Multinationals and Exchange Rates: Evidence from Switzerland *

Jianlin Wang†

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Abstract

In this article, I present the first-step evidence that foreign affiliates of multinational enterprises propagate the transmission of international monetary shocks to domestic inflation dynamics. I further highlight the importance that ownership matters in the usage of imported inputs due to potential organizational bonds between foreign affiliates and the intangible assets of their parents. When propagating the transmission of international monetary shocks, imported inputs themselves do not give a complete picture. Rather, the interaction between ownership and imported inputs matters. Utilizing a novel database that splits the Inter-Country Input-Output tables along the dimension of ownership, I find that foreign affiliates have an influential presence in the domestic sales of the tradable sectors of major developed economies. I also confirm that foreign affiliates tend to use more imports compared with the domestic-owned firms in the same industry. However, there is mixed evidence on foreign affiliates systematically selecting into import intensive industries. Using the 2015 Swiss franc appreciation as a natural experiment, I show that foreign affiliates in Switzerland gained market share following the appreciation, compared with not only the domestic-owned firms, but also the domestic-owned multinational enterprises in the same industry. This finding is consistent with the narrative that the foreign affiliates propagated the deflationary shock by adjusting prices downward further due to the cheaper imports following the appreciation. I also provide evidence that tradable sectors in Switzerland with a higher import intensity gained relative market share from the appreciation. But the positive effect of import intensity on domestic sales is significant only for the foreign-owned sectors.

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†Department of Economics, University of California at Berkeley, jianlinw@berkeley.edu.

1 Introduction

Multinational enterprises (MNEs) have been long recognized as an influential force in the world economy. Representing only a small number of firms, MNEs and their foreign affiliates account for around one-third of global output, an equivalent share in world GDP, and have found to be active in both the domestic sales and exports of their host countries, especially among the developed economies (see, e.g., Alviarez 2013; Kleinert, Martin, and Toubal 2015; Cadestin et al. 2018b).[1] It has also been well established that global input-output linkages propagate the transmission of productivity and cost shocks across borders, promoting the synchronization of business cycle and producer price inflation for countries within the same production network. An increasing amount of attention has been paid to MNEs recently, revealing their roles in the international transmission of productivity shocks and business cycles, potentially through the input-output linkages of global value chains.

Despite their economic importance and roles of propagating international shocks, little is known if MNEs have a special interaction with monetary policy. This paper makes the first-step effort by asking whether MNEs, especially their foreign affiliates, display a higher price elasticity with regards to an exogenous monetary shock that affects the cost of imported inputs. If such higher price sensitivity exists, and its effects matter in the medium or long run, affiliates of foreign MNEs can play a special role in transmitting international financial shocks to domestic inflation dynamics, compared to the counterfactual where their market share are domestically owned. The local monetary authority may then need to respond by adjusting the spending of monetary resources to maintain its policy objectives, such as the inflation target.

Using a novel database that decomposes the international input-output (IO) table at the country-industry-ownership level and the 2015 Swiss franc appreciation as a natural experiment, I provide preliminary evidence from domestic sales that foreign affiliates propagate the transmission of international monetary shocks to domestic inflation dynamics in the medium-long run. In specific, after decomposing output into domestic sales and exports, I find that foreign affiliates have an important presence in the domestic sales of tradable sectors across major developed economies. The shares of domestic sales by foreign affiliates in Switzerland and the US, for example, are around 25% and 18% among the tradable sectors, respectively. By computing the ratio of imported value-added in exports (VAE) for each country-industry-ownership sector, I confirm that foreign affiliates tend to use more imported inputs compared with their domestic-owned counterparts in the same industry. However, the evidence for for-

[1] As Cadestin et al. (2018b) report, around 70% of the output of foreign affiliates is produced in OECD countries, which amounted to roughly 14 trillion USD in 2014.

eign affiliates systematically selecting into import intensive activities is weak and unstable at best. Conditioning on productivity and sectoral fixed effects at the industry-ownership level, the domestic sales of foreign affiliates in Switzerland's tradable sectors are estimated to have become 30% higher relative to their domestic-owned counterparts in the same industry over the course of two years after an unexpected and exogenous appreciation in the Swiss franc. This result is consistent with the narrative that foreign affiliates can benefit from a higher import usage associated with the multinational nature of their organizational frameworks following a local currency appreciation. When testing the effect of import intensity on changes in domestic sales from the appreciation, the estimate is, as expected, positive and statistically significant. However, this effect is driven by the foreign affiliates subgroup. In fact, the coefficient of import intensity loses significance among both the domestic-owned firms and domestic-owned MNEs in my sample. This finding suggests import intensity by itself does not tell a full story. There seems to be a special interaction with foreign affiliates and the usage of imported inputs in transmitting international monetary shocks to a domestic economy.

The specific channel of the shock transmission, however, is complicated by the still inconclusive role of MNEs in input trade. Ramondo, Rappoport, and Ruhl (2016) find that foreign affiliates of US MNEs in the manufacturing sector sell mostly in the local market, with the median affiliate has 0 intra-firm trade with its parent. Instead, the intra-firm trade of US MNEs is primarily performed by a small group of large affiliates. In addition, the ownership of vertically linked affiliates is not related to the transfer of goods within the boundary of firms. In other words, the intra-firm trade of US MNEs does not support the idea of a pure vertical integration: a parent sets up affiliate to trade inputs with them. These findings are consistent with theories of firm production that is based on economies of scale. In the model of Grossman, Helpman, and Szeidl (2006), for example, the production of inputs for the entire MNE is concentrated into a few large affiliates due to economies of scale. As a result, the model predicts a small number of large affiliates will ship goods within the corporation, while numerous smaller affiliates are set up to complete the final production and serve local markets.

In a non-international context, Atalay, Hortacsu, and Syverson (2014) show that most of the vertical ownership linkages in the US are not primarily motivated by need of input trade within the firm. Instead, a primary purpose of ownership expansions, regardless they are horizontal or vertical, is to efficiently transfer and match higher-quality intangible inputs with a greater set of productive assets, especially when the parent company faces physical scale and/or antitrust constraints. In fact, while there are modest changes upon integration, most of the productivity, size, and capital intensity measures of affiliates can be explained by their parents' endogenous selection on preexisting heterogeneity. Furthermore, once integrated, the acquired affiliates

start shipping their outputs to locations that their acquirers had already been shipping to, and they begin producing products that their acquirers had already been manufacturing. It is precisely the last two behaviors discovered in the US that motivate my main intuition for why foreign affiliates can have a higher price elasticity on imported inputs due to their organizational connections with their parents.

Taking Coca-Cola Hellenic Bottling Company (CCHBC) as an example. As a large foreign affiliate of the Coca-Cola Company (TCCC), the headquarter of CCHBC entered Switzerland from Greece in 2013 in search for a stable economic and regulatory environment.[2] According to its 20-F filings at SEC, the principal raw material CCHBC uses is water, with other basic materials from local sources or imports, including sugar, carbon dioxide, PET resin, aluminium cans, and etc.[3] These ingredients are likely common for all carbonated soft drink manufacturers in Switzerland with a similar degree of import reliance, which I call the industry's "benchmark import intensity."

As an affiliate of Coca-Cola, CCHBC's second key ingredient following water is concentrate for licensed TCCC's products, which approximately represents 44% of the company's total raw material costs in 2013. In addition, CCHBC is required to purchase these concentrate from other affiliates designated by TCCC's headquarter under its bottlers' agreements. CCHBC explicitly states in its 20-F report that the imports of concentrate are denominated in euro, which is different with the company's operating currency for local sales (Swiss franc) and poses a key foreign exchange exposures for the company's performance in the medium or long run, since foreign exchange risk cannot be perfectly hedged at such horizons. With a weaker operating currency, "raw materials purchased in currencies such as the US dollar or the euro can lead to higher cost of goods," which "if not recovered through local price increases, will lead to reduced gross profit margins."[4]

Comparing CCHBC with Rivella, a Swiss-owned MNE in the carbonated soft drink industry and a direct regional competitor of Coca-Cola, instead of importing concentrate, Rivella sells concentrate to its licensing partners in other European countries. Assuming Rivella and CCHBC share similar productivity, use an equivalent amount of local inputs, and have the same benchmark import intensity in producing soda, CCHBC will import a higher share of inputs due to its organizational connections, in this case, contractual obligations, with Coca Cola. With an exogenous monetary shock, such as an exogenous appreciation of Swiss francs, CCHBC will see a higher reduction in marginal costs relative to that of Rivella from cheaper

[2]See `https://money.cnn.com/2012/10/11/investing/coca-cola-greece/index.html`.

[3]See `https://www.sec.gov/Archives/edgar/data/1558633/000104746914003213/a2219211z20-f.htm`.

[4]Sugar, PET, and aluminium, which respectively represents 17.6%, 10.1% and 6.7% of CCHBC's raw material costs in 2013 are also invoiced in euro or US dollars.

imports, which can then pass-through into a further decrease in its prices. If such downward adjustment persists in the medium or long run, CCHBC, and other foreign affiliates, can amplify the deflationary pressures in Switzerland in addition to those from imports following the appreciation. Under a zero lower bound (ZLB) environment, the amplified deflationary pressure can translate into a further increase in the real interest rate and a larger contraction in output. It can also reallocate market share from domestic-owned firms to foreign affiliates during the deflation episode.

The organizational bonds of foreign affiliates with their parents are not necessarily constrained to the input-output linkages of key ingredients. Yet these linkages arguably anchor an affiliate's additional import reliance, as key ingredients associated with the parent organization's intangible assets are hard to be substituted by other inputs. Boehm, Flaaen, and Pandalai-Nayar (2019), for example, document that the output of Japanese affiliates in the US fell roughly one-to-one with their imports from Japan after the Tohoku earthquake, consistent with a relationship between imported and domestic inputs that is close to Leontief. In addition to the linkages based on key ingredients, parents can introduce existing long-term suppliers from abroad to their affiliates, since they are already familiar with the common management, product, and quality standards of the parent organization.[5] Foreign affiliates can also choose, or be required, to import services from dedicated affiliates in their home organization to utilize economies of scale. If foreign affiliates obtain working capital through their parents' financial networks, the working capital loans and associated interest rates can be denominated in the parents' reporting currency, further increasing an affiliate's exposure to foreign monetary shocks. It may even be the case that foreign affiliates import parts of the most skillful laborers or pay them in a foreign currency. The last point can be reflected from CCHBC's 20-F report that the company's CEO and senior management team receive exchange rate protection on top of their base salary and standard benefits paid in Swiss francs.[6]

To study if foreign affiliates systematically display a higher price elasticity to an exogenous monetary shock that affects the cost of imported inputs, one faces at least three empirical challenges. To start with, under price rigidity, firms adjust prices based on expected changes in marginal costs. Thus, to capture the complete price adjustments, the monetary shock must be both exogenous and unexpected. This is especially the case among developed economies, since an one-time, expected change in costs can be financially hedged in advance, at least for

[5]For instance, CCHBC enjoys a non-exclusive most favoured client status from a commercial refrigeration and glass manufacturer in South Africa, Frigoglass S.A., due to its established relation with Coca Cola. To maintain the most favoured client status, CCHBC agrees to purchase at least 60% of its annual requirements of coolers from Frigoglass S.A.

[6]The exchange rate protection is to match senior executives' benefits with their peers in the US and the other parts of the world.

the short run. Therefore, prices can start to adjust ahead of the shock due to both a change in expectations and the cost of hedging.

Secondly, though firms in the same industry can share the same benchmark import intensity, foreign affiliates can endogenously select into import intensive industries, precisely because they expect to have additional import reliance. Assuming imports invoke fixed costs, operating in an import intensive industry allows foreign affiliates to enjoy an increasing returns to scale. To distinguish the endogenous selection on import intensity, one needs to have data with an ownership decomposition at least at the industry level. Data with this feature is largely unavailable until recently.

Last but not least, since parents can expand based on preexisting heterogeneity, foreign affiliates can endogenously have higher productivity. A higher productivity can encourage the usage of imported inputs (Amiti, Itskhoki, and Konings 2014). In addition, firms with a higher productivity under variable markups can have a higher strategic complementarity in pricing with their competitors, as Amiti, Itskhoki, and Konings (2019) have discovered from Belgian manufacturing firms. As a result, even without any organizational connections associated with their parents' intangible assets, foreign affiliates can reduce prices more following a local currency appreciation simply because they are more productive and imports have become cheaper. Alternatively, under variable markups, a more productive firm has a higher markup elasticity and a lower cost-to-price pass-through in equilibrium. This can mute foreign affiliates' price responses from any changes in their marginal costs and thus underestimate the effect of foreign ownership on price sensitivity. In fact, under the hypothesis that parents' intangible assets overwhelmingly induce productivity growth, foreign affiliates can play a stabilizing, instead of propagating, role in transmitting international monetary shocks to the inflation dynamics of a domestic economy.

Using a novel database that decomposes the international IO table at the country-industry-ownership level, this paper makes a first-step effort in addressing the empirical concerns and provides evidence from domestic sales that foreign affiliates propagate the transmission of international monetary shocks to a domestic economy in the medium-long run. Guided by the evidence, I propose future analyses on import and export price changes that combine detailed, high-frequency data from the Swiss customs, which I have gained access, with firm-level ownership and financial statement information from the ORBIS database. Based on the results of my empirical estimations, I also plan to develop and calibrate a model to perform counterfactual analysis in the long run.

To identify an unexpected and exogenous monetary shock in the cost of imported inputs, I take advantage of the 2015 Swiss franc appreciation as a natural experiment. On January

15, 2015, the Swiss National Bank (SNB) unexpectedly abandoned the lower bound on the EUR/CHF exchange rate, which had effectively pegged the EUR/CHF exchange rate at 1.20 since its introduction on September 6, 2011. This policy change resulted in a sharp, unanticipated, and permanent appreciation of the Swiss franc by more than 11% against the euro (Bonadio, Fischer, and Saure 2019). The effects of the Swiss franc appreciation were largely presented in the foreign exchange market even at the end of 2016. It has also been documented that the policy change occurred in an otherwise stable macroeconomic environment in Switzerland, and the SNB's decision was made as a response to the changes in monetary conditions in the US and the EU (Jordan 2015; Auer, Burstein, and Lein 2018; Auer et al. 2019). As a result, the sudden appreciation of the Swiss franc is orthogonal to the domestic demand and supply conditions in Switzerland and can be used to identify an unexpected and exogenous cost shock in imported inputs for firms in Switzerland's tradable sectors.[7] [8]

The data I use in this paper comes from the novel Analytical AMNE database developed by the OECD. The Analytical AMNE database marks the first and ongoing effort to fully split Inter-Country Input-Output (ICIO) tables along the dimension of domestic and foreign ownership. The new ICIO tables are available at the annual frequency for 2005-2016 at the country-industry-ownership level, where ownership distinguishes domestic-owned firms and foreign affiliates based on majority. That is, an affiliate is regarded as foreign as soon as it has at least 50% of foreign ownership. The domestic-owned category can be further decomposed into domestic-owned MNEs vs. domestic-owned non-MNEs for 2008-2016.

In its present form, the Analytical AMNE database only includes industries at the 2-digit level by ISIC Rev. 4 codes and information on prices is not available. Nevertheless, the ICIO tables allow me to perform a difference-in-differences (DID) analysis on domestic sales using the 2015 Swiss franc appreciation as a natural experiment for first-step evidence. In specific, I perform a DID estimation on foreign affiliates vs. domestic-owned firms and foreign affiliates vs. domestic-owned MNEs in Switzerland's tradable sectors over the sample of 2013-2014 vs. 2015-2016, where I define 2013-2014 and 2015-2016 as the before and after periods respectively.

[7] Around 67% of imports in Switzerland were invoiced in euro during the appreciation episode based on the transaction-level records from the Swiss customs. At the time of the appreciation, import prices denominated in euro would mechanically jump down in Swiss francs due to the valuation effect. Bonadio, Fischer, and Saure (2019) report that the exchange rate pass-through (ERPT) to import prices invoiced in Swiss francs is also exceptionally fast. The medium-run pass-through is reached after 12 working days. This is consistent with the arguments of Alvarez, Lippi, and Passadore (2017) and Alvarez, Lippi, and Paciello (2018) that firms may optimally choose not to adjust prices to small shocks, but can promptly adjust prices in the face of large shocks.

[8] Following the definition of the Swiss customs, I focus on the core tradable sectors in my analysis by excluding industries related with precious metals and jewellery to avoid trade flows associated with changes in the financial environment around the appreciation episode. I also further exclude industries containing the production of petroleum to account for fluctuations in oil prices. However, my results are robust to the inclusion of the aforementioned sectors.

The identification assumption is that the only time-variant factor significantly affected the prices of the domestic-owned firms and foreign affiliates *differently* during the sample period is the sudden appreciation of the Swiss franc starting in January, 2015, which exogenously and substantially lowered the cost of imported inputs. Conditioning on productivity and the benchmark import intensity, if foreign affiliates systematically use more imports due to the organizational connections with their parents, they would be able to lower prices further in the after period and thus gain market share in domestic sales compared with their domestic-owned counterparts.

The findings of my analysis are threefold. To begin with, after decomposing output into domestic sales and exports, I find that foreign affiliates have an important presence in the domestic sales of tradable sectors not only for small open economies like Switzerland, but also for large economies, such as the US. Taking sample averages over 2005-2016 for each of the 2-digit tradable sectors, the median domestic sale share of foreign affiliates in an industry is around 25% for Switzerland (mean value 27%), 18% for the US (mean value 19%), and 18% among major developed economies (mean value 18%).[9] [10] In contrast, there is a higher degree of heterogeneity in foreign affiliates' contributions to exports across countries. Calculated in the same manner, the median export share of foreign affiliates in an industry is around 52% for Switzerland (mean value around 53%), 19% for the US (mean value 18%), and 33% among the major developed economies (mean value 31%).[11]

Using the ratio of imported VAE as a measure of import intensity following Johnson and Noguera (2012, 2017) and Cadestin et al. (2018b), I confirm that foreign affiliates tend to use more imports compared with the domestic-owned firms in the same industry. Based on the same sample averages, the median imported VAE ratio of foreign affiliates in an industry is around 0.41 for Switzerland (mean value 0.40), 0.21 for the US (mean value 0.22), and 0.33 among the major developed economies (mean value 0.33). In contrast, the median imported VAE ratio of domestic-owned firms in the same industry is around 0.26 for Switzerland (mean value 0.27), 0.13 for the US (mean value 0.14), and 0.20 among the major developed economies (mean

[9]Foreign affiliates are particularly important for certain industries in the US. For example, around 30% of the domestic sales come from foreign affiliates in the manufacturing of chemical products, pharmaceutical products, machinery and equipment, basic metals, and other non-metallic mineral products. The domestic sale share of foreign affiliates in the automobile industry is around 40%.

[10]Following Georgiadis, Grab, and Khalil (2019), the major developed economies include: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, USA, and UK.

[11]The fact that foreign affiliates' export shares tend to be larger than their domestic sale shares is expected, because not all domestic-owned firms participate in exports. From Bernard, Jensen, and Lawrence (1995) and Melitz (2003), exports are performed by larger and more productive firms. Even larger firms own foreign affiliates (Helpman, Melitz, and Yeaple 2004).

value 0.21).[12] In addition, there seems to be mixed evidence on the idea that foreign affiliates systematically select into import intensive industries. Among foreign affiliates of the major developed economies, the correlation between their domestic sale shares and imported VAE ratios across industries is 0.35 for all tradable sectors. However, much of the correlation comes from agriculture and industries related with precious metals, jewellery, and the production of petroleum. After excluding these industries, the correlation becomes 0.07.[13]

In the end, the DID estimations for the foreign affiliates vs. domestic-owned firms and the foreign affiliates vs. domestic-owned MNEs both report that the domestic sales of the foreign affiliates become around 30% higher relative to their domestic-owned counterparts in the after period, though both groups see a decline in sales from the appreciation because of a stronger competition from cheaper imports. The estimates are statistically significant and remain unchanged after the inclusion of sectoral fixed effects at the industry-ownership level. These results are consistent with the argument that foreign affiliates can benefit from a higher import usage associated with the intangible assets of their parents following an appreciation in the affiliates' local currencies. Since they are able to adjust prices downward further from the cheaper imported inputs, they gain market share in domestic sales relative to their domestic-owned counterparts.

It is also unlikely that my results are driven by the higher productivity of the foreign affiliates. If a higher productivity encourages import usage, or more productive firms are able to better retain market share from the competition of cheaper imports due to a lower demand elasticity under variable markups, the same result would appear from the analysis of the foreign affiliates vs. domestic-owned firms. However, assuming domestic-owned MNEs, especially those in Switzerland, have similar productivity compared with the foreign affiliates in the same industry, the significant result would vanish in the DID estimation for the foreign affiliates vs. domestic-owned MNEs.

When interacting the imported VAE ratio of an industry-ownership sector with the after period dummy, the intensity of the treatment effect is, as expected, positive and statistically significant. However, the effect of import intensity on domestic sales is only significant for the foreign affiliate subgroup. This result suggests import intensity by itself does not tell a complete

[12]The values of domestic sale share, export share, and imported VAE ratio remain stable after excluding industries related with precious metals, jewellery, and the production of petroleum. These values are also very stable across time.

[13]This correlation is also not stable across countries. For instance, the correlations for all tradable sectors and the tradable sectors excluding agriculture, precious metals, jewellery, and petroleum in the US are 0.38 and 0.35, respectively. The same correlations for Switzerland are -0.4 and -0.54. In fact, the industry composition of foreign affiliates in Switzerland seems to be working against me in finding a propagating effect through the usage of imported inputs.

story. There seems to be a special interaction with foreign affiliates and the usage of imported inputs. Overall, I interpret my findings as a potentially promising start for future analyses on price changes using transaction- and firm-level data.

Admittedly, there can be confounding factors other than the natural experiment in my sample period. 2015, for instance, coincides with a major international commodity price shock associated with the Ukrainian crisis, which can lower the cost of commodity imports. Furthermore, an inflow of foreign capital could have changed other economic conditions, such as consumer preferences or costs of working capital. These complications may have led to a differential response in prices between the domestic-owned firms and foreign affiliates in my sample even without the natural experiment. As a preliminary attempt to address these concerns, I perform the same DID estimations but for the US. Similar to Switzerland, the US experienced a significant inflow of foreign capital around 2015, which induced an appreciation of the US dollar. The US was also exposed to the 2015 commodity price shock. Unlike Switzerland, however, there was a lack of natural experiment that lowered the costs on imported inputs *exogenously* through exchange rates. My placebo test using the US therefore ask if the commodity price shock and the endogenous appreciation of the US dollar can generate results similar to those from my main analysis. If they can, then my findings can be driven by confounding factors. The results from the placebo test suggest this is not the case. In fact, the key coefficients from the US estimations are insignificant and close to zero. Many of them also bear a wrong sign.

My results from the main analysis are also consistent to other robustness checks, including a placebo test for pre-trends, a robustness check using only the domestic sales of final goods, and a DID analysis extending the before period from 2013-2014 to 2011-2014.

This article contributes to four strands of the literature. The first is the debate in monetary policy that whether inflation rates are primarily driven by national or international factors (Bernanke 2007; Fischer 2015; Draghi 2016; Carney 2017). Obstfeld (2020) documents that domestic inflation in the US has been increasingly exposed to shocks import prices, particularly, shocks in producer import prices. Auer, Levchenko, and Saure (2019) find that international input-output linkages propagate the synchronization of producer price inflation across regions. Gopinath et al (2020) highlight the role of dominant currency pricing in transmitting international monetary shocks to a domestic economy. Specifically, imported input use and variable markups play a key propagating role in the shock transmission under the framework of Gopinath et al (2020), which accounts for one-half to 30% of the predicted pass-through. This paper investigates if MNEs play a special role in the transmission of international monetary shocks through imported inputs under variable markups. Combining with the transaction-level data from the Swiss customs, my research also has the potential to study if MNEs are driving the

endogenous choice of dominant currency invoicing through the multinational nature of their organizational frameworks and the need to adopt a dominant currency as a reporting currency to better access the international capital market.

This paper is also related to an extensive literature on the role of input linkages in business cycle synchronization (see, e.g., Kose and Yi 2006; Burstein, Kurz, and Tesar 2008; di Giovanni and Levchenko 2010; Johnson 2014), the role of input linkages for inflation synchronization (see, e.g., Auer and Saure 2013; Antoun de Almeida 2016; Auer, Borio, and Filardo 2017; Auer, Levchenko, and Saure 2019), and the role of MNEs in the transmission of international business cycles (see, e.g., Contessi 2010; Menno 2014; Zlate 2016; Cravino and Levchenko 2017). My study contributes to this literature by addressing the role of foreign affiliates in transmitting international monetary shocks to domestic inflation dynamics. Specifically, I highlight the importance of organizational ties between foreign affiliates and their parents' intangible assets in inducing import exposure in the activities of the affiliates. It is the imports associated with parents' intangible assets, which are not necessarily driven by the demand of input trade directly with the parents, that make foreign affiliates play a propagating role in transmitting international monetary shocks to a domestic economy. This argument is in line with the findings of Atalay, Hortacsu, and Syverson (2014) on vertical ownership expansion based on intangible assets, and those of Ramondo, Rappoport, and Ruhl (2016) on a lack of direct parent-to-affiliate intra-firm trade among US MNEs. Also related is the work by Boehm, Flaaen, Pandalai-Nayar (2019), which documents the close to Leontief relationship between the imported inputs from Japan and domestic inputs used by the Japanese affiliates in the US. In addition, Cravino and Levchenko (2017) reports a comovement between the productivity shocks of foreign affiliates and their parents that is not driven solely by vertical production linkages.

The third literature my work contributes to is the studies of exchange rate pass-through (ERPT) and its impacts utilizing the 2015 Swiss franc appreciation as a natural experiment (Auer, Burstein, and Lein 2018, Auer et al. 2019, Bonadio, Fischer, and Saure 2019). Bonadio, Fischer, and Saure (2019) document that the ERPT in Switzerland's import prices following the appreciation is exceptionally fast, regardless the imported goods are invoiced in euro or Swiss francs. This finding is related with the empirical evidence from Burstein and Jaimovich (2012) and Gorodnichenko and Talavera (2017) and is in line with the theoretical explanations by Alvarez, Lippi, and Passadore (2017) and Alvarez, Lippi, and Paciello (2018). My study has the potential to reveal another round of price adjustment by domestic producers in Switzerland in the medium or long run. Since ERPT to marginal costs is incomplete and the exchange rate shock can be partially hedged by supply contracts in the short run, the urgency for domestic producers to promptly adjust their prices can be reduced. Instead, the price adjustments by

domestic producers can follow a standard Calvo procedure and occur in the medium or long run, consistent with observations made by Campa and Goldberg (2005) and Gopinath et al. (2010). In terms of allocations, Auer et al. (2019) report that Switzerland's industries with higher CHF-invoicing shares experienced substantially weaker export growth in the two-year period after January 2015. At very short horizon, however, export quantity did not respond. These results are consistent with my findings that foreign affiliates, which arguably invoice less in CHF in trade, also gained market share in domestic sales in the same two-year period. It can be interesting to see if foreign affiliates can provide an explanation for the findings on currency of invoicing from Auer et al. (2019).[14]

Finally, a large literature studies multinationals and technology transfers (see, e.g., McGrattan and Prescott 2009; Keller and Yeaple 2013; Ramondo and Rodrıguez-Clare 2013; Alfaro-Urena, Manelici, and Vasquez 2019). My study compares the stabilizing role from potential productivity growth and the propagating role from imports induced by MNEs' organizational frameworks in the context of international monetary shock transmission to domestic inflation dynamics.

The rest of my article is organized as follows. Section 2 outlines a baseline model. Section 3 describes the data used in my current analysis. Section 4 presents the main empirical results, and Section 5 concludes with directions for the next step.

2 Baseline Model

I start my analysis by describing the pass-through of cost shocks into prices in a static environment under variable markups, heterogeneous productivity, and imported intermediaries. The theoretical framework is standard in the literature, but it can facilitate the discussion of markup and pass-through distributions in the economy and discipline my arguments in the empirical analysis. Based on my empirical estimations from the transaction- and firm-level data in the future, I plan to fully develop the model in a DSGE environment, incorporation specific features that the data suggests as important. The empirical estimates can also be used to inform a model calibration for a counterfactual analysis.

[14]Another related work is Desai, Foley, Forbes (2008), which find that foreign affiliates gain market share in the context of large domestic currency crises, compared to the domestic-owned firms that are financially constrained. Foreign affiliates are able to expand during currency crises, since they have better access to working capital through their parents' financial networks. My work speaks to the responses of foreign affiliates vs. domestic-owned firms in prices and domestic sales when facing international monetary shocks outside of a currency crisis. The main mechanism I focus on is the differential cost-to-price pass-through generated by the differential usage of imported inputs.

2.1 Model Environment

The world is consisted of symmetric economies, each is populated by a continuum of identical households of measure 1. I let $\omega \in \Pi$ denote both a variety of consumption, and the firm producing that variety. The equilibrium price and quantity of variety ω produced in country i and sold in country j are $p_{ij}(\omega)$ and $q_{ij}(\omega)$, respectively. In the baseline, I assume all domestic firms are domestically owned.

2.2 Households

All households in country j have the same preference and income y_j, which derives from the household wages and the profits of the firms that the household owns, if any. Starting from a general demand framework, the Marshallian demand of variety ω in country j is:

$$q_{ij}(\omega) = q_{ij}(p_{ij}(\omega), P_j, Q_j) = Q_j D_j(\frac{p_{ij}(\omega)}{P_j}), \tag{1}$$

where the demand function $D(.)$ is twice continuously differentiable with $D'(.) < 0$.

Let $\mathbf{p} \equiv \{p_{ij}(\omega)\}_{\omega \in \Omega}$ be the schedule of prices in country j. Under homothetic preferences, the aggregate demand shifters $Q_j(\mathbf{p}, y_j)$ and $P_j(\mathbf{p}, y_j)$ are jointly determined by:

$$\int_{\omega \in \Omega} H(\frac{p_{ij}(\omega)}{P_j}) d\omega = 1 \tag{2}$$

$$\int_{\omega \in \Omega} p_{ij}(\omega) Q_j D(\frac{p_{ij}(\omega)}{P_j}) d\omega = y_j, \tag{3}$$

where H(.) is strictly increasing and concave.[15] As a result, $P_j(\mathbf{p}, y_j)$ is determined by equation (2) and is independent with y_j, and $Q_j(\mathbf{p}, y_j)$ is proportional to y_j.

The partial demand elasticity under this general framework is:

$$\epsilon_{ij}(\omega) = -\frac{\partial ln(q_{ij}(\omega))}{\partial ln(p_{ij}(\omega))} = -\frac{\partial ln(D(p_{ij}(\omega)/P_j))}{\partial ln(p_{ij}(\omega))}, \tag{4}$$

which varies with $p_{ij}(\omega)$ and will give rise to variable markups. Also note that Q_j affects only the level of $q_{ij}(\omega)$, while P_j affects both the level of $q_{ij}(\omega)$ and its demand elasticity. The prices of other varieties will impact $p_{ij}(\omega)$, but only do so through from affecting Q_j and P_j. In the end, country-specific Q_j and P_j implies pricing to market.

To add textures in the model and give the demand function a specific form, two popular

[15] This general framework is standard in the literature, see, e.g., the description by Arkolakis et al (2019).

preferences are usually chosen: the Kimball utility function, as in Kimball (1995) and Klenow and Willis (2016), and the quadratic mean of order r (QMOR) expenditure function, as in Feenstra (2018). Since the QMOR preference has the feature of more productive firms charging lower markups, which contradicts what have been generally observed from the data (see, e.g. Amiti, Itskhoki, and Konings 2014, 2019), I use the Kimball preference in the baseline model.

Under Kimball preferences, Q_j is implicitly defined by a Kimball (1995) homothetic demand aggregator:

$$\int_{\omega\in\Omega} A_j(\omega)\Upsilon(\frac{q_{ij}(\omega)}{A_j(\omega)Q_j})d\omega = 1, \tag{5}$$

where $A_j(\omega)$ is a set of preference weights that capture consumers' tastes or home consumption bias, and the function $\Upsilon(.)$ satisfies the constraints that: $\Upsilon(1) = 1$,$\Upsilon'(.) > 0$, and $\Upsilon''(.) < 0$. Without loss of generality, we can set $A_j(\omega) = 1$ for simplicity.

The demand function can be derived by a standard cost minimization problem given prices and Q_j:

$$\min_{q_{ij}(\omega)} \int_{\omega\in\Omega} p_{ij}(\omega)q_{ij}(\omega)d\omega \tag{6}$$

such that (5) holds.

The consumption demand of the households can then be solved as:

$$\frac{q_{ij}(\omega)}{Q_j} = \Psi(\tilde{Q}_j\frac{p_{ij}(\omega)}{P_j}), \tag{7}$$

where $\Psi(.) = \Upsilon^{-1'}(.) > 0$ so that $\Psi'(.) < 0$. In addition, $P_j \equiv \int_{\omega\in\Omega} p_{ij}(\omega)\frac{q_{ij}(\omega)}{Q_j}d\omega$, and $\tilde{Q}_j \equiv \int_{\omega\in\Omega} \Upsilon'\left(\frac{q_{ij}(\omega)}{Q_j}\right)\frac{q_{ij}(\omega)}{Q_j}d\omega$.

2.3 Firms

Each producer in country j manufactures an unique variety $\omega \in \Omega_j$ and sells it to all markets. In line with Gopinath et al. (2020), the output of a firm can be used both for final consumption and as an intermediate input. In addition, there is firm-level heterogeneity in productivity draws z, which comes from some known distributions with country-specific parameters.[16] As a result, firms can be indexed by either ω or their productivity draws z.

[16]The distribution can be calibrated based on firm-level data from ORBIS using revenue-based total factor productivity (TFP). For instance, one can calibrate a Pareto distribution using firm-level data from Switzerland and its major trade partners. In 2015, more than 50% of Swiss exports were directed to the EU, while more than 70% of Swiss imports were sourced from the EU countries (Egger and Erhardt 2016).

Firms use a Cobb-Douglas production function with labor $L_j(z)$ and intermediates $X_j(z)$:

$$Y_j(z) = zL_j(z)^{1-\alpha}X_j(z)^{\alpha}, \tag{8}$$

where $L_j \equiv \int_z L_j(z)u_j(z)dz$, $X_j \equiv \int_z X_j(z)u_j(z)dz$, and $u_j(z)$ is the probability density function (pdf) of z in country j. I assume free entry for each destination market with a mass of 1 firms for simplicity. However, it is possible that $\Psi(\tilde{Q}_j\frac{p_{ij}(\omega)}{P_j}) \equiv \tilde{\Psi}(\frac{p_{ij}(\omega)}{P_j}) = 0$ from equation (7), meaning there exists a choke price p_j^* such that there is 0 consumption demand for all $p > p_j^*$ in country j.

Similar to equation (5), the Kimball aggregator for $X_j(z)$ is defined as:

$$\int_{\omega\in\Omega} A_j(\omega)\Upsilon(\frac{x_{ij}(\omega|z)}{A_j(\omega)X_j(z)})d\omega = 1, \tag{9}$$

where $x_{ij}(\omega|z)$ is the input demand for ω by a producer in country j with a productivity draw z. The preference weights can still be set as $A_j(\omega) = 1$ without loss of generality.[17]

Solving a cost minimization problem equivalent to equation (6) given prices and $X_j(z)$, the input demand can be derived as:

$$\frac{x_{ij}(\omega|z)}{X_j(z)} = \Psi(\tilde{X}_j\frac{p_{ij}(\omega)}{P_j}), \tag{10}$$

where $P_j \equiv \int_{\omega\in\Omega} p_{ij}(\omega)\frac{x_{ij}(\omega|z)}{X_j(z)}d\omega$ and $\tilde{X}_j \equiv \int_{\omega\in\Omega} \Upsilon'\left(\frac{x_{ij}(\omega|z)}{X_j(z)}\right)\frac{x_{ij}(\omega|z)}{X_j(z)}d\omega$. Since producers face the same distribution of prices as households in country j, $X_j(z)$ and Q_j share the same composition across varieties. Therefore, producers and consumers have the same price aggregator.

Given the Cobb-Douglas production function, the marginal cost of each firm from country j is:

$$MC_j(\omega) = \frac{1}{z_j(\omega)}\left(\frac{w_j}{1-\alpha}\right)^{1-\alpha}\left(\frac{P_j}{\alpha}\right)^{\alpha} = \frac{v_j}{z_j(\omega)}, \tag{11}$$

where w_j is the equilibrium wage in j, and v_j denotes the common components of marginal costs across producers in j.

The optimality conditions for labor and intermediate inputs are standard and given as:

$$(1-\alpha)Y_j(\omega)MC_j(\omega) = w_jL_j(\omega) \tag{12}$$

$$\alpha Y_j(\omega)MC_j(\omega) = P_jX_j(\omega), \tag{13}$$

[17]In practice, $A_j(\omega)$ can be calibrated for the consumption of final goods and intermediate inputs separately at the country-industry level.

where $\omega \in \Omega_j$ for equations (11) to (13).

2.4 Equilibrium

Given the demand conditions for final goods and intermediaries as well as the country-specific aggregate demand shifters, producers in country j maximize profits by:

$$\pi_j(\omega) = \max_{p_{ji}(\omega)} \sum_i \left(p_{ji}(\omega) d_{ji}(\omega) - MC_j(\omega) d_{ji}(\omega) \right), \tag{14}$$

where the total bilateral demand $d_{ji}(\omega) = q_{ji}(\omega) + \int_z x_{ji}(\omega|z) u_i(z) dz$ and the total demand $d_j(\omega) = \sum_i d_{ji}(\omega)$ for $\omega \in \Omega_j$.

The optimality condition, as it is standard, is:

$$p_{ji}(\omega) = \frac{\epsilon_{ji}(\omega)}{\epsilon_{ji}(\omega) - 1} MC_j(\omega), \tag{15}$$

where $\epsilon_{ji}(\omega)$ is the demand elasticity a firm from j faces in i, and $\mu_{ji}(\omega) = \frac{\epsilon_{ji}(\omega)}{1-\epsilon_{ji}(\omega)}$ is the optimal markup. We can also write $\epsilon_{ji}(\omega)$ now as $\epsilon_{ji}(\omega) = -\frac{\partial ln d_{ji}(\omega)}{\partial ln p_{ji}(\omega)}$.

2.4.1 Cost-to-Price Pass-Through

To provide main intuitions for my empirical analysis, I assume country j is a small open economy (SOE) like Switzerland so that it takes all foreign variables as given. Furthermore, let υ denote an exogenous shock in the marginal costs of domestic producers, such as a shock in their trade costs or, in my context, an exogenous shock in the valuation of domestic currency.[18] The domestic prices for firms from country j can be rewritten in log as:

$$ln p_{jj}(\omega) = ln \mu_{jj}(\omega) + ln MC_j(\omega, \upsilon) \tag{16}$$

for $\omega \in \Omega_j$.

In addition, from equations (7) and (10), both $q_{jj}(\omega)$ and $x_{jj}(\omega|z)$ are a function of the relative price $\frac{p_{jj}(\omega)}{P_j}$, which means $d_{jj}(\omega) = q_{jj}(\omega) + \int_z x_{jj}(\omega|z) u_j(z) dz$ is a function of the relative price. Since $\epsilon_{jj}(\omega) = -\frac{\partial ln d_{jj}(\omega)}{\partial ln p_{jj}(\omega)}$, both $\epsilon_{jj}(\omega)$ and $\mu_{jj}(\omega)$ can also be written as $\epsilon_{jj}(\omega) = \epsilon_{jj}(\frac{p_{jj}(\omega)}{P_j})$ and $\mu_{jj}(\omega) = \mu_{jj}(\frac{p_{jj}(\omega)}{P_j})$.

[18] In the context of Switzerland, the Swiss franc appreciation is caused by an exogenous policy change made by the SNB and should have mainly affected the marginal costs of domestic producers in Switzerland. The assumption is that foreign firms exporting to Switzerland do not crucially depend on inputs from Switzerland in their production. However, foreign affiliates in Switzerland may have additional reliance on imported inputs or foreign exchange risk exposure.

Taking log differences in equation (16), we will have:

$$dlnp_{jj}(\omega) = -\Gamma_{jj}(\omega)\left(dlnp_{jj}(\omega) - dlnP_j\right) + \rho_\upsilon dln\upsilon, \tag{17}$$

where $\Gamma_{jj}(\omega) = -\frac{\partial ln\mu_{jj}(\omega)}{\partial ln(p_{jj}(\omega)/P_j)}$ is the markup elasticity to the relative price, and $\rho_\upsilon = \frac{\partial lnMC_j(\omega,\upsilon)}{\partial ln\upsilon}$ is the pass-through of the exogenous shock to marginal costs. Since the composition of marginal costs is identical for all producers in country j in the baseline environment, ρ_υ is common for all firms from j.

The cost-to-price pass-through can then be written as:

$$\frac{dlnp_{jj}(\omega)}{dln\upsilon} = \frac{1}{1+\Gamma_{jj}(\omega)}\rho_\upsilon + \frac{\Gamma_{jj}(\omega)}{1+\Gamma_{jj}(\omega)}\frac{dlnP_j}{dln\upsilon}, \tag{18}$$

where $\frac{1}{1+\Gamma_{jj}(\omega)}\rho_\upsilon$ is the direct effect of the pass-through and $\frac{\Gamma_{jj}(\omega)}{1+\Gamma_{jj}(\omega)}\frac{dlnP_j}{dln\upsilon}$ is the general equilibrium effect from strategic complementarity. Also note that $\Gamma_{jj}(\omega) = \Gamma_{jj}(\frac{p_{jj}(\omega)}{P_j})$.

How does the pass-through distribute among domestic producers? Following Arkolakis and Morlacco (2017), if productivity is the only source of heterogeneity in addition to the shock, the relative price $\frac{p_{jj}(\omega)}{P_j}$ can be mapped one-to-one positively to a sufficient statistic $\frac{p_{jj}(\omega)}{p_j^*}$, where p_j^* is the choke price in j. $\frac{p_{jj}(\omega)}{p_j^*}$ can also be mapped one-to-one negatively to a firm's relative productivity rank $\frac{z}{z_j^*}$, where z_j^* is the least productivity cut-off in j so that firms with $z = z_j^*$ will make zero profit and charge the competitive price $p_j^* = \frac{v_j}{z_j^*}$. Combining the sufficient statistic $\frac{p_{jj}(\omega)}{p_j^*}$ with a characterization of the Kimball aggregator, such as the flexible functional form for $\Psi(.)$ following Klenow and Willis (2006), it is standard to show that demand elasticity $\epsilon_{jj}(\omega)$ increases with $\frac{p_{jj}(\omega)}{p_j^*}$, and markup $\mu_{jj}(\omega)$ and markup elasticity $\Gamma_{jj}(\omega)$ decrease with $\frac{p_{jj}(\omega)}{p_j^*}$ (see Arkolakis and Morlacco 2017). In equilibrium, a domestic producer with a higher productivity will charge a lower relative price $\frac{p_{jj}(\omega)}{p_j^*}$, face a lower demand elasticity, and have a higher markup elasticity. In other words, productive domestic producers tend to adjust their markups more to stabilize their prices, resulting in a lower cost-to-price pass-through by the direct effect $\frac{1}{1+\Gamma_{jj}(\omega)}\rho_\upsilon$.

Independent with the shock in marginal costs, more productive firms also display a higher strategic complementarity in pricing, as indicated by $\frac{\Gamma_{jj}(\omega)}{1+\Gamma_{jj}(\omega)}\frac{dlnP_j}{dln\upsilon}$. This can mute the stabilizing role of productivity in pass-through. However, it is fairly established that, while the magnitude of the strategic complementarity $\frac{\Gamma_{jj}(\omega)}{1+\Gamma_{jj}(\omega)}$ can be large, the direct effect of the pass-through dominates the general equilibrium effect, since $\frac{dlnP_i}{dln\upsilon}$ tends to be much smaller.[19] In terms of

[19] $\Gamma_{jj}(\omega)$ has been reported to be around 0.5-0.6, see, e.g., Gopinath et al (2020) and Amiti, Itskhoki, and Konings (2019). Meanwhile, it is well documented that more productive firms have lower ERPT under variable

Switzerland, there has been a 1.1% consumer price index (CPI) deflation in 2015 following the appreciation, in contrast to an around 11% appreciation of the EUR/CHF exchange rate even at the end of 2015 (Auer et al. 2019). Though the 1.1% deflation is substantial, considering a target of annual inflation rate below 2% by the SNB, the magnitude of $\frac{dlnP_i}{dlnv}$ is very small in terms of the cost-to-price pass-through.

2.4.2 The Stabilizing Role of Foreign Affiliates

Instead of assuming all domestic firms are domestically owned in country j, now suppose that parts of the firms have become foreign affiliates. If the international affiliation results in a productivity growth, the distribution of productivity among domestic producers in country j can be distorted in favor of foreign affiliates in the equilibrium. The source of this distortion could be that parents introduce better shape parameters to the productivity distribution of their affiliates before their establishment. Alternatively, Alfaro-Urena, Manelici, and Vasquez (2019) show that joining an established multinational supply chain can itself lead to an exogenous productivity boost. With such improvement in productivity, caeteris paribus, equation (18) indicates that foreign affiliates would play a stabilizing role in transmitting cost shocks to domestic inflation dynamics, since they have a larger $\Gamma_{jj}(\omega)$.

In addition to the direct role in potentially stabilizing the cost shock transmission, an improved productivity draw means a foreign affiliate can charge a lower relative price $\frac{p_{jj}(\omega)}{p_j^*}$ and attract a larger market share from both the domestic-owned and foreign firms active in country j to begin with. Thus, foreign affiliates can further reduce j's import or ERPT exposure indirectly by reallocating equilibrium market share.

2.4.3 The Propagating Role of Foreign Affiliates

If multinational parents expand to country j primarily by matching their intangible assets with the preexisting productivity, changes in productivity at the affiliate level can be modest after integration or establishment, as reported by Atalay, Hortacsu, and Syverson (2014). However, parents can encourage import use by lowering the trade costs of imported inputs for their affiliates, potentially via means associated with parents' intangible assets. This means $p_{ij}(\omega)$ in equation 10 can be lower for foreign affiliates in country j, either uniformly for $i \neq j$ or for $\omega \in \Omega^p$, where Ω^p denotes the set of varieties associated with the parent organization of a given affiliate. As a result, foreign affiliates will have a higher demand on the now cheaper imported inputs in their intermediary bundles and a lower producer price aggregator

markups, see, e.g., Chatterjee, Dix-Carneiro, and Vichyanond (2013), Goldberg and Hellerstein (2013), and Amiti, Itskhoki, and Konings (2014).

$P_j^f = \int_{\omega \in \Omega} p_{ij}(\omega) \frac{x_{ij}(\omega|z)}{X_j(z)} d\omega$, since there are more weights on the cheaper components. In other words, foreign affiliates in country j can have lower marginal costs compared with their domestic counterparts, even if their productivity draws are the same. Also, because foreign affiliates will now have a larger share of imports in their marginal costs, their price sensitivity to import cost shocks would be larger holding productivity constant, as implied by equation (15).[20]

Due to the potential existence of stabilizing vs. propagating roles of foreign affiliates in the cost-to-price pass-through, this paper aims to make a first-step effort to test the differential role of foreign affiliates in the shock transmission. However, it is worth noting that even if foreign affiliates are propagating international shocks to domestic inflation dynamics under partial equilibrium, one cannot conclude that replacing foreign affiliates by domestic ownership will reduce the shock pass-through. This is because an ownership replacement will have an indirect reallocation effect in general equilibrium. For instance, if a foreign affiliate enjoys a lower trade cost on imported inputs due to the organizational connections with its parent, these benefits can be lost under a domestic ownership, perhaps because a domestic parent's intangible assets are largely domestically bonded. As a result, an ownership replacement will increase the affiliate's marginal cost, which can raise its equilibrium relative price and rebate its market share back to domestic-owned and foreign firms. A demand reallocation from foreign affiliates toward imports can end up increasing a country's direct import exposure. Under the conventional wisdom that foreign affiliates and exports can be substitutes for multinational parents, the indirect reallocation effect through general equilibrium can be large from a domestic ownership takeover.

With this in mind, I plan to perform a counterfactual analysis in the future, if there is convincing evidence that foreign affiliates are playing a propagating role in the shock transmission under partial equilibrium. In specific, I can test whether the predicted pass-through will be reduced if all foreign affiliates in a SOE are replaced the characteristics of their domestic-owned counterparts, for example, a higher trade costs on imported inputs. Admittedly, my model may not be able to fully capture the extent of the reallocation effect in the sense that the market share of foreign affiliates can be much easier to transfer to imports than to the sales of domestic-owned firms. To address this concern, I can further ask how much preference weights $A_j(\omega)$

[20]The lower trade costs of foreign affiliates on imported inputs will introduce a market segmentation in country j along the dimension of ownership. This is because the price aggregator of foreign affiliates will be different than the one faced by the domestic-owned firms and households, due to the affiliates' potentially lower $p_{ij}(\omega)$ and the correspondingly different $\frac{x_{ij}(\omega|z)}{X_j(z)} d\omega$. As it is now possible for a foreign affiliate and a domestic-owned firm with different productivity to charge the same equilibrium price, the one-to-one mappings of the sufficient statistic $\frac{p_{jj}(\omega)}{p_j^*}$ no longer applies. As a result, one can no longer write a clean exposition for the cost-to-price pass-through as in equation (18).

need to be shifted toward imports to offset the potentially lower predicted pass-through after an ownership replacement. If the potentially lower predicted pass-through can be easily offset in a general equilibrium, the optimal policy response may as well be to increase the resilience of foreign affiliates to import cost shocks, rather than to impose restrictions on international capital movements.

3 Data

The theoretical framework has explained the possible roles of foreign affiliates in stabilizing or propagating the transmission of exogenous international monetary shocks to domestic inflation dynamics through the cost of imported inputs. This section documents the data I use in my current efforts to empirically test these roles.

3.1 The Analytical AMNE Database

The data used by this article comes from the novel Analytical AMNE database developed by the OECD, which marks the first effort to fully split ICIO tables along the dimension of domestic and foreign ownership. Though there are examples aiming at splitting IO tables by ownership at the regional level, such as the ones for the US (Polenske 1980) and China (Okamoto and Ihara 2005), the roles of MNEs have been largely excluded from the context of production networks at the country-industry level.

The Analytical AMNE database brides this gap by incorporating bilateral activities of MNEs into the established ICIO tables without the dimension of ownership, such as the World Input-Output Database (WIOD) and the OECD ICIO tables. The bilateral activities of MNEs are based on the official data collected by national statistics offices and central banks of major OECD and non-OECD countries, supplemented by the OECD Trade by Enterprise Characteristics (TEC) database and other micro-level data sources when available. If certain values on the bilateral activities of MNEs are missing, various statistical methodologies are used to estimate these values, including gravity estimations, such as the one based on the model of Bergstrand and Egger (2007). The activities of MNEs and established ICIO tables are then merged by a quadratic programming model that fits the ICIO flows with values the closest as possible to the bilateral activities of MNEs regarding gross output, value-added, imports, and exports. The values of transactions are also adjusted for taxes on products minus subsidies as well as trade and transport margins. The estimated trade and transport margins are added back to the corresponding whole and retail trade and transport sectors. At this stage, both the WIOD and OECD ICIO tables have been split using the same methologdy with consistent outcomes. The split OECD ICIO tables are available in the Analytical AMNE database. Cadestin

et al. (2018a) provide a full description of the construction of the data set.

The new OECD ICIO tables cover 34 industries based on the ISIC Rev. 4 classification at the 2-digit level and 59 major OECD and non-OECD countries, plus a category for the rest of the world. The ICIO tables are available at the annual frequency for 2005-2016 at the country-industry-ownership level. The ownership category distinguishes domestic-owned and foreign-owned firms based on majority. That is, an affiliate is regarded as foreign as soon as it has at least 50% of foreign ownership. The domestic-owned category can be further decomposed into domestic-owned MNEs vs. domestic-owned non-MNEs for 2008-2016. Current work is undertaking by the OECD to expand the data set on the domestic-owned MNEs vs. non-MNEs decomposition.

Admittedly, the splitting of the ICIO tables is performed with considerable interpolations, primarily due to the scarcity of data on MNEs. It nevertheless represents the first systematic effort detailing the activities of MNEs in global value chains at the country-industry level. In addition, the US and EU countries have a particularly good data coverage on the bilateral activities of MNEs, which reduces concerns on data quality for my study. Overall, the new ICIO tables allow me to perform a DID analysis on domestic sales using the 2015 Swiss franc appreciation as a natural experiment, which can provide first-step evidence on the role of foreign affiliates in transmitting international monetary shocks to domestic inflation dynamics. These insights can guide me in my future investigations combing the transaction-level data from the Swiss customs and firm-level data from ORBIS. A further effort can also be made by using the Swiss custom records to test the data accuracy of the Analytical AMNE database.

3.2 Key Variables

Before the discussion of my empirical analysis, it is necessary to define the key variables available from the new OECD ICIO tables. Let $Y_{ijo,t}$ denote the gross output of country i, industry j, and ownership category o in year t, where $o = \{D, F\}$ with D denotes domestic-owned firms and F represents foreign affiliates. From the ICIO tables, the gross output of a country-industry-ownership sector can be decomposed as:

$$Y_{ijo,t} = X_{ijo,t} + S_{ijo,t} = V_{ijo,t} + I_{ijo,t} + T_{ijo,t}, \tag{19}$$

where $X_{ijo,t}$ is gross exports, $S_{ijo,t}$ denotes domestic sales, $V_{ijo,t}$ is gross value-added, $I_{ijo,t}$ is total inputs, and $T_{ijo,t}$ represents value-added taxes minus subsidies. In the ICIO tables, all values are in millions of current USD.

In addition to equation (19), I also observe the complete input matrix net of taxes minus

subsidies. Let $M_{ijo,\iota\tau\phi}$ denotes a flow of intermediate inputs net of taxes from ijo to $\iota\tau\phi$ in a given year, where i and $\iota = 1, ..., n$ denote the list of countries, j and $\tau = 1$,...,m represent the list of industries, and o and $\phi = \{D, F\}$. Furthermore, let $M_{ijo,\iota\tau}$ be a transaction for final consumption net of taxes from ijo to $\iota\tau$ in the same year, where the definitions of i, j, o, and ι are the same, but $\tau = m{+}1, ..., m{+}f$ denotes a list of final demand categories.[21] In year t, the gross output Y_{ijo} can be written as:

$$Y_{ijo} = \sum_{\iota=1}^{n}\sum_{\tau=1}^{m}\sum_{\phi} M_{ijo,\iota\tau\phi} + \sum_{\iota=1}^{n}\sum_{\tau=m+1}^{m+f} M_{ijo,\iota\tau} + T_{ijo}. \tag{20}$$

The domestic sales of the sector ijo net of taxes in year t is:

$$\tilde{S}_{ijo} = \sum_{\tau=1}^{m}\sum_{\phi} M_{ijo,i\tau\phi} + \sum_{\tau=m+1}^{m+f} M_{ijo,i\tau}. \tag{21}$$

The exports of the sector ijo net of taxes in year t is:

$$\tilde{X}_{ijo} = \sum_{\iota\neq i}\sum_{\tau=1}^{m}\sum_{\phi} M_{ijo,\iota\tau\phi} + \sum_{\iota\neq i}\sum_{\tau=m+1}^{m+f} M_{ijo,\iota\tau}. \tag{22}$$

Throughout this paper, I use $\tilde{S}_{ijo,t}$ and $\tilde{X}_{ijo,t}$ when possible. Unfortunately, the complete input matrix for the domestic-owned MNEs vs. non-MNEs decomposition requires further data application to the OECD. As a result, I use their domestic sales according to equation (19) as a robustness check. However, comparing $\tilde{S}_{ijo,t}$ vs. $S_{ijo,t}$ and $\tilde{X}_{ijo,t}$ vs. $X_{ijo,t}$ using domestic-owned firms and foreign affiliates reveals that the correlations for both groups are around 0.99. In addition, the results of my main analysis remain robust when using $S_{ijo,t}$ and $X_{ijo,t}$ instead.

The ICIO tables also allow me to construct a measure of import intensity for each country-industry-ownership sector using the VAE. Following Johnson and Noguera (2012) and Cadestin et al. (2018b), in a given year, let $\frac{V_{ijo}}{Y_{ijo}}$ be the ratio of value-added to output for sector ijo, and

[21] The final demand categories include households final consumption expenditure, non-profit institutions serving households, general government final consumption, gross fixed capital formation, changes in inventories, and final consumption expenditure of resident households abroad. The definition of each categories is consistent with those from the original OECD ICIO tables. For details, see Cadestin et al. (2018a).

define the technical coefficient matrix A as:

$$A = \begin{bmatrix} \frac{M_{11D,11D}}{Y_{11D}} & \frac{M_{11D,11F}}{Y_{11F}} & \cdots & \frac{M_{11D,nmF}}{Y_{nmF}} \\ \frac{M_{11F,11D}}{Y_{11D}} & \ddots & & \vdots \\ \vdots & & \ddots & \vdots \\ \frac{M_{nmF,11D}}{Y_{11D}} & \cdots & \cdots & \frac{M_{nmF,nmF}}{Y_{nmF}} \end{bmatrix}. \tag{23}$$

Each column of A documents the inputs needed from all sectors in order to produce 1 unit of output in the column sector.

The global Leontief matrix B can then be defined as $B = (I - A)^{-1} = (I + A + A^2 + ...)$. By taking the Leontief inverse, matrix B tells the total output needed from sector ijo to produce 1 unit of output in sector $\iota\tau\phi$, including the output from ijo to produce the first round of inputs used by $\iota\tau\phi$, the output from ijo to produce the second round of inputs to produce the first round of inputs, and etc.

Finally, the VAE matrix E can be computed as:

$$E = \begin{bmatrix} \frac{V_{11D}}{Y_{11D}} & 0 & \cdots & 0 \\ 0 & \ddots & & \vdots \\ \vdots & & \ddots & 0 \\ 0 & \cdots & 0 & \frac{V_{nmF}}{Y_{nmF}} \end{bmatrix} (I - A)^{-1} \begin{bmatrix} \tilde{X}_{11D} & 0 & \cdots & 0 \\ 0 & \ddots & & \vdots \\ \vdots & & \ddots & 0 \\ 0 & \cdots & 0 & \tilde{X}_{nmF} \end{bmatrix}, \tag{24}$$

$$= \begin{bmatrix} E_{11D,11D} & E_{11D,11F} & \cdots & E_{11D,nmF} \\ E_{11F,11D} & \ddots & & \vdots \\ \vdots & & \ddots & \vdots \\ E_{nmF,11D} & \cdots & \ldots & E_{nmF,nmF} \end{bmatrix}, \tag{25}$$

where $E_{ijo,\iota\tau\phi}$ tells the value-added sector ijo has contributed in total for one unit of exports of sector $\iota\tau\phi$. Thus, the ratio of imported VAE for sector $\iota\tau\phi$ can be calculated as:

$$\text{Imported VAE Ratio}_{\iota\tau\phi} = \frac{\sum_{i \neq \iota} \sum_{j=1}^{m} \sum_{o} E_{ijo,\iota\tau\phi}}{\tilde{X}_{\iota\tau\phi}} \tag{26}$$

in a given year. The higher this ratio, the more imported value-added is embedded in a sector's (export) production.[22]

[22]I use the imported VAE ratio as a standard measure of a sector's import intensity, following Johnson and Noguera (2012, 2017) and Cadestin et al. (2018b). In fact, one can also calculate the value-added in domestic sales by replacing the export matrix with the corresponding matrix for domestic sales. But doing so should not affect the imported value-added ratio, as the ratio effectively measures a sector's import intensity in production.

3.3 Stylized Facts

Based on the key variables from the ICIO tables, I introduce two stylized facts for foreign affiliates in Switzerland and other major developed economies. To begin with, foreign affiliates have an important presence in the domestic sales of tradable sectors not only for small open economies like Switzerland, but also for large economies, such as the US. In contrast, there is a higher degree of heterogeneity in foreign affiliates' contributions to exports across countries.

Taking sample averages over 2005-2016, Figure 1, Panel A plots the shares of domestic sales by foreign affiliates across the tradable sectors of Switzerland, while Panel B plots the distribution of domestic sales among Switzerland's tradable sectors. The red dashed line in Panel B represents the share of each industry if their sales were to distribute evenly. The domestic sales in the US and the major developed economies are shown in Figures 2 and 3 in the same manner.[23] [24] To avoid complications by the trade flows of the service sectors, which are more likely to be affected by factors other than changes in the cost of imported inputs, I focus on the tradable sectors in my current analysis. The tradable sectors are defined by the industry codes from A to C31T32 used by the Analytical AMNE database based on the ISIC Rev. 4 classification.[25] A copy of the industry codes from Cadestin et al. (2018a) is attached in Table A1. See Cadestin et al. (2018a) for a more detailed description.

From the figures, the median share of domestic sales by foreign affiliates in an industry is around 25% for Switzerland (mean value 27%), 18% for the US (mean value 19%), and 18% among the major developed economies (mean value 18%).[26] Using the same method, Figures 4-6 plot the equivalent summary statistics for exports, where the median share of exports by

[23] In specific, in Figures 1 and 2, the sample averages are taken for each country-industry-ownership sectors of Switzerland and the US. The domestic sales of an industry is the sum of the domestic sales of domestic-owned firms and foreign affiliates in that industry. The domestic sale share of the foreign affiliates is computed as the sales of foreign affiliates over the industry's total sales. As explained by footnote 10, I use the major developed economies defined in Georgiadis, Grab, and Khalil (2019) in this study. For each year, the sum of domestic sales across the majored developed economies is taken at the industry-ownership level. The sample averages and summary statistics are then calculated in the same way as those in Figures 1 and 2.

[24] The reason why foreign affiliates have a 100% sale share in the automobile industry (C29) of Switzerland is caused by the fact that the sales from Swiss domestic-owned firms are missing in the Analytical AMNE database. Unlike the US, automobile industry in Switzerland is very small (Egger and Erhardt 2016), thus the missing sales from domestic-owned firms can reflect a reporting bias. But all my results remain unchanged with or without the automobile sector of Switzerland.

[25] In the data provided by the OECD, C31T32 and C33 are somehow combined together, thus in practice my tradable sectors also include C33. However, both C31T32 and C33 should be dropped following the definitions of the Swiss customs on the core tradable sectors, since C31T32 includes activities related with precious metals and jewellery. In addition, my results remain robust with and without the inclusion of C31T32 and C33.

[26] Foreign affiliates are particularly important for certain industries in the US. For example, around 30% of the domestic sales come from foreign affiliates in the manufacturing of chemical products, pharmaceutical products, machinery and equipment, basic metals, and other non-metallic mineral products. The domestic sale share of foreign affiliates in the automobile industry is around 40%.

foreign affiliates in an industry is around 52% for Switzerland (mean value around 53%), 19% for the US (mean value 18%), and 33% among the major developed economies (mean value 31%). Though it can be expected that foreign affiliates' export shares tend to be larger than their domestic sale shares, since not all domestic-owned firms participate in exports, and that foreign affiliates tend to play a more important role in exports in small open economies, such as Switzerland, these numbers suggest foreign affiliates are a recognizable force among the tradable sectors of developed economies in general, both in terms of exports and domestic sales. It is their influences in domestic sales that can directly propagate the transmission of international monetary shocks to domestic inflation dynamics.

Having demonstrated their economic importance, I also confirm that foreign affiliates tend to use more imports compared with their domestic-owned counterparts in the same industry. Figures 7-9 plot the sample averages of the imported VAE ratios for foreign affiliates (Panel A) and domestic-owned firms (Panel B) in the tradable sectors of Switzerland, the US, and the major developed economies, respectively.[27] The median imported VAE ratio of foreign affiliates in an industry is around 0.41 for Switzerland (mean value 0.40), 0.21 for the US (mean value 0.22), and 0.33 among the major developed economies (mean value 0.33). In contrast, the median imported VAE ratio of domestic-owned firms in the same industry is around 0.26 for Switzerland (mean value 0.27), 0.13 for the US (mean value 0.14), and 0.20 among the major developed economies (mean value 0.21).

Given their preferences toward imported inputs, one may argue that a higher share of firms in a more import intensive sector would endogenously choose to become foreign affiliates. If this is the case, we should expect to observe a positive correlation between the market share of foreign affiliates in an industry and the foreign affiliates' imported VAE ratio. However, there seems to be mixed evidence in support of this argument. Among foreign affiliates of the major developed economies, the correlation between their domestic sale shares and imported VAE ratios across the tradable sectors is 0.35. But much of the correlation comes from agriculture and industries related with precious metals, jewellery, and the production of petroleum. After excluding these industries, the correlation becomes 0.07. Furthermore, this correlation is not stable across countries. For instance, the correlations for all tradable sectors and the tradable sectors excluding agriculture, precious metals, jewellery, and petroleum in the US are 0.38

[27]In Figures 7 and 8, the sample averages are taken over the imported VAE ratios at the country-industry-ownership level. In Figure 9, the imported VAE ratios are first computed at the country-industry-ownership level for each individual country in the majored developed economies. Then, in each year, a weighted average is taken at the industry-ownership level across the members of the major developed economies, weighted by each industry-ownership sector's exports. The statistic remains largely the same if a simple average or a weighted average by output is taken instead. In the end, a sample average is taken for the VAE ratios of the major developed economies at the industry-ownership level across time.

and 0.35, respectively. The same correlations for Switzerland are -0.4 and -0.54. In fact, the industry composition of foreign affiliates in Switzerland seems to be working against me in finding a propagating effect through the usage of imported inputs.[28] Finally, it is worth noting that all summary statistics reported in this section are rather stable across time, thus the sample averages can be considered as a representative presentation of their behaviors, at least during my sample period.

4 Empirical Analysis

Based on the baseline theoretical framework, international monetary shocks can positively interact with the price sensitivity of foreign affiliates through the cost of imported inputs. A potential source of this interaction is the affiliates' organizational connections with the intangible assets of their parents. To empirically test this possibility, one need identify a relevant import cost shock. In addition, under price rigidity, firms adjust prices based on expected changes in marginal costs. Thus, to capture the complete price adjustments, the import cost shock must be both exogenous and unexpected. This is especially the case among developed economies, since an one-time, expected change in the cost of imports can be financially hedged in advance, at least for the short run. Therefore, prices can start to respond ahead of the shock due to both a change in expectations and the cost of hedging.

This section describes my empirical analysis, in which I use the 2015 Swiss franc appreciation as a natural experiment. The natural experiment allows me to perform a DID estimation on domestic sales and obtain first-step evidence suggesting a propagating role of foreign affiliates in transmitting international monetary shocks.

4.1 The 2015 Swiss Franc Appreciation

On January 15, 2015, the SNB unexpectedly abandoned the minimum exchange rate of CHF 1.20 per euro, which had effectively pegged the EUR/CHF exchange rate since its introduction on September 6, 2011. The exchange rate floor was implemented by the SNB as a policy tool to ward off the risk of deflationary development due to CHF appreciation. In early 2015, the minimum exchange became unsustainable. Not only were there signs that a US exit from a highly expansionary monetary policy was drawing closer, but there was mounting evidence that monetary policy in the euro area would be eased further. The demand for assets denominated in Swiss francs also rose sharply due to geopolitical tensions associated with Greece and Ukraine.

[28] In robustness checks that are not reported in this article, similar weak and unstable correlations appear between foreign affiliates' export sale shares and imported VAE ratios. Instead, the correlations tend to be positive and much stronger between the sale shares of domestic-owned firms and their imported VAE ratios, suggesting more productivity and larger domestic-owned firms tend to participate more in imports and exports.

As a consequence of these international spillovers, the euro depreciated considerably against the US dollar, resulting in enormous pressure for the SNB to defend the minimum exchange rate. To avoid losing controls over its balance sheet by maintaining the exchange rate floor, the SNB decided to discontinue the minimum exchange rate in January, 2015 (Jordan 2015).

It has been documented that this policy change resulted in a sharp, unanticipated, and permanent appreciation of the Swiss franc by more than 11% against the euro (Bonadio, Fischer, and Saure 2019), which can be seen from Figure 10, Panel A. Panels B and C of the same figure further plot the 3-month and 1-year forward rates of CHF per euro. As the figure suggests, the sudden drops in the forward rates occurred at the same time of the Swiss franc appreciation, indicating the unexpected nature of the exchange rate shock. Furthermore, considering the expected downward pressure on the nominal interest rates in euro around the time of the appreciation, the still decreased forward rates reflect that the effects of the CHF appreciation were overwhelming under the covered interest parity (CIP). Since around 67% of imports in Switzerland were invoiced in euro during the appreciation episode, and the ERPT to import prices invoiced in Swiss francs is estimated to be completed within 12 days at around 0.5 (Bonadio, Fischer, and Saure 2019), the 2015 natural experiment can introduce a substantial reduction in import costs for domestic producers in Switzerland.

It has also been established that the policy change occurred in an otherwise tranquil macroeconomic environment in Switzerland. Auer, Burstein, and Lein (2018), for example, show that the Swiss economic aggregates were remarkably stable before the shock in terms of real GDP growth, real consumption growth, and inflation. Following the appreciation, there was a -1.1% inflation in 2015. Such deflation is influential, comparing to a target of annual inflation rate below 2% by the SNB.[29]

Overall, the discontinuation of the exchange rate floor is a response to international spillovers external to the Swiss economy, thus it can be considered as an unexpected and exogenous shock that substantially lowers the import costs for the domestic producers in Switzerland. This natural experiment allows me to perform a DID estimation for my empirical analysis. In the end, to avoid trade flows associated with changes in the financial environment around the appreciation episode, I use the core tradable sectors in my analysis by excluding industries

[29]There were a series of subsequent policy responses by the SNB to fend off the deflationary pressure, including the adoption of negative interest rates. In fact, the negative interest rate environment was expected before the shock as a measure to defend the exchange rate floor. This can be seen by the relatively small decrease in the 1-year forward rates at the end of 2014. However, these expansionary responses should work against me in finding any propagating effect associated with the deflationary shock, since they were designed to stimulate demand and thus would mute the downward pressure on prices. In addition, any non-differential effects of the policy responses on domestic producers in Switzerland can be accounted for by my DID framework. I also run a placebo test using the US to check if my results are driven by time-variant confounding factors.

related with precious metals and jewellery following the definitions of the Swiss customs. I also further exclude industries containing the production of petroleum to account for the fluctuations in oil prices during my sample period. However, my results are robust to the inclusion of the aforementioned sectors.

4.2 The Econometric Framework: Difference-in-Differences Estimator

Using the 2015 Swiss franc appreciation as a natural experiment, I employ a DID estimator to test if there exists evidence that foreign affiliates systematically display a higher price sensitivity in the medium-long run to international monetary shocks affecting import costs, conditioning on productivity and the benchmark import intensity in production. Assuming multinational parents endogenously expand in import intensive industries by owning affiliates based on preexisting productivity, their affiliates should have a similar import exposure compared with the domestic-owned firms that are equally productive and share the same production function. Alternatively, if foreign affiliates increase import exposure exogenously by connecting with the intangible assets of their parent organizations, they can lower their prices further and gain market share in face of a negative shock in import costs, even if they have equivalent productivity and benchmark import intensity relative to their domestic-owned counterparts. Since information on prices is not available from the ICIO tables, I use domestic sales in my current analysis for first-step evidence, based on the condition that demand is a decreasing function in relative prices $\frac{p_{jj}(\omega)}{P_j}$.

Let i denote an industry-ownership sector in Switzerland and t index time in my DID framework. To capture effects at the medium-long run and account for the possibility that it can take up to 18 months for firms to reset their prices,[30] I include two years before and after the 2015 exchange rate shock in my sample. I also follow Bertrand, Duflo, and Mullainathan (2004) and take the averages of the observations in the before period (2013-2014) and the after period (2015-2016).[31]

The baseline specification of my analysis is defined as follows:

$$LnSales_{it} = Foreign_i + \beta After_t + \gamma After_t \times Foreign_i + \sum_{k=1}^{K} \delta_k Control_k + \epsilon_{it}, \qquad (27)$$

where $LnSales_{it}$ is the log of the domestic sales net of taxes, $Foreign_i$ is a dummy variable indicating if sector i is foreign owned, $After_t$ is a dummy variable taking a value of 1 in the after

[30] See, e.g., Gopinath, Itskhoki, and Rigobon (2010).

[31] Bertrand, Duflo, and Mullainathan (2004) present this approach as the most robust of the alternatives, including bootstrapping and asymptotic approximation of the variance-covariance matrix.

period, and $Control_k$ represents a list of additional sector-level controls. In specific, $Control_k$ contains sectoral fixed effects, the log of gross value-added of sector i at t, and the log of the imported VAE ratio of sector i at t. I control for the gross value-added to absorb potential time-variant omitted variables that may affect a sector's domestic sales through its value-added, such as unobserved productivity shocks. In addition, I include the imported VAE ratio to account for potential changes in a sector's import intensity across time.

My main DID analysis is performed on foreign affiliates vs. domestic-owned firms in Switzerland. Though firms in the same industry can use a production function with the same benchmark import intensity, foreign affiliates can be endogenously more productive than the domestic-owned firms. A higher productivity can also encourage the usage of imported inputs (Amiti, Itskhoki, and Konings 2014). To address these concerns, I conduct the same estimation in equation (27) but replacing the domestic-owned firms with domestic-owned MNEs in Switzerland instead. Assuming domestic-owned MNEs, especially those in Switzerland, have similar productivity to the foreign affiliates in the same industry, my results would become weaker if they are previously driven by the endogenous difference in productivity.

In addition to the baseline specification, I replace the $Foreign_i$ variables in equation (27) with the imported VAE ratio to examine the effect of treatment intensity. A subgroup regression is also ran individually for the foreign affiliates and their domestic-owned counterparts. If the results based on my baseline specification can be explained inherently by using import intensity as a sufficient statistic, independent with the dimension of ownership, I should expect to obtain a similar coefficient from the interaction term between the $After_t$ dummy and the imported VAE ratio for each of the subgroups.

Given the framework of my DID analysis, the identification assumption is that the only significant time-variant factor affected the domestic sales of foreign affiliates and domestic-owned firms in Switzerland *differently* is the unexpected appreciation of the Swiss franc, which exogenously and substantially lowered the cost of imported inputs. Asides from the CHF appreciation, any time-invariant differences between the foreign affiliates and domestic-owned firms can be captured by the $Foreign_i$ dummy. Likewise, any common trend shared by the two groups would be accounted for by the $After_t$ indicator.

Under the identification assumption, there should be a parallel trend in the domestic sales of the foreign affiliates and domestic-owned firms before the 2015 natural experiment. Figure 11, Panel A plots the domestic sales of the two groups as annual averages. As the panel suggests, there is in fact a parallel development in the domestic sales up till the exchange rate shock. Following the discontinuation of the exchange rate floor, both groups see a decline, potentially due to the stronger competition from cheaper imports. Yet, the decrease for the foreign affiliates

is relatively smaller. When plotting the same annual averages for the foreign affiliates and domestic-owned MNEs, the pre-shock growth of the domestic-owned MNEs appears to be much weaker, as shown in Figure 11, Panel B. However, this is caused by the fact most of the domestic sales of Switzerland's MNEs are concentrated in the sectors that are also the largest in Switzerland's exports, revealing the comparative advantages of the country in the international market.[32] Averaging across many industries where the domestic-owned MNEs have low sales will bias the changes in the annual averages toward 0. By focusing on the sectors with a significant presence of the domestic-owned MNEs, Figure 11, Panel C indicates the existence of a similar parallel trend.[33]

4.3 Main Results: Evidence from Domestic Sales

This section describes the main results of my empirical analysis. Table 1 summarizes the results of the DID estimations on foreign affiliates vs. domestic-owned firms in Switzerland. Table 2 presents the results on the foreign affiliates vs. domestic-owned MNEs. In all models, standard errors are clustered at the industry-ownership level.

I start my analysis by running the baseline specification in equation (27) without the sectoral fixed effects at the industry-ownership level (Table 1, Column (1)), before including them to absorb the $After_t$ dummy (Table 1, Column (2)). Both specifications suggest that, in the two years following the appreciation episode, the domestic sales of the foreign affiliates become around 27% higher relative to the domestic-owned firms in the same industry. The estimates are statistically significant and are robust to the sectoral fixed effects. In addition, the insignificant coefficient of the imported VAE ratio after its inclusion as an additional control (Table 1, Column (2)) is consistent with the fact that the import intensity at the sector-level is stable cross time.[34]

The results from Table 1, Columns (1) and (2) are consistent with the narrative that foreign affiliates in Switzerland benefited from a higher import usage on top of the benchmark import intensity at the industry-level following the appreciation. Since they were able to adjust prices downward further from the cheaper imported inputs, they gained market share in domestic sales compared with the domestic-owned firms in the same industry. However, the same results can also be explained by the possibility that foreign affiliates are endogenously more productive

[32] In specific, nearly 70% of the domestic sales of the domestic-owned MNEs are occur in the manufacturing of chemical products, pharmaceutical products, electronic and optical products, electrical equipment, machinery and equipment, and food products and beverages.

[33] The possibility that my results can be driven by a few outlier sectors can be accounted for by the inclusion of the industry-ownership-level fixed effects.

[34] I exclude the automobile industry for all regressions on Switzerland, as the domestic-owned category reports all missing values. My results stay the same after including the automobile sector only for the foreign affiliates.

in Switzerland. If higher productivity induces import use endogenously in equilibrium, my regressions would produce the same outcomes. Alternatively, given the competition from the cheaper imports after the CHF appreciation, more productive firms could simply be able to retain market share better, since they face a lower demand elasticity under variable markups.

To test these concerns, the same regressions are performed on the foreign affiliates vs. domestic-owned MNEs. Since their productivity should be similar, the results would become weaker if they are previously driven by the difference in productivity. Table 2, Columns (1) and (2) show that the estimates remain robust. If anything, the results seem to become stronger.[35]

In the next step, I ask if there is direct evidence that the results I have observed so far can be contributed to the imported input use. To answer this question, I utilize the imported VAE ratio as a measure of an industry-ownership sector's import intensity. In specific, I replace the $Foreign_i$ dummy in equation (27) with Imported VAE Ratio$_{it}$ and the interaction term $After_t \times Foreign_i$ with $After_t \times$Imported VAE Ratio$_{it}$. Table 1, Columns (3) and (4) suggest that the effect of import intensity on domestic sales in the after period is, as expected, positive and statistically significant. Table 2, Columns (3) and (4) yield consistent estimates. As a result, a sector with more imported inputs embedded in production sees a higher relative increase in domestic sales two years after the appreciation shock.[36]

However, the positive impact of $After_t \times$Imported VAE Ratio$_{it}$ on domestic sales turns out to be non-linear across the dimension of ownership. When the same regression is carried out for the subgroups of foreign affiliates and their domestic-owned counterparts, the positive effect of import intensity in the after period is only significant for the foreign affiliate subgroup (see Table 1, Column 5 and Table 2, Column 5). The coefficient is half in size and statistically insignificant for the subgroup of domestic-owned firms (Table 1, Column 6). For the subgroup of the domestic-owned MNEs, the magnitude of the coefficient recovers, but there is no statistical significance.[37] These preliminary findings suggest that import intensity by itself does not tell a complete story. The interaction between imported input use and ownership matters. Overall, I interpret the results of my main analysis as supportive evidence that foreign affiliates propagate the transmission of international monetary shocks through imported inputs. The existence of

[35] A potential explanation is that, compared with an average domestic-owned firm in Switzerland, it is harder for the domestic-owned MNEs to recover market share by lowering their prices, since the higher productivity of the MNEs gives them a lower demand elasticity under variable markups.

[36] The negative coefficients in front of the standalone Imported VAE Ratio$_{it}$ are also expected, since the foreign affiliate sectors tend to have higher imported VAE ratios but lower domestic sales in level compared with the domestic-owned sectors in the same industry.

[37] The higher coefficients of the interaction term $After_t \times$Imported VAE Ratio$_{it}$ in Columns (3) and (4), compared with those in Columns (5) and (6), should be a consequence of the nonlinear combination of the subgroups.

such role can be used to motivate the directions of my further investigations.

4.4 Robustness Checks

My main analysis relies on the assumption that the 2015 CHF appreciation is the only time-variant factor that differentially affects the domestic sales of Swiss producers in my sample by lowering their costs on imported inputs. Admittedly, there could be other confounding factors, especially considering that my current estimations are performed at the annual frequency. 2015, for instance, coincides with a major international commodity price shock associated with the Ukrainian crisis, which can lower the costs on commodity imports. Switzerland also faced an inflow of foreign capital that could change other economic conditions, such as consumer preferences or costs of working capital. These factors may bias domestic sales toward foreign affiliates even without the presence of the natural experiment.

The ideal response to these concerns is to compare the differential price changes between foreign affiliates and domestic-owned firms in Switzerland at the product level, while controlling for the presence of commodity imports and firm-level financial constraints. I am hoping to achieve this in the next step. But as a preliminary attempt to address the confounding factors, I conduct the same DID estimations but for the US. Similar to Switzerland, the US experienced a significantly inflow of foreign capital around 2015, which induced an appreciation of the US dollar. The US was also exposed to the 2015 commodity price shock. The difference is there was not a similar natural experiment in the US that lowered the costs on imported inputs *exogenously* through exchange rates. I therefore use the US to run a placebo test and ask, with an endogenous appreciation of the US dollar and the influences of the commodity price shock, whether I can still obtain results similar to those from my main analysis.[38] If I can, then there is evidence that my findings are driven by confounding factors.

Tables 3 and 4 display the results from my placebo test using the US. As the tables indicate, the key coefficients are insignificant and close to zero. Many of them also have a wrong sign.

The results of my main analysis are also consistent to other robustness checks. To start with, I check for pre-trends by running the same DID regressions over 2011-2014, when there was no natural experiment. The before period of this placebo test is defined as 2011-2012 and the after period is defined as 2013-2014. Tables 5 and 6 report findings similar to those from the US

[38]The endogenous appreciation of the US dollar can be reflected by Figure 12, which plots the USD/EUR spot and forward rates. As Figure 12, Panel A suggests, the USD started to appreciate against the euro in the second half of 2014, with the most notable appreciation occurred in early 2015. However, the forward rates largely moved toward the opposite direction, as shown by Panels B and C. This implies that the movements in the spot rates can be endogenously driven by the expected increase in US nominal rates, as the US was on the path out of the ZLB. As a result, rather than providing an exogenous decrease in the marginal costs, the appreciation of the US dollar was endogenous.

estimations, relaxing concerns that my results are driven by pre-trends. In addition, my main DID estimates are robust when using only the domestic sales of final goods as the dependent variable. In fact, Table 7 suggests the main estimates have become stronger.[39] Finally, Tables 8 and 9 show that my findings remain stable when extending the before period of the main DID estimations from 2013-2014 to 2011-2014, which covers the entire duration of the minimum exchange rate floor.

5 The Next Step

This article documents the first-step evidence that foreign affiliates play a propagating role in the transmission of international monetary shocks among developed economies. Comparing to an equally productive domestic-owned firm that shares the same level of benchmark import intensity in the production function, a foreign affiliate can use more imports because of the organizational connections with its parent's intangible assets. These organizational bonds do not necessarily reflect the demand for input trade between parents and their affiliates. Rather, they can be a natural outcome of a parent's expansion by matching its intangible assets with the already productive establishments abroad. Due to the increased import exposure in marginal costs associated with the multinational nature of their organizational frameworks, foreign affiliates can systematically display a higher price sensitivity to exogenous changes in exchange rates, which can also affect the allocation of their market share. Given the economic importance of foreign affiliates, at least among the tradable sectors of the developed economies, this higher price sensitivity can propagate the transmission of international monetary shocks to domestic inflation dynamics.

Based on the evidence from the new ICIO tables using the 2015 Swiss franc appreciation as a natural experiment, I plan to further investigate the roles of foreign affiliates in transmitting international monetary shocks by combining the transaction-level data from the Swiss customs and firm-level information from the ORBIS database. In the customs database, one can observe all transactions crossing the Switzerland border at daily frequency since 2014 with detailed transaction-level characteristics.[40] The ORBIS database can be used to identify the historical ownership structure of the firms in the customs database. As explained by Kalemli-Ozcan et al. (2019), ORBIS offers good data coverage on firms' ownership, especially for firms in the developed European economies. Firm-level information, such variables from the financial

[39]Since the complete input matrix for the domestic-owned MNEs vs. non-MNEs decomposition is not yet available from the OECD, I can only decompose domestic sales into the sales of final goods and intermediaries for the foreign affiliates and domestic-owned firms.

[40]For example, for each transaction, one can observe its unit value price, total value, invoicing currency, weight, number of pieces, product codes at 8- to 10-digit levels, product descriptions, names and addresses of the buyer and seller, mode of transaction, and etc.

statements, is also available at the annual frequency from ORBIS.

Though there is much work to be done in data cleaning, I plan to run two regressions to initiate the next step analysis when the data is ready, both of which are based on the 2015 natural experiment.

Let i denote a sale at the firm-product level, and t indicate the number of quarters after 2014Q4. For each horizon $t = 1, ...8$, a cross-section regression can be run for all exporters of Switzerland as:

$$\Delta LnP_i^t = \alpha Product_i + \beta Currency_i + \gamma Destination_i + \delta Foreign_i + \sum_{n=1}^{K} \theta_n Control_{n,i}, \quad (28)$$

where ΔLnP_i^t represents the change in unit value prices at the firm-product level t quarters after the 2015 Swiss franc appreciation, $Product_i$ is the HS code associated with i, $Currency_i$ indicates the invoicing currency of the transaction, $Destination_i$ controls for i's destination market, $Foreign_i$ documents if the transaction belongs to a foreign affiliate, and $\sum_{n=1}^{K} Control_{n,i}$ is a list of additional firm-level controls, including firm size, the revenue-based TFP, a measure of firms' financial constraint, such as the quick ratio, and an indicator for the firm-level accounting practice, which can affect the measured TFP (Barrios, Lisowskym and Minnis 2019). The regression can be run with either 6- or 8-digit product codes, depending on the firm-level variations.[41] As the specification implies, for each horizon t, all sales in the sample should have the same firm-product level characteristics in 2014Q4 and t quarters after 2014Q4. The firm-level controls can come from 2014Q4.

Based on the regression design, equation (28) asks if a foreign affiliate tends to lower its price further compared to a domestic-owned firm in Switzerland that sells the same product to the same destination market, with the same invoicing currency, and has similar firm-level characteristics, including size and productivity. If the coefficient δ is significantly negative, then there is evidence that ownership matters in the price sensitivity. In other words, ownership can induce additional import exposure compared to the counterfactual where the same firm is domestically owned. Furthermore, equation (28) can test at which horizon the potential difference in price adjustments starts to appear. It may also be interesting to see if δ changes the magnitude of β. If it does, then there can be an interaction between MNEs and the endogenous choice of invoicing currency.

In addition to the regression for the Swiss exporters, the same specification can be used

[41]There are around 300 firm names on average per HS 6-digit code, for instance, according to the export records of the Swiss customs.

on foreign firms that export to Switzerland to test an upper bound for the stabilizing role of foreign affiliates. In specific, equation (28) can be carried out for the domestic-owned firms in Switzerland's major trade partners, such as Germany, France, and Italy, vs. the foreign affiliates in the same countries whose parents are from another country of the eurozone. The assumption is that, if a foreign affiliate and its parent are in the same currency union, most of the connections between the affiliate and its parent's intangible assets can occur under the same invoicing currency. As a result, the foreign affiliate can be viewed as if it were a domestic affiliate of the parent. Conditioning on exporting to Switzerland, this means the differences between the foreign affiliates and their domestic-owned counterparts should now be mainly in productivity, even if some of these differences are preexisting. By re-running equation (28) for the new groups without the relevant productivity controls and $Destination_i$, as all sales are exports to Switzerland, I am interested to see whether the foreign affiliates can display a smaller ERPT to their export prices at all. If δ is insignificant and close to 0, then there is evidence that the productivity difference of foreign affiliates plays only a limited role in stabilizing the transmission of international monetary shocks.

Finally, I can perform standard ERPT regressions at firm-product level for 2014-2018 to see if there is generalized evidence that foreign affiliates tend to display a higher ERPT. Such regressions can be run for domestic-owned firms vs. foreign affiliates in Switzerland based on the export data from the customs. Additionally, they can be carried out for domestic-owned firms vs. foreign affiliates in Germany, France, and Italy with a non-eurozone parent, as an example, based on the import records from the Swiss customs. If there is convincing micro-level evidence that ownership matters in price sensitivity when facing international monetary shocks, I can work on developing the baseline model into a DSGE framework to see if foreign affiliates matter in transmitting international monetary shocks to domestic inflation dynamics in a general equilibrium environment. The counter-factual analysis can be calibrated based on the industry-ownership level data from the new ICIO tables and/or the micro data on the firm-product level.

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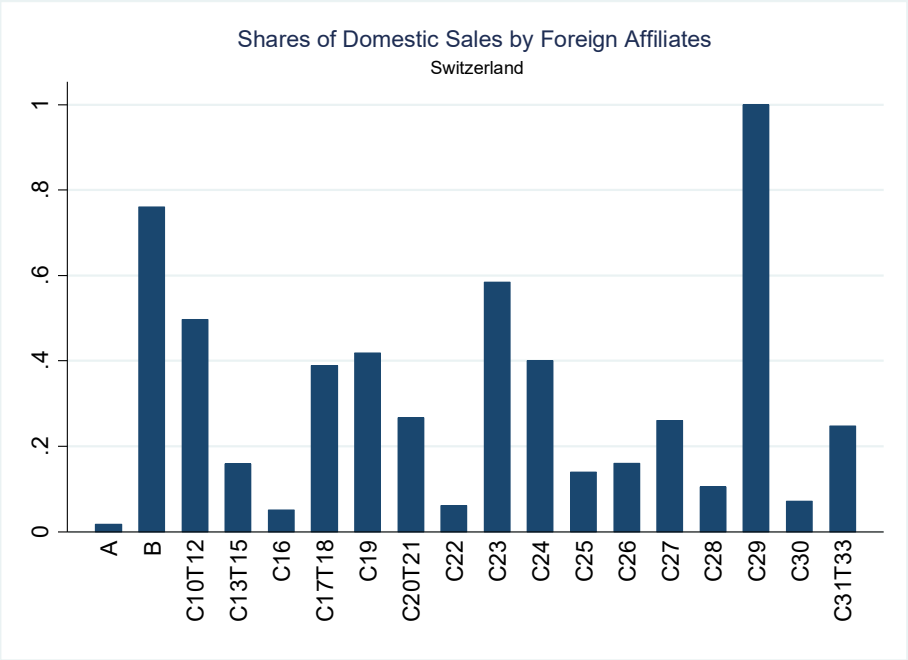
Figure 1: Domestic Sales by the Tradable Sectors of Switzerland

Panel A: Shares of Domestic Sales by Foreign Affiliates



Panel B: The Industry-Level Distribution of Domestic Sales

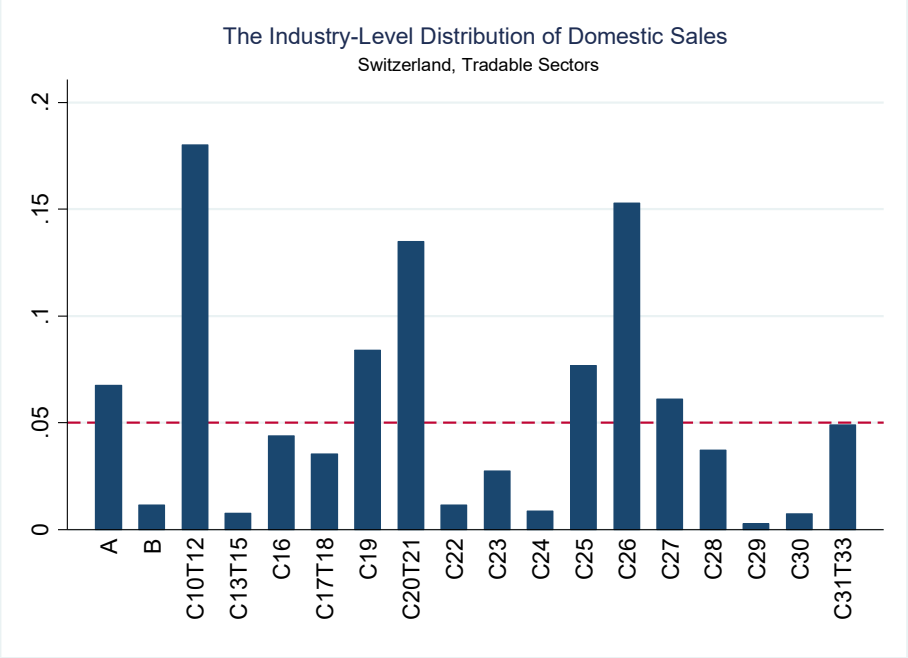
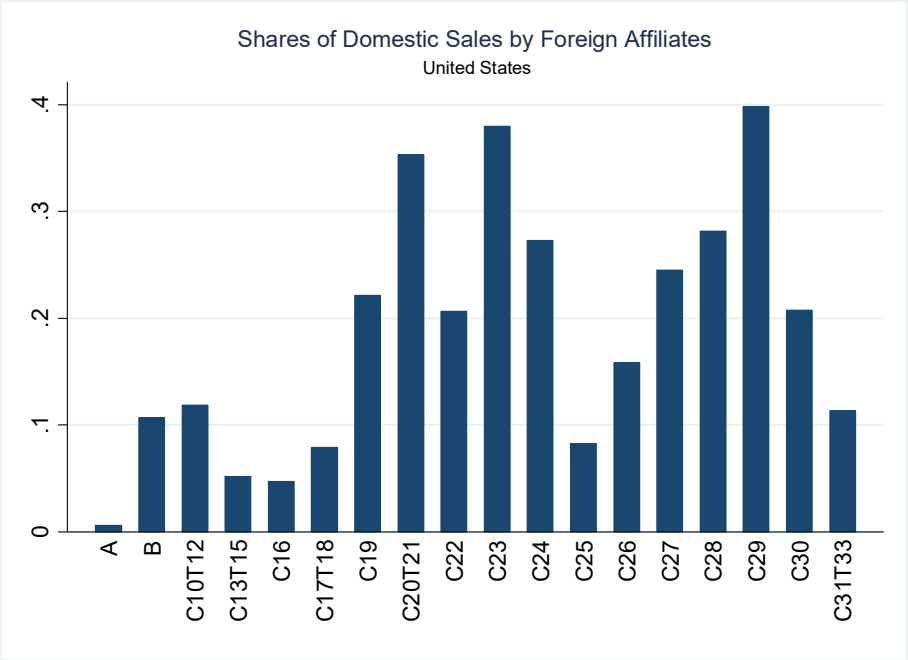


Figure 2: Domestic Sales by the Tradable Sectors of the United States

Panel A: Shares of Domestic Sales by Foreign Affiliates



Panel B: The Industry-Level Distribution of Domestic Sales

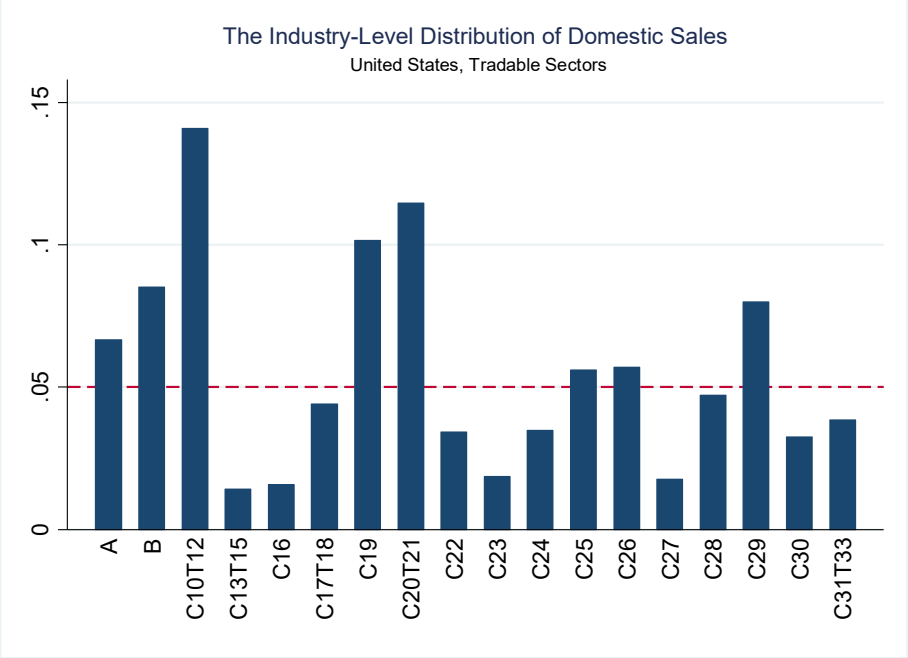
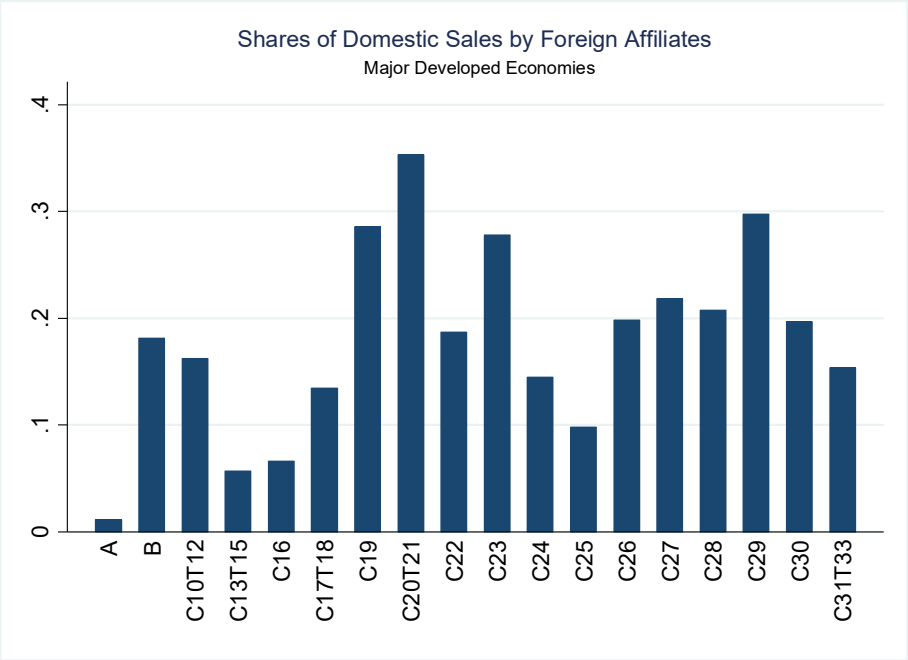


Figure 3: Domestic Sales by the Tradable Sectors of the Major Developed Economies

Panel A: Shares of Domestic Sales by Foreign Affiliates



Panel B: The Industry-Level Distribution of Domestic Sales

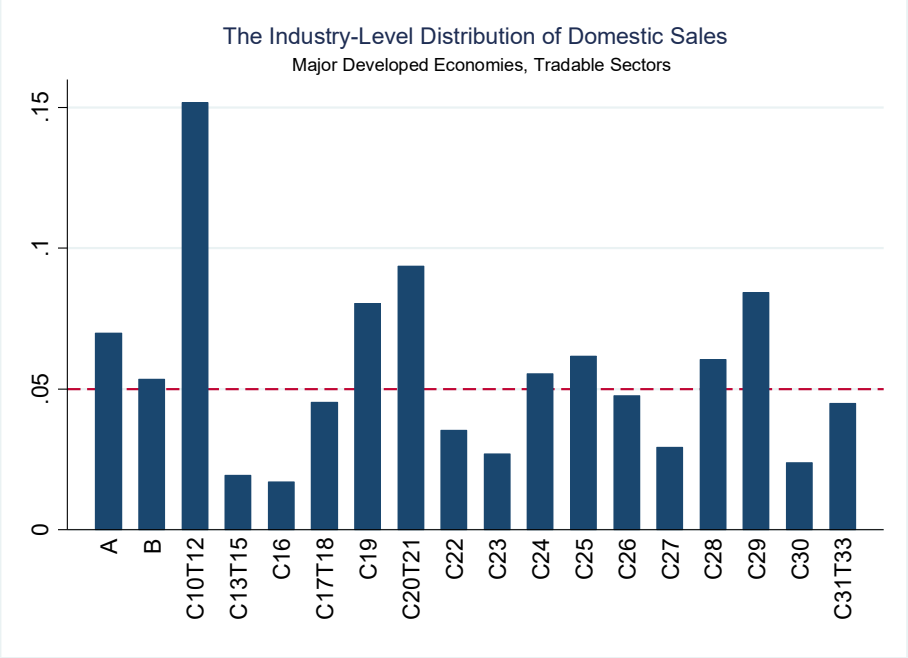
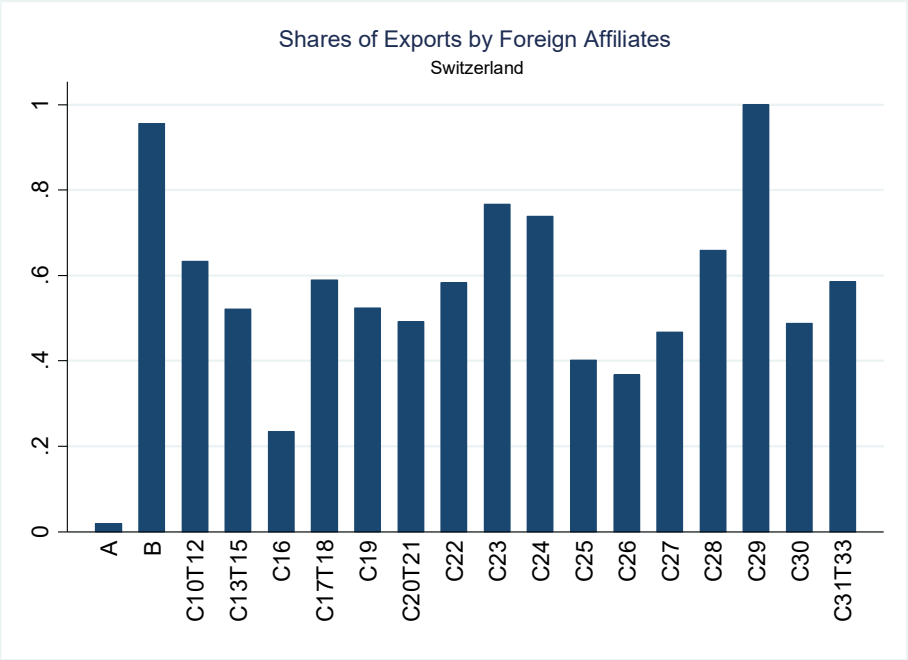


Figure 4: Exports by the Tradable Sectors of Switzerland

Panel A: Shares of Exports by Foreign Affiliates



Panel B: The Industry-Level Distribution of Exports

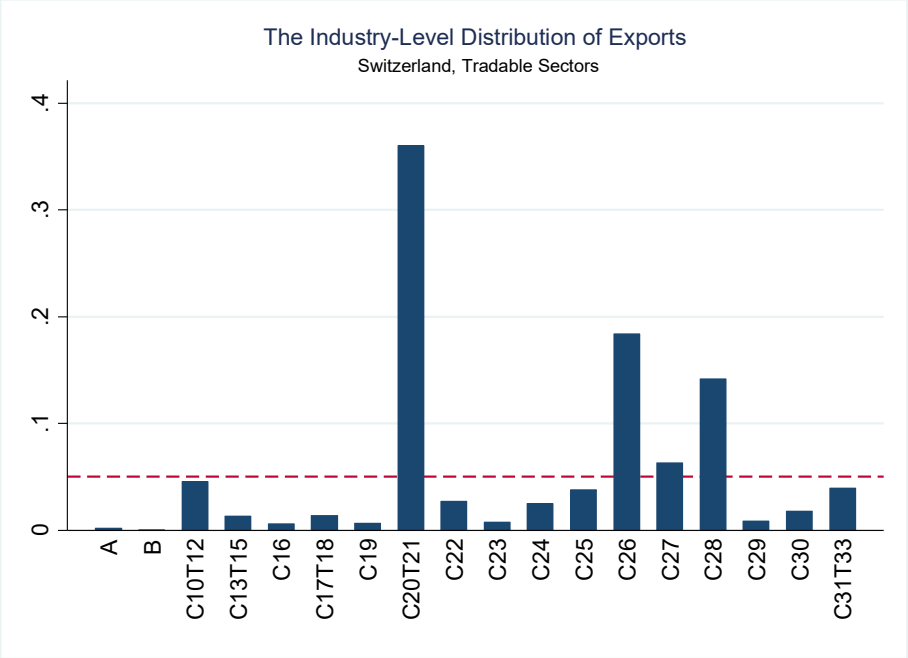
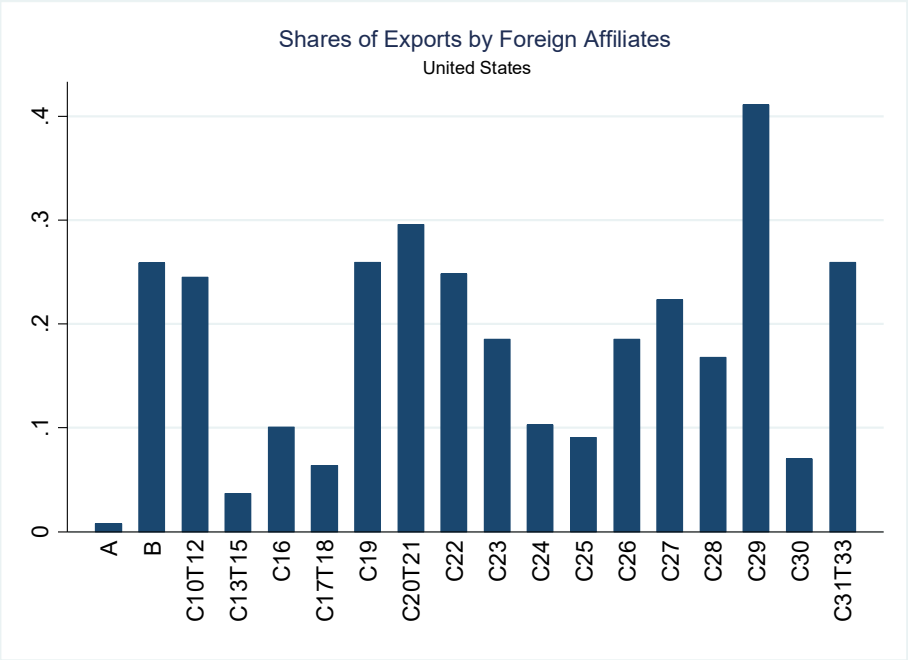


Figure 5: Exports by the Tradable Sectors of the United States

Panel A: Shares of Exports by Foreign Affiliates



Panel B: The Industry-Level Distribution of Exports

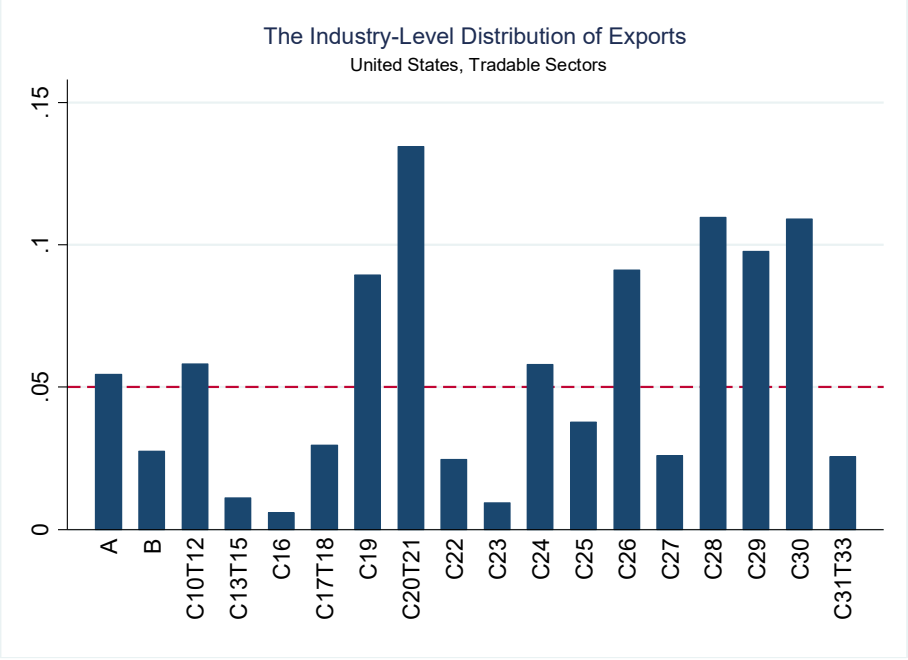
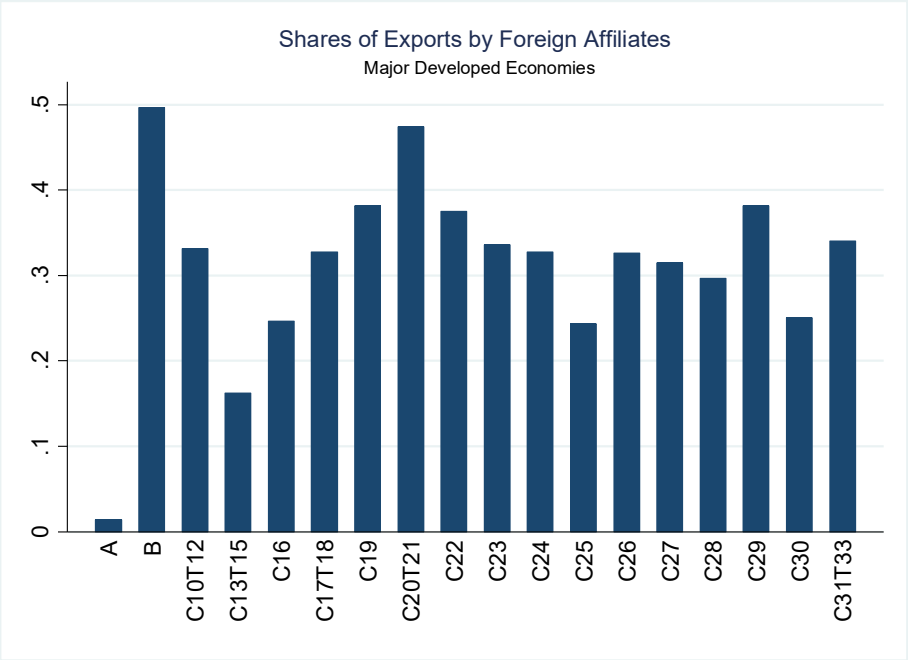


Figure 6: Exports by the Tradable Sectors of the Major Developed Economies

Panel A: Shares of Exports by Foreign Affiliates



Panel B: The Industry-Level Distribution of Exports

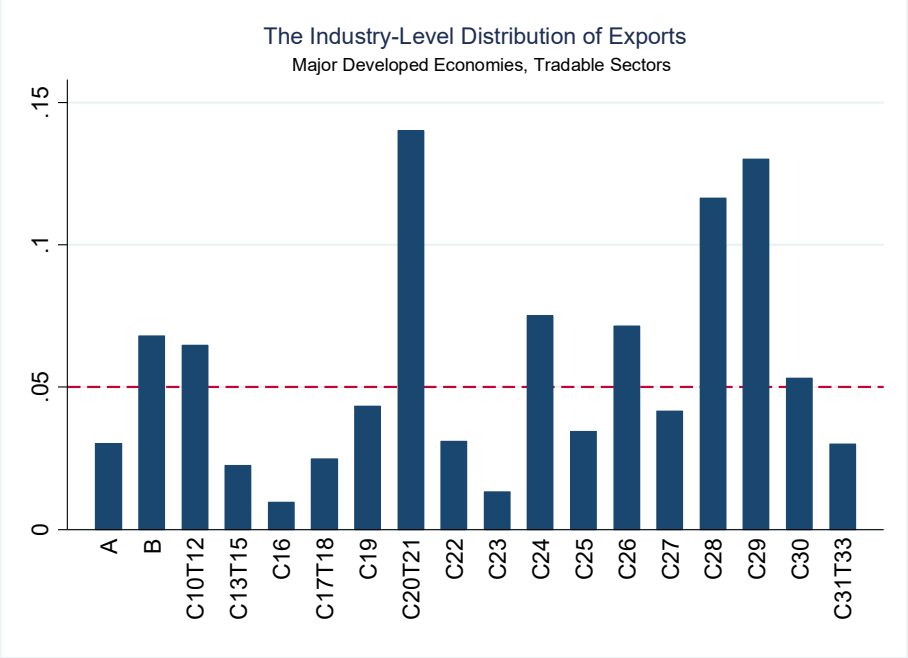
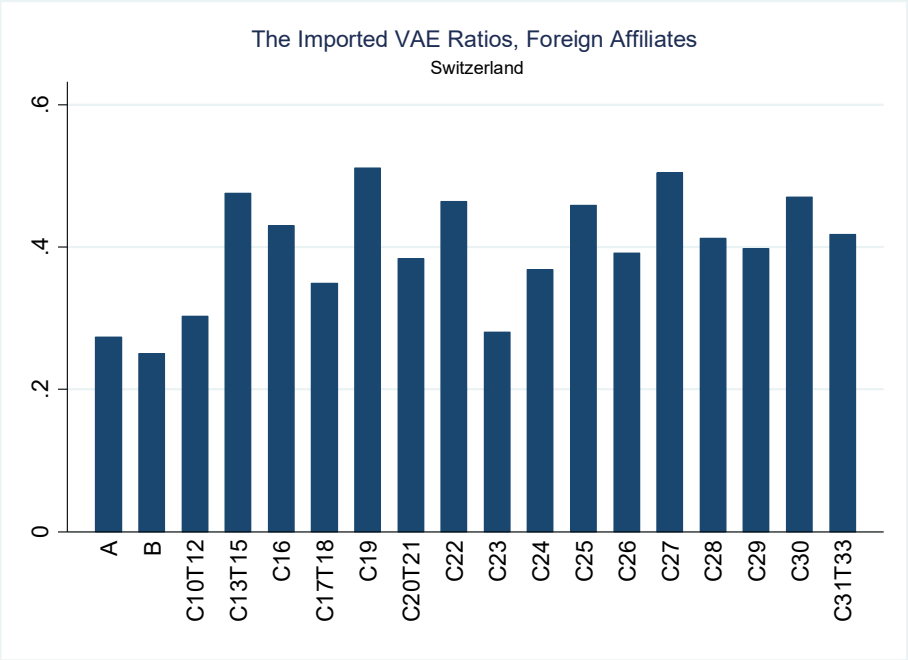


Figure 7: The Imported VAE Ratios in Switzerland

Panel A: Foreign Affiliates



Panel B: Domestic-Owned Firms

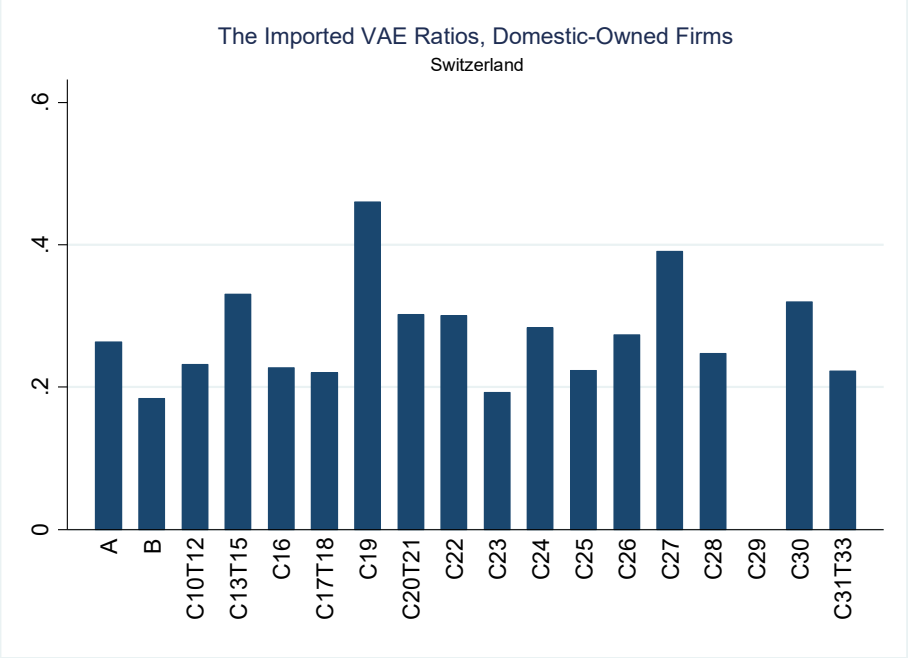
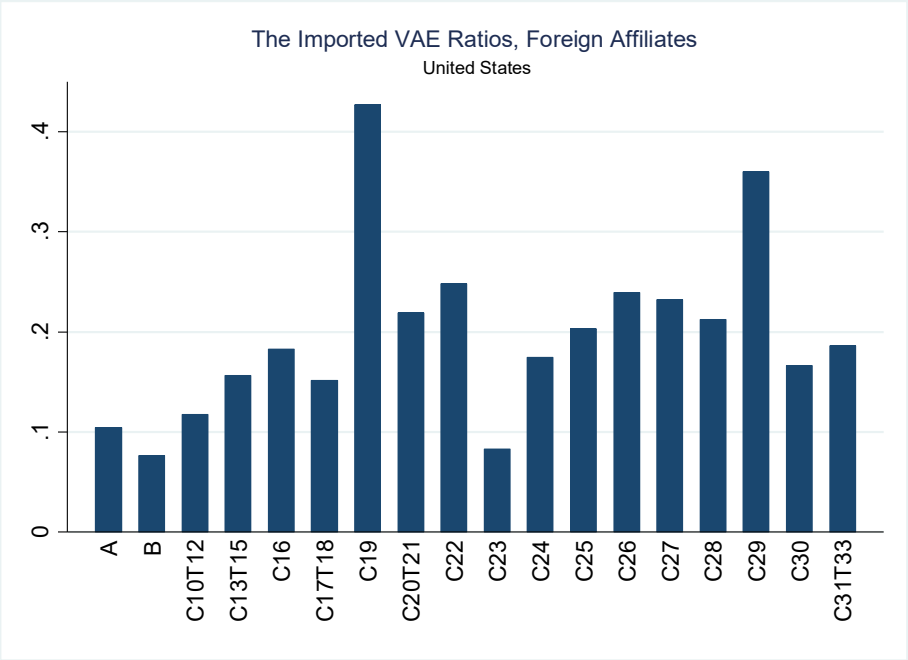


Figure 8: The Imported VAE Ratios in the United States

Panel A: Foreign Affiliates



Panel B: Domestic-Owned Firms

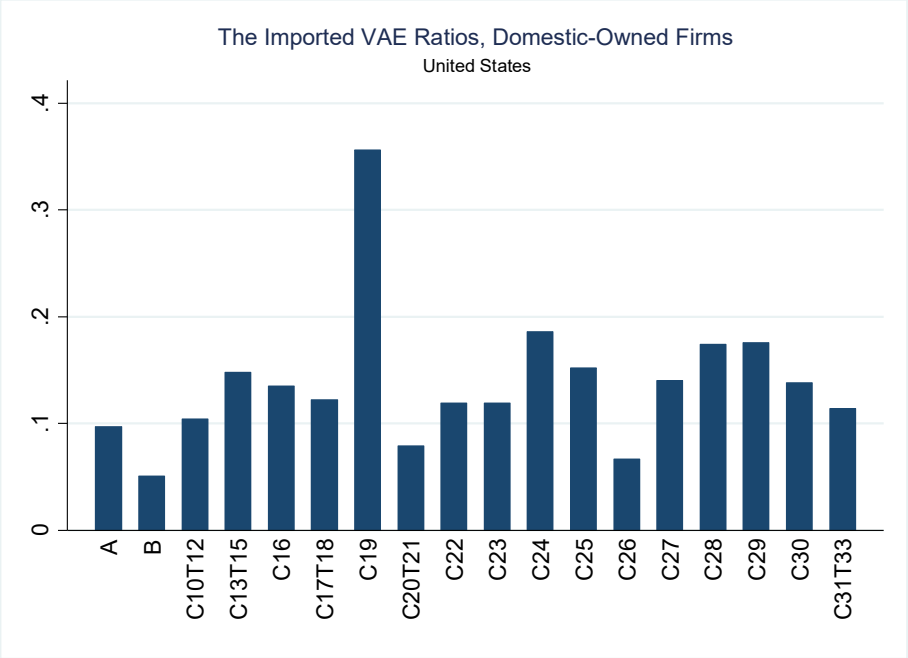
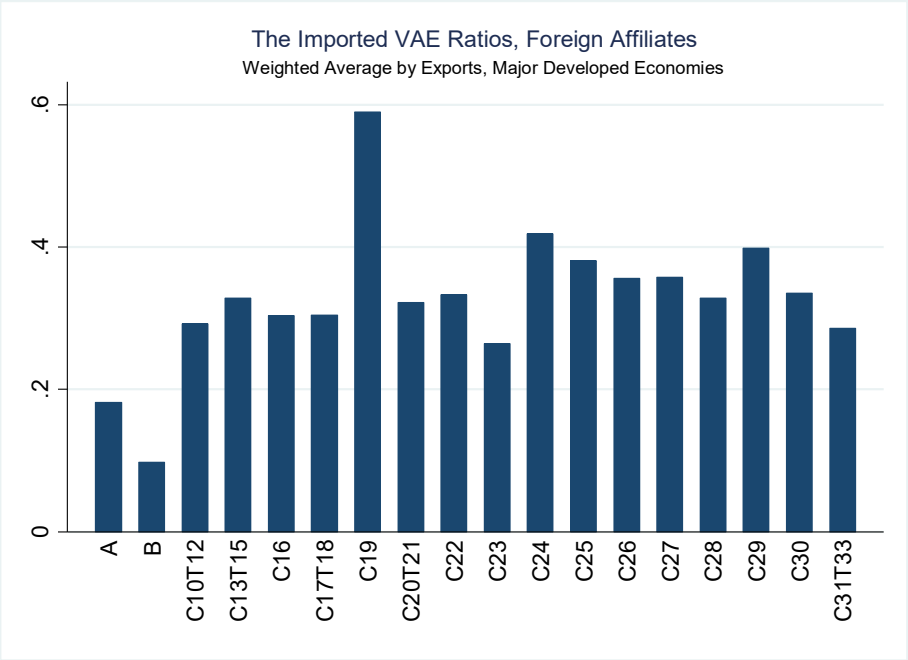


Figure 9: The Imported VAE Ratios in the Major Developed Economies

Panel A: Foreign Affiliates



Panel B: Domestic-Owned Firms

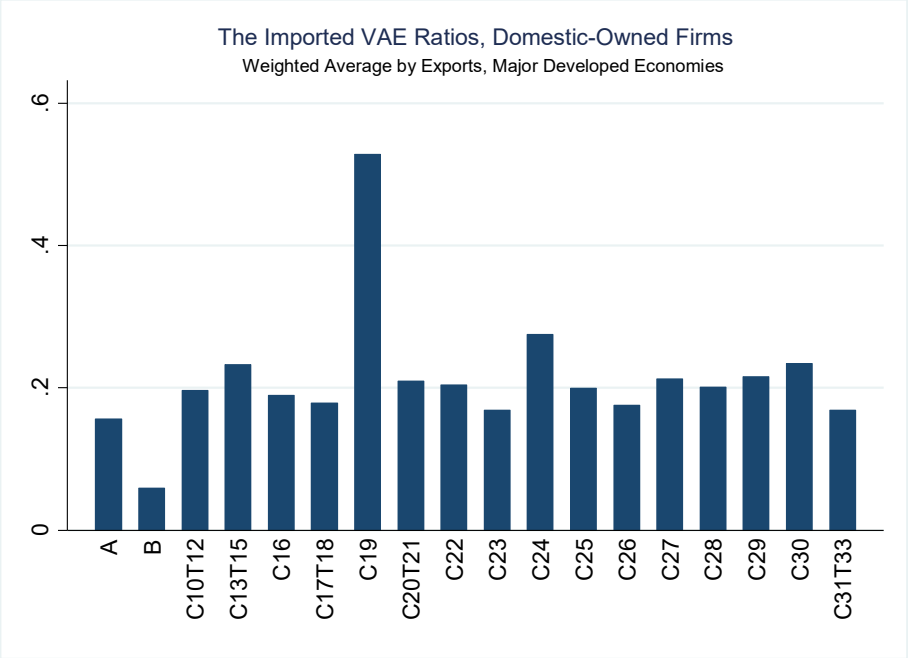
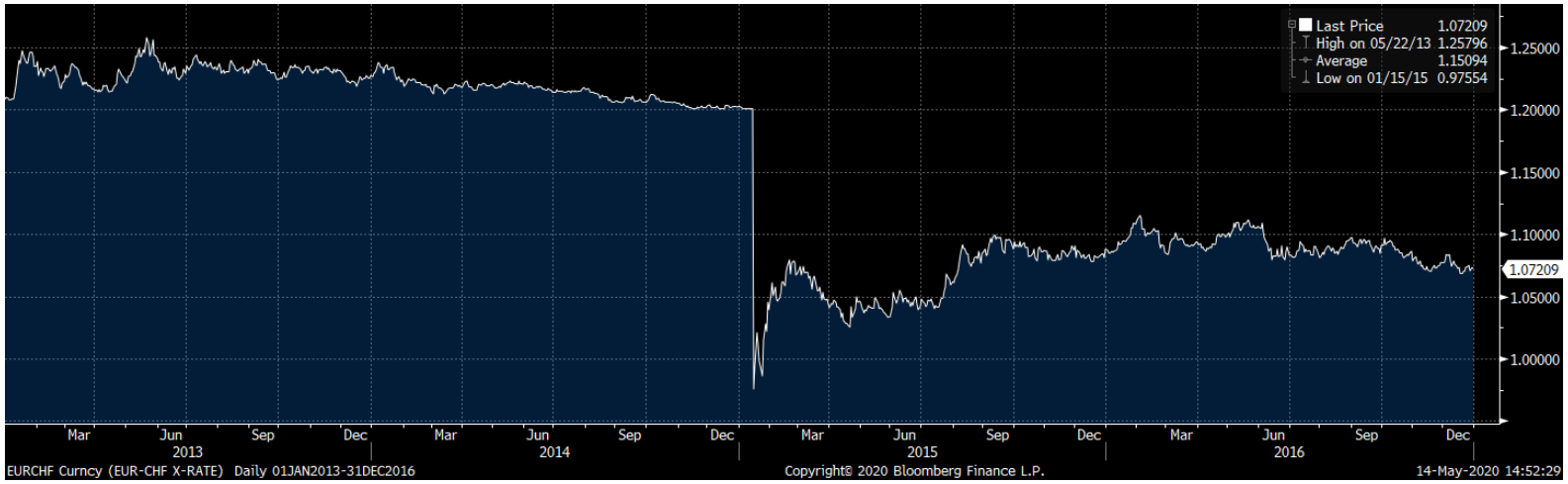
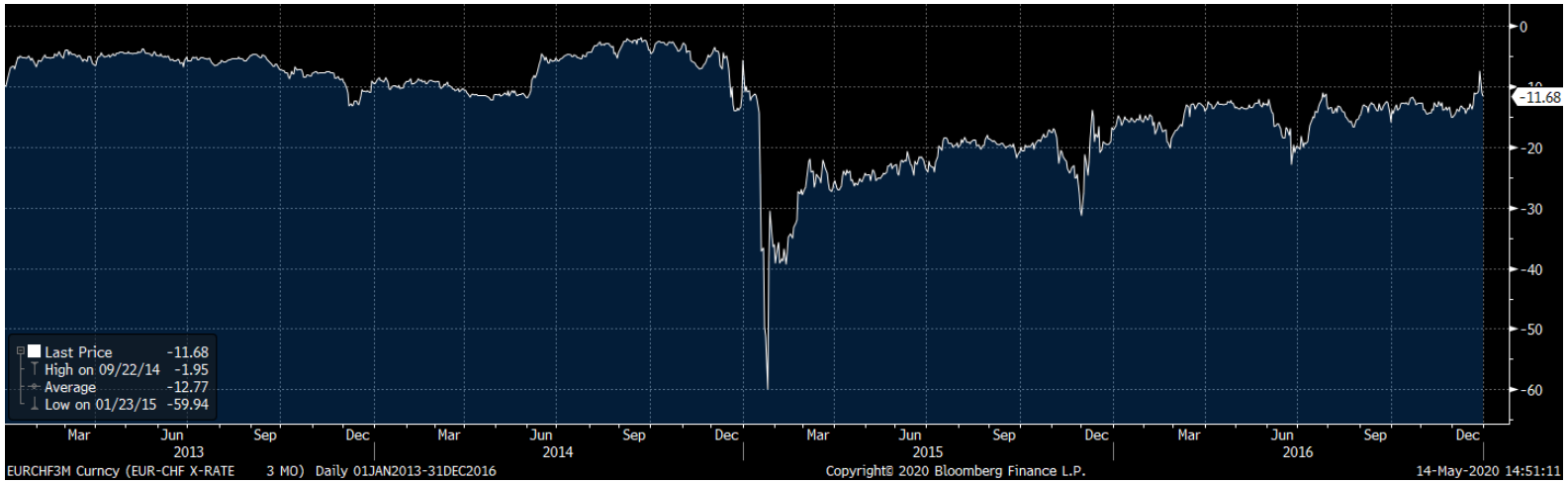


Figure 10: The CHF/EUR Exchange Rates

Panel A: Spot Rates, CHF per Euro



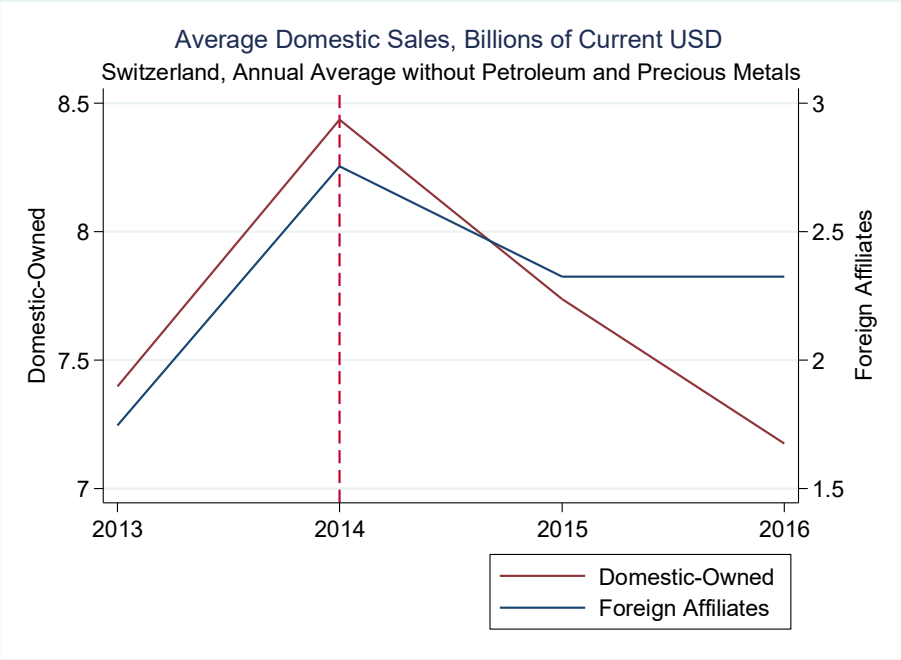
Panel B: 3-Month Forward Rates, CHF per Euro



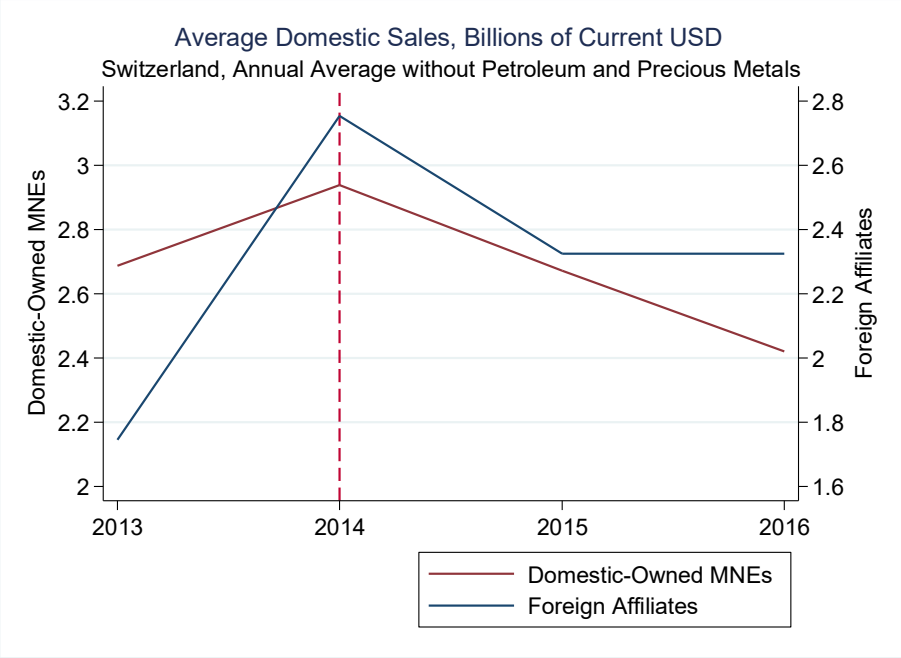
Panel C: 1-Year Forward Rates, CHF per Euro

Figure 11: Domestic Sales in Switzerland

Panel A: Average Domestic Sales of Foreign Affiliates vs. Domestic-Owned Firms



Panel B: Average Domestic Sales of Foreign Affiliates vs. Domestic-Owned MNEs



Panel C: Average Domestic Sales of Foreign Affiliates vs. Domestic-Owned MNEs, MNE Heavy Sectors

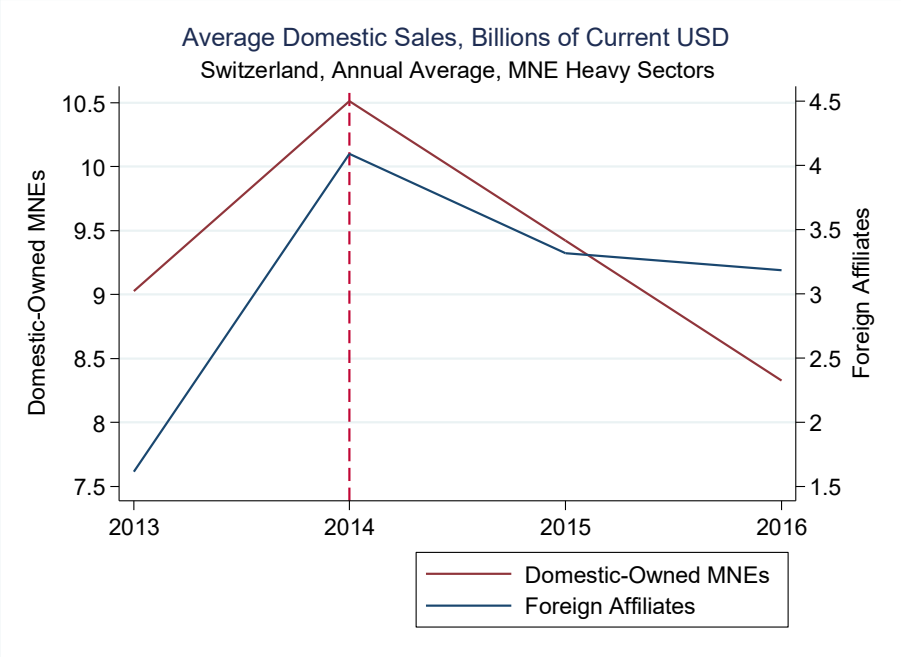


Figure 12: The USD/EUR Exchange Rates

Panel A: Spot Rates, USD per Euro

Panel B: 3-Month Forward Rates, USD per Euro

Panel C: 1-Year Forward Rates, USD per Euro

Table 1: DID Analysis on Domestic Sales: Foreign Affiliates vs. Domestic-Owned Firms in Switzerland

	(1) LnSales	(2) LnSales	(3) LnSales	(4) LnSales	(5) LnSales-FOR	(6) LnSales-DOM
After=1	0.050	0.001	-0.648**	-0.571***	-0.636**	-0.137
	(0.043)	(0.096)	(0.236)	(0.148)	(0.230)	(0.142)
Foreign=1	-1.298***					
	(0.404)					
After=1 # Foreign=1	0.273**	0.270**				
	(0.119)	(0.121)				
After=1 # VAE Ratio			0.021**	0.021***	0.019**	0.008
			(0.009)	(0.005)	(0.007)	(0.005)
LnGVA	0.812***	0.715**	0.856***	0.566**	-0.048	0.678***
	(0.133)	(0.275)	(0.092)	(0.260)	(0.813)	(0.156)
Imported VAE Ratio		-0.023	-0.087***	-0.038	-0.110	0.038
		(0.039)	(0.020)	(0.028)	(0.083)	(0.029)
Sectoral FEs	No	Yes	No	Yes	Yes	Yes
Observations	52	52	52	52	26	26
R-squared	0.715	0.519	0.782	0.599	0.617	0.762

t-statistics in parentheses are based on robust standard errors clustered at the industry-ownership level.
* p<0.10 , ** p<0.05 , *** p<0.01.

Table 2: DID Analysis on Domestic Sales: Foreign Affiliates vs. Domestic-Owned MNEs in Switzerland

	(1) LnSales	(2) LnSales	(3) LnSales	(4) LnSales	(5) LnSales-FOR	(6) LnSales-DOM
After=1	0.012	-0.058	-0.702***	-0.724***	-0.636**	-0.447
	(0.073)	(0.123)	(0.222)	(0.160)	(0.230)	(0.310)
Foreign=1	0.338					
	(0.464)					
After=1 # Foreign=1	0.310**	0.331**				
	(0.132)	(0.135)				
After=1 # VAE Ratio			0.026***	0.024***	0.019**	0.017
			(0.008)	(0.005)	(0.007)	(0.011)
LnGVA	0.860***	0.636**	0.789***	0.475*	-0.048	0.371
	(0.157)	(0.271)	(0.153)	(0.258)	(0.813)	(0.209)
Imported VAE Ratio		-0.023	-0.015	-0.041	-0.110	0.046
		(0.042)	(0.023)	(0.029)	(0.083)	(0.046)
Sectoral FEs	No	Yes	No	Yes	Yes	Yes
Observations	52	52	52	52	26	26
R-squared	0.493	0.470	0.474	0.560	0.617	0.520

t-statistics in parentheses are based on robust standard errors clustered at the industry-ownership level.
* p<0.10 , ** p<0.05 , *** p<0.01.

Table 3: Placebo Test: Foreign Affiliates vs. Domestic-Owned Firms in the United States

	(1) LnSales	(2) LnSales	(3) LnSales	(4) LnSales	(5) LnSales-FOR	(6) LnSales-DOM
After=1	-0.014	-0.003	0.017	-0.026	-0.069	-0.068
	(0.018)	(0.017)	(0.053)	(0.034)	(0.058)	(0.042)
Foreign=1	0.142					
	(0.129)					
After=1 # Foreign=1	-0.055**	-0.041				
	(0.027)	(0.024)				
After=1 # VAE Ratio			-0.002	0.000	0.001	0.004
			(0.003)	(0.002)	(0.002)	(0.004)
LnGVA	0.926***	0.719***	0.910***	0.693***	0.736***	0.590**
	(0.052)	(0.060)	(0.039)	(0.057)	(0.063)	(0.220)
Imported VAE Ratio		-0.000	0.015*	-0.001	-0.000	-0.016
		(0.006)	(0.009)	(0.008)	(0.008)	(0.016)
Sectoral FEs	No	Yes	No	Yes	Yes	Yes
Observations	56	56	56	56	28	28
R-squared	0.955	0.838	0.958	0.818	0.912	0.646

t-statistics in parentheses are based on robust standard errors clustered at the industry-ownership level.
* p<0.10 , ** p<0.05 , *** p<0.01.

Table 4: Placebo Test: Foreign Affiliates vs. Domestic-Owned MNEs in the United States

	(1) LnSales	(2) LnSales	(3) LnSales	(4) LnSales	(5) LnSales-FOR	(6) LnSales-DOM
After=1	-0.029	-0.009	0.163	-0.033	-0.069	-0.023
	(0.044)	(0.040)	(0.155)	(0.060)	(0.058)	(0.062)
Foreign=1	1.127***					
	(0.265)					
After=1 # Foreign=1	-0.042	-0.017				
	(0.046)	(0.038)				
After=1 # VAE Ratio			-0.008	0.001	0.001	0.002
			(0.007)	(0.002)	(0.002)	(0.007)
LnGVA	0.945***	0.585***	0.729***	0.571***	0.736***	-0.490**
	(0.099)	(0.157)	(0.094)	(0.159)	(0.063)	(0.220)
Imported VAE Ratio		0.000	0.047**	-0.001	-0.000	-0.033
		(0.006)	(0.019)	(0.008)	(0.008)	(0.029)
Sectoral FEs	No	Yes	No	Yes	Yes	Yes
Observations	56	56	56	56	28	28
R-squared	0.711	0.523	0.662	0.522	0.912	0.226

t-statistics in parentheses are based on robust standard errors clustered at the industry-ownership level.
* p<0.10 , ** p<0.05 , *** p<0.01.

Table 5: Placebo Test: Foreign Affiliates vs. Domestic-Owned Firms in Switzerland, 2011-12 vs 2013-14

	(1) LnSales	(2) LnSales	(3) LnSales	(4) LnSales	(5) LnSales-FOR	(6) LnSales-DOM
After=1	-0.043	-0.046	0.123	0.121	0.077	0.172
	(0.028)	(0.031)	(0.195)	(0.168)	(0.306)	(0.108)
Foreign=1	-1.221***					
	(0.426)					
After=1 # Foreign=1	-0.068	-0.076				
	(0.116)	(0.117)				
After=1 # VAE Ratio			-0.006	-0.006	-0.005	-0.008*
			(0.007)	(0.006)	(0.008)	(0.004)
LnGVA	0.821***	0.879***	0.832***	0.909***	0.654	0.783***
	(0.155)	(0.233)	(0.101)	(0.206)	(0.754)	(0.180)
Imported VAE Ratio		-0.068**	-0.082***	-0.073**	-0.102	-0.014
		(0.032)	(0.020)	(0.034)	(0.078)	(0.031)
Sectoral FEs	No	Yes	No	Yes	Yes	Yes
Observations	52	52	52	52	26	26
R-squared	0.711	0.436	0.800	0.449	0.428	0.765

t-statistics in parentheses are based on robust standard errors clustered at the industry-ownership level.
* p<0.10 , ** p<0.05 , *** p<0.01.

Table 6: Placebo Test: Foreign Affiliates vs. Domestic-Owned MNEs in Switzerland, 2011-12 vs 2013-14

	(1) LnSales	(2) LnSales	(3) LnSales	(4) LnSales	(5) LnSales-FOR	(6) LnSales-DOM
After=1	-0.080	-0.083	-0.154	0.078	0.077	0.251
	(0.053)	(0.052)	(0.217)	(0.178)	(0.306)	(0.190)
Foreign=1	0.368					
	(0.484)					
After=1 # Foreign=1	-0.030	-0.043				
	(0.125)	(0.123)				
After=1 # VAE Ratio			0.002	-0.005	-0.005	-0.012
			(0.007)	(0.006)	(0.008)	(0.008)
LnGVA	0.859***	0.837***	0.777***	0.857***	0.654	0.866***
	(0.175)	(0.248)	(0.159)	(0.221)	(0.754)	(0.261)
Imported VAE Ratio		-0.076**	-0.018	-0.081**	-0.102	-0.055
		(0.033)	(0.022)	(0.034)	(0.078)	(0.050)
Sectoral FEs	No	Yes	No	Yes	Yes	Yes
Observations	52	52	52	52	26	26
R-squared	0.484	0.415	0.482	0.429	0.428	0.505

t-statistics in parentheses are based on robust standard errors clustered at the industry-ownership level.
* p<0.10 , ** p<0.05 , *** p<0.01.

Table 7: Robustness Check: Foreign Affiliates vs. Domestic-Owned Firms in Switzerland, Final Goods

	(1) LnSales	(2) LnSales	(3) LnSales	(4) LnSales	(5) LnSales-FOR	(6) LnSales-DOM
After=1	0.102*	0.045	-1.188**	-1.104*	-1.159	0.053
	(0.056)	(0.256)	(0.499)	(0.594)	(0.882)	(0.145)
Foreign=1	-1.742**					
	(0.695)					
After=1 # Foreign=1	0.624*	0.643*				
	(0.343)	(0.335)				
After=1 # VAE Ratio			0.044**	0.043**	0.045*	0.004
			(0.019)	(0.018)	(0.024)	(0.005)
LnGVA	0.789***	0.602	0.864***	0.374	-0.086	0.713***
	(0.225)	(0.746)	(0.170)	(0.807)	(3.333)	(0.180)
Imported VAE Ratio		-0.018	-0.101**	-0.051	-0.082	0.043
		(0.107)	(0.040)	(0.104)	(0.388)	(0.025)
Sectoral FEs	No	Yes	No	Yes	Yes	Yes
Observations	52	52	52	52	26	26
R-squared	0.484	0.300	0.499	0.339	0.356	0.739

t-statistics in parentheses are based on robust standard errors clustered at the industry-ownership level.
* p<0.10 , ** p<0.05 , *** p<0.01.

Table 8: Robustness Check: Foreign Affiliates vs. Domestic-Owned Firms in Switzerland, 2011-14 vs 2015-16

	(1) LnSales	(2) LnSales	(3) LnSales	(4) LnSales	(5) LnSales-FOR	(6) LnSales-DOM
After=1	0.031	-0.053	-0.584**	-0.416***	-0.504**	-0.120
	(0.038)	(0.081)	(0.216)	(0.138)	(0.213)	(0.120)
Foreign=1	-1.252***					
	(0.405)					
After=1 # Foreign=1	0.237*	0.150				
	(0.116)	(0.114)				
After=1 # VAE Ratio			0.018**	0.013**	0.014*	0.006
			(0.008)	(0.005)	(0.007)	(0.004)
LnGVA	0.824***	0.920***	0.855***	0.835***	0.819	0.678***
	(0.135)	(0.195)	(0.090)	(0.206)	(0.552)	(0.156)
Imported VAE Ratio		-0.069*	-0.084***	-0.069**	-0.089	0.024
		(0.036)	(0.020)	(0.032)	(0.056)	(0.022)
Sectoral FEs	No	Yes	No	Yes	Yes	Yes
Observations	52	52	52	52	26	26
R-squared	0.719	0.661	0.786	0.702	0.713	0.842

t-statistics in parentheses are based on robust standard errors clustered at the industry-ownership level.
* p<0.10 , ** p<0.05 , *** p<0.01.

Table 9: Robustness Check: Foreign Affiliates vs. Domestic-Owned MNEs in Switzerland, 2011-14 vs 2015-16

	(1) LnSales	(2) LnSales	(3) LnSales	(4) LnSales	(5) LnSales-FOR	(6) LnSales-DOM
After=1	-0.026	-0.130	-0.764***	-0.579***	-0.504**	-0.334
	(0.058)	(0.095)	(0.219)	(0.138)	(0.213)	(0.225)
Foreign=1	0.361					
	(0.464)					
After=1 # Foreign=1	0.293**	0.223*				
	(0.123)	(0.122)				
After=1 # VAE Ratio			0.026***	0.017***	0.014*	0.011
			(0.008)	(0.005)	(0.007)	(0.008)
LnGVA	0.867***	0.860***	0.793***	0.770***	0.819	0.531**
	(0.157)	(0.202)	(0.153)	(0.218)	(0.552)	(0.184)
Imported VAE Ratio		-0.070*	-0.016	-0.073**	-0.089	0.028
		(0.038)	(0.022)	(0.033)	(0.056)	(0.040)
Sectoral FEs	No	Yes	No	Yes	Yes	Yes
Observations	52	52	52	52	26	26
R-squared	0.500	0.629	0.479	0.676	0.713	0.706

t-statistics in parentheses are based on robust standard errors clustered at the industry-ownership level.
* p<0.10 , ** p<0.05 , *** p<0.01.

Appendix

Table A1: Classification of Industries (ISIC Rev. 4)

This table provides a copy of the industry classification used by the Analytical AMNE database from Cadestin et al. (2018a).

Panel A: Sectors A-H49

Label	Code
Agriculture, forestry and fishing	A
Mining and quarrying	B
Manufacture of food products; beverages; tobacco products	C10T12
Manufacture of textiles; wearing apparel; leather and related products	C13T15
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	C16
Manufacture of paper and paper products; Printing and reproduction of recorded media	C17T18
Manufacture of coke and refined petroleum products	C19
Manufacture of chemicals and chemical products; basic pharmaceutical products and pharmaceutical preparations	C20T21
Manufacture of rubber and plastics products	C22
Manufacture of other non-metallic mineral products	C23
Manufacture of basic metals	C24
Manufacture of fabricated metal products, except machinery and equipment	C25
Manufacture of computer, electronic and optical products	C26
Manufacture of electrical equipment	C27
Manufacture of machinery and equipment n.e.c.	C28
Manufacture of motor vehicles, trailers and semi-trailers	C29
Manufacture of other transport equipment	C30
Manufacture of furniture; other manufacturing	C31T32
Repair and installation of machinery and equipment	C33
Electricity, gas, steam and air conditioning supply; water collection, treatment and supply	D_E36
Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	E37T39
Construction	F
Wholesale and retail trade; repair of motor vehicles and motorcycles	G
Land transport and transport via pipelines	H49

Panel B: Sectors H50-TOTAL

Label	Code
Water transport	H50
Air transport	H51
Warehousing and support activities for transportation	H52
Postal and courier activities	H53
Accommodation and food service activities	I
Publishing activities	J58
Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities	J59T60
Telecommunications	J61
Computer programming, consultancy and related activities; information service activities	J62T63
Financial and insurance activities	K
Real estate activities	L
Professional, scientific and technical activities	M
Administrative and support service activities	N
Public administration and defence; compulsory social security	O
Education	P
Human health and social work activities	Q
Arts, entertainment and recreation; other service activities	RTS
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	T
Activities of extraterritorial organizations and bodies	U
Total	TOTAL