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FOREIGN DIRECT INVESTMENT IMPACT ON ECONOMIC GROWTH:
a GVAR analysis of international linkages

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Abstract

This thesis investigates the role of Foreign Direct Investment (FDI) as a contributing factor to economic and technological progress in a set of target countries. The research is conducted via the Global Vector Autoregressive (GVAR) model, developed by Pesaran et.al (2004), to investigate the most relevant implications of an introduced shock in bilateral outward FDI flows from the United States. A sample of defined "host countries" is selected among the primary recipients of direct investments from the U.S. during the period 2000Q1-2019Q4; attention is posed to the inclusion of both developed and developing nations for the selection of a heterogeneous sample.

The Introduction is dedicated to a theoretical approach to economic growth, together with the intuitions to be tested on the chosen indicators. GVAR models are then discussed in Chapter 1, followed by a review of the dataset in Chapter 2; the last two Chapters are thus focused on model specification and analysis of the results via Generalised Impulse Response Functions (GIRF).

Key words: FDI, GVAR, economic growth, technological progress, spillover, GIRF.

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Introduction to FDI

This thesis exploits the Global Vector Autoregressive (GVAR) estimation technique developed by Pesaran *et.al.* (2004) to investigate the impact of Foreign Direct Investment (FDI) quarterly flows to target countries in terms of economic growth and technological innovation during the period 2000-2019.
In an increased globalised market infrastructure, the role of direct investment in foreign markets has acquired growing importance, and from the mid-1980s the registered global FDI net outflows show a staggering growth, rising from 95 Billions USD in 1986 to 2.12 Trillions USD in 2021, reaching its peak at 3.12 Trillions in 2007, thus arriving at an overall growth of more than 2000% in the last 25 years[1]. From these numbers, empirical-based studies on FDI implications on the economical well-being of target countries become a very timely topic; the issue has been explored building the research on the theory of Sarnstrom and Ryan (2022). In their work, the two authors pose attention to explaining the bilateral and third-country effects of exchange rates movements on U.S. FDI outflows to different countries; in most cases they found no significant statistical or economical evidence, with some exceptions for bilateral exchange rates in 5 destinations, albeit showing little durations and economic impact. Their findings contributed to enriching a not-so-explored theory on the relationship between currencies' appreciation/depreciation and FDI flows[2]: with the same logic, the impact of FDI outflows from the U.S. on a set of representative foreign countries' growth indicators is studied here, in order to find positive or negative relationships among the variables included in the model.

FDI drivers and deterrents are not the ultimate end of this work but will be briefly presented in this introduction, together with a description of their characteristics and

[1]Data from World Bank.
[2]Previous relevant work was developed for example from Egger *et.al.* (2009).

declinations, in order to frame the context. Moreover, notions on the determinants at the base of investment allocation to other countries will be of hand when analysing the empirical results of this work.

Foreign Direct Investment is a form of cross-border capital transfer exploited by investors (individuals or companies) who seek to establish control in businesses located in other countries; the rationales behind these type of investments are multiple, and so are the forms in which these transactions come.

Both OECD and IMF define these kinds of operations as a ”lasting interest” in an enterprise resident in another economy to express their long-term horizon, indicating that FDIs are considered direct investments when they represent (at least) 10% of the voting power in the target company, since their purpose is related to a gain in control and influence of those entities[3]. The lasting interest in the foreign enterprise is also represented by all the subsequent capital transactions involving the two parties; for this reason, FDI flows comprise not only the initial investment, but also equity transactions and reinvestment of earnings as instruments to enlarge the initial outflow of capital to the host entity, whilst divestments and loans received from the affiliate reduce the initial investment. When equity transfers and loans from the host company are larger than the outflows from the investor, FDI outflows are reported with a negative sign.

The broader distinction in FDI forms is between *Greenfield* FDI and cross-border M&As (*Brownfield*). The former, as the name suggests, is a market penetration strategy based on the creation of a new subsidiary from scratch in a foreign country and it differs from cross-border acquisitions since M&A transactions are related to the acquisition of a part, or the entirety, of an ongoing business, already running its operations in the target market. Of course, these two instruments have their own risks, factors of attraction, and demand of time and economic resources, furthermore they are differently affected by changes in government policies on FDI in the host country. In their work, Nocke and Yeaple (2004) develop an equilibrium model of free trade between two countries, with no transportation nor tariff costs, resulting in same goods prices between the two nations in a perfectly competitive global market for corporate assets; they introduce differences in the cost of labor and in the distribution of endowments with entrepreneurial abilities.

[3]The IMF Balance of Payments Manual (BPM) and the OECD Benchmark Definition of Foreign Direct Investment (Benchmark Definition) are drafted consistently for the definition of direct investments.

Considering the two types of FDI in the model, they find that greenfield FDIs tend to disappear in favor of mergers if the assumption of no differences in prices is enforced, meaning that the former occurs mostly for lower-costs-advantages in a foreign country; conversely, brownfield FDIs in the model are sensitive to both price differences and entrepreneurial endowments. Their findings are supported by data on U.S. firms engaging in cross-border acquisitions preferring higher-wage and more skilled countries; on the contrary, and this is a very interesting observation, greenfield FDI represents a much larger percentage of direct investments from rich to poor countries, being price differences offered by developing countries an attractive feature, especially for multinational enterprises who do not require particular levels of knowledge and skills. The aforementioned distinction should be kept in mind in order to evaluate possible unbalances in direct investment flows and government policies between developed and developing economies, further in this work.
A more detailed specification of foreign direct investment strategies can be made by evaluating the line of business in which investors decide to target their funds: horizontal, vertical, conglomerate, and platform are different strategies of FDI based on the characteristics of the end market. An investor who wishes to geographically expand its core business will pursue a horizontal direct investment strategy in a non-saturated foreign economy; in contrast, vertical strategies are used to cover additional roles in the supply chain, either up or down-stream in the production, usually to exploit closeness to production factors or higher technologies enabling the achievement of cost reductions, with respect to the outsourcing of those activities. Conglomerate FDI is rather uncommon since the investor should explore a completely detached business from its core activities in a foreign economy, and this is significantly more challenging for they would have little field knowledge of the market and, furthermore, should penetrate it with a new line of business. The last case, Platform FDI, differentiates itself from the previous ones for it is included in the framework a third market which represents the end-market for the production running in the second country, where an affiliate enterprise has been activated from the original business.

There is a number of studies focused on the determinants of FDI flows and, even if literature can be discordant, the decision to invest in another country is always related to the exploitation of locational advantages, being these related to cost opportunities, quality of infrastructures and economic framework or incentives and favorable legal conditions (opportunities mainly sought by MNEs which use direct investments as an instrument to reinforce their position in the global market, trying to reduce costs on international trade and factors supplies). Moreover, each form of direct investment profits from different opportunities, for example, horizontal FDIs are guided by cuts of trade barriers and transportation costs when seeking for the entrance in a new market, whilst vertical FDIs could be useful in pursuing price reductions of materials in an already-known chain of production; conglomerate acquisitions represent a way to diversify in growing businesses or to seize from particularly favorable legal conditions in another country, whereas platform FDIs may be guided by the desire to profit from trade agreements between the ”second” and ”third” countries.

Blonigen and Piger (2011) develop a Bayesian Model Averaging (BMA)[4] procedure in order to retrieve an appropriate set of covariates that should be included among the variables used to explain the path of FDI flows. They highlight that cultural factors, labor endowments in the target country and regional trade agreements (RTA) have high explaining powers in the composition of the flows, whereas, in contrast with other studies, impacts of government policies in both the investing and host country are not supported in the model. Of course, these results are not univocally accepted, but from this starting point one can understand, for example, that direct investments outside the resident's country are moved by cultural factors as well.

te Velde (2001) proposes a model on the attractive powers of host country's government policies on foreign investments, finding that relevance should be posed on the creation of locational advantages from the host country in the form of up-skilled institutions; in particular, higher levels of education, infrastructures and supply services quality, percentage of skilled workers, R&D centers and open trade policies represent evidence for an increase in FDI inflows from other countries, whilst contrasting evidence is found on the attractive powers of fiscal advantages.

Going into detail, one could expect cultural factors to be thoroughly examined by corporations who wish to gain a position in a foreign enterprise, since non-matching practices, work habits, attitudes and orientations etc. could result in poor returns on the invest-

[4]BMA is a statistical procedure that works as an averaged combination of multiple candidate models.

ment. Great volume of literature is dedicated to the determination of cultural distance effects on investments, but as van Hoorn and Maseland (2014) pointed out, these analyses can be problematic in the determination of appropriate measures expressing cultural differences (usually constructed on the differentiation of country scores on a set of dimensions); Kapas and Czeglédi (2020) build an econometric model for the comparison of the impact of cultural difference on FDI in a sample of 52 destinations. In their research they find that separating the cultural effects on FDI in "cultural level" (i.e. related to the higher level of culture in one destination in respect of the others, regardless of the cultural level of the country of origin) and "cultural distance" leads to the attribution of more importance to the former, meaning that investors heavily weight countries with higher cultural values in their allocation decisions, regardless of the distance with the resident country.

Human capital, as previously reported from Blonigen and Piger, represents an important factor in attracting capital inflows from foreign countries, but it is also a determinant in the long-term absorption of new technologies, innovations, and, more generally, growth that may come from outside investors; for this reason, several studies are focused on establishing the importance of labor endowments not just in the form of land and resources, but skilled workers endowments and skilled labor force cost. Amoroso *et.al.* (2015) find that investment decisions are positively related to levels of skilled labor, posing a further differentiation between "knowledge-intensive" and manufacturing activities; the former results to be more closely related to the presence of skilled-labor, and for this reason high-technological investments will be attracted to technology-oriented locations, whilst for manufacturing activities the level of skilled labor is sensitively less important. Yeaple (2003) study on the impact of skill endowment on U.S. outward FDIs flows supports these evidences by diving the countries in the sample into sub-groups via skilled-labor abundance, and industries via skilled-labor intensity; the model results in the allocation of low (high)- skilled U.S. investments in low (high)- skilled abundant labor markets, with higher (lower) consideration for labor and transport costs rather than levels of technological infrastructures.

As previously stated, the decision to invest in another country may be also affected by the market relationship between the two nations; in this context several types of agreement

are put in place across the World to facilitate trade and capital movements. RTA is a type of agreement signed by two or more countries in which the governments wish to promote a relieved movement of goods and services in cross-border transactions, in order to foster export growth and develop a market-oriented relationship with volume-relevant partner countries; the United States-Mexico-Canada (USMCA) agreement (which replaced the NAFTA on the 1st of July 2020, after 26 years of validity) is one of the main examples of agreement focused on the movement of goods together with services, investments and workers. Bilateral Investment Treaties (BITs) are another important form of agreement with similar goals, signed by two countries; these kind of agreements (as are RTAs) are put in place in order to secure private investors with guarantees on legal and economic conditions when directly investing in the partner country[5]. Berger *et.al.* (2012) find evidence for positive contribution of market liberalisation in attracting foreign investments, specifying that BITs tend to attract investors indiscriminately, whilst RTAs focused only on free trades have little influence on investment decisions, leaving greater importance to rules on dispute settlement and legal guarantees offered by the agreement. Interestingly, Meguerian-Faria (2021) shows that RTAs are a better incentive for FDI as they have effects on host countries governance, comparing their positive impact on Mexico against the conservative measures enforced in Brazil; furthermore, the author dwells on the importance of FDIs in developing countries and the incentives that can (and should) be put in place by governments in order to attract foreign fundings[6] .
Blonigen and Davies (2000) support the significance of tax treaties, moreover indicating an immediate response of FDI flows to changes in tax conditions between countries, whilst FDI stocks require a certain lag of time.

Undoubtedly, the drivers are deeply tied to each singular transaction, but these broad categories may help in understanding the logic of these capital flows and will be of hand, later in this thesis.
As remark, being FDI impacts the focus of this thesis, this introduction is concluded with a brief presentation of the main advantages that foreign direct investments bring to recipient countries, without forgetting the drawbacks these instruments can have.

[5]Examples of BIT signed by the U.S. can be found on ustr.gov .
[6]As example, the "Economic Reforms" enacted in India (1991), focused on liberalisation, privatisation and globalisation of the Indian economy had a significant role in attracting foreign funds, as a result of a more international market and a growing economy.

Foreign direct investments have been frequently associated, not without contrasts in literature, with technology and knowledge transfers to the host economy, which has the role of creating the infrastructure conditions and government actions to help local enterprises in absorbing spillovers from affiliate companies. A higher absorption capacity would, at least in theory, allow domestic firms to exploit opportunities of cost reductions and efficiency expansion through better technologies, with the result of fostering economic growth in the industry and, hopefully, to the entire host country's economy through the enhancement of income and purchasing power, creating new possibilities for business initiative and, therefore, increased demand for workers. Moreover, not only technology is involved in spillovers from new companies, but human capital is, in theory, affected by increases in knowledge and additional workplaces that should help the reduction of unemployment rates (undoubtedly, in order for these effects to be significant, so have to be the investments in the economy).

Expansions in innovation and technology are additionally prompted by increased competition in the market, therefore allowing consumers to gain access to better/less-costly products; competition should also raise investments in research and development, again contributing to economic growth through the movement of capital and additional demand for skilled workforce.

Furthermore, positive impacts related to the rising levels of FDIs may be tied to the increase in exports from the host country; for instance, assuming that new business openings lead to more production and economic growth, one could expect that the exporting capacity of the country would increase, either to home countries for affiliate enterprises through solid relationships with already secured end markets, or to third countries where new trade routes could be opened via higher distribution powers of multinational enterprises. Related to the level of global trade and the increase in foreign funds inflows, exchange rates may register an appreciation of the currency in the host country due to its higher worldwide demand, in this case positively (negatively) affecting the balance of payments if the currency is considered undervalued (overvalued)[7].

FDI provides access to a different form of funding outside country borders and this is frequently vital for emerging economies, which have often difficulties in raising adequate

[7] In Sarnstrom and Ryan (2022), as in the bulk of the literature, the cause-effect relationship is inverted, with currency depreciation positively affecting FDI inflows, but a limited number of other works study the effects of FDI flows on exchange rate volatility (*see* Kiliçarslan, 2018).

levels of capital in order to stimulate growth in the country through the same FDI principles proposed here; for this reason, as introduced before, developing economies should enact responsive government policies able to appeal foreign investors. In the previously cited work by Meguerian-Faria (2021), the author underlines the importance of direct investments for developing countries, specifying that there should be a balance in the two broad categories of FDI (greenfield and M&As); whichever is the form, developing countries are evidence for the need of an even more globalised market, able to include the most secluded regions, to try and promote more stable relationships with strong economies and exploit the opportunities of growth coming with foreign funds. Considering today's worldwide data on FDI inflows, the bulk of foreign direct investments is concentrated among developed countries; the benefits gained through higher technology, greater tax advantages, more legal protection, trade expansion and infrastructure efficiency are key factors in the decision to explore a different market, often offering more advantages than cost-reductive-oriented developing countries, and with investments being sensitively-less risky than those directed to usually unstable emerging economies and governments.

Foreign direct investments, however, can also have negative impacts in the involved economies and among the most cited, excessive alteration of the domestic market and environmental issues can be included.
In particular, when foreign investors heavily irrupt in domestic markets of other countries, the risk is that local firms may be pushed out, since the advantages in terms of technology and efficiency in the access and utilisation of resources of more advanced enterprises could not leave enough room to establish a fair competition, essentially without giving domestic businesses enough time to adapt, absorb and react; for this reason, evaluating the competitive framework after great inflows of foreign funds can bring either to the aforementioned spillovers and competition-enhancing effects or to a fierce monopolisation of the market by multinational enterprises[8]. The outcome depends indeed on economy-specific factors, such as the number of small-medium-enterprises (SME) in the market, usually characterised by lower efficiency and larger risks of market share takeover compared to multinationals companies; other factors are consumer responses to the introduction of cheaper products, technologies or distributions models and govern-

[8]These are the most extreme outcomes in the spectrum, frequently mild reactions are observed.

ment facilitations to the entrance of foreign actors, which in their attracting role of FDIs may pose unfavorable conditions on domestic firms.
Starting from these considerations, it becomes intuitive that great disparities between foreign and local firms are more likely to appear in developing countries, since the competitive levels of technology and infrastructure of developed countries make the appropriation of abundant market fractions, or monopolisation of business lines, usually more demanding with respect to lagging economies; developing nations are instead several steps behind in the exploitation of resources, with a rising risk of triggering higher inequalities in income distribution and associated life-stiles for workers not deployed in MNEs.
Furthermore, several studies are related to the determination of FDI impacts on natural resources and ecosystem stability in host countries, since the issue is becoming more relevant than ever. This is, again, of particular preoccupation in developing countries, since little government actions may be dedicated to the right utilisation of natural resources, risking an excessive and sometimes disastrous exploitation; this situation can be worsened by government policies enacted to attract FDIs, in particular the issue becomes more relevant when emerging economies deliberately reduce their protections and loosen their sanctions for the excessive utilisation of natural resources, in order to permit the entrance of cost-reduction seeking multinational enterprises. These policies have, in most of the cases, been rightful in their attempt of obtaining additional foreign funds, but at the same time the natural and climate risks have increased sensibly. Not only environmental issues related to FDI are tied to the excessive exploitation of natural resources, but these can be closely related to the level of technology reached in the country; for instance, developing nations with low levels of energetic technology and little government limits on carbon emissions, allow foreign enterprises to establish their businesses abroad, where the need for more advanced (and costly) technologies can be set aside due to loosen rules on minimum technological requirements; Huang *et.al.* (2022) find that FDI inflows in G20 countries with higher regulatory attention have actually helped in the reduction of carbon dioxide emissions through increased innovation, however stating that FDI and carbon emissions are historically positively related and attributing the role of inverting this relationship to timely and stricter policies on environment protection.

This overview on Foreign Direct Investments and their drivers should represent an introduction to the topic and help to understand the movements of FDI across the World.
The chapters of this thesis are organised as follows: in the 1st Chapter the GVAR model theory is presented, in order to define the method developed for the study of international linkages among domestic and foreign variables; the 2nd Chapter is dedicated to the collection and transformation of data and the motivation on the specific choice of the variables to address the problem; Chapter 3 is focused on the empirical analysis, implemented; whilst the ultimate end of this thesis is found in the 4th Chapter, dedicated to the interpretation of the obtained results, both from a statistical as well as from an economic point of view, trying to associate the results with coherent explanations from evidence in international relationships.

Chapter 1

GVAR models

This thesis fits a sample of 16 target countries for American direct investments, plus the US, through the Matlab GVAR toolbox developed by Smith and Galesi (2014)[1], in order to explore their interactions in a GVAR model and investigate their dynamic traits through Generalised Impulse Response Functions (GIRF).
As previously introduced, the estimation properties of the Global Vector Autoregressive model were first proposed in Pesaran *et.al* (2004) as a tool for credit risk analysis and precautionary measure for financial institutions, but soon it was implemented as a technique to study macroeconomic systems and the political and economic relationships between countries, regions, industries, or even banks and good categories; moreover, its forecasting ability is also positively valued as predicting tool for exogenous shocks and government policies implications. In the last decades GVAR modelling has attracted many fields of research also outside the economic context.
The GVAR development is closely tied to a period of high international uncertainty, related to the spread of the East-Asian Financial Crisis which began in Thailand in 1997, also referred as the "Asian Contagion". The negative shock is traced back to Thailand's Bath strong devaluation with respect to the U.S. Dollar, as in July 1997 the Thai government could only decide to float its currency (since then pegged to the USD) following a shortage of their foreign exchange reserves; this sudden change in stability of the currency determined a severe exchange rate fall and a period of high economic distress, which eventually spilled to other countries. Banks were exposed to strong pressures and capital inflows faced drastic flights in many Asian countries, in particular Indonesia, Philippines

[1] sites.google.com/site/gvarmodelling/gvar-toolbox

and South Korea, with the latter nearly reaching sovereign default[2].
Eastern Europe and Latin America were both affected by the contagion.
It was in this framework that the authors developed a model dedicated to assisting financial institutions in assessing their credit risk and being "more prepared" for such events. Pesaran's model is not the first to study the World macroeconomic system in its complexity[3], but its introduction was proposed with a set of strengths, among which the principal is addressing the *curse of dimensionality*, typical in the VAR literature, referred as analysis issues brought by the increase of parameters when working in complex environments. The model specification includes domestic, foreign and global variables; in the economic context, domestic variables can be represented by indicators signalling the state of a country's well-being, among which one could list real GDP, foreign debt exposure, short and long-term interest rates, etc. These variables are country-specific as they represent temporary states of the single economy, whereas global variables are usually associated to global shocks (for instance liquidity crises or sudden changes in primary goods prices), but they can refer also to "unobserved" factors and their evolution during time (such as changes in the level of education), or even modelled in order to describe region-specific shocks.
The foundation of the model resides in its "two-steps approach", where firstly a number of small-scale country-specific VAR models are estimated separately, with domestic variables conditioned on the rest of the World under a small open economy (SOE) similar-assumption; secondly, the procedure consists in the aggregation of the estimated models in a unique Global VAR through a set of "link", or weighting, matrices. Under the small economy assumption, domestic variables are treated as endogenous to the system as they depend on the rest of the World, whereas the modelling of foreign variables treats them as weakly exogenous items, constructed via weighted-averaging the correspondent domestic ones, and considered as determined outside of the system (Engle, Hendry and Richards, 1983).
This type of approach permits to perform the procedure simultaneously on multiple economies, without having to include them in one single VAR model with too many parameters.

[2]South Korea, as many Asian countries, was characterised by massive external debt and liquidity scarcity as it was bailed out by the IMF in December 1997.
[3]Granger and Jeon (2007) describe the most accepted models for global analysis.

1.1 VAR(p) models

In order to understand the procedure of Global VAR models, it is useful to present first the characteristics of the single Vector Autoregressive model.

VAR models are defined as an implementation of Univariate Autoregressive models, as they allow for the analysis of multivariate stationary time series, in order to study the relationship not only with past observations of the single series, but with the other variables as well. As p are the lags included in the model, starting by considering the basic equation for a VAR(1), it is obtained:

$$\boldsymbol{Y}_t = \boldsymbol{c} + \boldsymbol{\Pi}_1\, \boldsymbol{y}_{t-1} + \boldsymbol{\varepsilon}_t \tag{1.1}$$

Supposing (1.1) is a bivariate VAR(1), the linear representation would thus result in a matrix form of this type:

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} \tag{1.2}$$

With the same principle, a VAR(2) would be linearly represented as:

$$\boldsymbol{Y}_t = \boldsymbol{c} + \boldsymbol{\Pi}_1\, \boldsymbol{y}_{t-1} + \boldsymbol{\Pi}_2\, \boldsymbol{y}_{t-2} + \boldsymbol{\varepsilon}_t \tag{1.3}$$

Thus, the VAR(p) general representation appears in equation (1.4) as:

$$\boldsymbol{Y}_t = \boldsymbol{c} + \boldsymbol{\Pi}_1\, \boldsymbol{y}_{t-1} + \boldsymbol{\Pi}_2\, \boldsymbol{y}_{t-2} + \ldots + \boldsymbol{\Pi}_p\, \boldsymbol{y}_{t-p} + \boldsymbol{\varepsilon}_t \tag{1.4}$$

With $\boldsymbol{\Pi}_i$ representing $(n \, \mathrm{x} \, n)$ coefficient matrices, $\boldsymbol{y}_i$ the $(n \, \mathrm{x} \, 1)$ vectors of variables in the model and $\boldsymbol{\varepsilon}_t$ as $(n \, \mathrm{x} \, 1)$ vectors of uncorrelated WN $\sim$ ($\mathbf{E}(\varepsilon) = 0$, var $= \sigma^2$).

The application of VAR models to multivariate time series comes with the possibility to jointly test a set of specifications, for instance, one could explore the optimal lag order in the series[1].

It is worth mentioning that the selection of delays and variables in VAR models has fundamental relevance since the number of parameters sensitively increases with the two;

[1] AIC, BIC or HQ criterion search for the optimal lag in order to reduce estimation bias and forecast errors, choosing the lag minimising the selection criteria.

the parameters are observed to grow quadratically with the number of variables included (Chudik and Pesaran, 2014).

To observe this feature, one could explore the difference between a bivariate and a trivariate VAR(1), here represented:

$$\begin{bmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \\ y_{3,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \end{bmatrix} \tag{1.5}$$

Resulting in the following <u>additional</u> <u>estimations</u>:

$$\begin{aligned} y_{1,t} &= c_1 + \beta_{11}\, y_{1,t-1} + \beta_{12}\, y_{2,t-1} + \underline{\beta_{13}\, y_{3,t-1}} + \varepsilon_{1,t} \\ y_{2,t} &= c_2 + \beta_{21}\, y_{1,t-1} + \beta_{22}\, y_{2,t-1} + \underline{\beta_{23}\, y_{3,t-1}} + \varepsilon_{2,t} \\ y_{3,t} &= c_3 + \underline{\beta_{31}\, y_{1,t-1}} + \underline{\beta_{32}\, y_{2,t-1}} + \underline{\beta_{33}\, y_{3,t-1}} + \varepsilon_{3,t} \end{aligned} \tag{1.6}$$

As stressed before, the inclusion of one single variable from (1.2) to (1.5) increases more than proportionally the parameters to be estimated; it is easily understandable that replicating this procedure for high dimensional systems, such as macroeconomic representations of the World, could result in estimate overloads in the environment. Moreover, as discussed by Dennis and Lopez (2004), it is found that to accurately evaluate a system with a large number of variables within the VAR approach, a progressively increasing lag structure is required to capture the dynamic properties of introduced shocks; in particular, they report examples of VAR simulations with five to six variables by Pagan (2003), where the author finds a VAR(15) still being inadequate in measuring shocks on foreign GDP.

This is the reason why VAR models are usually based on solid theoretical grounds, in particular, the choice of the variables should be a careful exercise in order to limit these unwanted effects; the selection of indicators that, at least in theory, could be related to one another is an important and necessary activity to exclude redundant parameters.

However, this could not be sufficient for complex environments, and VARX* models are introduced as an extension of VAR models with exogenous variables (X*).

1.2 VARX* (p,q) models

The lag order of VARX* models is described by p and q for, respectively, domestic and foreign variables; in literature a limit is usually imposed at 2, with no restriction of equivalence on the two.
The general form of VARX*(p,q) models is described as:

$$\boldsymbol{Y}_t = \boldsymbol{a}_{j0} + \boldsymbol{a}_{i1}t + \boldsymbol{\Pi}_1\, \boldsymbol{y}_{t-1} + \boldsymbol{\Pi}_2\, \boldsymbol{y}_{t-2} + ... + \boldsymbol{\Pi}_p\, \boldsymbol{y}_{t-p} + \boldsymbol{\Theta}_0\, \boldsymbol{y}^*_t + \boldsymbol{\Theta}_1\, \boldsymbol{y}^*_{t-1} + \boldsymbol{\Theta}_2\, \boldsymbol{y}^*_{t-2} + ...$$
$$... + \boldsymbol{\Theta}_q\, \boldsymbol{y}^*_{t-q} + \boldsymbol{\varepsilon}_t$$

or, *compactly as* :

$$\boldsymbol{Y}_t = \sum_{i=1}^{p} \boldsymbol{\Pi}_p\, \boldsymbol{y}_{i,t-p} + \boldsymbol{\Theta}_0\, \boldsymbol{y}^*_t + \sum_{j=1}^{q} \boldsymbol{\Theta}_q\, \boldsymbol{y}^*_{j,t-q} + \boldsymbol{\varepsilon}_t \tag{1.7}$$

The first part of the equation is the same as in VAR(p) models with $\boldsymbol{y}_i$ representing the $(n \,\mathrm{x}\, 1)$ vectors for domestic, endogenous, variables; here are also found the $\boldsymbol{y}_i{}^*$ vectors of $(n^* \,\mathrm{x}\, 1)$ foreign, weakly exogenous, variables included as $\boldsymbol{y}_j{}^* = (\boldsymbol{y}_{0j}{}^*, \boldsymbol{y}_{1j}{}^*, .., \boldsymbol{y}_{Nj}{}^*)$.
$\boldsymbol{\Pi}_i$ and $\boldsymbol{\Theta}_j$ are $(n \,\mathrm{x}\, n)$ and $(n^* \,\mathrm{x}\, n^*)$ coefficient matrices for lagged domestic and foreign variables.
Foreign variables $\sum_{j=0}^{q} \boldsymbol{\Theta}_q\, \boldsymbol{y}^*_{j,t-q}$ start at time t, since their contemporary influence is included, whereas this is not true for domestic variables, starting from the first lag of delays, with $\sum_{i=1}^{p} \boldsymbol{\Pi}_p\, \boldsymbol{y}_{i,t-p}$.
Moreover, Smith and Galesi (2014) highlight that long-run feedbacks from domestic to correspondent foreign variables are not allowed in cointegrating models, without excluding, however, short-term influence.

Foreign variables are defined as weighted averages of other countries' correspondent variables. The weights in macroeconomic analysis are retrieved from relevant economic measures, and are used to attribute different shares of importance to the countries included in the model. In the GVAR toolbox used in this study, the authors model the weight matrix on bilateral trade flows between the countries (or regions) of choice.

The foreign vectors of cross-sectional averages are calculated as:

$$\boldsymbol{y}^*_{jt} = \bar{\boldsymbol{W}}'_i \, \boldsymbol{y}_{it} \tag{1.8}$$

As $\boldsymbol{y}_{it}$ are the panel vectors containing the cross-sectional vectors of domestic variables, and $\bar{\mathbf{W}}_{\mathrm{i}}$ represents the $(n \, \mathrm{x} \, n^*)$ matrix of country weights, with $\sum_{j=1}^{q} w_i = 1$.

1.3 GVAR models

From Chudik and Pesaran (2014), the second step of the GVAR approach is described as the combination of the country-specific VARX* models in one unique global VAR via the $(n_{\mathrm{i}} + n^*) \, \mathrm{x} \, n$ link matrices, obtained from the weight matrix $\bar{\mathbf{W}}_{\mathrm{i}}$ (1.8) and the dimensional selection matrix $\mathbf{E}_{\mathrm{i}}$, used to select $\boldsymbol{y}_{\mathrm{it}}$[1]:

$$\boldsymbol{W}_i = [\boldsymbol{E}'_i \, , \bar{\boldsymbol{W}}'_i] \tag{1.9}$$

After some algebra, Pesaran *et.al* (2004) show that it is possible to express the combination of country-specific VARX*s into one unique formula for the GVAR model, independent from starred variables.
Given $\boldsymbol{y}_{\mathrm{t}} = (y_{1,\mathrm{t}}, y_{2,\mathrm{t}}, \ldots, y_{\mathrm{N,t}})$, referring to the vector of endogenous variables of each VARX*, stacked together, the GVAR model specification is found in equation (1.10):

$$\boldsymbol{y}_t = \sum_{l=1}^{p} \boldsymbol{F}_l \, \boldsymbol{y}_{t-l} + \boldsymbol{G}_0^{-1} \, \boldsymbol{\varepsilon}_t \tag{1.10}$$

With $\mathbf{F}$ and $\mathbf{G}_0$ being functions of the matrix $\mathbf{W}_{\mathrm{i}}$ and the parameters calculated in the first step.
This procedure allows to express a complex model with the standard VAR formulation by estimating large number of parameters separately, and finally aggregating them in one single model without having dimensionality problems (since the parameters are already known).
The GVAR specification is, for instance, useful in the investigation of dynamic properties of the system: of particular interest for this thesis is the analysis of Generalised Impulse

[1] $\boldsymbol{y}_{\mathrm{it}} = \mathbf{E}'_{\mathrm{i}} \, \boldsymbol{y}_{\mathrm{t}}$.

Response Functions. These curves are estimated from the representation of equation (1.10), where different shocks can be introduced in the vector $\boldsymbol{\varepsilon}_{\mathrm{t}}$ in order to observe how the variables of the model react to a perturbation in the system; as it will be presented in Chapter 4, GIRFs are defined as a comparison between steady states and shock-affected systems, by $\varepsilon_{\mathrm{i,t}} = \delta$.

1.4 GVAR literature

The popularity of GVAR models has grown significantly as a large number of studies use these techniques to model systems in disparate fields of research. A very interesting review of the literature is found in ”The GVAR Handbook” (2013) by di Mauro and Pesaran; among the different works, the authors cite analysis of Global recession impacts on output growth, international transmissions of credit supply shocks, scenario-based forecasting of monetary policies, and more. Financial and regional applications are also cited, for instance respectively focused on fiscal spending spillovers on equity prices and on the construction of a small GVAR model for the Swiss economy[1].
Outside of this review, other implementations of GVAR models are found for example in Gunter and Zekan (2021) who forecast the number of air passengers in a global network of airports, and in Milani (2020) as a research on COVID-19 implications on health shocks and social-distancing responses in the population of a sample of countries. These examples constitute evidence for the broad extent that GVAR modelling has reached.
In the scope of this thesis, GVAR models are a useful tool for the representation of interdependencies in the chosen sample of countries; the properties of the model are exploited in order to investigate the dynamic traits of the system when considering the impacts of exogenous shocks. In particular, following the discussed specification between endogenous and exogenous variables in VARX* models, a shock is introduced in the foreign variable referring to bilateral Foreign Direct Investment flows from the US to each single country, whose impact is valued on a set of four indicators for host countries' economic growth, described in Chapter 2. The ultimate end of the analysis is developed in Chapter 4, where GIRFs are presented and interpreted empirically and theoretically, discussing economic implications and political interactions between countries.

[1]Cited studies by (in order): Garrat *et.al*, Eickmeier, Greenwood-Nimmo *et.al*, Nickel and Vansteenkiste, Katrin. (*The GVAR Handbook, 2013).*

Chapter 2

Data collection and transformation

As briefly presented in the Introduction, the idea behind this thesis is to empirically analyse the interdependencies within a chosen sample of countries; in particular, to study the relationship between the level of Foreign Direct Investment flows from a reporting country and the economic growth in a number of nations chosen as sample, among the ones receiving these funds.
The United States of America represents in this case the reporting country and the choice is based on two main rationales: firstly, the U.S. has been for the main part of the last three decades the major economy involved in FDI transactions, both in outward and inward terms and secondly, to develop the thesis from the work by Sarnstrom and Ryan (2022) in which they consider the U.S. as the home country to also capture the impact in the originating economy. If one compares the level of outward FDI stocks at 2019 in the OECD database[1], it is evident that the U.S. is the first country in terms of value expressed in Millions of Dollars, whereas Luxembourg is the principal economy for FDI measured in % of GDP, with the U.S. lagging behind several modern countries like Switzerland or Sweden. In this case, a larger weight has been assigned to the absolute value of foreign investment for the choice of the reporting country, rather than using a more comparable measure (like the % of GDP), because the main focus is on the global impact of these investments and a more economically and politically relevant country like the U.S. is perhaps more prone to help in reaching clearer conclusions.

[1] data.oecd.org/fdi/fdi-stocks.htm

2.1 Bilateral FDI outflows

The set of target host countries for direct investments from the U.S. is chosen on the basis of the number of FDI flows directed to these nations, as the sample includes most of the principal destinations of American funds. As anticipated in the Abstract, a number of developing countries has been included in the sample as well to represent an interesting comparison with affirmed economies in the World; this specification could make possible to observe differing results of the analysis, keeping in mind the peculiarities of poor and rich host-countries described in the Introduction.

As additional selection criteria, countries have been considered among the sample economies included in the GVAR toolbox by Smith and Galesi (2014), mentioned in Chapter 1.

Data for U.S. outward FDI are retrieved from the Bureau of Economic Analysis of the U.S. Department of Commerce (BEA)[1] and comprise 20 years of quarterly data from 2000Q1 to 2019Q4 for 16 countries (apart from the reporting economy).

Figure 2.1 reports the main target countries for American funds net inflows in the World, during the considered timespan. Netherlands has the largest involvement, peaking over 500B of USD, followed by UK and Canada, reaching respectively 482B and 367B; other significant net positions are found mainly in Mexico and Northern Europe, with China, Japan, Australia and few South American countries as notable exceptions.

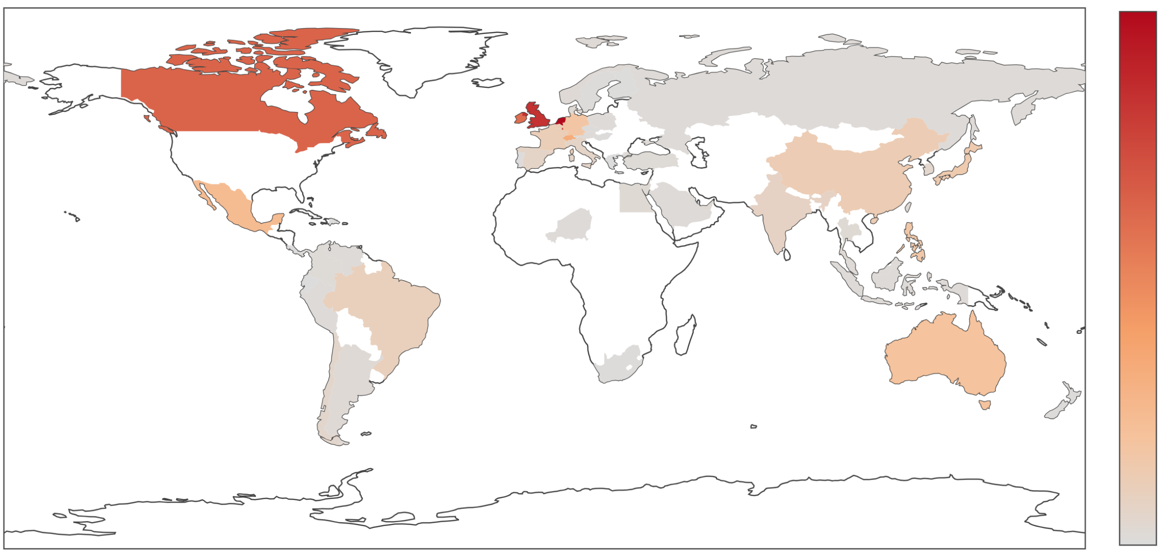

Figure 2.1: Stock of U.S. outward FDI in the World ($), *data from BEA* (2000-2019).

[1] bea.gov/international/di1usdbal

Table 2.1 reports the chosen countries, included in the analysis:

Australia	Brazil
Canada	China
France	Germany
India	Italy
Japan	Korea
Mexico	Netherlands
Norway	Sweden
Switzerland	United Kingdom
United States	

Table 2.1: Countries included in the GVAR model.

It is here important to stress the fact that data for foreign direct investments contain negative signs as means of inflows in the U.S. exceeding outflows to the target country; this happen in several occasions during the timespan and could be due to the fact that capital inflows from the affiliate in the target country are exceeding the outflows to it, mainly due to disinvestments or loans from the host. Overall, the observed net flows for the period are negative only for two nations: Italy (which in 2018 has strongly invested in U.S.[2]) and Sweden. Furthermore, if one is to consider the FDI flows in terms of % of GDP of the host country it would be evident the leading role of Netherlands, since the percentages are frequently well above the other countries for quarterly data (in few occasions showing significantly negative percentages).
Data downloaded from the BEA database are specified to be "not seasonally adjusted" and, in order to obtain seasonally adjusted time series for outward FDI, the *seasonal* package in R has been used, which depends on the *x13binary* package to access features of X-13, the seasonal adjustment software developed by the United States Census Bureau[3]. The importance of seasonal adjustments in time series is related to the comparability factor, in particular, data adjusted in this scope is freed from recursive behaviors in particular days, weeks or months of the year; the comparison thus becomes more reliable, not only between multiple time series but within different periods of one time series itself. Below is reported an example of a code chunk used to retrieve seasonal adjusted data for

[2] From Banca d'Italia database of FDI by partner country, one can observe that the U.S. is above Romania and only behind Spain in terms of FDI inflows from Italy, with a 600% increase since the previous year.
[3] census.gov/data/software/x13as.html

outward FDI to Australia. *australia* is a tibble extracted from the data collected in Excel which has been transformed in time series (*ts* object), with the *tk_ts* function; the result is plotted as two lines representing the un-adjusted and adjusted series.

```
australia_ts <- tk_ts(australia, start = 2000, freq = 4)
aus <- seas(australia_ts)
```

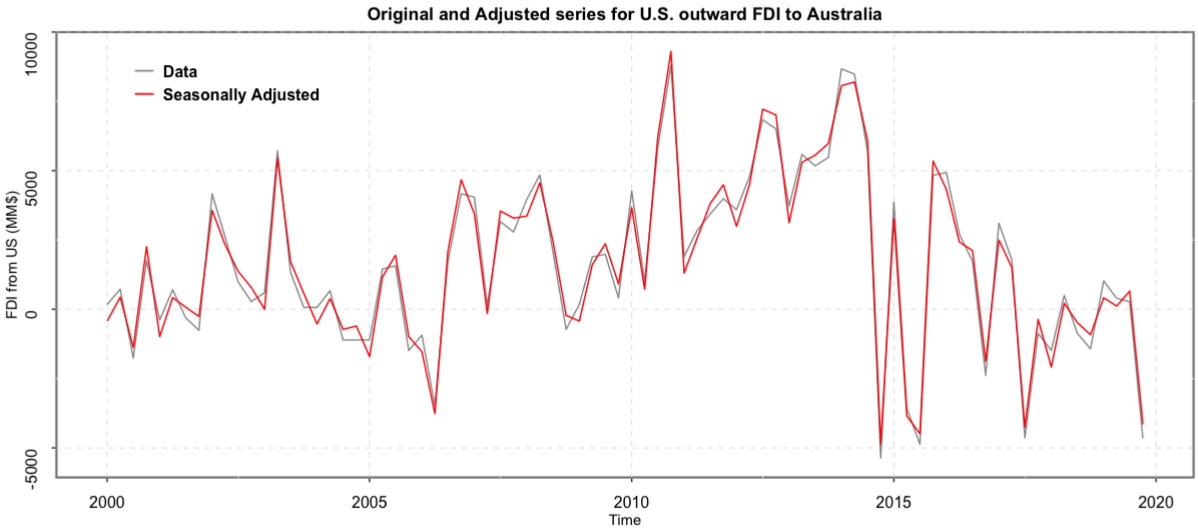

Figure 2.2: Example of seasonal adjusted series for outward FDI to Australia.

In the example plotted in Figure 2.2, the red line represents the series adjusted for seasonal patterns and highlights the trend in the data, leaving out seasonal and noise components. Figure 2.2 suggests that the AUS series is not seasonal, however, a more evident example may be the case for Netherlands in Figure 2.3, where the adjusted series exhibits a sensitively more stable behavior if compared with the original data.

The *seasonal* package performs the adjustments automatically, without the need for the user to specify the used method; in particular, for time series adjustments one could rely on additive or multiplicative seasonal adjustment methods, based on the characteristics of the data. If the time series exhibits stable cyclical patterns during the period, the additive method is used, whilst the multiplicative method is chosen in order to extract the trend of a time series which shows increasing movements with time[4].

With the aid of the *decompose* function, one could manually decide the decomposition method, using the *plot* function to obtain all the components of the time series. As one can observe in Figure 2.4, the *third* graph highlights a recursive, seasonal, pattern in the

[4]The additive seasonal adjustment method sums the components $Y_t = T_t + S_t + \varepsilon_t$ whilst they are multiplied in the second case $Y_t = T_t \cdot S_t \cdot \varepsilon_t$.

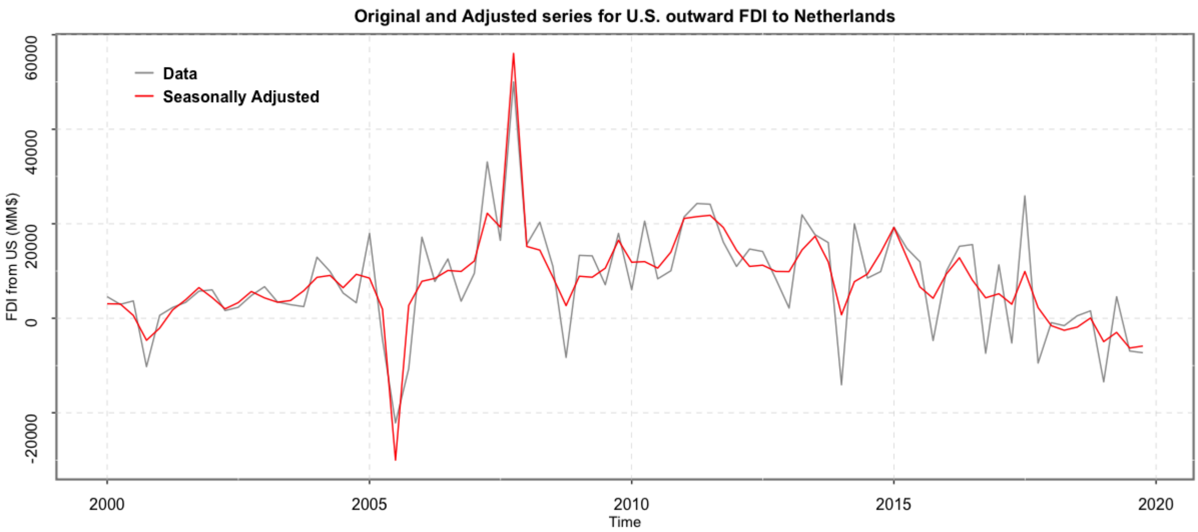

Figure 2.3: Example of seasonal adjusted series for outward FDI to Netherlands.

series that has been removed in the adjusted data; the *second* representation displays the trend movement of outwards FDI to Netherlands, whereas the random component reported in the *fourth* graph shows a series of irregular deviations around a 0 mean[5].

The seasonal adjustment performed on all the bilateral flows of the dataset is the only transformation applied to this variable, since logarithmic transformations (frequently applied to time series in order to "stabilise" the data) cannot be performed on negative values.

Table 2.2 presents the other four variables (included to observe their relationship with US FDI), with the source of the series used to retrieve the data, most of the times found in the OECD database.

[5]Coherently with the definition of White Noise stochastic process, representing random shocks.

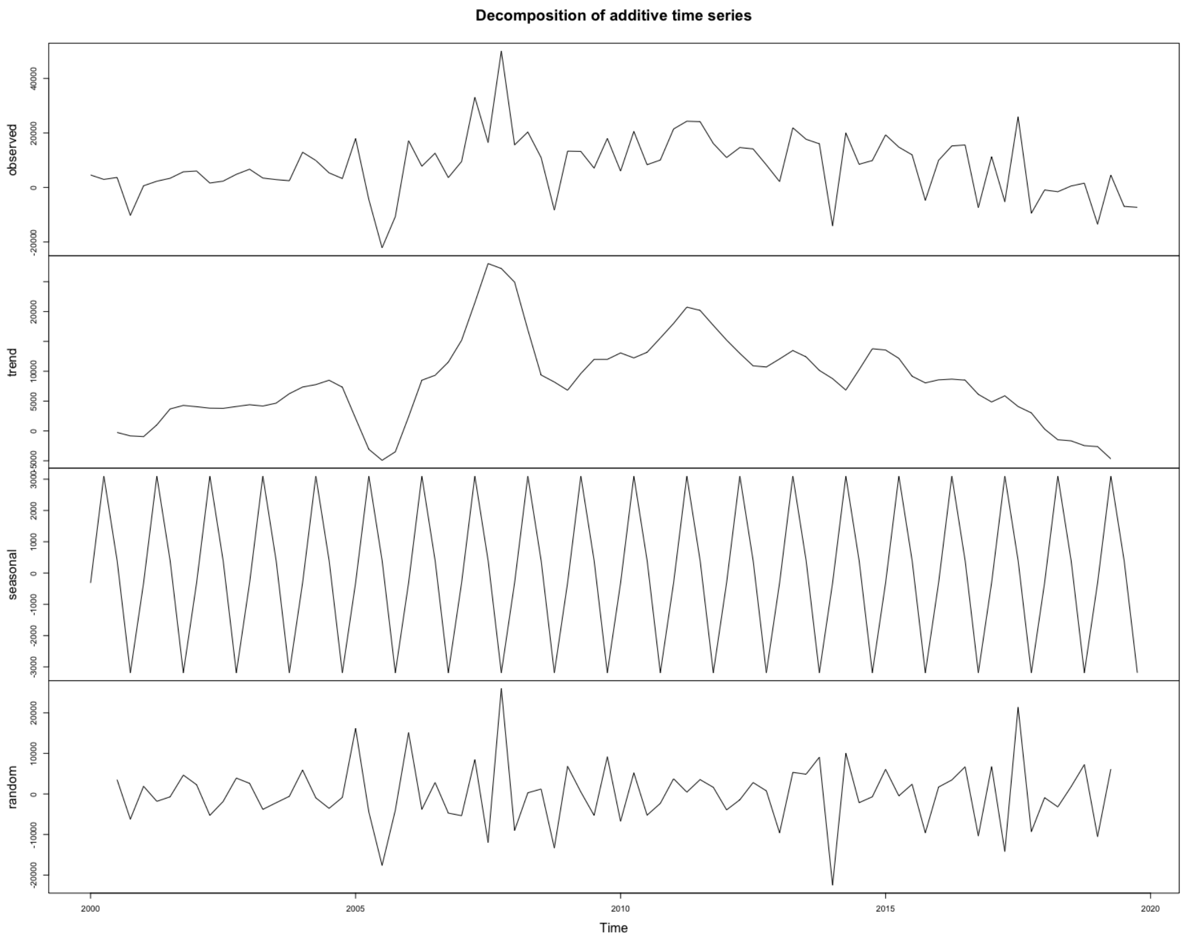

Figure 2.4: Example of components for seasonal adjusting procedure of outward FDI to Netherlands.

Endogenous variables	**Database**	**Series**
Real GDP	OECD Nominal GDP	CPCARSA
	OECD CPI	CPI: 01-12 - *All items*
	FRED Nominal GDP (CHN)	CHNGDPNQDSMEI
	FRED CNY/USD	DEXCHUS
Balance on goods	OECD International Trade Statistics	BOP6: *Balance on Goods*
Unemployment	OECD Labor market statistics	Unemployment rate - *Total* (% of labor force)
R&D expenditures	World Bank	R&D Expenditure (% of GDP)

Table 2.2: Endogenous variables included in the GVAR model, with sources.

2.2 Real GDP

Gross Domestic Product reflects the level of an economy capacity of raising capital from goods and services produced domestically, to which are included government expenditures; the level of GDP of a given country can be measured in either nominal or real terms, being the latter a reflection of inflation and the purchasing power of the domestic currency.

In order to obtain Real GDP for the countries in the model, first the Nominal GDP has been retrieved and then adjusted by considering the inflation level during the quarters. Nominal GDP is obtained from the "OECD - CPCARSA" database, calculated at current prices on annual basis (and disaggregated *ex-post* for quarterly estimates) with the expenditure approach, which from the Eurostat definition is determined as such:

$$Nominal\,GDP_{exp} = P_{fc} + G_{fc} + GC + (X - M) \tag{2.1}$$

where:

- P_{fc}: represents the expenditures for private final consumption;
- G_{fc}: represents the expenditures for government final consumption;
- GC: is the Gross Capital formation and is based on the net variation of fixed assets and inventories;
- X - M: is the trade balance, the difference between exports and imports.

A different method used for the calculation of Nominal GDP is the income approach, which is related to the level of income reached with the production of goods and services[1]; it is important to notice that the two approaches yield the same result, since expenditures are related to income for the other party[2]. In order to obtain Real GDP, the CPI series from the "OECD CPI: 01-12 - All items" database has been used to adjust the GDP at current prices to the inflationary levels during the period, this will result in more comparable time series, since Real GDP is not an absolute measure of an economy wellbeing.

[1] Not only wages are included, but every item related to the production, e.g. rents or interests.

[2] Expenditures could be thought as lower then income if savings are considered, but also these are tied to future levels of expenditures if evaluated as investments (for example bank loans from savings accounts appear as future expenses).

In general, Real GDP is found by dividing Nominal GDP (2.1) by the GDP deflator:

$$Real\,GDP = \frac{Nominal\,GDP}{1 + CPI} \tag{2.2}$$

Nominal GDP is available in the OECD dataset for all countries in the model except for China, whose data have been retrieved from the "FRED - CHNGDPNQDSMEI" database, which reports the quarterly levels of Nominal GDP for the Republic of China expressed in Yuan Renminbi, the domestic currency. In order to obtain values in Millions of USD as in the rest of the dataset, they have been converted with the CNY to USD spot exchange rate quarterly data from "FRED - DEXCHUS", performing then the deflator procedure with inflationary data in China in order to retrieve Real GDP for the country.
An interesting detail with respect to the exchange rate between China and U.S. is that the Chinese currency is somewhat pegged to the American dollar; more specifically the Chinese Yuan is not officially tied to a basket of currencies which includes the Dollar with a traditional fixed exchange rate, but there is an elaborated, somewhat loose, tie with the U.S. currency. The People's Bank of China, in particular, operates in order to maintain the exchange rate within a fixed range with respect to a basket of currencies; the benefits from this systems come in particular with the export-driven economy framework of the country, particularly towards the United States. In general, it makes sense, in some cases, for less developed countries to establish a fixed exchange rate in order to gain more stability and exploit their export capacity towards stronger economies which, instead, are usually characterised by a floating exchange rate depending on trades on the foreign exchange[3].

To conclude this section, the time series obtained from the mentioned sources are log-transformed in order to stabilise the distribution of the data, for comparability purposes. Moreover, the series are already seasonally adjusted.
These elaborations on Real GDP are related to its explanatory power in determining the wealth of the country and the variable is included in the model in order to understand if changing levels of FDI have an impact on far more bigger quantities.

[3] One of the main reason is the faith in their Central Banks fiscal policies and, in general, a greater economic and political stability.

2.3 Balance on goods

The second endogenous variable included in the analysis is the level of trade in both the home and the different host countries for direct investments.

From FDI literature, it is easily understandable that the relationship between foreign direct investments and trade levels is very strong and timely. What could be opaque in understanding is the edge between the two types of flows but, as publicly accepted, FDI and trades can be considered to be complements. As introduced, FDI are a form of direct investment with a lasting interest in a foreign business, being these ongoing or to be started; trade flows, instead, are related to (international in this case) transactions for the purchase of goods and services and are stimulated by technology level, economic growth, liberalisation and relationship between trading partners. Fontagné (1999) studies the relationship between trade and FDI and concludes that not only the two different types of flows are, in most of the cases, complementary but also that there is a stimulus-response of one variable to the increase of the other. This cause-effect relationship exhibit changing behaviour from the 1980s to nowadays, being now trades empirically influenced by increases in foreign direct investments (the contrary is observed until some decades ago, with lower levels of internationalisation); in particular, the author suggests that increases in FDI stimulate exports from the home country, whilst increasing imports in the short term for the host country, with positive-effects on exports only in the long run[1]. The actual relationship in the model will be explored empirically, but works like the one cited here are interesting examples in the study of the two flows; for this reason data on international trades are included in the dataset.

When choosing the right measure for international trades, several possibilities have been explored: firstly, the type of flows to be used could have been either imports, exports or net balance and secondly, the decision could whether lean towards bilateral trade statistics between the home and the other nations of the sample, or to overall-country data with respect to the World. Concerning the first issue, the balance on goods has been chosen, and the decision is based on the possibility to observe increases/decreases in both directions of trade in the country of interest. For the second specification, the selected

[1] The short-term period is usually associated also with positive increases in technology transfer and job creation in the host country.

data refer to the overall level of trades, whilst rejecting bilateral flows; this choice is dictated by the fact that a dataset on bilateral trades would limit the observation of changes in trade relationships with the home country only. In particular, the interesting, potential, interdependencies between the host and the other (in that case) third economies would not have been visible, with the only possible spillovers observed between third countries and the U.S.. Even if bilateral trades are surely an interesting representation of the secluded link between the home and the host country, the choice is to assign larger importance to the possibility of observing also the overall effects on third nations, which may perhaps benefit from a geographically or politically close target economy for FDI.
Data on the balance include, for this reason, the overall difference between exports and imports on goods for every country in the model, without the specification on the direction of these flows. The series are entirely obtained from the "OECD - BOP6: *Balance on Goods*" database and expressed in Millions of USD. No logarithmic transformation was possible since the data contains negative values, representing importing countries for the quarter[2].
Report data for Mexico, Netherlands and Norway is incomplete until 2006Q1 and since the GVAR model specification does not allow for the introduction of missing values, the variable on trades for these countries has been excluded.

2.4 R&D intensity

The literature on FDI is frequently associated to the technology-enhancing role of direct investments in host countries, with further distinction between strong economies and lagging countries; in particular, for technology to increase, host countries have to put in place adequate levels of infrastructure and government position in order to help innovations flourish.
The dataset includes a variable explaining the level of investments on Research and Development in the target countries in order to capture the innovation impacts that FDI could have in foreign countries. In this case R&D is expressed as percentage of GDP because it is a measure strongly sensible to variations in economy size (other than the aforementioned infrastructure and government aids, as well with technology clusters and

[2] "importing countries" is referred to the higher level of imports over exports in the specific quarter.

intrinsic culture) and a percentage scaled to the economic dimension may be a better comparison measure between countries.

Data on R&D rates are obtained from the World Bank database[1] as annual data; the issue of not having quarterly data is solved performing a linear interpolation in R with the aid of the *approx* function. This function is based on linear or constant interpolation and allows to represent annual data via quarterly information. For example in Italy the annual R&D expenditure rates on GDP follow the path of Figure 2.5:

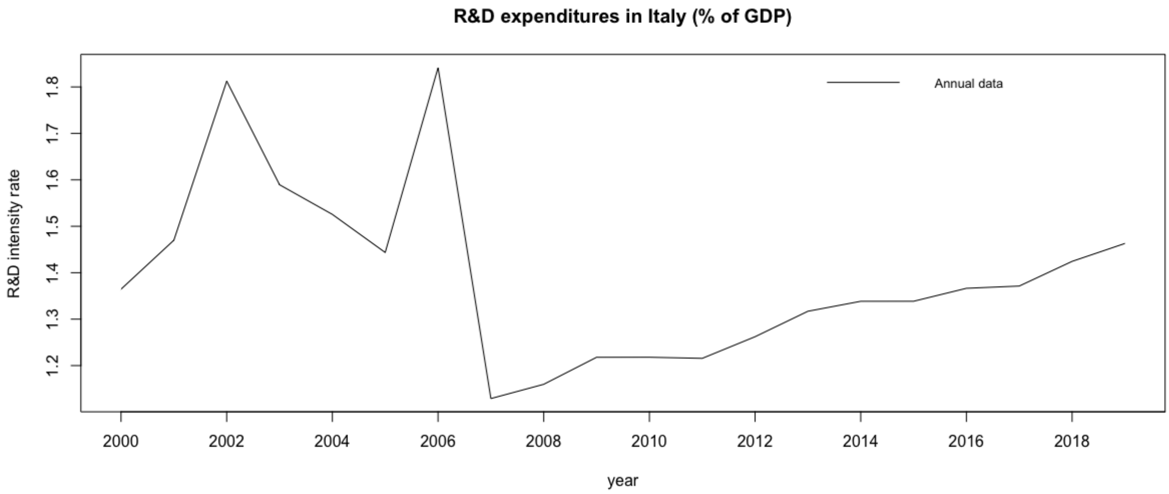

Figure 2.5: Annual R&D expenditures as percentage of GDP in Italy

The role of linear interpolation is to find the best approximation of quarterly data between two annual values. Below is reported a line of code containing the *approx* function to estimate quarterly data in Italy.

```
estita <- approx(ann$Italy, method = "linear", n=length(quar))
```

The line uses the *approx* function to estimate *"quar"* data (a date vector from 2000-01-01 to 2019-12-31 constituted by quarters) from a column of annual data extracted from *"ann$Italy"*, with the linear method[2].

The result of the procedure is graphically shown in Figure 2.6, again in the Italian case. One could imagine the annual time series as a set of points with missing connections, the role of interpolation is to find the best-suitable missing data between those values.

[1] worldbank.org/en/home.

[2] Linear interpolation fits the curve in a specific range (i.e. in this case between annual values, multiple times), whilst the constant method fits only on the last observation.

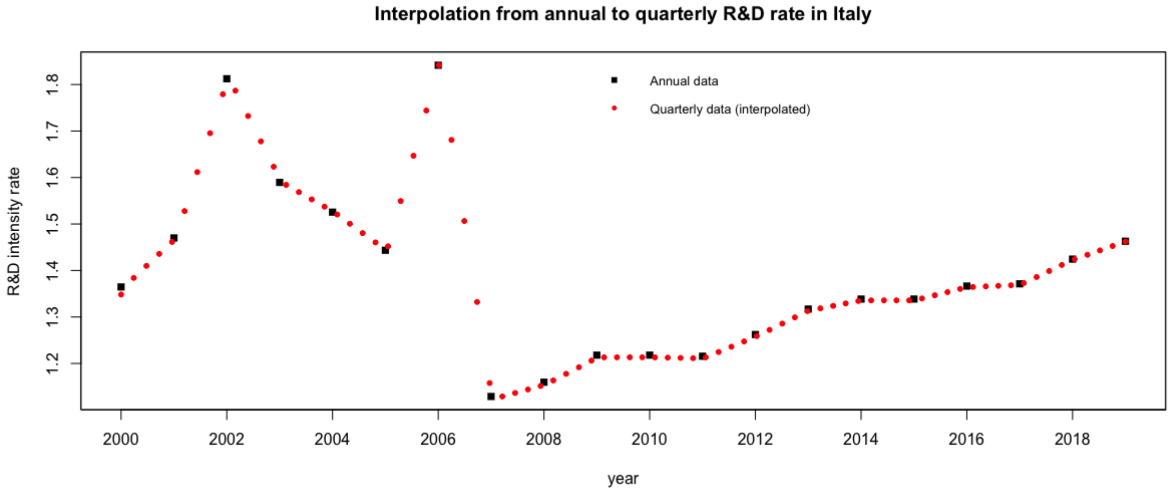

Figure 2.6: Result of linear interpolation for R&D quarterly data in Italy

The original time series presented missing values for Australia, Norway, Sweden and Switzerland. Interpolated quarterly values associated to non-officially reported annual data have not been considered, for this reason the variable referring to the level of technological progress has been excluded for these countries.

2.5 Unemployment

The last endogenous variable included in the analysis is represented by the unemployment rate in each selected country of the sample.

Job creation in the host country is frequently mentioned in the literature as an FDI effect. Not only benefits in employment levels should be related to new business openings but, if the absorption capacity of the country is strong enough, also to an overall growth in the economy which would (in theory) lead to more production and higher incomes for already employed workers, increasing spendings with a spillover effect to the entire economy and ultimately, to the creation of new businesses induced by stronger domestic activity. Moreover, it is interesting to evaluate again the spillover effects in third countries' labor markets as an effect of FDI directed to another economy; movement of this type could be related for example to migrations or increased trade relationships.

The data is obtained from the "OECD Unemployment rate - *Total* (% of labor force)" database as seasonally adjusted series of quarterly rates and a log transformation is applied.

OECD defines the unemployment rate on the percentage of total labor force, referred as the sum of unemployed and employed people; in particular, considering unemployed the amount of working-aged people which are currently without occupation and are actively taking measures in order to get a job.

Due to the large number of missing data for Brazil, China, India and Switzerland, these countries are excluded from labor market dynamic analysis with respect to FDI movements.

Chapter 3

Model Specification

From the data presented in the previous chapter, a GVAR model has been developed using the GVAR Toolbox implemented by Smith and Galesi (2014), in order to understand direct and third-countries impacts of a positive shock on a foreign variable for each country of the sample.

The results of the analysis are discussed in the present and the following chapters, such as model specification and intermediate observations, and then as the dynamic analysis of Generalised Impulse Response Functions as ultimate output.

Table 3.1 defines the variables included in the dataset:

Variable short-name	**Data**
y	Log of Real GDP
Ntr	Balance on goods
rd	R&D intensity
un	Log of Unemployment rate
FDI	Bilateral outward Foreign Direct Investment from the US

Table 3.1: Variables specification in the model.

Goal of this thesis is to investigate the impact on the first four variables and for this reason are included as domestic, endogenous. FDI is also specified among the domestic variables, and the rationale of this choice is based on the possibility to further define FDI also as foreign (starred) variable calculated with the weighted-averaging procedure described in Chapter 1, and introduce a positive shock to each bilateral flow in the dataset, to observe its impact.

In the analysis there are no global variables, since these are usually represented by common factors observed across the globe, like the price of oil or primary goods, which do not fall in the scope of this thesis.
The corresponding foreign variables are represented with a star (e.g. $y*$) or with an s at the end (e.g. uns) and are defined as the weighted average of the same variables observed in foreign countries.
Moreover, the country-specific weights produced to arrive at VAR models with foreign variables are computed using a fixed-weights procedure based on trade flows from one country to the others in the sample. The matrix is reported in Table A2 of the Appendix[1]. Columns of the matrix sum up to 1 since the weights represent the relative importance attributed to countries in the sample by the column country.

Unit root tests are computed in order to determine the stationarity of the variables, with their eventual order of integration; on this matter, augmented Dickey-Fuller (ADF) tests are performed under the null-hypothesis of having a unit root in the time series[2]: the null-hypothesis is rejected for levels of the test-statistics below the critical value[3] (which depends on factors like time series length and number of variables, or, furthermore, presence of trends).
These results for the domestic variables are presented in the Appendix (Table A3). Overall, one can observe in the table a recursive result, in particular, test-statistics of the ADF for original series usually fail to reject the null-hypothesis and this is, most of the times, solved by applying a first differentiation to the series (integrated of order one, $I(1)$), in order to reach stationarity.

The next step is the model selection, for which a limit on the number of lags has been imposed at 2, as usually done in the literature, in order not to overload the models with too many parameters. On this restriction, a series of model-fitting procedures is performed, in order to find the more suitable specification for the data; in this regard, the Shwartz - Bayes Criterion (SBC) is used to choose the specification which allows to achieve the lowest information score. Tests of this type (another is the Akaike Informa-

[1]Trade data is used as provided from the GVAR Toolbox.
[2]If the tests fails to reject H0: $\delta = 1$, one can expect the series to behave like a non-stationary Random Walk. Whilst the alternative hypothesis H1: $\delta < 1$ is accepted for stationary time series.
[3]The critical value represents the threshold for 5% of the values.

tion Criterion) penalise over fittings in the choice of the number of parameters.

$$
\begin{aligned}
SBC &= K\, ln\,(n) - 2\, ln\,(\hat{L}) \\
AIC &= 2\, K - 2\, ln\,(\hat{L})
\end{aligned}
\tag{3.1}
$$

In equations (3.1), n is the number of observations, K the number of parameters and $\hat{L}$ the maximum Likelihood. From these equations one can understand that each criterion weights (differently) the number of parameters, penalising model complexity, requiring a higher log-Likelihood in order to be preferred to lower-parameters models.
Overall, the results suggest to use a VARX*(2,1) in most of the cases, with exceptions for Australia, Japan, Norway, Sweden and Switzerland, where a VARX*(1,1) is indicated as the better fit (*see* Table A1).

Moreover, the number of cointegrating relations for each country is noted in Table A4. As reported, no full-rank cases are individuated, whereas for Australia, Brazil and Netherlands no cointegrating relationships are discovered[4]. Cointegrating relationships are reflected in the VECMX* representation of each country model; VECM (*Vector-Error Correction Mechanism*), as discussed in the Granger Representation Theorem, are tied to VAR models, as they propose another representation of the system which enables to isolate the short and long-term relationship among variables. VARX* specification is usually preferred in the context of impulse response functions studied in the next chapter, since GIRFs do not require the isolation of cointegrating relationships; however, the VECM structure is presented in the two examples that follow, for Australia and Norway, in Chapter 3.1.
Note that is possible to switch from VAR to VECM and *vice-versa* through simple algebra.

[4] *Full rank* of the autoregressive matrix is reached when the number of cointegrating relations is equal to K (the number of variables) and all the variables are considered to be stationary, whilst for results equal to 0, the variables behave like completely independent *Random Walks*; for ranks between 0 and K, a number of long-term *relationships* is found in the non-stationary variables, as their error terms are covariance stationary.

3.1 VECMX* representation

When $rank\,(\mathbf{\Pi}) = 0$, the model in VECM representation becomes a VAR$\,(p$-1) of first differences, this can be observed in the four-variate Australian VARX*(1,1), in (3.2):

$$\mathbf{\Delta}\,X_t = \boldsymbol{c}_i + \mathbf{\Gamma}_j^*\,\mathbf{\Delta}\,\boldsymbol{x}_t^* + \boldsymbol{\varepsilon}_t =$$

$$\begin{bmatrix} \Delta\,y \\ \Delta\,Ntr \\ \Delta\,un \\ \Delta\,FDI \end{bmatrix} = \begin{bmatrix} 0,0055 \\ 217,8443 \\ 0,0007 \\ 88,1273 \end{bmatrix} + \begin{bmatrix} 0,0144 & -14742,6 & -0,0759 & -18922,5 \\ 0 & -0,0309 & 0 & 0,1234 \\ 0,0936 & -20028,6 & 0,6166 & 12006,3 \\ 0 & -0,1975 & 0 & 0,3661 \end{bmatrix} \mathbf{\Delta}\,\boldsymbol{x}_t^* + \boldsymbol{\varepsilon}_t \tag{3.2}$$

The explaining power of long-term relationships is not present here, and only the first-differenced exogenous regressors at time t are considered[1]. The representation is different if $0 < rank\,(\mathbf{\Pi}) <$ K, for instance in the Norwegian case, a trivariate VARX* (1,1) with intercept and trend, and $rank\,(\mathbf{\Pi}) = 1$, is represented in VECMX* form as:

$$\mathbf{\Delta}\,X_t = \boldsymbol{c}_i + \mathbf{\Phi}\,\boldsymbol{D} + \mathbf{\Pi}\,\boldsymbol{z}_{t-1} + \mathbf{\Gamma}_i^*\,\mathbf{\Delta}\,\boldsymbol{x}_t^* + \boldsymbol{\varepsilon}_t =$$

$$\begin{bmatrix} \Delta\,y \\ \Delta\,un \\ \Delta\,FDI \end{bmatrix} = \begin{bmatrix} -0,1163 \\ 0,4036 \\ 82258,29 \end{bmatrix} + \begin{bmatrix} -0,0001 \\ 0,0004 \\ 78,9181 \end{bmatrix} +$$

$$+ \begin{bmatrix} 0,0041 & 0,0088 & 0 & 0,0159 & -0,0086 & 0 \\ -0,0139 & -0,0295 & 0 & -0,0534 & 0,0289 & 0 \\ -2931,6465 & -6224,9885 & -1,1015 & -11273,2119 & 6115,9237 & -0,0848 \end{bmatrix} \boldsymbol{z}_{t-1} +$$

$$+ \begin{bmatrix} 0,8968 & -0,1713 & 0 \\ -2,1828 & 0,6629 & 0 \\ 37904,7989 & -2131,1649 & -0,0437 \end{bmatrix} \mathbf{\Delta}\,\boldsymbol{x}_t^* + \boldsymbol{\varepsilon}_t \tag{3.3}$$

[1]Endogenous regressors are only considered starting from the first leg of delays (as introduced in Chapter 1), for instance the VARX* (2,1) found for Brazil, would become a VARX* (1,0) in VECMX* representation since the rank is zero; one would thus consider the endogenous variables at lag *t*-1 and the exogenous at *t*.

Where $\boldsymbol{z}_{t-1} = (\boldsymbol{x}'_{i,t-1}, \boldsymbol{x}'^{*}_{i,t-1})$, $\boldsymbol{\Pi}$ is a $(n \text{ x } n)$ matrix obtained by the product of the *speed of adjustment* vector $\boldsymbol{\alpha}$ $(r \text{ x } n)$ and the matrix $\boldsymbol{\beta}'$ of rank $(n_i + n_i^*)$ x n, defining the strength of the cointegrating relations among regressors.

In the example $\boldsymbol{\alpha}$ is a (3 x 1) vector, whilst $\boldsymbol{\beta}'$ is a (2 x 3) matrix:

$$\boldsymbol{\Pi} = \boldsymbol{\alpha}\,\boldsymbol{\beta}' = \begin{bmatrix} 0,0041 \\ -0,0139 \\ -2931,65 \end{bmatrix} \begin{bmatrix} 1 & 2,1234 & 0,0004 \\ 3,8453 & -2,0862 & 0,00003 \end{bmatrix} \tag{3.4}$$

From equation (3.4) one can understand that the VECM representation explicits cointegrating relations by $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$, where the former measures the rapidity with which the cointegration is reinforced after a temporary deviation on stability measured by $\boldsymbol{\beta}$. The largest is $\boldsymbol{\alpha}$ in absolute value, the fastest the deviation in absorbed.

Introducing the next chapter, Table A5 of the Appendix presents the aggregation weights of country-specific models for the evaluation of Generalised IRF in one unique GVAR model. The columns sum up to 1, representing the relative importance given by each country to the included variables, in order to stack together the estimated small-scale VARX* models.

Chapter 4

GIRF Dynamic analysis

The last chapter of this thesis is focused on the analysis of the dynamic traits of the model, in order to determine the duration and intensity in the dependent variables' response to the introduced shock via graphical representation.

The impact that is studied is related to a one standard error positive shock on outward direct investments from the US to each other country included in the model. For this reason, both the bilateral and third-country responses are investigated, with the former referring to a direct effect in the host country for American FDI, whilst the second representing spillover effects in countries not directly affected by a shock in FDI flows.

The Generalised Impulse Response Functions obtained from the shock are discussed in this Chapter. As defined by Kook *et.al.* (1996) and Pesaran *et.al* (1998), GIRFs are a derivation of traditional impulse responses applied to multivariate models; traditional IRF are in fact defined as time-profile measurements of introduced shocks at a certain point in time and in this definition two realisations are compared, one where a shock δ enters the system at time t, whilst in the second, the benchmark, no shocks are observed. Kook defines the traditional impulse response function as:

$$I_y(n, \delta, \omega_{t-1}) = E[Y_{t+n}|V_{i,t} = \delta, \omega_{t-1}] - E[Y_{t+n}|V_{i,t} = 0, \omega_{t-1}] \tag{4.1}$$

where $V_{i,t}$ is one of the shocks involved in the GVAR model and $\boldsymbol{V}_t = (V_{1,t}, \ldots, V_{N,t})$ being the (n x 1) vector of global shocks, set at zero at any time except t in the first realisation, and ω_{t-1} as a realisation of a random variable used to forecast $\boldsymbol{Y}_t$. Note that n refers to the sum of the dimensions of country-specific VARs.

In linear univariate models, traditional impulse response functions are independent from shocks and from the past, however these properties do not apply to multivariate models, with IRF being dependant on t and δ.

Generalised IRFs are introduced in order to consider both past observations and shocks, via conditional expectations. Moreover, GIRFs are, unlike the Orthogonalised representation (OIRF), independent from the ordering of the variables in the model and for this reason are studied in this thesis.

In the following sections the most representative graphs among the four endogenous variables are discussed; overall, one can notice that positive shocks in FDI bilateral flows have a larger impact on economic variables directly affected by changes in international trade, such as the Balance on goods, whereas, for instance, relevant shock responses in the unemployment rate tend to be more disperse, but are still present in some cases. As a preliminary interpretation one could attribute significant explanatory power to international statistics on imports and exports since, as introduced in Chapter 2.2, direct investments in foreign countries and trade are two economically-related concepts; in particular, from the cited Fontagné (1999), FDI are found to be empirically relevant on trade movements, and positive short term effects have been observed in originating countries, with host countries positively affected only in the long run. As said, this is just a preliminary observation and a case-by-case analysis has to be performed when dealing with macroeconomic systems of this type.

Furthermore, the focus of the interpretation is also posed on the differentiation between bilateral and spillover effects; on this matter, it is found in the GIRFs that spillover effects tend to be more easily observable than bilateral impacts in the variable referring to the technological progress, on the contrary the best explanatory responses for unemployment rates are observed as bilateral effects in the host countries; this could be an indicator for international diffusion properties of both technological progress and labor force deployment.

In the next sections, the most relevant generalised impulse responses are presented[1], with a particular attention to the short-term reaction and its speed to an eventual return to stability. The graphs are observed as median estimates, with confidence bounds obtained via bootstrap; coherently with Sun *et.al* (2013) and Dees *et.al* (2007), confidence bands

[1]The total responses are over a thousand (nearly 250 GIRF for each variable, depending on the availability of quarterly data), for this reason the recursive, non-significant and low-explanatory graphs are excluded.

tend to widen rapidly after some lags, and, approximatively, horizons larger than 10 quarters should be treated as indicative. For this reason the first two years are the focus of the analysis of the GIRFs.

Moreover, it should be noted that the interpretation of the results is made on the significance and direction in the response functions generated by the shock, and secondly, considerations on the intensity in the reaction can be made; on the first matter, significance in the graphs resides in both the characteristics of the response observed in the median estimates and in the movement suggested by the structure of confidence intervals. Tight, asymmetric confidence bands pointing in the direction of the median estimate should represent an important indicator in the significance of the curve; whereas a "flat" confidence area, with almost parallel lines, could imply lesser relevance.

As final introductory note, it should be taken into account that the 95% confidence intervals adopted here are broader than those frequently implied in macroeconomic literature, thus possibly leaning more towards the rejection of significant estimates in ambiguous cases.

4.1 FDI impact on Balance on Goods

In order to estimate the impact on trade of an introduced positive shock on FDI across the sample countries, Balance on Goods has been considered as informative measure to capture properties of economic growth in international relations with the US, and between countries. BoG has been used as trade measure since multinational enterprises, when starting a business abroad, are frequently accompanied by transactions in technology and machinery markets, as well as being involved in transfers of intermediate or final products to be either processed or delivered (or both).

In this section, the most explanatory GIRFs for bilateral effects in both directions are presented in Figures 4.1 and 4.2, together with third-country impacts in Figure 4.3 and 4.4.

From the produced graphs, a set of 11 bilateral responses has been selected, however not always possessing the same level of significance. In particular, it should be noted

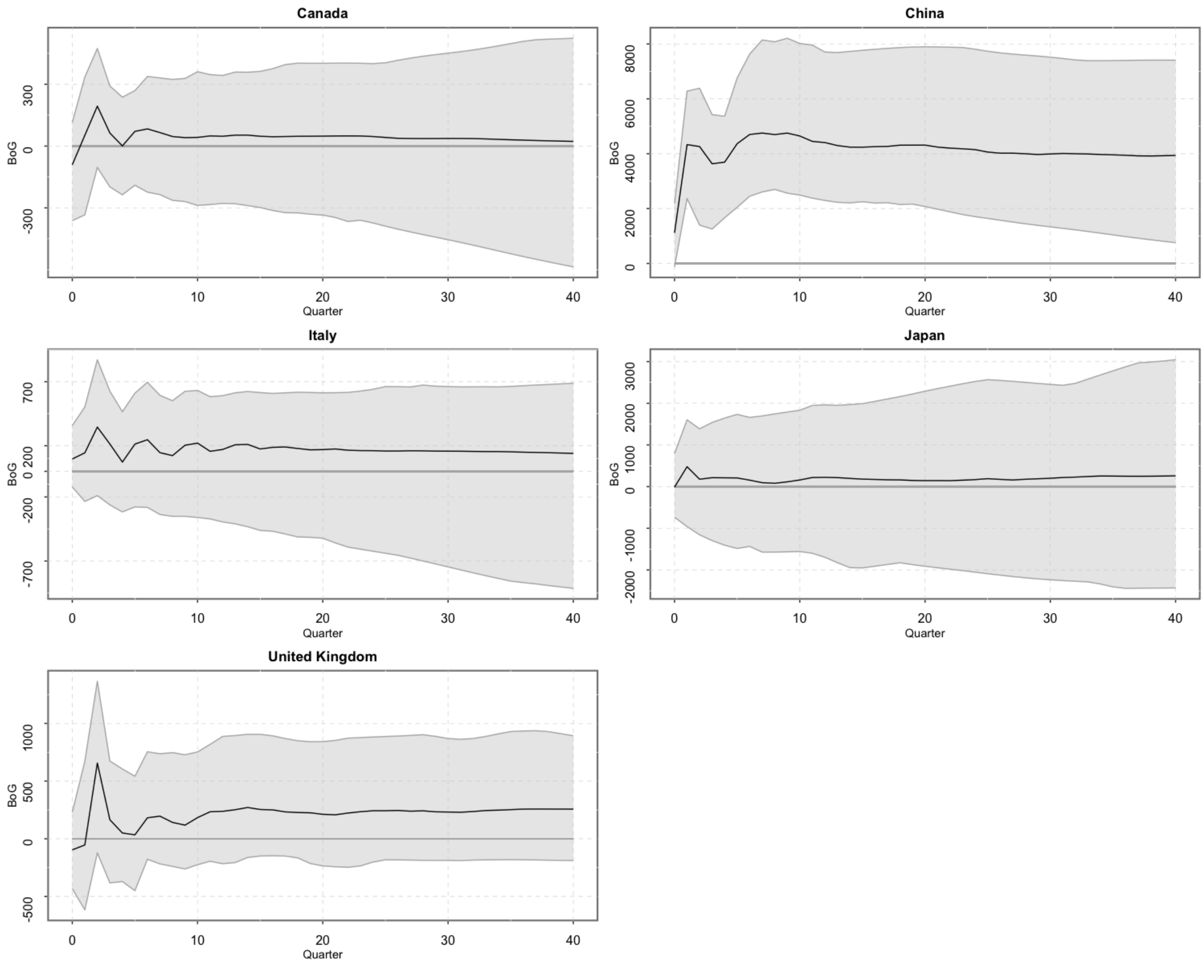

Figure 4.1: FDI positive bilateral effects on Balance on Goods in Canada, China, Italy, Japan and UK.

that, among the two set of results, the positive[1] reaction observed in China is arguably the most relevant in terms of speed, asymmetry of the confidence bands movement and also with respect to its intensity (in absolute value), peaking over 3 Billions of Dollars. Additionally, the response in UK describes a quite relevant behaviour, with a high initial spike, short in duration, eventually reabsorbed somewhat quickly by the system; Canada exhibits the same evolution, but its significance might be less appreciated, given the amplitude of the confidence bands, a characteristic much more evident for Japan (and partially Italy), which has almost no explanatory powers.
Negative functions, in Figure 4.2, reveal a very comparable behaviour in terms of extent of the perturbation, as the tests almost always present a crest followed by minor secondary movements, limited to the first year, which are usually brought back rapidly to a much

[1] The term *"positive"*, used from here on, refers to the increasing direction of the GIRF and it is not necessarily related to positive economics implications (even if, for this variable, the two coincide).

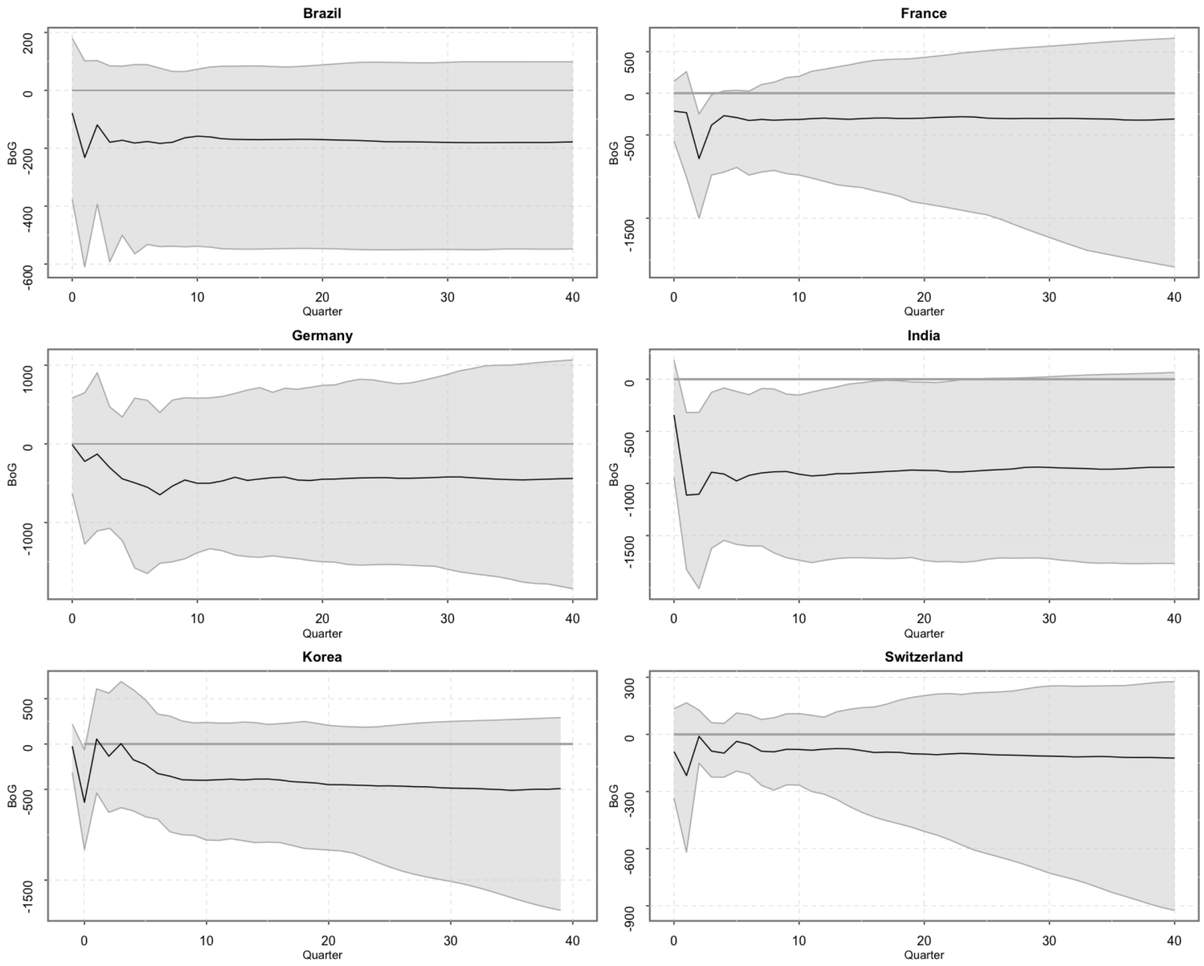

Figure 4.2: FDI negative bilateral effects on Balance on Goods in Brazil, France, Germany, India, Korea and Switzerland.

more steady state; exceptions to this observation are reported for Italy and Germany, in the two different directions, where oscillations are observed until higher lags, however without being of particular relevance.

Furthermore, some countries are significantly and adversely affected by an increase in inwards FDI from the United States; among them France and Korea are perhaps the most explanatory, with Switzerland likewise affected by the shock but with minor intensity, and India revealing a quite interesting drop in BoG in the first 2 quarters, however being enclosed in relatively large and steady confidence intervals.

These mixed results obtained for bilateral effects of FDI on trade balance are differently supported in the literature, where empirical conclusions seem to prevail for the negative reaction, or more specifically, a short-term decreasing impact on the trade balance[2];

[2] A branch of the literature on FDI impacts and determinants is dedicated to the analysis of the causal relation between trade and FDI, for this reason the two measures might interact with each other differently; *see* Lederman (2011) and Sarnstrom and Ryan (2022) for exchange rate impact on FDI.

Fontagné (1999) and Tran and Dinh (2014) provide the same deduction, where a temporary higher increase in imports versus exports is eventually followed by a long-term strengthening of the host country's trade balance. The intuition is backed by bilateral trade investigations in the first study, where the increase of imports in the host country comes from an export expansion of intermediate and capital goods in the home country[3]; whereas for the latter, much of the detrimental effects on trade are attributed to a depreciation of the host country's currency.

Contrasting evidence is therefore found in this thesis for China, UK and Canada, with progressively declining rates of significance.

In the cited study by Tran and Dinh, the authors allow for a boost in the trade balance in the most absorptive host countries (in terms of growth induced by increased investments), with highly productive manufacturing capacities sensitively affecting the response in export levels. From this consideration, one could adapt the observation to the World leading Chinese manufacturing industry, which contributed to nearly 30% of the global output in 2021[4].

Moreover, as discussed in the Introduction, political and international treaties have a considerable impact in favoring FDI benefits, in particular from increased international relations. In this regard, Tseng and Zebregs (2002) list, among the features characterising the late exceptional economic growth and FDI attraction in China, its market liberalisation and trade openness obtained through a gradual loosening of restrictions in foreign investment, together with a progressive shift towards benefits for investors coming from abroad[5]. In particular, the Chinese government enacted *ad-hoc* policies to capture a larger share of global FDI, basically constituted by tax concessions and creation of Open Economic Zones (OEZs); in these decentralised areas (one example is Shenzhen), where the state influence has been limited progressively from the 1980s, MNEs are able to minimise, and even eliminate, tariffs and trade costs in order to entirely leverage this export-oriented infrastructure.

Considerations of this type hold also for Canada, where the USMCA trade agreement between Canada, Mexico and the United States allows to attract FDI and eliminate transaction costs, favouring in particular SMEs which are no longer required to open a foreign

[3]This is found to be particularly true for France by Fontagné, coherently with the result obtained here.
[4]China SCIO (*State Council Information Office*).
[5]Along with these, domestic market size, infrastructures and supply of low-cost workforce are considered to be relevant.

office to run cross-border businesses, and eliminating double-taxation for citizens abroad. Furthermore, the FDI relationship between Canada and its most-southern neighbour is very strong, being the US its largest investor, accounting for nearly 44% of foreign funds inflows at 2020[6], and with Canada representing also the third-primary recipient for US outward FDI flows across the Globe in the considered timespan (after Netherlands and UK), especially in the agriculture and food industry.

Moving to third-country responses, considered as spillovers coming from the FDI target country to one or more linked economies, positive reactions are more easily observable both in quantity and in relevance, even though attention might be posed to UK and Germany in Figure 4.4, since negative spillovers are registered in the two nations alone, with peaks being relatively significant, although not having large intensity[7].
Figure 4.3 highlights the same reaction-stabilisation pattern of bilateral impacts, even though oscillations can be appreciated at higher lags in some cases. Of particular relevance are the two spillovers in Switzerland, deriving from the closely situated Italy and Germany; here, the confidence bands are very tight and firmly follow the trend of the median estimate and, additionally, the intensity of the reaction is high in both cases, if compared to the other graphs. UK is also affected by shocks in Germany and Switzerland, but the relevance is sensitively inferior, having confidence intervals, likewise in the other cases, much more disperse. The Chinese spillover in Korea exhibit a fairly different response, as the reaction does not have a sharp increase, being more shifted towards further lags; its significance is initially interesting, however is rapidly deteriorated.
An interesting characterisation of the results can be made if processed by geographical region, since it appears to be present a recursive distribution channel of the shock in "neighbouring" economies for the one directly affected. This behaviour is particularly evident in Europe, where Switzerland is remarkably integrated in the European Union; conversely, the UK seems to be less-affected by these positive linkages, with the main results leaning towards negative, minor, spillovers in the country.
The observed neighbouring-effect can be an important indicator for the level of integration in the region, closely tied to trade advantages generated from a greater export activity

[6]U.S. Department *of* State.

[7]*Note that*: for few nations, a low-initial shock opposing to the one reported is "ignored"; for example GIRFs in Figure 4.4 (a,d) start off with a negligible increase, before dropping significatively.

when close economies are positively affected by a shock on FDI inflows and possibly, an increased productivity and demand for goods and technology.

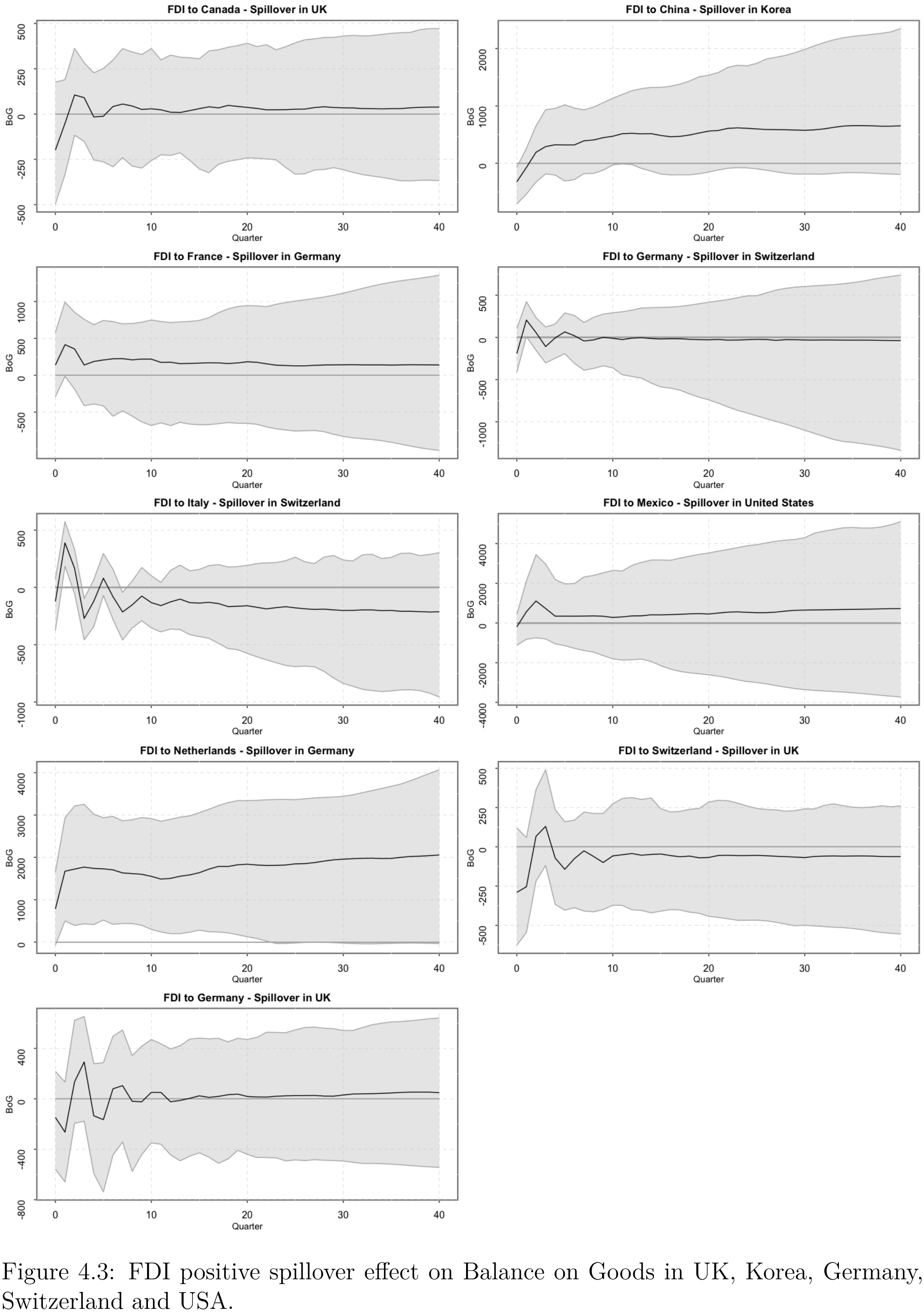

Figure 4.3: FDI positive spillover effect on Balance on Goods in UK, Korea, Germany, Switzerland and USA.

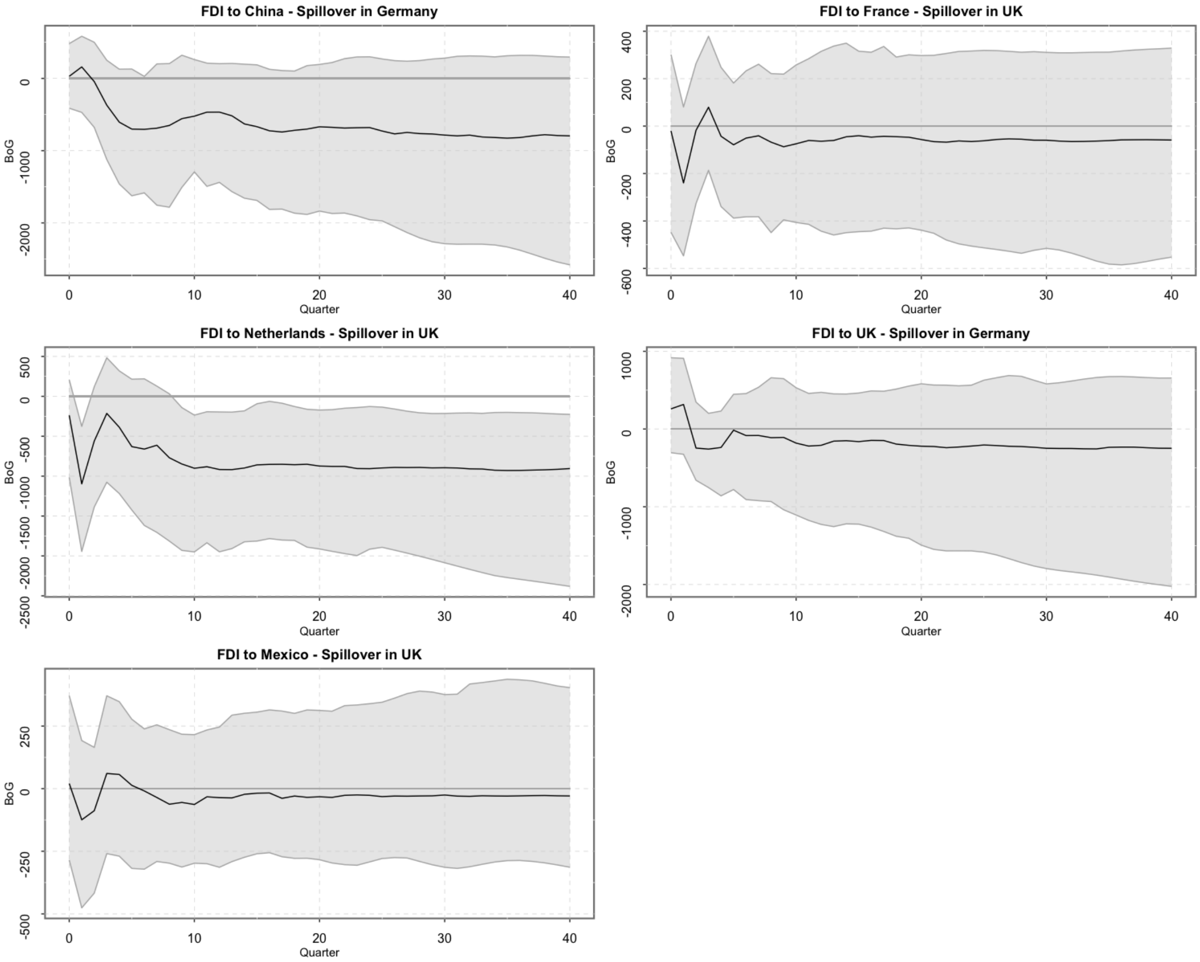

Figure 4.4: FDI negative spillover effects on Balance on Goods in Germany and UK.

A summary of the results is reported in Table 4.1, indicating the direction of the response (*Direction*), the duration of its reaction until stabilisation or approach to the absorption tendency (*Quarters*), its intensity in absolute terms, measured in Millions of Dollars (*Intensity*) and the relative impact on the quarterly mean estimate of the period BoG in the country (*BoG effect*).

Mixed results are obtained for bilateral impacts; whereas positive effects prevail on negatives among spillovers, exhibiting also higher relative percentages for increases in BoG. The highest-relative reaction is observed in Canada, as an increase of nearly 300 Million Dollars is reflected in a 8,1438% increase of its BoG, yet not ignoring the second-highest relative percentage, observed in France as a significant negative reaction of 5,9627 % . Moreover, the highest percentages are all registered as positive reaction, with values frequently surpassing 4 % .

The considerations on the duration are matched by the table, where bilateral impacts are usually relegated to the first 3 quarters, whereas spillovers frequently have longest implications.

FDI host country	**Affected country**	**Direction**	**Quarters**	**Intensity (MM $)**	**BoG effect (Q average)**
Brazil	**Brazil**	Negative	3	153,0924	2,5048 %
Canada	**Canada**	Positive	6	284,4259	8,1438 %
	UK	Positive	2;5-7	303,9957	0,7902 %
China	**China**	Positive	2	3144,7223	4,7582 %
	Korea	Positive	10	613,9755	4,5440 %
	Germany	Negative	1-5	860,5018	1,5747 %
France	**France**	Negative	2	570,1223	5,9627 %
	Germany	Positive	1	276,4166	0,5058 %
	UK	Negative	1;3-5	219,1270	0,5696 %
Germany	**Germany**	Negative	1; 2-7	729,5383	1,3350 %
	Switzerland	Positive	4	397,8541	4,3598 %
	UK	Positive	1-3	557,1563	1,4483 %
India	**India**	Negative	1	769,5878	3,1522 %
Italy	**Italy**	Positive	2	249,2572	4,4774 %
	Switzerland	Positive	9	511,8110	5,6085 %
Japan	**Japan**	Positive	1	489,3461	4,2343 %
Korea	**Korea**	Negative	1	618,7412	4,5793 %
Mexico	USA	Positive	2	1304,2249	0,7423 %
	UK	Negative	3	145,0565	0,3771 %
Netherlands	Germany	Positive	1	891,2012	1,6308 %
	UK	Negative	1;3-10	858,5782	2,2318 %
Switzerland	**Switzerland**	Negative	3	126,2648	1,3836 %
	UK	Positive	7	420,0177	1,0918 %
UK	**UK**	Positive	2	752,5871	1,9563 %
	Germany	Negative	1-3	574,6802	1,0516 %

Table 4.1: Bilateral and third-country impact of a positive shock in FDI flows to target countries on Balance on Goods *(bilateral effects are indicated in* ***bold****).*

4.2 FDI impact on Research & Development

In order to study the American impact on technological progress in the sample host countries, the R&D intensity rate, measured as the fraction of national expenditures in research and development on GDP, has been used.

Figures 4.5 and 4.6 report the most explanatory GIRFs for research and development responses as bilateral impact; in this case there is no great numeric evidence for direct effects supporting one tendency more than the other, as the relevant graphs are few and evened in their directions.

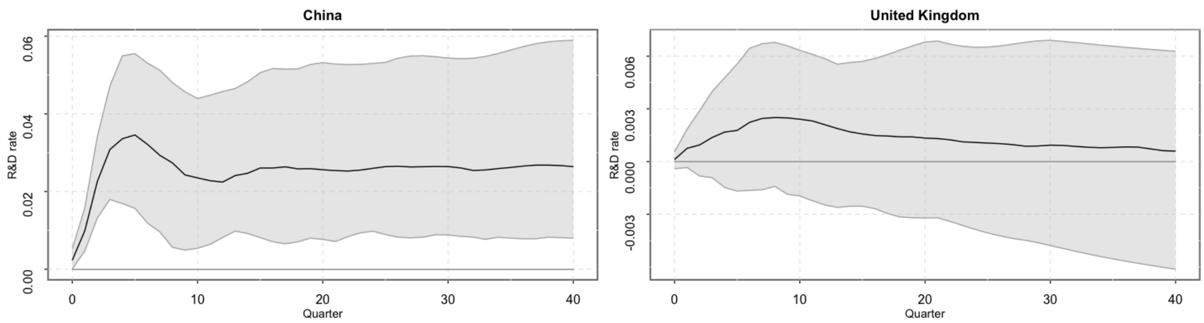

Figure 4.5: FDI positive bilateral effects on R&D rate in China and UK.

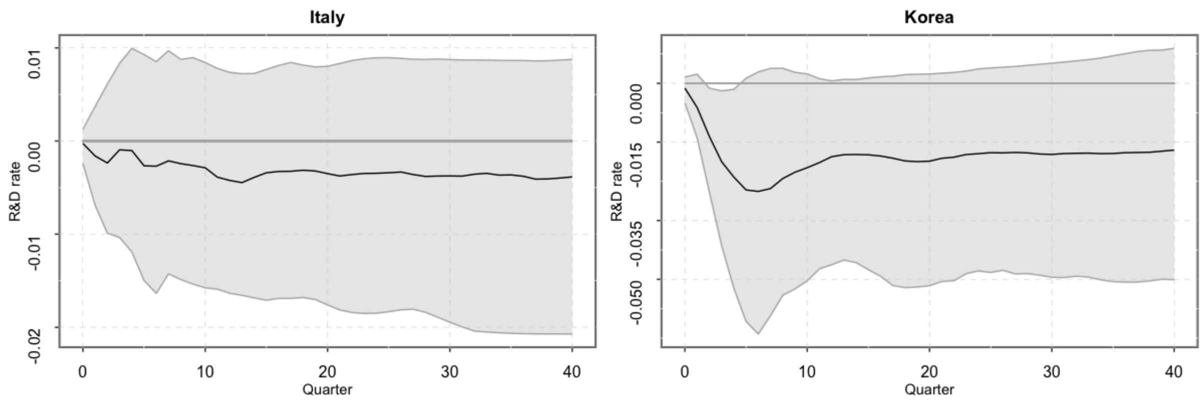

Figure 4.6: FDI negative bilateral effects on R&D rate in Italy and Korea.

However, of particular significance is again the Chinese response to a positive shock on FDI inflows, since its bilateral GIRF for R&D not only reaches higher levels of intensity if compared to the other graphs, but it exhibits also strong significance, as a sharp increase is observed until the 6^{th} quarter; moreover, its confidence bands are very close to the median estimate and help suggesting a very high relevance of the result. The function enters then its stable state around the 10^{th} lag.

Contradictory evidence is found in Asia, since the Korean reaction firmly points towards a decrease of the intensity rate of research and development; the path of the estimate is considerably similar to the previous one, but its features are less pronounced in almost every aspect, thus its relevance being weaker. The intensity is lower, the peak of the function is smoothened, and the approach to a steadier state is delayed; furthermore its confidence intervals, even if quite asymmetric, are much larger and quickly start moving in the same direction.

As a comparison measure, the negative, non-significant, Italian reaction is reported together with a positive reaction in UK with limited explanatory powers.

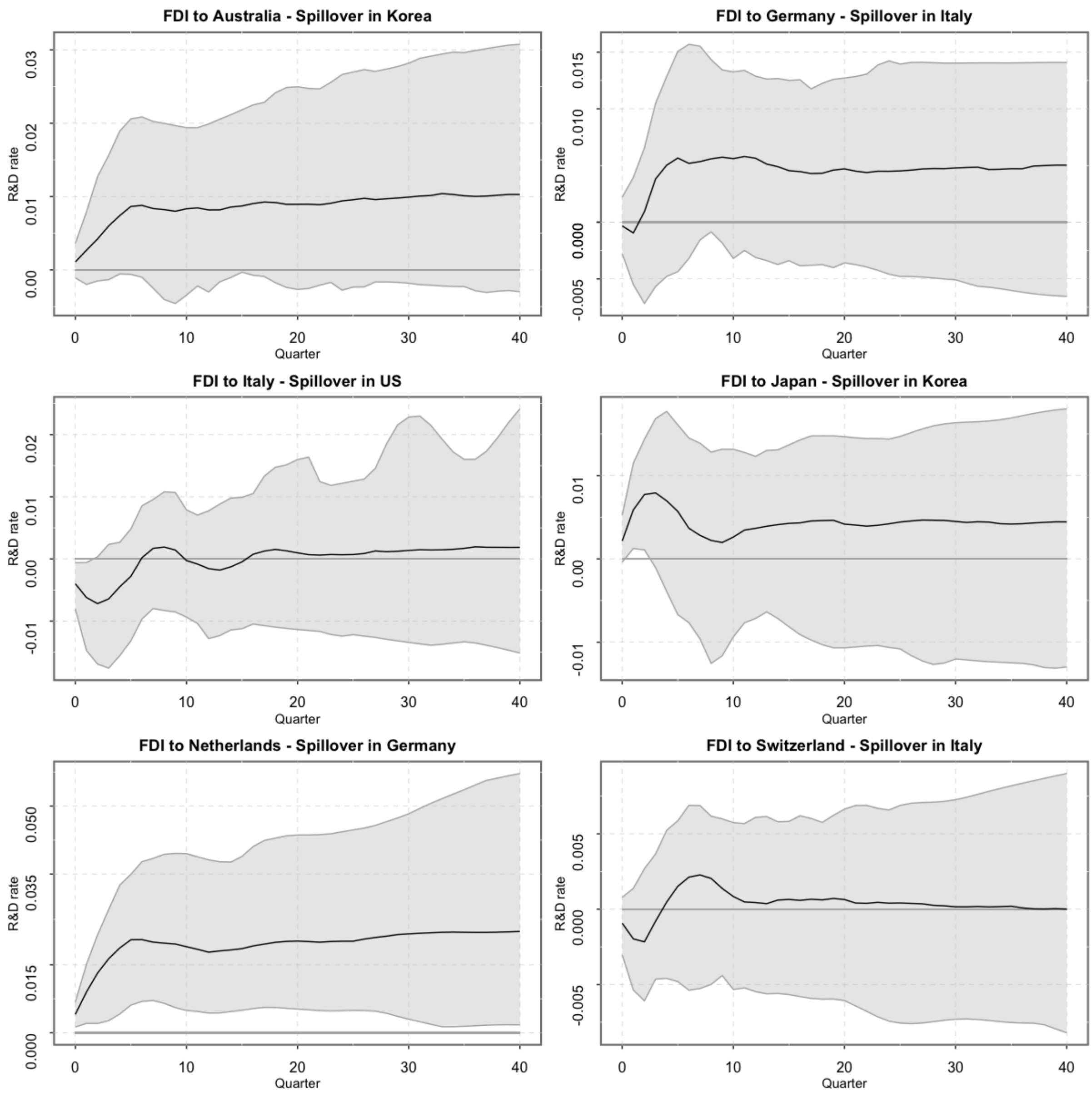

Figure 4.7: FDI positive spillover effects on R&D rate in Korea, Italy, Germany and USA.

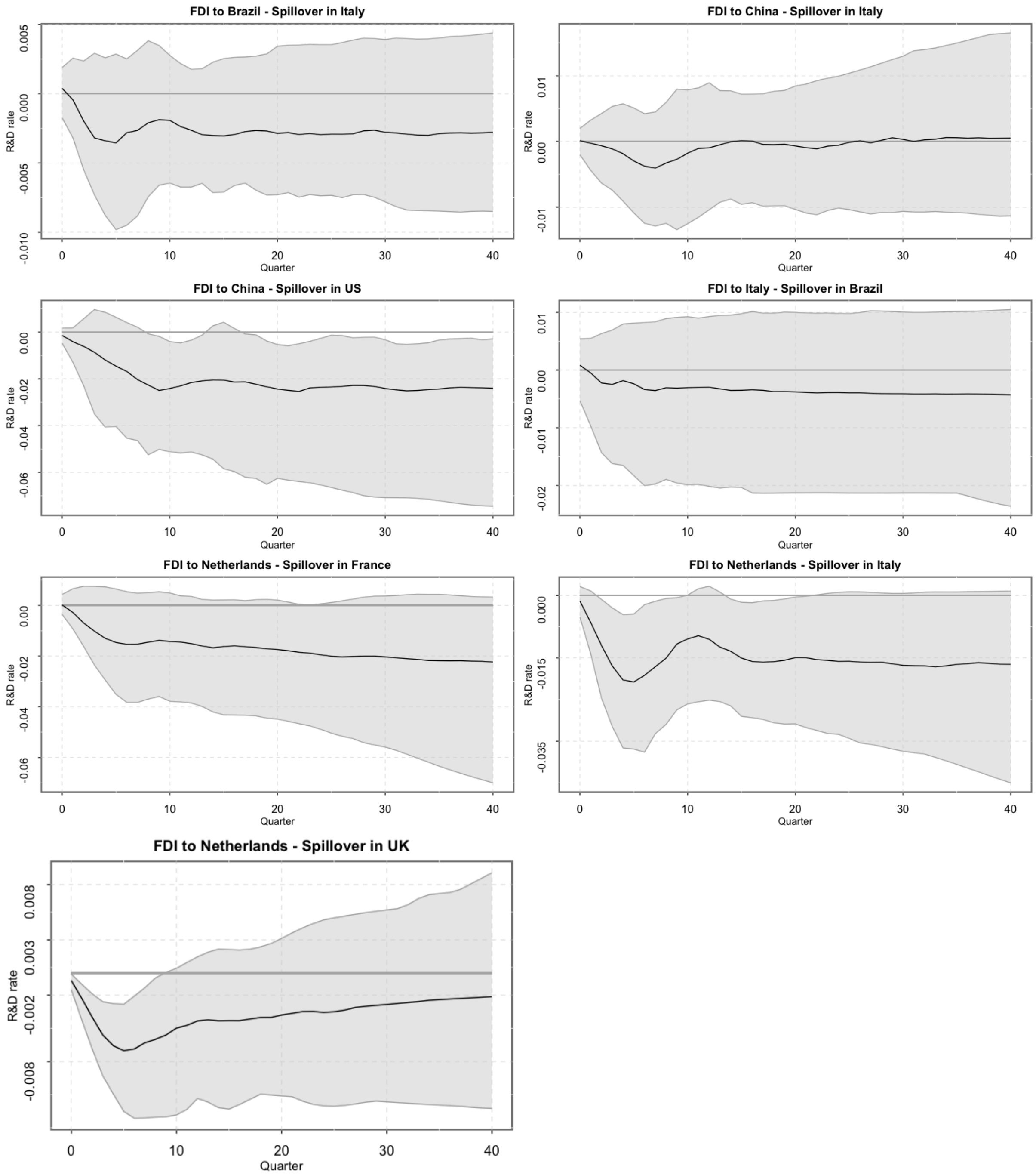

Figure 4.8: FDI negative spillover effect on R&D rate in Italy, Brazil, USA, France and UK.

Figures 4.7 and 4.8 present the effect on third-countries' technological progress, with evidence indicating a preponderance of significant GIRFs over bilateral reactions, at least in their number, since matching significance of the Chinese bilateral response is still arguably not found in the graphs. Apart from this exception, the "new" functions frequently reach higher levels of intensity and relevance; the duration of the perturbation is instead usually in line with Figures 4.5 and 4.6, as the functions reach stronger intensities during the second year, with a progressive and quite slow stabilisation approximately around the 10th quarter[1].

For what concerns the direction of spillovers, mixed results are obtained, considering that significant evidence is found both for positive and negative functions. Figure 4.7 reports explanatory relations in Germany, Korea and Italy, in particular the interaction between Netherlands and Germany and between Japan and Korea exhibit the highest degrees of significance; Germany has also a quite meaningful positive impact in Italy, with the latter partially influencing the United States. Overall, the median estimates for positive directions are accompanied by initial asymmetry in the confidence bands, which is usually spread out somewhat rapidly.

Negative spillovers in Figure 4.8 follow the same behaviour, where the primary relations are registered from Netherlands towards a subset of European countries, and from China to the US, and partially Italy.

In terms of intensity, as collected in Table 4.2 at the end of this section, third-country responses with negative direction usually have a greater impact on the quarterly average rate of R&D intensity, with the highest percentages discovered for Netherlands' impact in Italy and in the Chinese relationship with the United States, home country[2].

Furthermore, the results suggest again a neighbouring-effect particularly present in Europe, however with relevant interactions observed in Asia between Japan and Korea.

These mixed results obtained while looking at the impulse responses, in particular for bilateral effects, are arguably tied to the competitive infrastructures in the host country. Fahran *et.al* (2015) find that a stimulus to R&D can be positively related to the increase in competition, however being affected by the type of reaction promoted in the target country; increases in private and public expenditures on technological progress, aimed to keep-up with innovations brought by foreign enterprises, eventually increase the R&D intensity rate, whilst mere imitation-oriented responses to new products introduced by multinationals tend to discourage local business to engage in research activities. The authors conclude that this is particularly true for developing countries with a low-absorption capacity for new technologies.

[1]Recall that in Chapter 4.1, the GIRFs presented a different behaviour, as their peaks were usually sharp and limited to the first year, and the tendency to a steadier state was very rapid.

[2]The highest percentage overall is observed in China, as its bilateral reaction to the shock accounts for an increase of 1,901% of its quarterly data.

Qin *et.al* (2022) coherently back this conclusion when studying the level of absorption capacity for technological spillovers coming from FDI inflows in a sample of 262 Chinese cities. In particular, they investigate the main determinants for an efficient leveraging of innovation brought by foreign businesses; among these factors they include, for the host country, the level of environmental policies, economic growth, human capital and the size of the industry. Their findings suggest that the chosen indicators are all meaningful in terms of absorption of technology spillovers, moreover, scientific clusters and innovative cities (mainly home of universities and research institutions) are significantly more prone to achieving greater results in terms of innovation.
In this framework, the Chinese bilateral GIRF is coherent with the exponentially increasing research activity promoted in the country in the last decades, whilst the negative reaction observed in Korea still represents contrasting evidence. However, it has to be noticed that the R&D intensity rate captures the relative innovation expenditures on GDP, for this reason a declining response might still indicate an increase in gross expenditures, but at slower rates compared to GDP expansion, being Korean research rates already large[3].

Without departing from China, it is interesting to discuss the negative spillover observed in the United States when a positive shock is introduced on FDI flows to the Chinese economy; this particular response should give important suggestions on the negative implications on innovating activities in the home country. Julie (2007) studies FDI impacts in the originating country's level of research programs, analysing possible relocation phenomena in a sample of 71 Swiss tech-MNEs; the work aims to understand if a "decentralised" approach to R&D may slow research activities in the domestic ground. The author finds that home-based innovating activities (proxied by the number of patents) have increased at a lower rate than their foreign affiliates located in a subset of developed nations; concluding that home country's importance has decreased in the previous three decades[4].
The primary intuition of this study is that technology FDIs are directed towards de-

[3]Korea has the highest quarterly average R&D rate of the dataset, averaging at 3,32% of national GDP for the period, being over 4 % from 2016 Q4 and reaching 4,63 % in 2019 Q4. (the lowest average rates are found in Mexico and India at 0,40% and 0,75%).
[4]It should be noted that the work also intuit that much of the innovation led abroad is "brought back" in terms of knowledge, but still, the balance has been shifted.

veloped nations at high-absorption capacity, and that this decentralisation could cause domestic research activities to deteriorate. In order to adapt this finding to the case observed here, it is useful to briefly compare the American and Chinese R&D tendencies. At first glimpse, the average intensity rate observed in US appears to be higher in the period (2,76 % against the lower 1,69 % registered in China); however it should be noted that the American rate has increased by 20 % in the 20 years of observation, whereas the Chinese one has expanded by 152 % [5]. In order to better appreciate the technologic and innovative expansion still occurring in China, Figure 4.9 compares the evolution of patent activity in the two nations from 1985 until 2020[6].

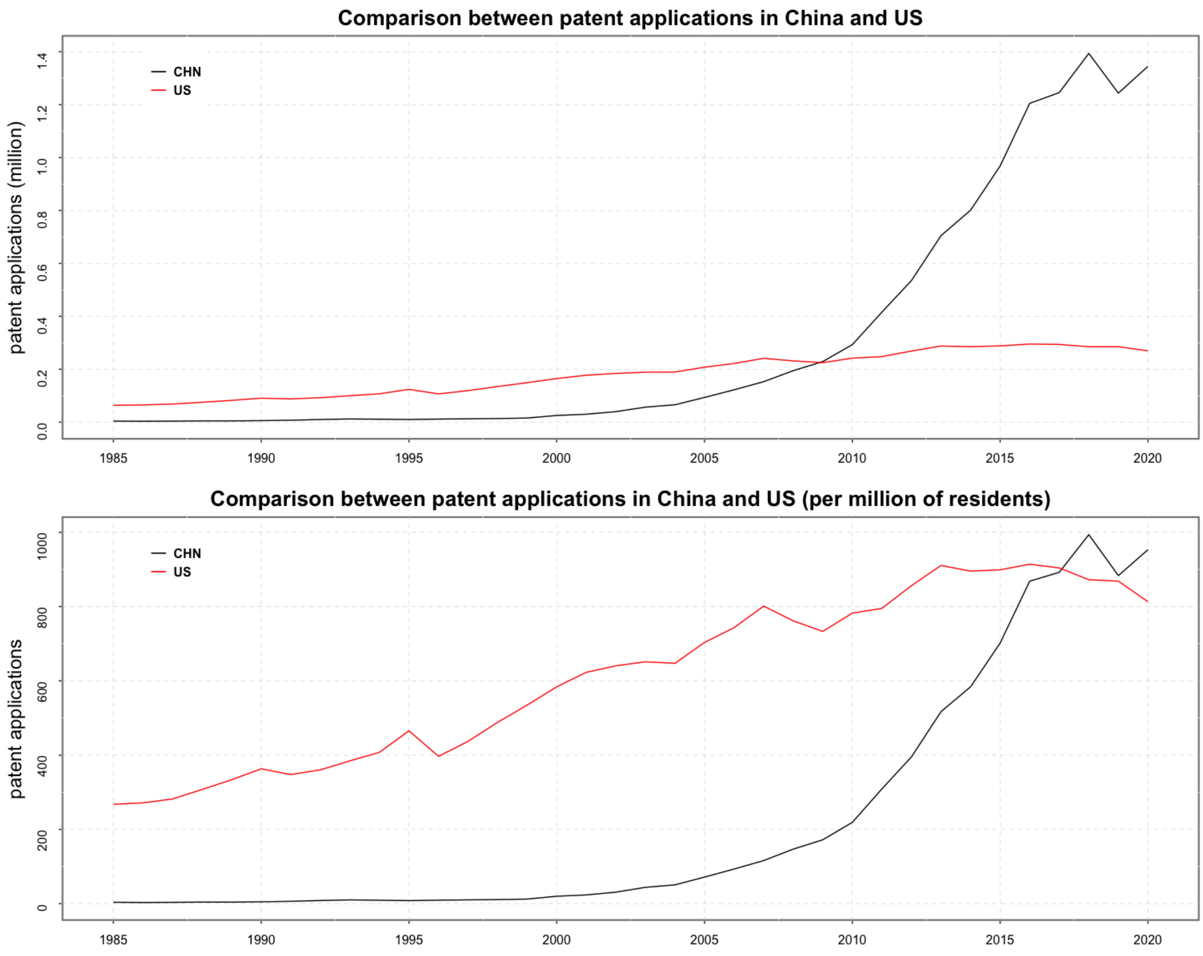

Figure 4.9: Evolution of patent applications in China and US from 1985 to 2020.

[5]2000Q1 R&D intensity rate was 2,63 % in US and 0,89 % in China, whilst in 2019Q4 the two rates were respectively 3,17 % and 2,24 % .

[6]Data from World Bank: *patent applications, residents*.

The two graphs show a vertiginous increase in China for both patent applications overall, and relative to the residents in the country; even though the second graph is scaled by the population of the two nations, the Chinese technological revolution is still highly appreciable, with United States that instead exhibit a slow increasing path. In 2018 China has surpassed for the first time the US in the number of patents per million of residents, whereas the absolute outnumbering happened in 2009.
This brief parenthesis should serve as additional supporting argument on the coherence of the findings with the study by Julie; being able to consider China as a growing technological hub, not only focused on the attraction of low-cost seeking MNEs but of qualitative foreign capital, allows to justify to a greater degree a partial decentralisation of research and development observed in Figure 4.8, as a negative spillover echoing back to the home country.
Table 4.2 summarises the findings for R&D intensity rate; it should be noticed the difference with Table 4.1 in the duration of the perturbation, since larger quarters are here reported more frequently. Moreover, as for BoG, there is an evident prevalence of developed nations, with the only partial exception found in the fast-transitioning China.

FDI host country	**Affected country**	**Direction**	**Quarters**	**Intensity (rate %)**	**R&D effect (Q average)**
Australia	Korea	Positive	6	0,0077	0,232 %
Brazil	Italy	Negative	5	0,0039	0,282 %
China	**China**	Positive	5	0,0322	1,901 %
	Italy	Negative	7	0,0042	0,301 %
	USA	Negative	9	0,0235	0,853 %
Germany	Italy	Positive	6	0,0066	0,474 %
Italy	**Italy**	Negative	13	0,0042	0,302 %
	USA	Positive	2-9;13-18	0,0091	0,329 %
	Brazil	Negative	7	0,0044	0,348 %
Japan	Korea	Positive	4	0,0058	0,175 %
Korea	**Korea**	Negative	6	0,0264	0,795 %
Netherlands	France	Negative	7;9-14	0,0155	0,667 %
	Germany	Positive	6	0,0165	0,602 %
	Italy	Negative	5;11-17	0,0194	1,393 %
	UK	Negative	5	0,0064	0,394 %
Switzerland	Italy	Positive	2-7	0,0044	0,316 %
UK	**UK**	Positive	8	0,0024	0,147 %

Table 4.2: Bilateral and third-country impact of a positive shock in FDI flows to target countries on Research & Development *(bilateral effects are indicated in **bold**).*

4.3 FDI impact on Unemployment

GIRFs of log-adjusted unemployment rate are examined in this section in order to capture possible FDI powers in influencing labor force allocation in the target nations. Overall, there is lesser significance in both bilateral and third-country responses than observed in the two previous variables, since median estimates are usually very stable, as well as their confidence intervals whose dispersion is very rapid, with little asymmetry in most of the cases. However, the most explanatory graphs of the sample are highlighted, with few of them reaching higher significance rates.

Figure 4.10 collects the most relevant cases of decreasing reactions in unemployment rate after a positive shock to FDI inflows in the nations. 5 out of 12 bilateral GIRFs exhibit a negative direction, whereas the three positive ones are reported in Figure 4.11 [1].

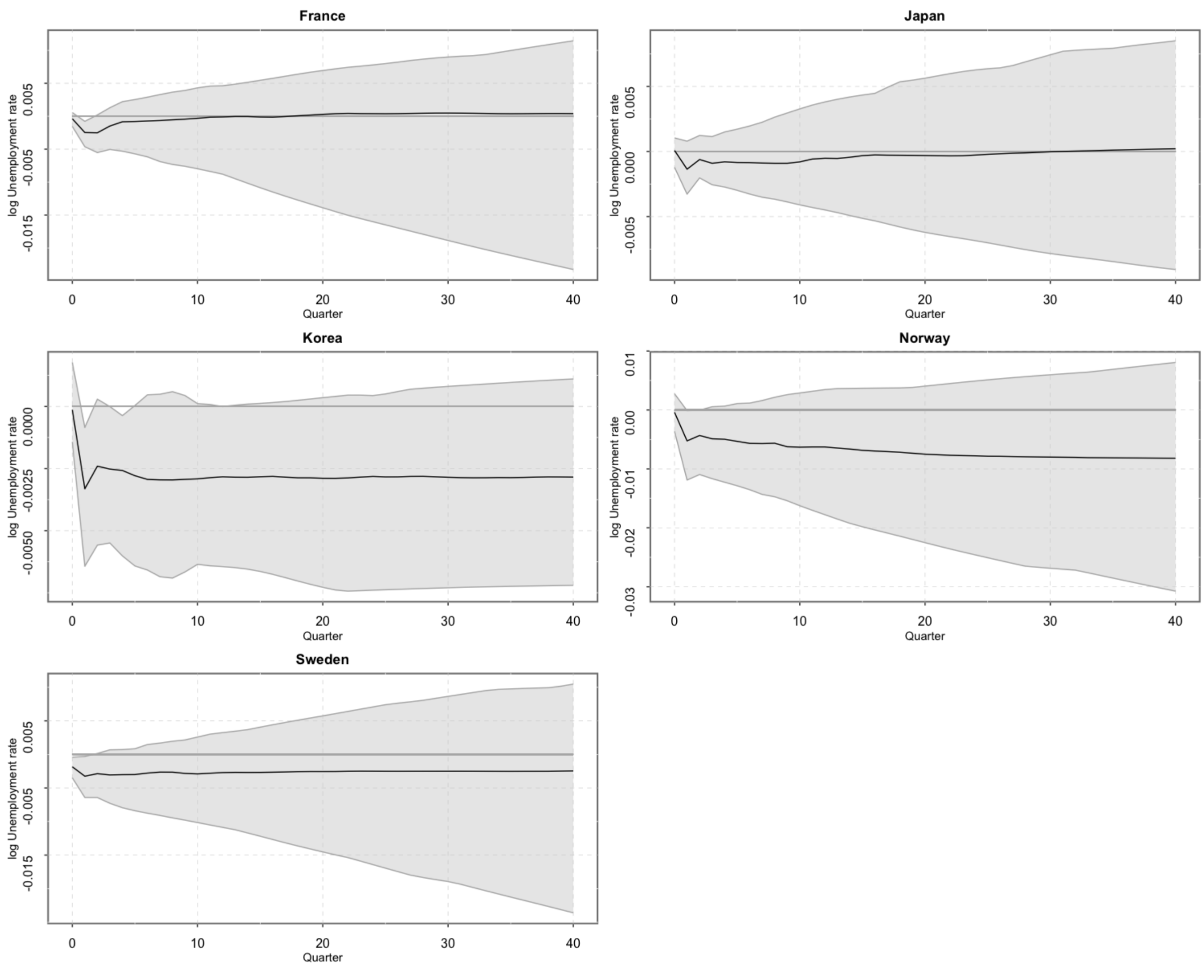

Figure 4.10: FDI decreasing bilateral effects on Unemployment rate in France, Japan, Korea, Norway and Sweden.

[1] Australia, Germany, Netherlands and UK do not produce appreciable responses, whilst Brazil, China, India and Switzerland were excluded for missing data.

In both directions, the perturbation is typically limited to the first 2-3 quarters, followed by a rapid stabilisation of the median estimate and its confidence bounds. Among the negative directions, Korea arguably shows the highest significance, followed by Norway, Japan and France which feature quite strict upper and lower intervals in the first quarter, yet revealing less appreciable asymmetry, whilst Sweden can be considered to be non-significant[2].

Relevant contrasting evidence is found particularly in Mexico, in Figure 4.11.

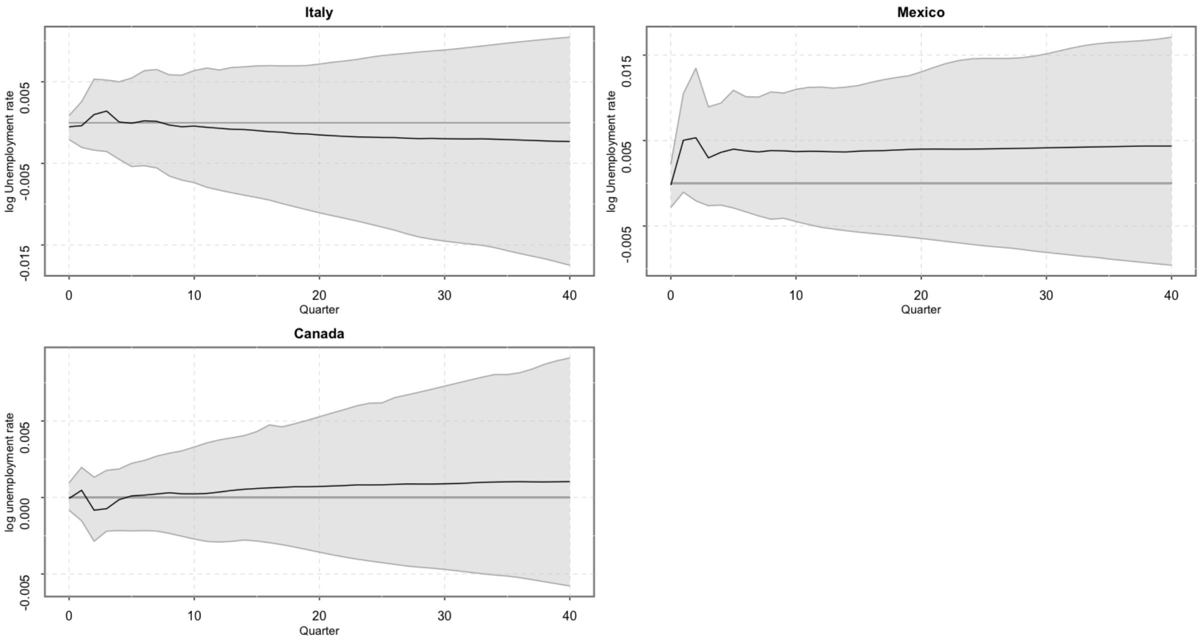

Figure 4.11: FDI increasing bilateral effects on Unemployment rate in Italy, Mexico and Canada.

The central-American country shows a sharp and increasing reaction in the first two quarters, supported by a relevant degree of asymmetry in its intervals; moreover, the intensity is the highest registered among the GIRFs for this variable. Italy and Canada do not follow this behaviour, since the former exhibits a lagged, minor, increase in unemployment rates which is eventually followed by a decreasing tendency in the long-run, whereas the latter presents an increasing trend subsequent to negligible initial oscillations; furthermore their asymmetry is trivial and their significance can be overlooked.

For what concerns third-country labor markets impacts, evidence from the dynamic analysis fail to establish a high-explanatory relationship with most of the shocks to FDI in target countries; Figure 4.12 and 4.13 present spillover impacts in unemployment rates.

[2] *Note that*: in this case, a negative reaction is associated to a contraction in unemployment, thus representing supporting evidence for economic growth and greater labor force allocation in the country.

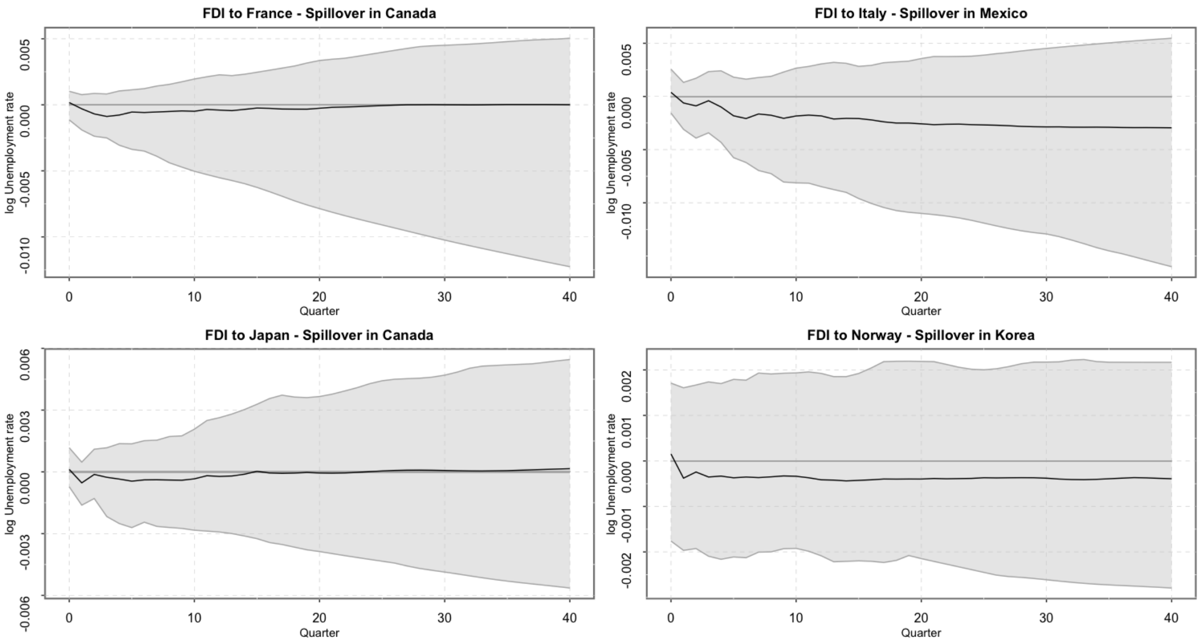

Figure 4.12: FDI decreasing spillover effects on Unemployment rate in Canada, Mexico and Korea.

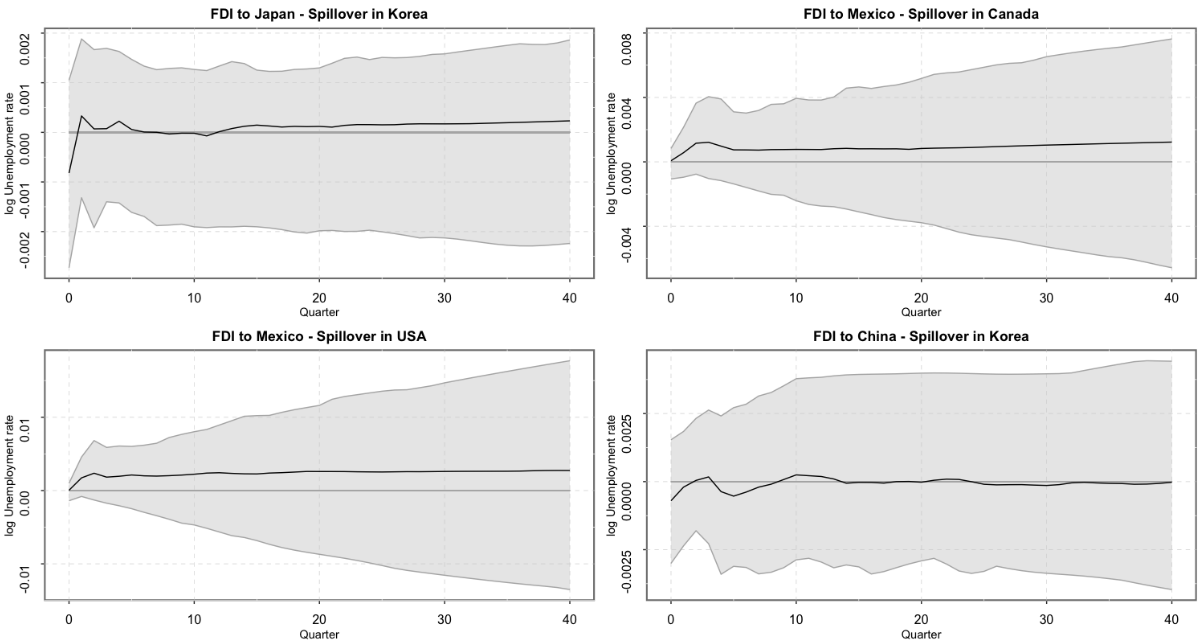

Figure 4.13: FDI increasing spillover effects on Unemployment rate in Korea, Canada and USA.

It is harder to highlight significant estimates for these functions, since most of the time the confidence area is very broad and the median estimate produces only minor reactions, both in duration and intensity, being very close to zero. One observation could be made on why the same nations are involved in these little labor market spillovers;

Canada, Korea, Mexico and USA are the only ones to be affected by FDI increases in other countries. Being the 8 functions not particularly significant, it is debatable that, in relative terms, increasing reactions have higher explanatory powers than negative ones; in particular the Mexican influence in Canada or USA, and partially the Japanese spillover in Korea, possess a greater degree of significance than the GIRFs of Figure 4.12, where only Japan somewhat impacts Canada with negligible intensity.

The neighbouring effect observed in Europe for Balance on Goods and R&D appears to be much smaller and confined to NAFTA[3] countries in the case of labor markets, where shocks to FDI inflows to Mexico rise, by limited degrees, the unemployment rate in US and Canada, perchance suggesting business relocations to a lower labor-cost country.

NAFTA's major critiques, in literature and public opinion, are often traced back to a job-deteriorating impact in the United States, especially in the manufacturing industry. Scott (2003) attributes large part of the American job recession and wage decline to the exponentially-increased imports resulting from the agreement; in particular, having observed the benefits of international agreements on trade in Chapter 4.1, their downside is in this case appreciated in labor markets, where a surge of FDI, in particular to Mexico, seem to have displaced a huge chunk of U.S. production, resulting in job losses in the originating country.

Turning again to the bilateral GIRFs of Figure 4.10 and 4.11, the findings of this section fail to establish a strong relationship between FDI and labor in most of the cases, however the majority of significant reactions are observed as bilateral decrease in unemployment rates in the target country. Literature offers here mixed results, Karlsson *et.al* (2007) find evidence for a significant impact of FDI on job creation in China, both as direct effect in foreign MNEs and as spillover to domestic firms in the same industry. This conclusion is confirmed by Lee and Park (2020) who investigate the labor market spillover on domestic firms in a sample of Korean companies; they find not only greenfield FDI to be a significant contributing factor to the increase of domestic employment levels, but they conclude also that this effect is particularly pronounced when inward investments come from developed economies, thus reinforcing the results obtained here for Korea.

With respect to the contrasting evidence found in Mexico in 4.11, it should be noticed

[3] *Notice that*: USMCA agreement has been signed on October 2018 and is valid from July 2020. The data in this thesis is therefore collected under the NAFTA agreement.

that, based on the earlier assumption of big portion of U.S. production being transferred to Mexico under the NAFTA, one could have expected to observe a decreasing unemployment rate in the country. However, the mentioned studies also suggest that spillovers to domestic firms are not immediate, but instead closely related to the type of infrastructure in place in the host country; in particular, greenfield FDI are usually associated to two possible outcomes: either the foreign enterprises are able to generate new business opportunities for downstream or upstream companies in the same industry or, conversely, a preeminence of MNEs in the country could cause a crowding out of local businesses, following unsustainable competition levels[4]. In the Mexican case this role could be attributed to the so-called ”Maquiladoras”, referred as manufacturing parent plants based in the Northern region of Mexico and administered in the US; the major advantages of these establishments are the low-costs of labor and their free duty nature[5]. Ernst (2005) determines that the maquiladora industry has been of particular relevance in favouring job creation during its boom in the 1990s, although this trend was inverted quite rapidly, since these FDIs were not able to guarantee sufficient opportunities to local businesses, with the majority of workers being relegated to the Mexican's informal sector (Faux, 2001).

Lastly, it is owed mentioning that the unemployment rate in Mexico is the third-lowest of the dataset, right above Korea and Norway, arguably failing to properly picture the problematic reality of the country; the rate is frequently considered to be heavy-underestimated mainly due to measurement methodologies and demographic distribution between cities and rural communities[6].

To conclude the overview of FDI impacts on unemployment, Table 4.3 reports the results of this section: it is noticeable that the duration of the perturbation is overall very limited, reaching the second year on just two occasions; moreover, the intensity is quite low, with the highest percentages observed as bilateral responses for Mexico and Norway, in opposing directions.

[4] *Notice that*: coherently with Mucuk and Demirsel (2013) greenfield are vastly accepted to be the most effective form of labor enhancing FDI, against brownfield which possesses lesser relevance in this field.

[5] US firms, when establishing a maquiladora in Mexico, are able to export materials to be processed in the plant without incurring in any tariffs, whereas these are only paid on the added value when the final product is imported back in the US, or in a third-country.

[6] Quarterly average unemployment rate in Mexico is 3,98 %, very similar to the Norwegian (3,83 %) and much below of the highest registered in Italy and France (9,42 % and 9,14 %).

FDI host country	Affected country	Direction	Quarters	Unemployment effect
China	Korea	Positive	3; 5-11	0,1626 %
France	**France**	Negative	2	0,2136 %
	Canada	Negative	3	0,1052 %
Italy	**Italy**	Positive*	3	0,1924 %
	Mexico	Negative	6	0,2463 %
Japan	**Japan**	Negative	2	0,0700 %
	Canada	Negative	1	0,0654 %
	Korea	Positive	1	0,1151 %
Korea	**Korea**	Negative	1	0,3183 %
Mexico	**Mexico**	Positive	2	0,5536 %
	Canada	Positive	3	0,1146 %
	USA	Positive	2	0,2326 %
Norway	**Norway**	Negative	2	0,4848 %
	Korea	Negative	1	0,0531 %
Sweden	**Sweden**	Negative	1	0,1401 %

Table 4.3: Bilateral and third-country impact of a positive shock in FDI flows to target countries on Unemployment rate *(bilateral effects are indicated in* ***bold****)*.
*Decreasing tendency in the long-run.

4.4 FDI impact on Real GDP

The last variable whose implications have been studied is Real GDP. As anticipated, it could be revealed that the impact of American FDI on the log-adjusted endogenous variable shows very little significance; this result is somewhat coherent with the size of the two economic measures, where the dependent one is in this case sensitively larger than the exogenous. The functions observed here show very large confidence areas, with usually limited asymmetry, moreover the intensity in percentage terms is of minor relevance, most of the time failing to even arrive at 0,1 %.
In this framework, the results are again presented as bilateral and third-country responses, and then collected in Table 4.4 at the end of the section.

Bilateral responses on log-adjusted real GDP are observed in Figure 4.14 and 4.15.
As one can capture, the pattern of the GIRFs is quite similar among the presented countries, where a limited sharp reaction at low lags (around the first two quarters) tends to quickly stabilise itself after minor perturbations.

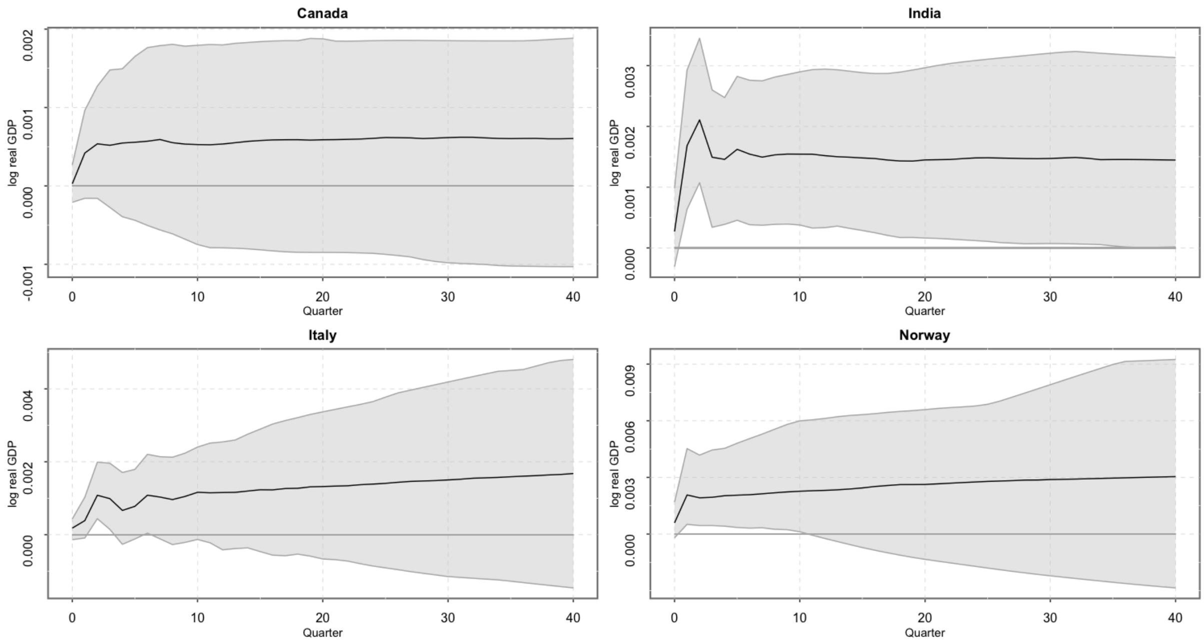

Figure 4.14: FDI positive bilateral effects on Real GDP in Canada, India, Italy and Norway

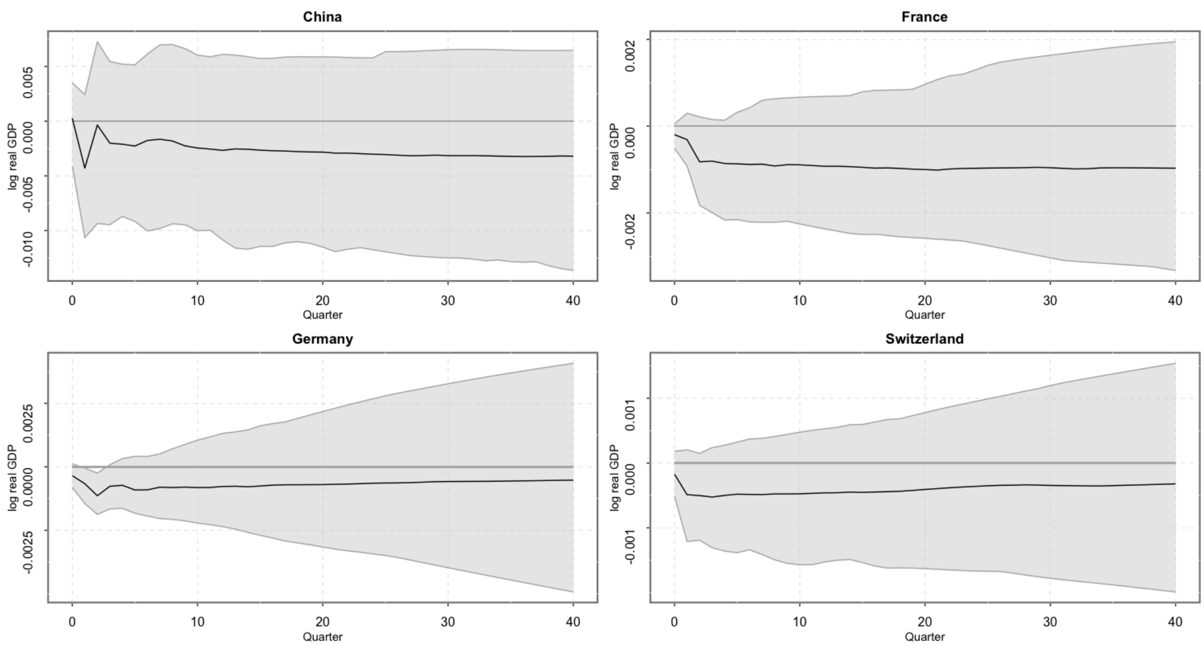

Figure 4.15: FDI negative bilateral effects on real GDP in China, France, Germany and Switzerland

Inadequate asymmetrical patterns are observed frequently among the confidence bands, in particular for negative reactions; the countries highlighting the best, relative, response are arguably India and Italy, since at least in the first quarters the intervals are somewhat tied to the increasing median estimates and with the former having the highest intensity.

Among third-country impacts, Figure 4.16 collects a series of positive spillovers directed to China, whilst 4.17 and 4.18 review other countries involved in both directions. The common feature is again a low-significance, with quick and minor responses confined in very broad confidence intervals.

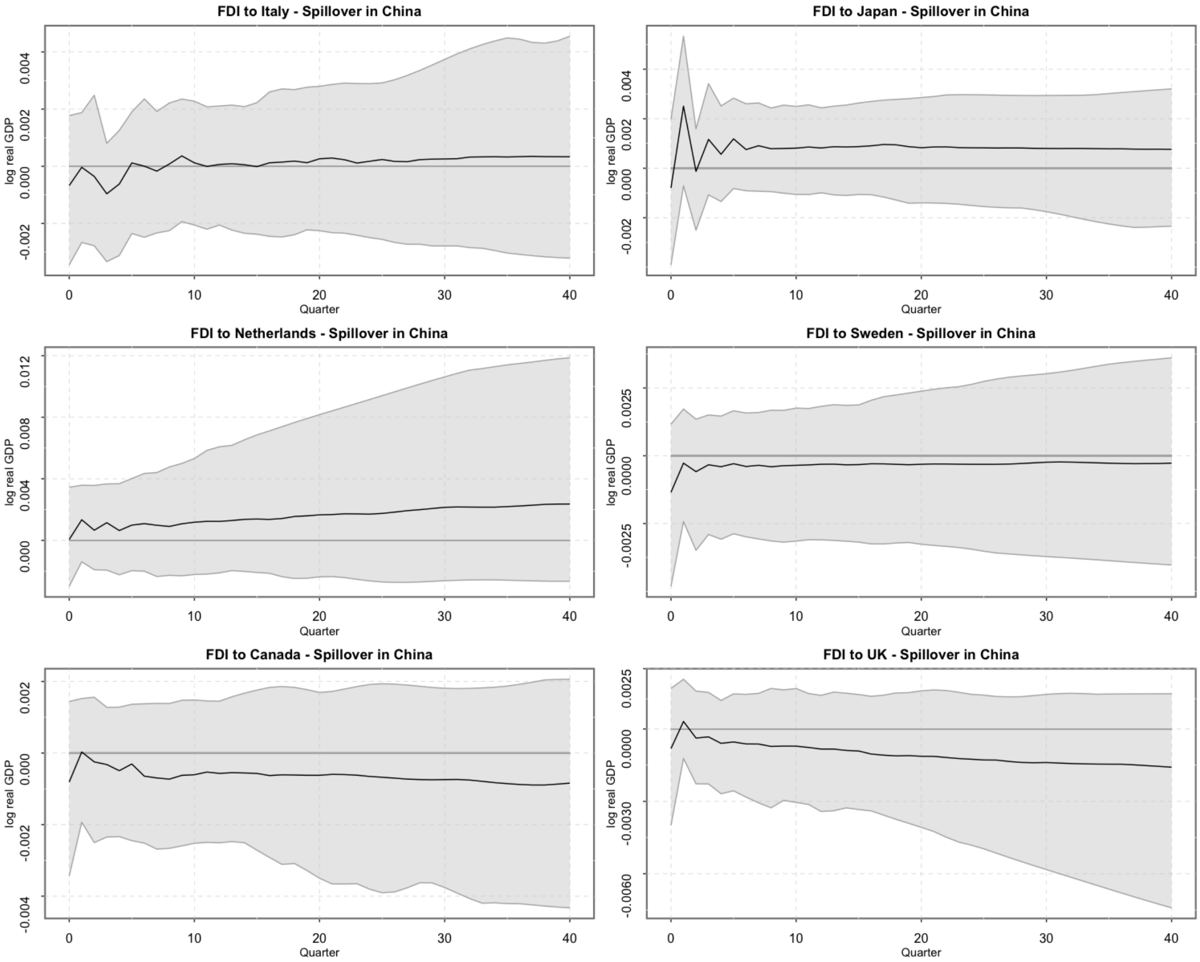

Figure 4.16: FDI positive spillover effects on Real GDP in China

Overall, it is again observed that negative reactions are particularly unexpressive in determining a solid short-term relation; the same holds for positive GIRFs, where only few graphs show poorly increasing levels of significance. The Japanese spillover to China in Figure 4.16 exhibit sudden movements during the first 5 quarters, enclosed in confidence bands which are not completely unaffected; moreover its intensity is the highest of the sample, arriving at 0,33 %. Furthermore, Figure 4.17 shows relatively higher degrees of significance for spillovers in UK.

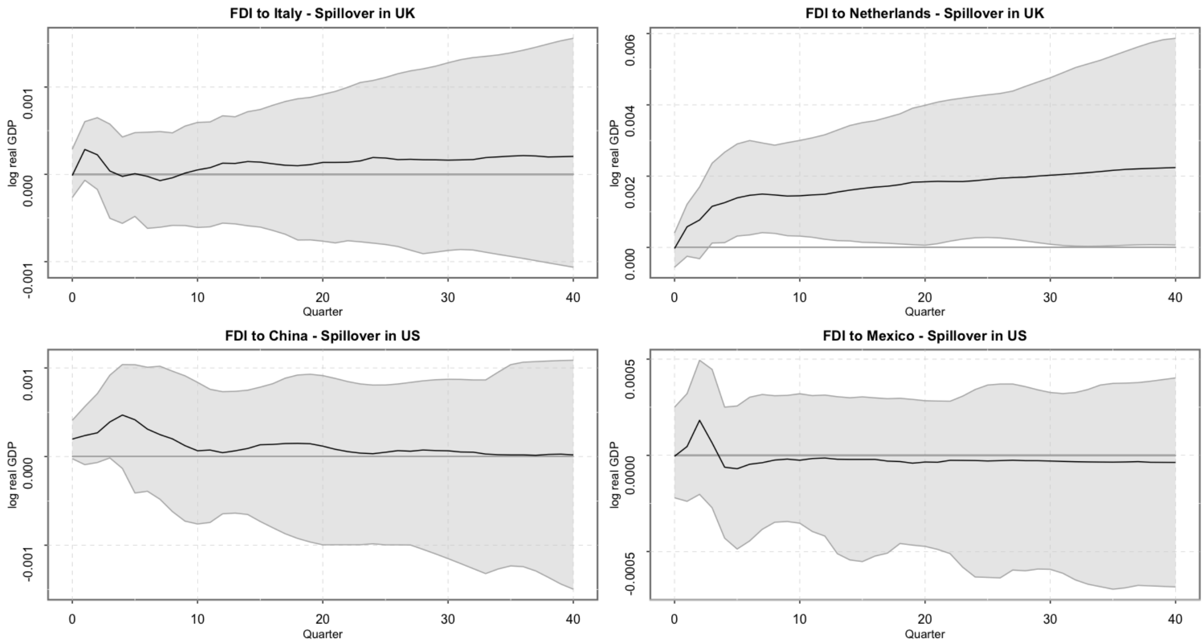

Figure 4.17: FDI positive spillover effects in UK and USA

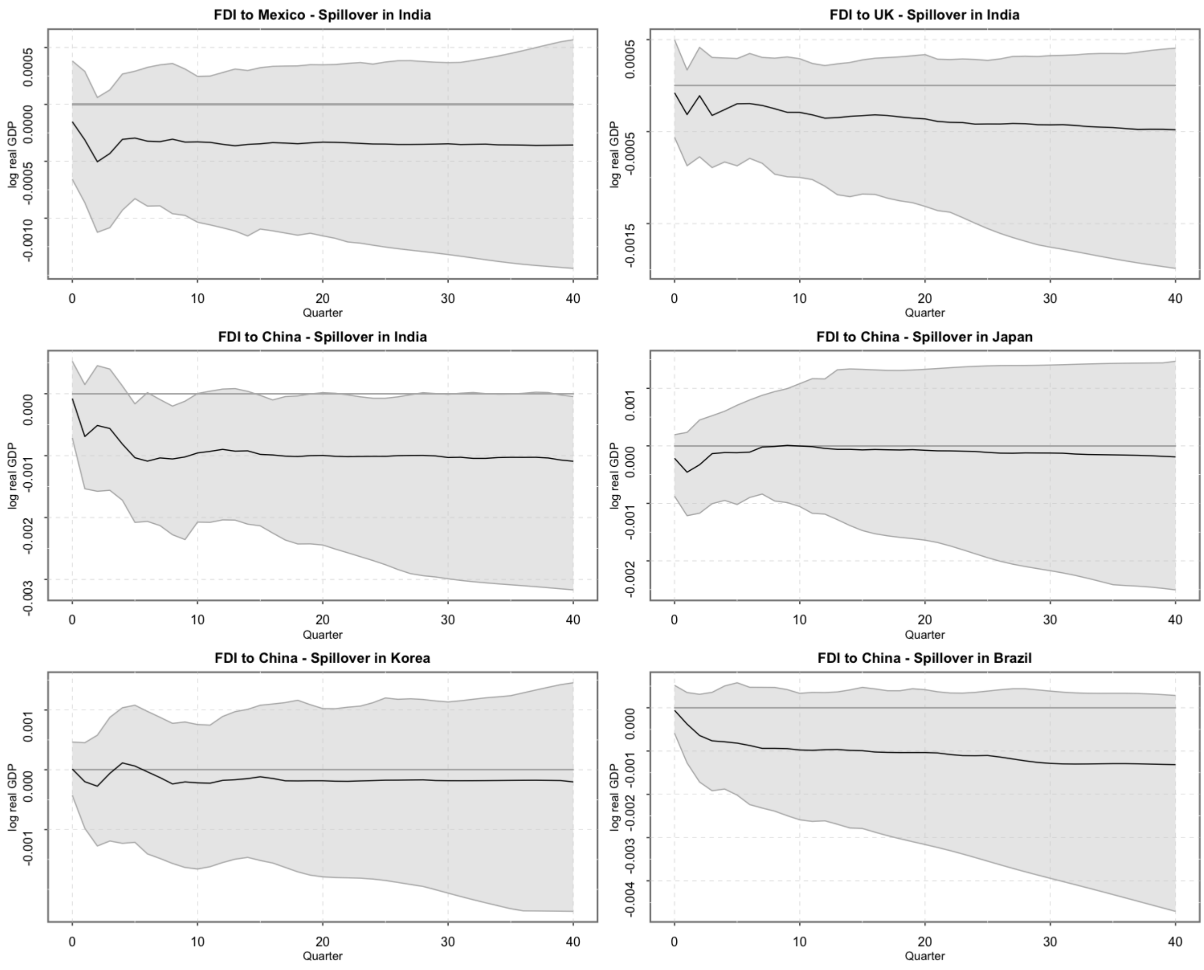

Figure 4.18: FDI negative spillover effects on real GDP in India, Japan, Korea and Brazil

The findings of this section are approximately unable to establish a relation cause between FDI and host country's GDP, this conclusion is confirmed by Encina-Ferrer and Villegas-Zermeño (2015); in particular, the authors test Granger causality between FDI and GDP in a set of five nations[1] and they find no causal link between the two variables in all the cases except for China, where instead GDP growth is revealed as the independent variable, playing an attracting role on FDI, and not the contrary. Gokmen (2021) arrives at the same result when studying impulse response functions in Turkey.
Yet, it should be noted that mixed evidence can be found in literature; Talwar and Srivastava (2018) test the relation on a set of developed and developing countries and find significant evidence only in India for the contributing role of FDI to GDP growth, partially reflecting the (little) relevance observed here, in the Indian economy.
Overall, the impact of FDI on economic growth is arguably tied to the characteristics of the single country, Baiashvili and Gattini (2020) find that positive contribution to GDP per-capita growth is somewhat higher in developing countries; moreover arriving to an inverse U-shaped relation, based on the income level of the host country. The pattern is justified by the fact that middle-income countries have higher absorption capacity than low-income ones, and higher demand for investments and technologies than high-income economies. On the basis of the World Bank Atlas method for classification of countries' development, the "low-middle income" Indian economy can be considered to be again quite coherent with the result found here[2].

Table 4.4 concludes this section and the entire analysis of the dynamic properties of the Generalised Impulse Response Functions.
It is evident the described negligible intensity of the responses, with a duration limited to the first year in most of the cases.

[1]Brazil, China, Korea, Mexico, Perù.
[2]Based on GNI per capita, *low-middle* income economies are found among the ones between $ 1'086 and $ 4'255 (*high* income economies are above $ 13'025).

FDI host country	**Affected country**	**Direction**	**Quarters**	**Real GDP effect**
Canada	**Canada**	Positive	2	0,0510 %
	China	Positive	5	0,0502 %
China	**China**	Negative	2	0,0612 %
	USA	Positive	4; 12-19	0,0372 %
	India	Negative	6	0,1012 %
	Japan	Negative	1	0,0241 %
	Korea	Negative	8	0,0249 %
	Brazil	Negative	2	0,0582 %
France	**France**	Negative	2	0,0626 %
Germany	**Germany**	Negative	5	0,0977 %
India	**India**	Positive	2	0,1836 %
Italy	**Italy**	Positive	2	0,0901 %
	China	Positive	9	0,1035 %
	UK	Positive	1; 7-12	0,0498 %
Japan	China	Positive	6	0,3302 %
Mexico	USA	Positive	2	0,0187 %
	India	Negative	2	0,0352 %
Netherlands	China	Positive	3	0,1771 %
	UK	Positive	3	0,1182 %
Norway	**Norway**	Positive	1	0,1477 %
Sweden	China	Positive	1	0,1076 %
Switzerland	**Switzerland**	Negative	1	0,0315 %
UK	China	Positive	1	0,1125 %
	India	Negative	3	0,0246 %

Table 4.4: Bilateral and third-country impact of a positive shock in FDI flows to target countries on Real GDP *(bilateral effects are indicated in **bold**).*

Conclusion

This thesis investigates the contribution of Foreign Direct Investment to economic growth and technological progress in a sample of countries during the period 2000Q1 - 2019Q4. The main characteristics of FDI have been examined in the Introduction, with theoretical evidence for benefits and downsides of the instrument. In particular, FDI has been defined as an investment abroad having a lasting interest in the foreign affiliate; from OECD and IMF, 10% of the voting rights in the target company is considered as the minimum threshold for the characterisation of the financial transaction as direct investment. A number of technical forms have been defined with their corresponding rationales, which are universally tied to the exploitation of locational advantages, being these in the form of costs reduction, advanced infrastructures and technologies, skilled workforce, trade agreements between countries, and more.

The United States has been chosen as reporting country for FDI outflows to a set of 16 target economies around the World, selected mainly among the principal nations receiving American funds. The U.S. has been analysed with the perspective of the home country given its large political international influence and its global-leading position for stock of investments to other economies.

In order to implement the empirical analysis, the Global Vector Autoregressive model by Pesaran *et.al* (2004) has been exploited, given its accepted contributions in addressing dimensionality problems when working with models of multiple variables. The model has been revised in Chapter 1, defining a two-step procedure used to arrive to a unique Vector Autoregressive model, from a set of country-specific VARs stacked together; the method allows to resolve the issue of model-complexity by defining a singular GVAR model with a large number of parameters, already-estimated separately in the first step.

The dynamic properties of the fitted model have been revised in Chapter 4 as interpretation of Generalised Impulse Response Functions, produced once a positive shock to FDI

outflows to each country has been introduced in the GVAR; these functions are used to evaluate the short-term response in four variables proxying sample countries' wellbeing: Balance on Goods, Research and Development, Unemployment rate and Real GDP.
The patterns have been observed as bilateral responses in the directly interested target countries and as third-country reactions, or *spillover*, when a shock to FDI inflows in one economy had impacts in another country. The results thus have been accompanied by relevant supporting or contrasting literature.

The most responsive variables throughout the sample are arguably BoG and R&D intensity rates, where not only significant bilateral responses were found but also spillover to close economies, frequently observing a neighbouring effect particularly pronounced in Europe.
Significant impacts on unemployment rates were more dispersed and mainly referred to bilateral relations with the target economy. Finally, impacts on Real GDP in sample countries were almost always non-significant, giving the magnitude of the endogenous variable if compared to the size of FDI flows, in this case failing to impact on economic growth with notable intensity and relevance.
In particular, mixed results are obtained for bilateral impacts on Balance on Goods, where China's trade balance significantly benefits from increases in FDI inflows, with UK and Canada exhibiting similar patterns at low-significance levels; contrasting evidence is found mainly in France, Korea and Switzerland. Relevant literature seems to support the latter reaction, however allowing for increases in exports in highly-productive countries for manufacturing activities and between economies involved in trade agreements. Third-country impacts are characterised instead by a strong prevalence of positive spillovers to geographically-close economies; particularly appreciable is the involvement of Switzerland, with significant responses affected by Italian and Deutsch economies.
Technological progress, measured by expenditures on R&D as percentage of GDP, is found to be significantly affected by FDIs; China shows a sharp increase in its GIRF at high significance and intensity and it is also involved in a negative spillover directed to the home economy, possibly related to a relocation phenomenon for research activities from the U.S. to the target country. Contrasting evidence is found for a decreasing curve in Korea and as negative spillovers from Netherlands to UK and Italy.

Among labor market effects, the most relevant responses exhibit decreasing rates of unemployment levels as bilateral impact in Korea, Norway, Japan and France, whereas contrasting evidence is found in Mexico for bilateral and third-country reactions in U.S. and Canada, in accordance with part of the literature which attributes this deteriorating effect to adverse implications of the NAFTA agreement and labor-intensive establishments.
Lastly, Real GDP impacts are overall negligible as anticipated, with minor involvement of Chinese and Indian economies.

The findings of this thesis are overall coherent with the size of FDI outflows to target countries from the U.S. reported in Figure 2.1, where the major economies involved are found in USMCA countries, Europe and China, with isolated impacts in Asia for Japan and Korea. Moreover, it is overall appreciated a prevalence of impacts in developed countries.

List of Figures

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Useful Links

GVAR Modelling:	sites.google.com/site/gvarmodelling/home
OECD website:	oecd.org
IMF website:	imf.org/en/Home
US BEA website:	bea.gov
FRED website:	fred.stlouisfed.org
World Bank website:	worldbank.org/en/home
X-13 software:	census.gov/data/software/x13as.html
US ITA website:	trade.gov

Appendix

Country	p	q
Australia	1	1
Brazil	2	1
Canada	2	1
China	2	1
France	2	1
Germany	2	1
India	2	1
Italy	2	1
Japan	1	1
Korea	2	1
Mexico	2	1
Netherlands	2	1
Norway	1	1
Sweden	1	1
Switzerland	1	1
United Kingdom	2	1
USA	2	1

Table A1: VARX* order of individual models.

Table A2: Weight matrix (based on fixed-weights)

Country	**Australia**	**Brazil**	**Canada**	**China**	**France**	**Germany**	**India**	**Italy**	**..**
Australia	0	0,008923	0,00467	0,04994	0,007523	0,007951	0,053012	0,01064	..
Brazil	0,006929	0	0,006495	0,035056	0,012941	0,014590	0,027485	0,017361	..
Canada	0,015111	0,0242787	0	0,025768	0,010357	0,009626	0,017617	0,011370	..
China	0,277299	0,202877	0,063618	0	0,055168	0,087603	0,206958	0,07049	..
France	0,02203	0,042961	0,010959	0,028435	0	0,167158	0,037007	0,195652	..
Germany	0,048259	0,09615	0,020355	0,087411	0,309553	0	0,08157	0,275683	..
India	0,046123	0,029125	0,005008	0,033276	0,010430	0,012325	0	0,015106	..
Italy	0,025802	0,046601	0,009167	0,026099	0,147382	0,111048	0,037928	0	..
Japan	0,219582	0,06312	0,032702	0,208076	0,025159	0,035041	0,060807	0,026256	..
Korea	0,088773	0,046058	0,01234	0,137248	0,011607	0,017743	0,057556	0,015232	..
Mexico	0,00814	0,038719	0,03108	0,015274	0,005171	0,010419	0,011968	0,008653	..
Netherlands	0,016115	0,058591	0,006946	0,036587	0,10034	0,161116	0,038089	0,074607	..
Norway	0,001889	0,006806	0,008839	0,003691	0,014590	0,026634	0,004978	0,008499	..
Sweden	0,010909	0,011265	0,00352	0,007741	0,022529	0,034409	0,011163	0,0195	..
Switzerland	0,011082	0,019365	0,004816	0,010714	0,049360	0,073282	0,076842	0,068400	..
UK	0,056159	0,034559	0,030170	0,033341	0,121579	0,115642	0,064055	0,085427	..
USA	0,145801	0,270592	0,74932	0,261340	0,096313	0,115413	0,212966	0,097101	..

Continued on next page

Table A2 – weight matrix continued.

Country	**Japan**	**Korea**	**Mexico**	**Netherlands**	**Norway**	**Sweden**	**Switzerland**	**UK**	**USA**
Australia	0,064951	0,048398	0,002675	0,005888	0,002449	0,01211	0,008372	0,018156	0,013858
Brazil	0,014870	0,021287	0,014561	0,016642	0,009518	0,010349	0,010542	0,010305	0,024914
Canada	0,026448	0,01823	0,030709	0,008051	0,035056	0,011148	0,01268	0,030578	0,250138
China	0,305527	0,325524	0,069269	0,08806	0,044236	0,053470	0,041695	0,071728	0,17192
France	0,023485	0,017029	0,007412	0,115835	0,087632	0,083273	0,122359	0,120466	0,030777
Germany	0,053174	0,050480	0,028674	0,352101	0,167259	0,235729	0,356945	0,197466	0,062364
India	0,014133	0,027136	0,005515	0,00886	0,004444	0,011667	0,01132	0,019762	0,018239
Italy	0,017657	0,016843	0,010028	0,061888	0,037339	0,053159	0,129973	0,063116	0,022147
Japan	0	0,196967	0,033263	0,030580	0,021632	0,027756	0,039462	0,036700	0,097748
Korea	0,105520	0	0,023119	0,011782	0,018952	0,011778	0,009649	0,014954	0,039637
Mexico	0,014882	0,018185	0	0,005953	0,001569	0,005654	0,006379	0,005303	0,168271
Netherlands	0,025195	0,017393	0,007257	0	0,112414	0,095289	0,050654	0,117585	0,023604
Norway	0,003824	0,007521	0,000497	0,028233	0	0,1492	0,004288	0,048803	0,004622
Sweden	0,005669	0,004639	0,002409	0,029059	0,127774	0	0,012654	0,032606	0,007833
Switzerland	0,013265	0,005652	0,003813	0,017127	0,010279	0,016967	0	0,040084	0,016154
UK	0,029491	0,02238	0,0073534	0,127253	0,243365	0,123054	0,065759	0	0,047768
USA	0,281910	0,20233	0,753445	0,092682	0,076082	0,099375	0,117267	0,172388	0

Table A3: Unit root test for the domestic variable at 5% confidence level.

Country	**y (w.t.)**	**y (n.t.)**	**Dy**	**DDy**	**Ntr (w.t.)**	**Ntr (n.t.)**	**DNtr**	**DDNtr**
Australia	-1,39	-3,04	-7,72	-9,26	-3,04	-2,30	-5,95	-9,35
Brazil	-1,56	-1,23	-4,62	-7,49	-2,30	-2,36	-8,13	-11,57
Canada	-2,01	-1,73	-3,55	-5,97	-3,88	-1,43	-8,50	-9,73
China	0,39	-1,04	-1,20	-73,49	-2,41	-1,46	-7,87	-9,22
France	-2,51	0,49	-3,98	-6,72	-1,58	-1,48	-8,67	-9,97
Germany	-2,67	0,73	-5,82	-6,86	-2,79	-2,49	-6,74	-8,08
India	-1,88	-1,15	-5,22	-11,32	-1,79	-1,46	-7,11	-7,49
Italy	-2,21	-0,02	-4,26	-7,28	-1,73	-0,68	-6,12	-8,53
Japan	-1,88	-1,71	-5,76	-7,70	-2,10	-1,80	-5,43	-10,48
Korea	-2,69	-1,14	-5,45	-7,06	-2,79	-1,57	-7,42	-9,35
Mexico	-1,58	-1,17	-6,06	-7,86	–	–	–	–
Netherlands	-1,81	-0,31	-4,66	-7,00	–	–	–	–
Norway	-1,68	-1,37	-4,57	-6,97	–	–	–	–
Sweden	-2,79	0,25	-4,81	-8,39	-2,13	-1,71	-8,05	-13,99
Switzerland	-2,09	-0,70	-4,72	-8,97	-6,38	-1,26	-10,28	-8,25
UK	-2,05	-0,09	-4,55	-7,61	-2,27	-2,38	-7,10	-9,98
USA	-1,89	-0,61	-5,68	-8,94	-2,77	-2,46	-5,85	-7,16

Continued on next page

Table A3 – unit root continued. (critical values at: -3,45, -2,89, -2,89, -2,89)

Country	**rd (w.t.)**	**rd (n.t.)**	**Drd**	**DDrd**	**un (n.t.)**	**un (n.t.)**	**Dun**	**DDun**
Australia	–	–	–	–	-1,98	-2,01	-5,10	-7,34
Brazil	-5,22	-4,94	-3,07	-9,46	–	–	–	–
Canada	-9,87	-0,55	-15,44	-14,30	-2,41	-2,00	-4,84	-8,90
China	-2,57	-1,45	-2,89	-9,31	–	–	–	–
France	-3,39	-2,84	-3,81	-11,84	-2,07	-2,14	-4,37	-9,47
Germany	-3,23	0,13	-2,31	-9,51	-2,81	-0,81	-2,76	-6,49
India	-2,32	-2,05	-2,38	-5,62	–	–	–	–
Italy	-3,70	-2,36	-2,99	-9,16	-1,84	-1,19	-3,51	-9,78
Japan	-2,02	-2,32	-3,53	-6,32	-1,57	0,43	-4,60	-8,23
Korea	-2,70	-0,28	-2,77	-8,74	-2,89	-2,99	-6,26	-7,24
Mexico	-8,23	-1,27	-2,19	-7,34	-1,04	-1,66	-5,81	-7,95
Netherlands	-2,48	-0,96	-1,72	-7,70	-2,45	-2,84	-3,04	-8,19
Norway	–	–	–	–	-2,72	-2,59	-4,48	-8,14
Sweden	–	–	–	–	-3,36	-3,65	-3,40	-7,57
Switzerland	–	–	–	–	–	–	–	–
UK	-3,56	-2,42	-2,24	-7,99	-1,08	-1,11	-3,43	-9,24
USA	2,29	3,92	0,99	-18,09	-2,23	-2,38	-3,06	-5,16

Country	**Cointegrating relations**
Australia	0
Brazil	0
Canada	4
China	2
France	3
Germany	2
India	1
Italy	2
Japan	3
Korea	1
Mexico	2
Netherlands	0
Norway	1
Sweden	2
Switzerland	2
United Kingdom	3
USA	2

Table A4: Number of cointegrating relations in each country.

Country	y	Ntr	rd	un	FDI
Australia	0,018522	0,024185	–	0,033661	0,018745
Brazil	0,026921	0,035153	0,034679	–	0,027246
Canada	0,009691	0,012654	0,012483	0,017611	0,009807
China	0,011756	0,015351	0,015144	–	0,011898
France	0,062080	0,081062	0,079969	0,112822	0,062828
Germany	0,038676	0,050502	0,049821	0,070288	0,039142
India	0,291670	0,380854	0,375720	–	0,295187
Italy	0,008747	0,011422	0,011276	0,015897	0,008852
Japan	0,005612	0,007328	0,007229	0,010200	0,005680
Korea	0,064631	0,084394	0,083257	0,117460	0,065411
Mexico	0,089018	–	0,114671	0,161779	0,090092
Netherlands	0,115246	–	0,148457	0,209445	0,116636
Norway	0,029903	–	–	0,054345	0,030264
Sweden	0,055873	0,072958	–	0,101542	0,056547
Switzerland	0,119406	0,155916	–	–	0,120845
UK	0,040333	0,052666	0,051956	0,073300	0,040819
USA	0,011913	0,015556	0,015346	0,021651	–

Table A5: Country-specific aggregation weights.