefits multinationals, or what kind of diversification benefits multinationals*

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