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Bilateral trade between China and the European Union: Emerging challenges and opportunities in a shifting global landscape

Oscar Claveria and Mihály Tamas Borsi

UBIREA Institut de Recerca en Economia Aplicada Regional i Pública

Abstract

This paper examines trade relations between China and the European Union from 2000 to 2022, focusing on the role of trade policy uncertainty alongside key economic and institutional factors. Using an extended gravity model, the results show that China's economic growth is a dominant driver of trade flows. The study introduces a novel proxy for China's trade policy uncertainty, finding that it significantly influences bilateral trade. Results are robust to different specifications. Additionally, the results indicate that while non-eurozone EU countries demonstrate higher trade flows with China, the immediate impact of China's Belt and Road Initiative on EU trade remains limited. Given the anticipatory nature of trade policy uncertainty and its relationship with economic growth, the findings highlight the usefulness of trade uncertainty indicators as tools for the early detection of shifts in trade patterns, offering valuable insights for policymakers to design strategies that promote greater stability and economic integration.

Keywords: international trade; economic growth; uncertainty; China; European Union; gravity model

JEL Classification: : C33; F13; F14; O24.

Authors:

Oscar Claveria, AQR-IREA University of Barcelona. Corresponding Author.

Tamas Borsi. IQS School of Management, Universitat Ramon Llull

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1. Introduction

The bilateral trade relationship between China and the European Union (EU) has become a cornerstone of global commerce, exerting a significant impact on both regional and international economic landscapes. With a combined Gross Domestic Product (GDP) exceeding $36 trillion (World Bank, 2025), China and the EU are among the world's largest trading partners, collectively influencing global market dynamics and economic stability. Since China's accession to the World Trade Organization (WTO) in 2001, its economic integration and trade interactions have deepened, driven by strategic government policies that promote export sophistication and foster global competitiveness (Rodrik, 2006). Initiatives such as the China-Europe Railway Express in 2011 and the Belt and Road Initiative (BRI) in 2013 have enhanced connectivity and lowered trade costs through investments in railways, ports, and trade corridors, and created new opportunities for economic cooperation and integration into global supply chains, facilitating cross-border trade, particularly between China and the EU (Fardella and Prodi, 2017; Li et al., 2020; Yu et al., 2020).

According to the European Commission (2025), China is the EU's second largest trading partner for goods after the United States (US), with bilateral trade reaching €739 billion in 2023. China is the EU's third-largest partner for exports and the biggest for imports. The EU-China trade balance has been persistently in favor of China. In 2023, the EU deficit amounted to €292 billion. The EU's economic relationship with China is critically unbalanced, both in terms of trade flows and of investment, due to a significant asymmetry in the EU's respective market openings. However, the challenges and opportunities presented by this symbiotic relationship has shifted over time.

Despite these achievements, recent global developments, including escalating geopolitical tensions, economic disruptions, and trade policy uncertainty, have introduced significant challenges to the China-EU trade relationship. The COVID-19 pandemic exposed critical vulnerabilities in global supply chains, disrupting production networks and leading to reconsiderations of over-reliance on single suppliers. Likewise, the most recent Russia-Ukraine conflict has further strained global trade dynamics, prompting European countries to reassess their energy dependencies and trade alliances, with implications for their relationship with China. Heightened scrutiny of trade dependence, industrial policies, and the strategic alignment of global supply chains have gained prominence in European policymaking. Meanwhile, the Comprehensive Agreement on

Investment that was concluded in 2020, initially envisioned as a milestone to deepen China-EU economic ties, has faced significant ratification setbacks amid concerns over human rights, political disagreements, and shifting priorities within the EU.

Adding to these complexities, the EU's growing focus on economic security, stricter regulatory measures, and debates over technological and market access reflect a broader shift in the bilateral trade landscape. At the same time, China has adjusted its trade strategy, moving from export-driven processing trade to ordinary trade centered on local inputs and domestic demand (Lemoine and Unal, 2017). The combination of all these factors emphasize the broader interplay of political, economic, and social frictions that shape the China-EU trade dynamics in an increasingly uncertain global environment.

In this evolving context, reassessing the key determinants of trade between China and the EU is crucial. This study provides a comprehensive analysis of bilateral trade dynamics and their policy implications, focusing on trade flows between China and the 27 EU member states over the period 2000-2022. Using an extended gravity model, it incorporates a novel measure of trade policy uncertainty in China proposed by Davis et al. (2019) as a key variable, along with other institutional and policy-related factors. To the best of our knowledge, this is the first study to include trade uncertainty as a potential driver of bilateral trade between China and the EU. By integrating these elements, the study offers new insights into the recent developments in China-EU trade relationships.

The empirical findings of this study, consistent with the gravity model framework and the corresponding literature, confirm that economic development is a primary driver of bilateral trade flows, with China's economic growth exerting a relatively stronger influence than that of EU member states. Trade policy uncertainty in China emerges as a significant factor negatively affecting trade volumes, reinforcing concerns about the growing unpredictability of global trade relations. Additionally, the results reveal that while non-eurozone EU members exhibit higher trade flows with China, the effect of BRI participation remains subdued. This suggests that although the initiative may have the potential to enhance trade, its immediate impact on EU member states has not yet translated into observable trade gains. Moving forward, policies aimed at mitigating trade uncertainty, enhancing institutional cooperation, and addressing structural trade barriers will be essential to realizing the full potential of China-EU economic relations. Moreover, given the ongoing tensions in China-US trade relations, a stable and resilient China-EU trade partnership is vital—not only for the economic interests of both regions but also for maintaining balance and stability in the global economy.

The remainder of the paper is structured as follows. The next section reviews the literature. In Section 3, the data are presented and a descriptive analysis is carried out. Section 4 describes the methodology and presents the results. Finally, Section 5 provides a discussion of the main findings and concludes.

2. Literature Review

The gravity model of trade, originally introduced by Linder (1961), Tinbergen (1962) and Linnemann (1966), has become a robust framework for analyzing bilateral trade flows. At its core, it posits that trade volumes are positively influenced by the economic size of trading partners and inversely related to geographical distance. Over time, the model has been methodologically refined and expanded with additional variables to account for the complexities of modern trade relationships.

These extensions include factors such population size, economic integration, foreign direct investment, R&D cooperation, institutions and infrastructure quality, trade facilitation measures like preferential trade agreements, and tariff and non-tariff trade barriers (see, e.g., Anderson, 1979; Pfaffermayr, 1994; Anderson and van Wincoop, 2003; Wang et al., 2010; Chen and Li, 2014; Yang and Martinez-Zarzoso, 2014; Baltagi, Egger, and Pfaffermayr, 2015; Golovko and Sahin, 2021; Kox and Rojas-Romagosa, 2021; Yao et al., 2021; Cuñat and Zymek, 2023).

A growing number of empirical works have demonstrated the gravity model's utility to analyze China's trade dynamics. Bussière and Schantz (2009) assessed China's integration in world trade between 1980 and 2003, concluding that China's trade share aligns well with economic fundamentals and indicating its strong integration with North America, East Asia, and euro area countries. Caporale et al. (2015) investigated the evolution of trade flows between China and its main trade partners in Asia, North America and Europe over the period 1992-2012, highlighting how China's trade structure has changed over time, transitioning from labor-intensive exports to those that are increasingly capital- and technology-intensive.

Closely related to our work, Karkanis (2018) applied a gravity model to study bilateral trade flows between China and the EU from 2001 to 2015, with a particular focus on the importance of economic integration, geographical proximity, and institutional factors in shaping China-EU trade patterns. Tang et al. (2023) compared China's bilateral trade relations with the Association of Southeast Asian Nations (ASEAN) and the EU and found that China primarily exported high-tech products to both regions but differed in importing high-tech products from ASEAN and medium-tech products from the EU. Rasoulinezhad and Wei (2017) employed a panel-gravity model to analyze trade between China and OPEC member countries, emphasizing the role of factor endowments—such as energy resources and technology—and economic integration in shaping bilateral trade patterns. Similarly, Emikönel (2021) investigated the determinants of trade between China and 97 countries from 2008 to 2019, underscoring the positive impact of international organizations on Chinese exports, such as the Asia-Pacific Economic Cooperation or the Organization of the Petroleum Exporting Countries.

A handful of studies have focused on trade efficiency and trade potential. In this regard, Mao and Xiong (2022) used a gravity model within a stochastic frontier setting to assess trade efficiency, incorporating value-added in exports. The authors found significant inefficiencies in trade between China and EU countries and highlighted the importance of infrastructure in unlocking trade potential. Using a similar approach, Fan (2021) examined the impact of digital economy development in importing countries on China's export efficiency, demonstrating that the development of the digital economy reduced trade costs and enhanced efficiency, especially in exports to low- and middle-income countries.

Studies applying the gravity model to China's trade have also explored the role of infrastructure development and regional initiatives. Cinar et al. (2016) analyzed trade potential between China and former Silk Road countries, finding that while most Silk Road countries underperformed in their trade with China, trade potential has improved remarkably since 1990. On a related theme, Garcia Herrero and Xu (2017) assessed the impact of the BRI on European trade and underlined the benefits of reduced transportation costs. Their results highlighted the advantages for landlocked EU countries in particular, showcasing the trade gains achievable through infrastructure development under the BRI framework. Similarly, Li et al. (2020) emphasized the significance of trade routes established under the BRI in shaping trade dynamics and reducing costs for Eurasian and African economies. Yu et al. (2020) provided further evidence of the BRI's impact, showing that China's export potential to BRI countries rose significantly after start of the initiative, particularly for capital-intensive products. Complementing these findings, Jing et al. (2020) analyzed China's renewable energy trade potential with BRI countries, identifying key factors such as total energy consumption and renewable energy production in driving trade.

Other related research is centered at sector- and industry-specific trade dynamics. For instance, Tang et al. (2013) investigated China's rising trade in services using a modified gravity model, emphasizing the role of comparative advantages and production sharing in driving services trade growth. Fang and Shakur (2018) highlighted the persistently high trade costs in the agri-food sector between China and the EU, noting that reductions in these costs, facilitated by initiatives like the BRI, are critical for strengthening bilateral trade in the future. Chang (2014) employed an augmented gravity model with spatial linkages to examine China's outward foreign direct investment into 138 countries and showed that Chinese firms strategically invested in high-tech industries in developed countries and resource extraction in developing ones, with the host country's economic size playing a significant role. In a complementary analysis, Liu et al. (2015) assessed the relationship between China's outward direct investment and exports and find that investment facilitated trade by enhancing industrial upgrading and global integration. Zhang et al. (2022) extended the gravity model to renewable energy goods trade, demonstrating the importance of economic size, economic freedom, trade agreements, and membership of common trade areas in boosting bilateral trade within the ASEAN Plus Three region. Their results were in line with those presented in Sheng et al. (2014) and Yang and Martinez-Zarzoso (2014), who showed that the ASEAN–China Free Trade Agreement significantly promoted trade creation, particularly in agriculture and key manufacturing industries, as well as trade in parts and components driven by industrial linkages.

Finally, trade policy uncertainty has emerged as another critical determinant in contemporary trade analysis, particularly for understanding China's bilateral trade dynamics. Economic uncertainty gained prominence especially following the onset of the trade war between the US and China in 2018. Uncertainty surrounding tariffs, regulatory changes, and geopolitical tensions can disrupt trade flows, as evidenced by studies exploring the impact of uncertainty shocks on both Chinese exports and imports. For instance, Handley and Limão (2017) employed counterfactual and applied policy measures to estimate the effects of uncertainty, showing how the reduction of policy uncertainty following China's WTO accession significantly boosted its exports to the US. Using the uncertainty indicators constructed by Ahir et al. (2022), Bandura (2021) provided evidence of the negative impact of uncertainty on trade between China, the US, and Sub-Saharan Africa. Ongan and Gocer (2020) further contributed to this literature by examining the effects of American and Chinese trade uncertainty on the US bilateral trade balances with China. Using the indices developed by Davis et al. (2019), their study applied a non-linear autoregressive distributed lag (ARDL) model to account for potential asymmetries in how increases and decreases in uncertainty affected trade flows. Their results revealed that increases in Chinese trade policy uncertainty tended to improve the US trade balances in aggregated models, while at the commodity level the impact varied across commodities.

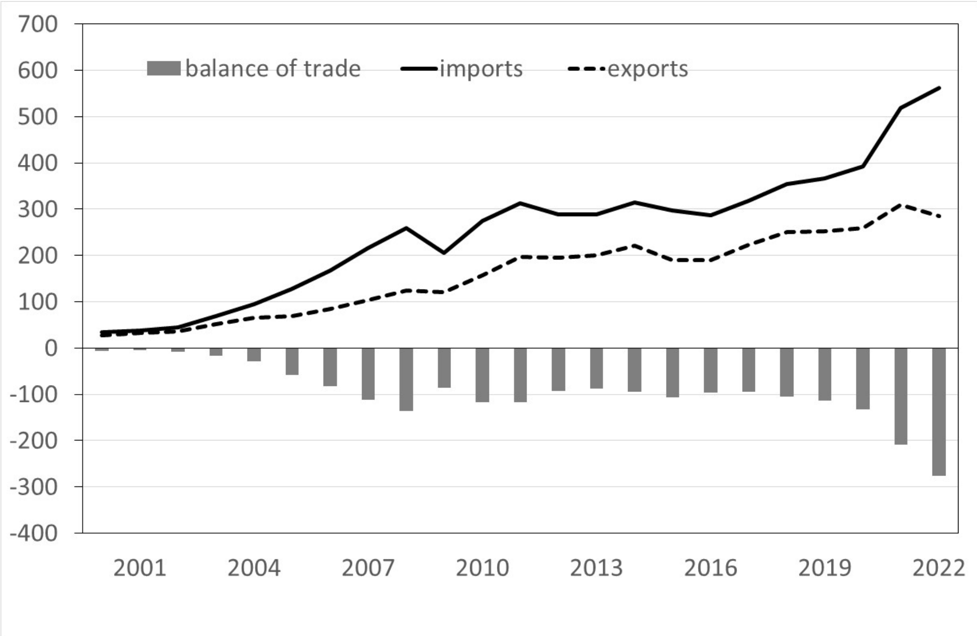
Despite these empirical contributions, the specific effects of TPU on China-EU trade remain unexplored, and while the gravity model has been widely used to analyze China's trade dynamics, a systematic examination of the China-EU trade relationship in the context of rising trade policy uncertainty is lacking. To address this gap, this study builds on the existing literature and considers a panel of 27 EU member states and their trade flows with China over the period 2000-2022, utilizing an augmented gravity model framework. In addition to incorporating a newly developed index of TPU in China by Davis et al. (2019), the model also accounts for institutional and policy-related factors, including eurozone membership and participation in the BRI. This expanded approach offers a comprehensive assessment of the principal forces behind China-EU trade, considering both structural economic factors and evolving geopolitical influences. By integrating these elements, the study provides new insights into how trade policy uncertainty, institutional differences, and regional initiatives shape China-EU trade dynamics in an increasingly volatile global environment.

3. Data

To gain some insight into the evolving commercial relationship between China and the 27 EU member states over the period 2000–2022, this study examines bilateral trade flows in relation to a broad set of variables, including income per capita, foreign trade dependency, and geographical distance between capital cities. In addition, it incorporates trade policy uncertainty along with other institutional and policy-related measures as potential determinants of bilateral trade dynamics between China and the EU.

To achieve this, we compiled data from multiple statistical sources, with data selection informed by the WTO's Guide to Trade Policy Analysis (Yotov et al., 2016). Bilateral trade flows were taken from the International Monetary Fund's (IMF) Direction of Trade Statistics (DOTS) database. Figure 1 illustrates the evolution of EU-China trade in goods over the sample period, displaying imports, exports, and the trade balance. The persistent and widening trade deficit reflects the growing asymmetry in trade flows between 2000 and 2022, with EU imports consistently exceeding exports, particularly in recent years. This trend suggests an increasing EU trade dependency on China.

Figure 1. EU27-China trade in goods – 2000-2022

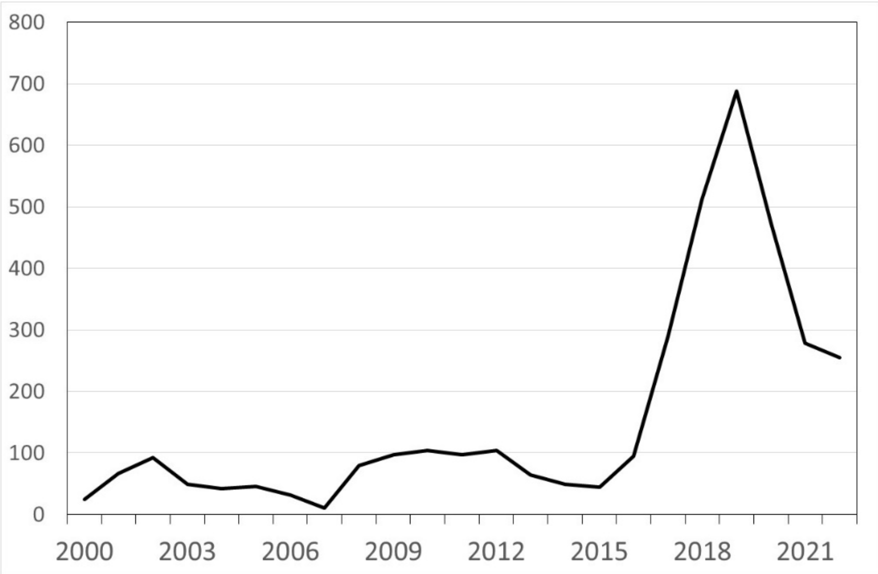


Notes: Compiled by the authors. The solid line represents the evolution of EU27 imports, and the dotted line the evolution of exports, and the bars indicate the balance of trade for each year (billions of USD).

The main explanatory variables for our analysis, GDP, population and per capita income (PPP), were obtained from the World Bank's World Development Indicators database. The geographic distance between the capital of China and that of each European country was sourced from the GEO-CEPII Database. In order to account for the impact of transport costs on trade, the distance measure is adjusted each period by multiplying it by the annual crude oil price, in order to assess the impact of the cost of longer trade routes. Crude oil prices were taken from the World Bank's Commodity Markets database.

Finally, given the anticipatory nature of economic uncertainty on the business cycle, where uncertainty shocks have been shown to affect economic growth and other macroeconomic indicators (Bloom, 2009; Claveria, 2021), the inclusion of Davis et al.'s (2019) trade policy uncertainty index for China is particularly appropriate. The authors constructed this index using data from *Renmin Daily* and *Guangming Daily*, providing a monthly measure of trade policy uncertainty in China from 2000 onwards. Figure 2 shows the annual evolution of the trade uncertainty index over the sample period.

Figure 2. Evolution of China's Trade Policy Uncertainty (TPU) index – 2000-2022



Notes: Compiled by the authors using data from Davis, Liu and Sheng's (2019) trade policy uncertainty (TPU) index for China.

The data presented in Table 1, which compares the value of exports and imports between 2000 and 2022, reveal a significant increase in both variables across all EU27 countries over the period considered. However, the magnitude of this increase varies considerably among member states. Notably, the Baltic countries – Estonia, Latvia, and Lithuania – experienced the largest relative increases in exports and imports, reflecting their deepening trade ties with China over the past two decades. In contrast, Finland recorded the smallest growth in both exports and imports over the period, with exports rising from 1,926.1 million USD in 2000 to 5,246.6 million USD in 2022, and imports increasing only marginally from 642.2 million USD to 4,548.2 million USD. Similarly, Western European economies such as France, Belgium, Austria, and Italy saw relatively smaller proportional increases in trade volumes, despite their high nominal trade values.

This pattern is again evident in Table 2, which compares total bilateral trade between each EU27 country and China in 2000 and in 2022. The data show that the largest relative increases in trade with China occurred in the Baltic states and several Central and Eastern European economies. Additionally, Ireland and Portugal also saw significant trade growth far exceeding the European average. In contrast, Finland and Sweden, along with Denmark to a lesser extent, exhibited the smallest increases in trade volumes over the period, while the largest Western European economies, including Germany and France, experienced more modest growth over the last two decades.

Table 1. Exports and imports of EU27 countries with China – 2000 vs 2022

Exports			Exports		
country	2000	2022	country	2000	2022
Austria	860.5	8,237.8	Italy	3,091.3	26,995.3
Belgium	1,386.3	8,736.6	Latvia	2.8	375.3
Bulgaria	9.1	1,271.3	Lithuania	9.7	91.0
Croatia	5.1	158.9	Luxembourg	45.7	521.7
Cyprus	0.6	34.8	Malta	14.7	584.8
Czechia	75.8	5,420.7	Netherlands	1,236.2	12,531.4
Denmark	550.3	5,720.1	Poland	156.7	5,060.8
Estonia	5.1	301.5	Portugal	46.9	3,040.9
Finland	1,926.1	5,246.6	Romania	107.1	3,076.6
France	3,955.2	35,614.7	Slovakia	22.8	7,709.5
Germany	10,411.3	111,422.4	Slovenia	11.8	589.5
Greece	48.1	833.2	Spain	623.0	9,799.7
Hungary	80.8	5,050.0	Sweden	2,199.1	9,184.1
Ireland	377.5	18,103.2	EU27	27,259.5	285,712.2
Imports			Imports		
country	2000	2022	country	2000	2022
Austria	391.8	5,097.9	Italy	3,844.4	50,875.2
Belgium	2,300.7	35,534.4	Latvia	26.3	1,023.4
Bulgaria	68.9	2,851.9	Lithuania	29.0	1,789.0
Croatia	80.0	2,268.2	Luxembourg	53.6	586.8
Cyprus	147.8	1,167.6	Malta	66.4	1,968.6
Czechia	328.6	18,228.8	Netherlands	6,683.7	117,679.7
Denmark	779.8	10,183.2	Poland	778.8	38,164.2
Estonia	61.8	945.8	Portugal	260.8	5,974.8
Finland	642.2	4,548.2	Romania	328.8	7,403.2
France	3,725.6	46,070.9	Slovakia	65.7	4,435.7
Germany	9,278.5	116,212.0	Slovenia	49.6	6,864.2
Greece	578.7	13,020.6	Spain	2,152.6	41,688.2
Hungary	708.4	10,408.1	Sweden	678.9	11,383.3
Ireland	336.2	5,706.4	EU27	34,447.7	562,080.2

Note: Exports and imports are expressed in relation to China (millions of USD).

Table 2. Bilateral trade flows and balance of trade of EU27 countries with China – 2000 vs 2022

	Trade flows			Trade flows	
country	2000	2022	country	2000	2022
Austria	1,252.2	13,335.8	Italy	6,935.6	77,870.5
Belgium	3,687.0	44,271.1	Latvia	29.1	1,398.8
Bulgaria	78.0	4,123.1	Lithuania	38.7	1,880.0
Croatia	85.0	2,427.1	Luxembourg	99.3	1,108.5
Cyprus	148.3	1,202.4	Malta	81.2	2,553.4
Czechia	404.4	23,649.5	Netherlands	7,920.0	130,211.0
Denmark	1,330.0	15,903.2	Poland	935.5	43,225.0
Estonia	66.9	1,247.3	Portugal	307.8	9,015.7
Finland	2,568.4	9,794.8	Romania	436.0	10,479.8
France	7,680.8	81,685.6	Slovakia	88.5	12,145.2
Germany	19,689.8	227,634.4	Slovenia	61.4	7,453.6
Greece	626.8	13,853.8	Spain	2,775.6	51,487.9
Hungary	789.2	15,458.1	Sweden	2,878.0	20,567.4
Ireland	713.7	23,809.6	EU27	61,707.2	847,792.4
	Balance of trade			Balance of trade	
country	2000	2022	country	2000	2022
Austria	468.7	3,139.9	Italy	-753.1	-23,879.8
Belgium	-914.5	-26,797.8	Latvia	-23.5	-648.1
Bulgaria	-59.8	-1,580.6	Lithuania	-19.3	-1,698.0
Croatia	-74.9	-2,109.3	Luxembourg	-7.9	-65.1
Cyprus	-147.2	-1,132.8	Malta	-51.7	-1,383.8
Czechia	-252.9	-12,808.1	Netherlands	-5,447.5	-105,148.3
Denmark	-229.5	-4,463.1	Poland	-622.2	-33,103.4
Estonia	-56.7	-644.3	Portugal	-213.9	-2,933.9
Finland	1,283.9	698.4	Romania	-221.7	-4,326.6
France	229.7	-10,456.2	Slovakia	-42.9	3,273.8
Germany	1,132.9	-4,789.6	Slovenia	-37.8	-6,274.7
Greece	-530.6	-12,187.5	Spain	-1,529.6	-31,888.5
Hungary	-627.6	-5,358.0	Sweden	1,520.2	-2,199.2
Ireland	41.3	12,396.8	EU27	-7,188.2	-276,367.9

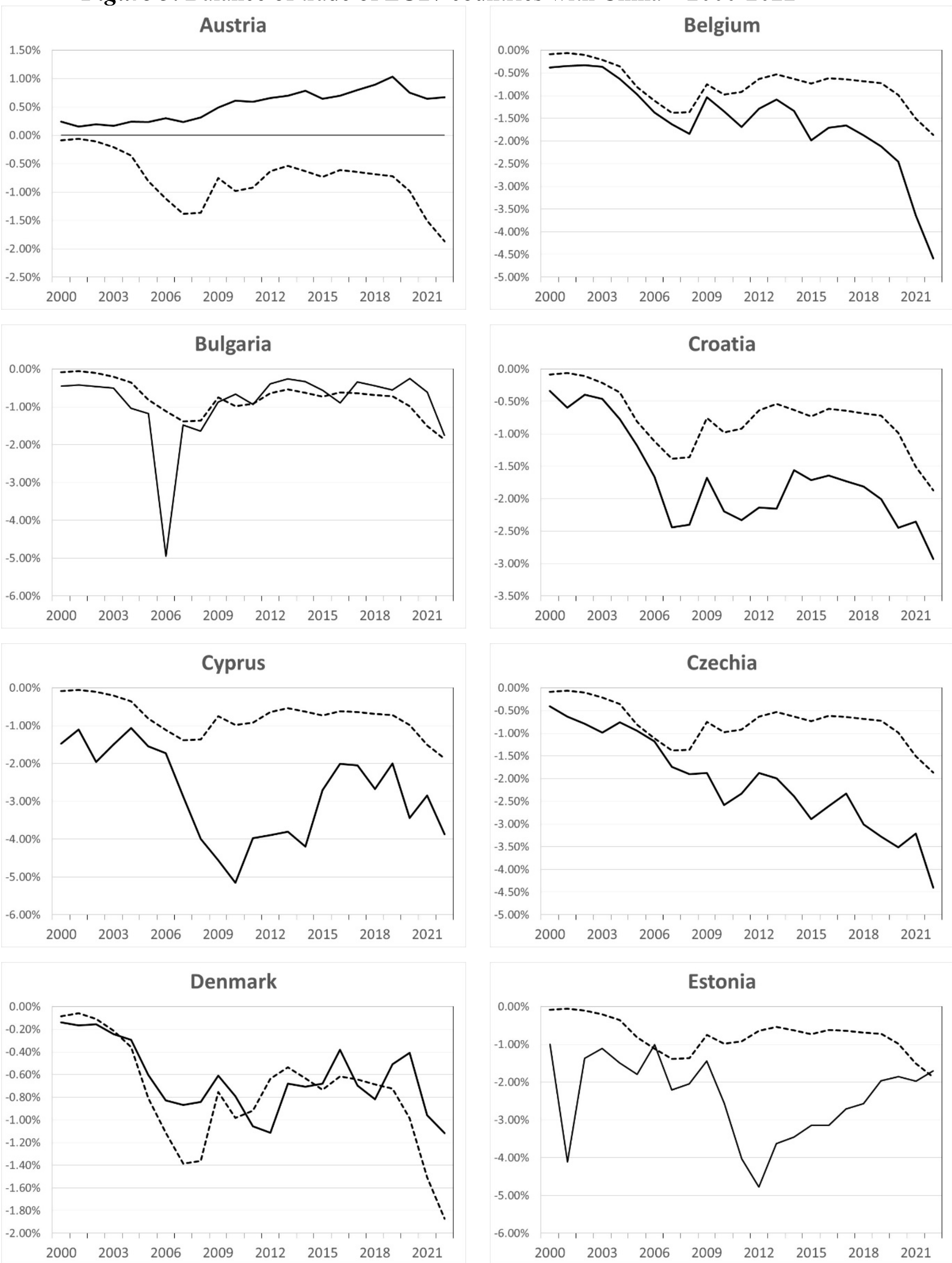
Note: Bilateral trade flows and the balance of trade are expressed in relation to China (millions of USD).

The lower panel of Table 2 presents the evolution of the trade balance between 2000 and 2022. Given that the balance of trade can be either positive or negative, these values should be interpreted with caution. While most EU countries exhibited a trade deficit with China at both the beginning and end of the sample period, three exceptions, namely, Austria, Finland, and Ireland, maintained a trade surplus in both years. Most notably, Slovakia switched from a deficit in 2000 to a surplus in 2022, whereas, in contrast, Germany, France, and Sweden saw their 2000 trade surpluses turn into deficits by 2022. These bilateral trade dynamics highlight structural changes that are of particular relevance for understanding trade relations between the EU and China over the past decades.

The graphs in Figure 3 offer a granular overview of the evolution of the trade balance between each EU27 country and China over the last two decades. Austria, Finland, Ireland, and Slovakia stand out as the only economies where the trade balance follows an increasing trend throughout the sample period, consistently maintaining a positive balance. Meanwhile, a second group of countries – Denmark, Estonia, Latvia, Lithuania, Luxembourg, and Malta, although experiencing a systematic trade deficit, exhibit a change in trend over the last decade, suggesting a gradual improvement in their trade position with China. Additionally, the trade balance trajectories of Germany and France are particularly noteworthy. Despite running a trade deficit at both the beginning and end of the period studied, these economies experienced several years of surplus in between. This fluctuation in trade dynamics may be one of the underlying factors contributing to the recent trade tensions between Europe and China.

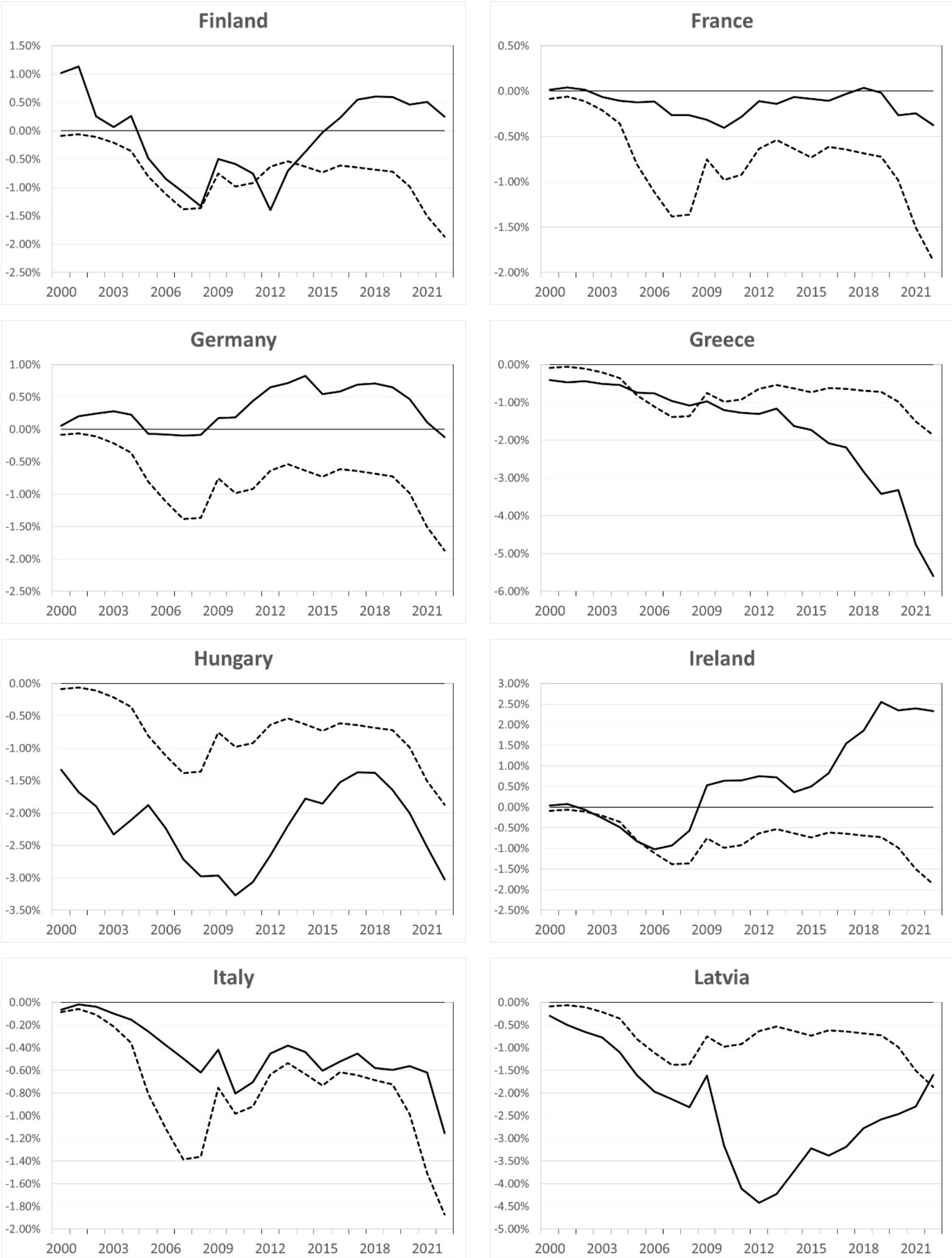
The final subfigure in Figure 3 provides a broader perspective by precisely illustrating the asymmetric evolution of the relative weight of bilateral trade between China and the EU27 in relation to their respective GDP. Figure 4 further reinforces these findings by depicting the distribution of total bilateral trade flows between China and each EU27 country in 2022. In line with the above, Germany, the Netherlands, France, and Italy emerge as the dominant European economies in terms of trade volume with China, while, not surprisingly, smaller economies, such as Luxembourg, Cyprus, and the Baltic states, maintain significantly lower levels of bilateral trade. This composition highlights the concentration of China-EU trade among a few key economies, reflecting long-standing patterns in European trade dynamics.

Figure 3. Balance of trade of EU27 countries with China – 2000-2022



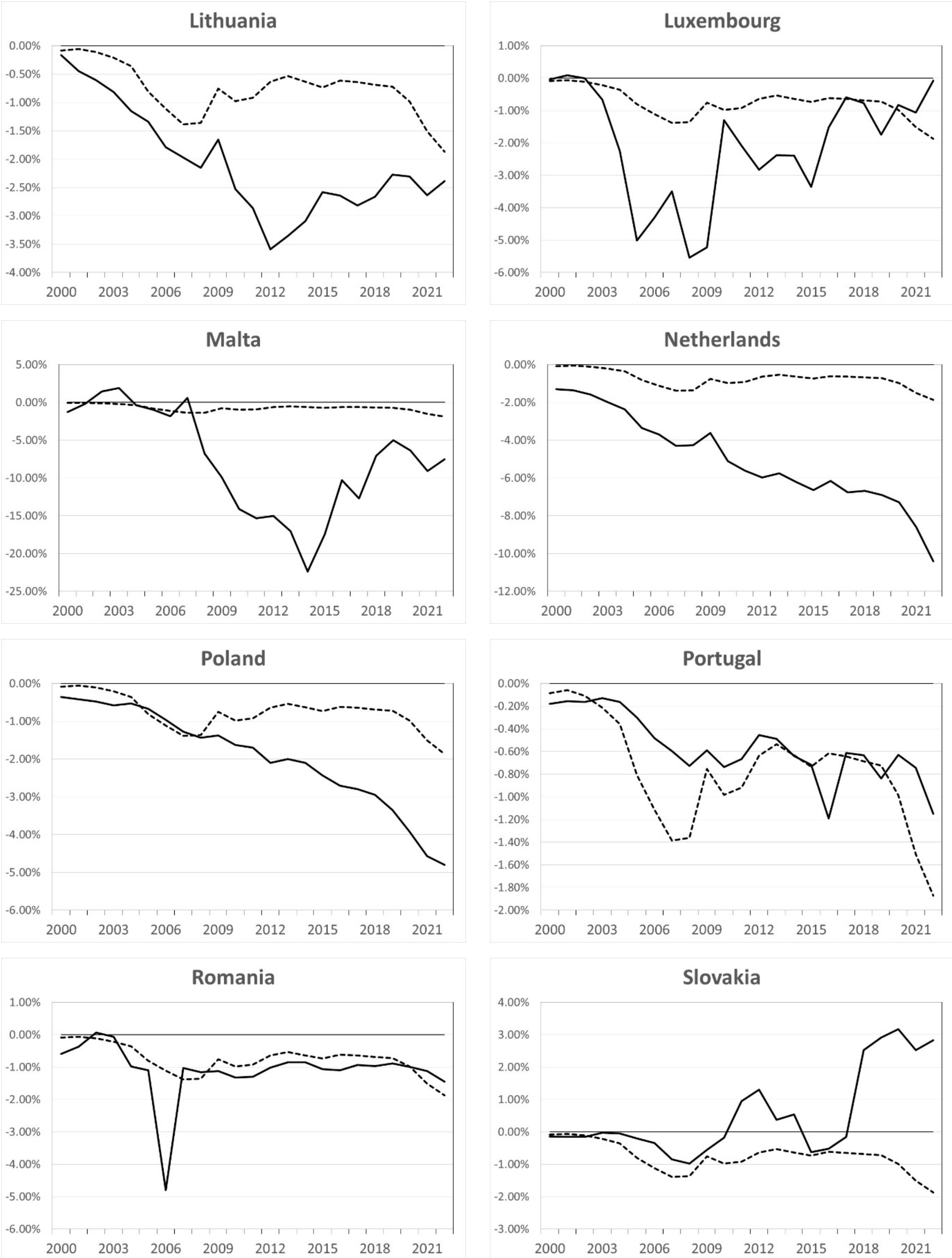
Notes: The solid line represents the evolution of the balance of trade of each EU27 country with China, and the dotted line that of the EU27. The balance of trade is expressed as the % relative to the current GDP (in USD).

Figure 3 (cont.1)**.** Balance of trade – 2000-2022



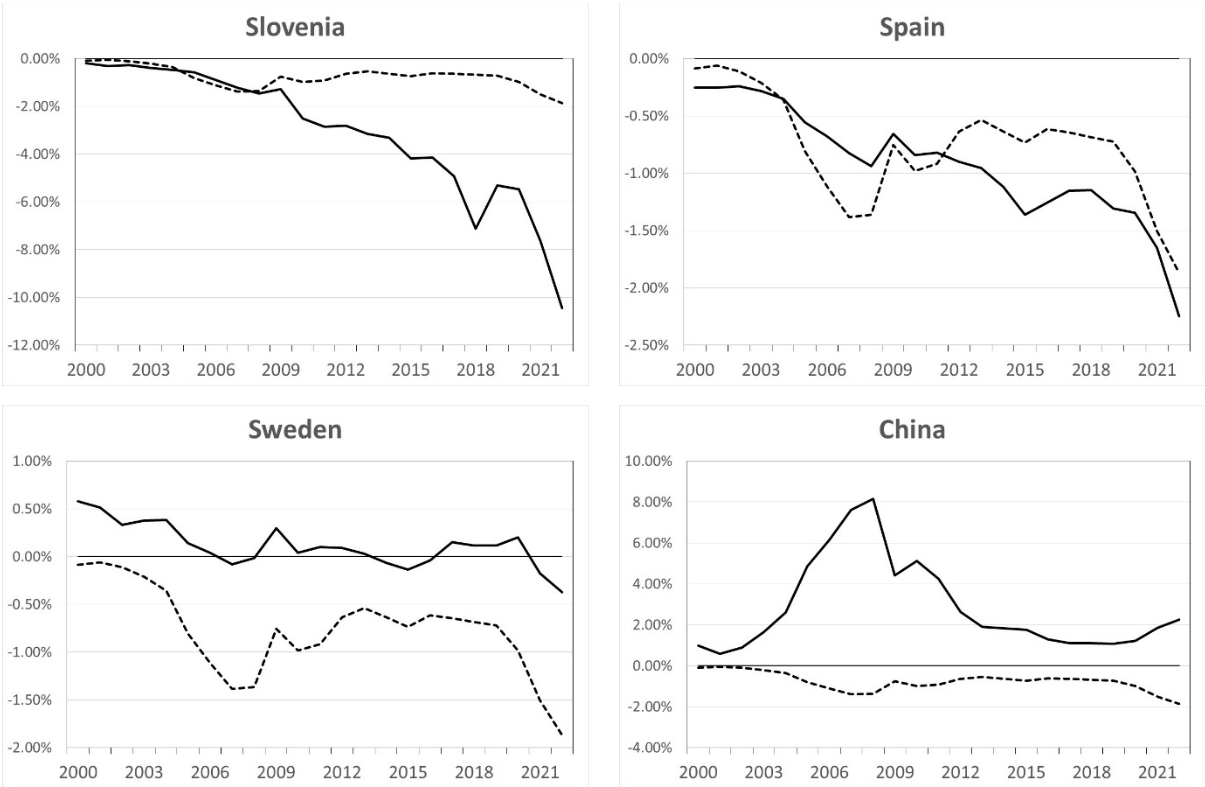
Notes: The solid line represents the evolution of the balance of trade of each EU27 country with China, and the dotted line that of the EU27. The balance of trade is expressed as the % relative to the current GDP (in USD).

Figure 3 (cont.2)**.** Balance of trade – 2000-2022



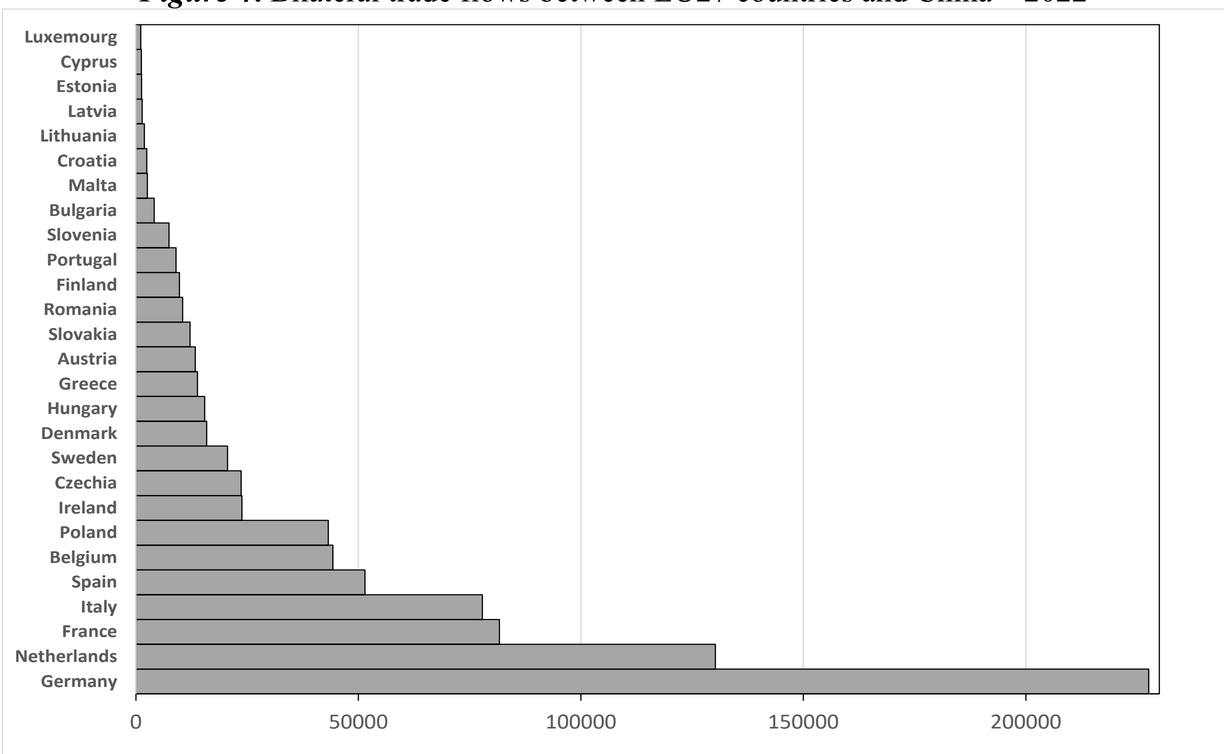
Notes: The solid line represents the evolution of the balance of trade of each EU27 country with China, and the dotted line that of the EU27. The balance of trade is expressed as the % relative to the current GDP (in USD).

Figure 3 (cont.3)**.** Balance of trade – 2000-2022



Notes: The solid line represents the evolution of the balance of trade of each EU27 country with China, and the dotted line that of the EU27. The balance of trade is expressed as the % relative to the current GDP (in USD). The last graph depicts the evolution of the balance of trade of China with the EU27.

Figure 4. Bilateral trade flows between EU27 countries and China – 2022



Note: Compiled by the authors using data from the IMF's DOTS database.

4. Empirical analysis

At the core of this study lies the empirical analysis, which is the focus of this section. In what follows, we present the methodological framework used to explore the dynamics of China-EU bilateral trade. Specifically, we develop an augmented gravity model to study the key factors influencing trade flows between these two economic giants from 2000 to 2022. In addition, as a robustness check, we perform a quantile regression analysis to assess how the relationship between bilateral trade and its determinants varies across different quantiles of the distribution of trade flows.

4.1. The gravity model

Inspired by Newton's gravitation theory, early versions of the gravity model mirrored this scientific principle, suggesting that the gravitational pull between two entities is directly proportional to their masses and inversely proportional to the square of the distance between them. Applied to bilateral trade, this concept translates to the economic size of the countries and the physical distance that separates them. Over time, gravity models have been employed across various fields, particularly in international trade, and have evolved into a widely accepted framework for analyzing trade flows.

The basic formulation of the gravity model, originally introduced by Linder (1961), Tinbergen (1962), and Linnemann (1966), and further developed in foundational models of international trade (e.g., Anderson, 1979; Anderson and van Wincoop, 2003; Yang and Martinez-Zarzoso, 2014), has since been extended in numerous ways to incorporate additional factors that capture the complexities of trade relationships and affect bilateral trade flows. Leitão (2024) provides a recent examination of the gravity model's applications and key determinants in international trade, along with a bibliometric review of related research. For a comprehensive review of the latest developments in the literature on estimation methods for the gravity model, refer to Gómez-Herrera (2013).

To analyze bilateral trade relationships between China and the 27 EU member states, the standard variables, such as economic size, geographical distance, and the degree of openness (i.e., foreign trade dependency) remain central to the analysis. Our baseline gravity model is defined as follows:

$$T_{ij,t} = \beta_0 + \beta_1\, GDPpc_{i,t} + \beta_2\, GDPpc_{j,t} + \beta_3 D_{ij} + \beta_4 FTD_{j,t} + \alpha_j + \delta_t + \varepsilon_{ij,t}, \tag{1}$$

where $T_{ij,t}$ refers to the total volume of bilateral trade flows between China (i) and each EU country (j) in year t; $GDPpc_{i,t}$ and $GDPpc_{j,t}$ refer to per capita GDP in real terms of China and EU country j in year t, D_{ij} is the oil price-adjusted distance between the capitals of China and country j, and $FTD_{j,t}$ is the foreign trade dependency of each EU country. Unobserved time-invariant country-specific characteristics are collected in α_j, which is a set of N-1 dummy variables multiplied by their respective regression coefficients to account for country fixed effects. We also added T-1 dummy variables to account for time fixed effects, noted in Equation (1) as δ_t. This allows controlling for time-varying differences in trade flows common to all countries (e.g., the 2008 financial crisis). All variables are log transformed.

Expanding on this, additional variables are particularly relevant in this context. Most importantly, trade policy uncertainty has emerged as a significant factor influencing bilateral trade relationships with the EU as well as its other major trading partners (Handley and Limão, 2017; Bandura, 2021). While economic uncertainty has become more pronounced in recent years due to shifting global economic and political landscapes, it has consistently played a role in shaping trade dynamics. Uncertainty surrounding trade policies can impact business confidence, disrupting supply chains, delaying investment decisions, and complicating long-term trade agreements, thereby introducing volatility into global trade flows. Accounting for trade policy uncertainty is therefore essential for the analysis of bilateral trade dynamics involving China. Based on these considerations, our extended gravity model is specified as

$$T_{ij,t} = \beta_0 + \beta_1\, GDPpc_{i,t} + \beta_2\, GDPpc_{j,t} + \beta_3 D_{ij} + \beta_4 FTD_{j,t} + \beta_5 TPU_{i,t} + \alpha_j + \delta_t + \varepsilon_{ij,t}, \tag{2}$$

where $TPU_{i,t}$ is an index of China's trade policy uncertainty, recently proposed by Davis et al. (2019). The TPU is a text-based indicator that is constructed using monthly counts of articles that contain at least one term in each of three term sets—'trade policy', 'economics', 'uncertainty'. In this study, the log transformed annual average of TPU is used as a determining factor of trade flows between China and EU countries.

Finally, to account for additional political-economic variables that may affect trade relations between the two blocs, two dichotomous variables have been introduced. On the one hand, given that a significant number of EU countries are members of the eurozone and share a uniform exchange rate, a binary variable has been included to discriminate between eurozone countries and those outside the monetary union. This distinction is important, as research has shown that euro area membership may influence bilateral trade flows by affecting relative competitiveness and economic integration (Bussière et al., 2008).

On the other hand, being part of the BRI could play a significant role in shaping trade relations, as its emphasis on improving infrastructure and reducing transportation costs is expected to have a sizable impact on trade volumes between China and the EU (Garcia Herrero and Xu, 2017). As demonstrated by Anderson and van Wincoop (2003), failing to account for multilateral resistance terms can lead to severe biases in the estimates of gravity model variables. To address this, our measure of BRI also serves as a control for multilateral resistance, alongside distance. This approach is particularly relevant in our context, where traditional controls such as a common official language and contiguous borders are not applicable. Accordingly, we have included an additional binary variable distinguishing between BRI countries and those that are not. As a result, Equation (2) is augmented with these two new variables:

$$T_{ij,t} = \beta_0 + \beta_1 \, GDP_{i,t} + \beta_2 \, GDP_{j,t} + \beta_3 D_{ij} + \beta_4 FTD_{j,t} + \beta_5 TPU_{i,t} + \beta_6 EUR_j + \beta_7 BRI_j + \alpha_j + \delta_t + \varepsilon_{ij,t}, \quad (3)$$

where dummy variables, EUR_j and BRI_j take the value 1 when corresponding to a non-eurozone country or a BRI country, respectively, and zero otherwise. All models were estimated using heteroskedasticity- and autocorrelation-consistent (HAC) standard errors. The results are presented in the next subsection.

4.2. Estimation results

The empirical results for the four alternative specifications are reported in Table 3. Column (1) presents the baseline model, with only GDP per capita, distance, and trade dependency included in the estimation equation. In accordance with the literature, the results indicate that the volume of bilateral trade flows is positively correlated with the per capita income of China and EU27 countries. It should be noted, however, that although statistically significant, the distance variable has a sign opposite to that expected. In addition, the variable representing trade dependency is not statistically significant.

By introducing fixed effects——both country-specific, to account for the heterogeneity among the economies of the EU27, and time-specific—, the coefficient of the distance variable shows an inverse relationship between the oil price-weighted geographic distance of each EU27 country and China (column 2). Furthermore, all variables in the model are statistically significant, including the measure of foreign trade dependency. Notably, the income of both China and the EU countries is positively associated with trade flows between the two blocs. However, the coefficient for China's per capita GDP is more than twice as large as that of the European countries, hinting at the Chinese economy's relatively stronger influence on bilateral trade flows.

Table 3. Regression results for total bilateral trade flows between EU27 countries and China – 2000-2022

	(1) Panel FE	(2) Panel FE	(3) Panel FE	(4) Pooled OLS regression
Distance	0.618*** (0.060)	-0.632*** (0.180)	-0.864*** (0.239)	-0.864*** (0.244)
Income (China)	0.939*** (0.112)	1.713*** (0.116)	2.705*** (0.350)	2.705*** (0.357)
Income (EU country)	1.494*** (0.331)	1.271*** (0.342)	1.271*** (0.342)	1.271*** (0.350)
Trade dependency	0.095 (0.331)	1.002** (0.342)	1.002** (0.342)	1.002** (0.350)
Trade uncertainty	-		-0.582*** (0.158)	-0.582*** (0.162)
Non-euro member	-	-	-	2.114*** (0.277)
BRI country	-	-	-	0.081 (0.263)
Constant	-24.266*** (3.598)	-13.296*** (3.748)	-16.815*** (3.271)	-16.815*** (3.271)
Country-fixed effects	No	Yes	Yes	Yes
Time-fixed effects	No	Yes	Yes	Yes
LSDV *R-squared*	0.962	0.971	0.971	0.971
Cross-sectional units	27	27	27	27
Observations	621	621	621	621

Notes: The dependent variable is the total volume of bilateral trade flows between EU27 countries and China. FE denotes fixed effects. Robust (HAC) standard errors between brackets. *** Statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

The inclusion of the novel index of trade policy uncertainty in our model represents a core contribution of this study. The results presented in column (3) reveal a statistically significant and negative relationship between trade policy uncertainty in China and bilateral trade flows between China and the EU. This finding highlights the important role of trade policy uncertainty for economic activity, as higher TPU levels are strongly associated with decreases in trade volumes. These results align with Ongan and Gocer (2020) and Bandura (2021), who demonstrated that trade uncertainty stemming from major economies, particularly China and the US, had a significant detrimental effect on bilateral trade balances and trade openness, suggesting that uncertainty could disrupt trade flows by increasing risks associated with investment and production decisions.

As discussed in Section 3, while trade policy uncertainty in China has been a persistent factor, its influence has intensified in recent years, reflecting the growing unpredictability of global trade relations. In addition, the estimate of the effect of distance is stronger in column (3) than in column (2), reinforcing the role that remoteness may play as a determinant of bilateral trade flows. Even so, it should be noted that in the case of the EU, the variable distance, understood as the kilometers between Beijing and the different European capitals, may introduce measurement biases. This is due to the fact that many goods from China could arrive at major ports of Western Europe before being transported to Eastern countries whose capitals are relatively closer to China.

Finally, the pooled ordinary least squares (OLS) estimates from a regression model incorporating two binary variables are presented in column (4). The first, an institutional variable, differentiates between eurozone and non-eurozone member countries, whereas the second, related to infrastructure development and regional initiatives, distinguishes between countries involved in the BRI and those that are not.[1] Interestingly, of these two dichotomous variables, the first is statistically significant and exhibits a positive sign. This result suggests that non-eurozone EU members, on average, experience higher trade flows with China compared to their eurozone counterparts. A potential explanation for this finding lies in the stronger economic ties that some non-eurozone countries have developed with China, particularly through initiatives like the 16+1 cooperation

[1] As of 2022, the final year in our sample, the non-eurozone EU member states included Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Poland, Romania, and Sweden. By the same year, several EU countries had signed cooperation agreements under the Belt and Road Initiative (BRI), including Austria, Bulgaria, Croatia, Cyprus, Czechia, Estonia, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Romania, Slovakia, and Slovenia. It should be noted that Lithuania withdrew from the initiative in 2021, while Estonia and Latvia left in 2022, and Italy in 2023, all citing geopolitical and strategic concerns.

framework (Vangeli, 2017; Sarsenbayev and Véron, 2020). More recently, countries such as Poland, Hungary, and the Czechia have actively engaged in China-led trade and investment initiatives, benefiting from increased infrastructure funding, trade agreements, and foreign direct investment.

In contrast, the dummy variable for BRI status is not statistically significant, even though it exhibits the expected positive sign. While this suggests that BRI participation may be associated with increased trade flows, its impact on EU member states has not yet materialized in a statistically robust manner. A possible explanation is that many EU countries already have well-established trade networks and regulatory structures, meaning that BRI-related infrastructure projects, while beneficial in the long run, have yet to translate into immediate trade gains (Garcia Herrero and Xu, 2017).

Moreover, as noted by Vangeli (2017), China has primarily focused on institutional cooperation and long-term investment projects rather than directly boosting short-term trade flows. This is consistent with Sarsenbayev and Véron (2020), who highlighted the EU's cautious and multifaceted approach to the BRI. While some EU27 countries, particularly in Southern and Eastern Europe, have welcomed Chinese investments in infrastructure and trade, the EU as a whole has maintained regulatory barriers that may slow the realization of BRI-related trade benefits. Unlike Southeast Asian or Central Asian countries, where infrastructure investments have been rapidly absorbed into trade networks, EU integration rules, investment screening mechanisms, and geopolitical concerns present additional challenges for BRI implementation. In this context, the insignificant coefficient for BRI participation may therefore reflect delayed trade effects rather than an absence of impact, with infrastructure-driven trade growth requiring a longer adjustment period and a clearer alignment with EU regulatory frameworks.

4.3. Robustness check: quantile regression analysis

To complement the analysis, we conduct a robustness check by examining the relationship between bilateral trade flows and their determinants over time using quantile regression. This approach allows us to evaluate the contribution of the different regressors to trade across quantiles. Unlike the least squares approach, which estimates the conditional mean of the response variable across values of the predictor variables, quantile regression estimates the conditional median or other quantiles of the response variable.

Another advantage of quantile regression over OLS regression is that quantile regression estimates are more robust to outliers in the response measurements. By focusing on conditional quantile functions, quantile regression can be used to analyze the relationship between variables more comprehensively, helping to uncover links between variables in cases where there is no clear or only a weak relationship between the means of the variables under study. The complexity of interactions between trade determinants and bilateral trade flows between China and EU economies may result in unequal variations of trade flows across different levels of income, trade dependency, and trade uncertainty. For a recent application of quantile regression, see Claveria (2025); for a more detailed discussion of quantile regression and its applications, refer to Yu, Lu, and Stander (2003) and Koenker (2005).

Briefly, let Y denote the dependent variable, and assume that it is a random variable with cumulative distribution function $F_Y(y) \geq P(Y \leq y)$. The τ^{th} quantile of Y could be expressed as $q_Y(\tau) = F_Y^{-1}(\tau) = inf\{y: F_Y(y) \geq \tau\}$, where $\tau \in (0,1)$. In quantile regression, for the τ^{th} quantile, it is assumed that the τ^{th} conditional quantile is given as a linear function of the explanatory variables (X), so that X: $Q_{Y|X}(\tau) = X\beta_\tau$. Consequently, quantiles can be expressed as the solution to a minimization problem. Given the distribution function of Y, β_τ can be obtained by minimizing the expected value of the loss function ρ_τ, i.e., by solving $\hat{\beta}_\tau = \min_{\beta \in R^k}\{E[\rho_\tau(Y_i - X_i'\beta)]\}$.

In our particular case, given the dependent variable y_i (total volume of bilateral trade flows) and the explanatory variables x_i, to obtain the quantile estimator the minimization problem can be reformulated as the following linear programming problem:

$$\min_{\beta \in R^k} \left[\sum_{i\in\{i:y_i \geq x_i'\beta\}} \tau|y_i - x_i'\beta| + \sum_{i\in\{i:y_i < x_i'\beta\}} (1-\tau)|y_i - x_i'\beta|\right] \quad (4)$$

The coefficients of the quantile regression estimate from the most general specification in Equation (3) are presented in Table 4, where each column shows the estimated coefficients for the main explanatory variables considered. It can be seen that, with the exception of the variable used to proxy the geographical distance between Beijing and the capital cities of the 27 EU member states, the coefficients obtained are consistent, in both sign and magnitude. However, it is important to emphasize that the intensity of the effect of trade uncertainty decreases progressively across the distribution, becoming statistically insignificant in the last two deciles.

Similarly, the coefficients for trade dependency fluctuate throughout the distribution, being significant only at the extremes and switching from negative to positive. In contrast, the coefficients for per capita income in both China and the EU member states remain very stable throughout the distribution. These results highlight the importance of understanding the distributional nature of trade dynamics, where policies focused on trade uncertainty and dependency may have differential impacts across countries depending on their position in the bilateral trade distribution.

Table 4. Quantile regression results for total bilateral trade flows between EU27 countries and China – 2000-2022

Bilateral trade flows	Explanatory variables				
	Distance	Income (China)	Income (EU country)	Trade dependency	Trade uncertainty
τ					
0.1	0.480***	1.310***	1.775***	-0.792***	-0.086***
	(0.024)	(0.043)	(0.137)	(0.239)	(0.012)
0.2	0.524***	1.206***	1.647***	-0.422***	-0.088***
	(0.029)	(0.042)	(0.080)	(0.115)	(0.009)
0.3	0.521***	1.139***	1.591***	-0.171	-0.090***
	(0.021)	(0.042)	(0.097)	(0.154)	(0.011)
0.4	0.520***	1.096***	1.416***	-0.050	-0.066***
	(0.027)	(0.042)	(0.102)	(0.128)	(0.014)
0.5	0.522***	1.101***	1.371***	-0.132	-0.064***
	(0.030)	(0.049)	(0.101)	(0.138)	(0.012)
0.6	0.481***	1.079***	1.303***	-0.052	-0.048***
	(0.026)	(0.041)	(0.104)	(0.118)	(0.012)
0.7	0.466***	1.032***	1.210***	0.080	-0.026***
	(0.019)	(0.030)	(0.109)	(0.094)	(0.009)
0.8	0.467***	0.988***	0.998***	0.154*	-0.010
	(0.013)	(0.027)	(0.083)	(0.111)	(0.009)
0.9	0.404***	1.001***	1.106***	0.146*	0.008
	(0.030)	(0.034)	(0.111)	(0.113)	(0.008)

Notes: Robust (sandwich) standard errors between brackets. Each row contains the coefficients of quantile estimates regression for the 10, 20, 30, 40, 50, 60, 70, 80 and 90 percent quantiles of bilateral trade flows (τ). *** Statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

5. Conclusion

Bilateral trade relations between China and the EU have experienced significant growth over the past two decades, with China's economic expansion playing a crucial role in boosting trade volumes. China's accession to the WTO in 2001 accelerated its integration into the global trading system, presenting both opportunities and challenges for its trade cooperation with the EU. All European countries have seen increases in exports and imports to China since then, although there are notable differences in the magnitude of this growth across EU member states. While trade volumes have generally increased, the value of the trade balance between 2000 and 2022 reveals a persistent trend: almost all EU countries run a trade deficit, indicating a structural imbalance in favor of China. This pattern highlights an asymmetric evolution in the relative weight of bilateral trade between the two regions, particularly when considering the differing levels of economic output and trade dependencies. However, this growing interaction has also given rise to recent tensions regarding the arbitration of trade relations between the two blocs, creating a particularly timely context for analyzing these dynamics.

This study has examined bilateral trade relations between China and the EU from 2000 to 2022, with a particular focus on the role of trade policy uncertainty alongside more conventional economic and policy-related measures. A major contribution of this analysis is the introduction of a novel proxy for China's trade policy uncertainty, which complements the gravity model framework. By incorporating key determinants such as economic size, geographic distance, foreign trade dependency, trade policy uncertainty, euro area membership, and participation in the Belt and Road Initiative, the analysis presented here offers a deeper understanding of the factors driving China-EU trade dynamics.

Our findings confirm that China's economic development is a dominant driver of trade, with China's per capita income exerting a stronger influence on average than that of EU economies. Trade policy uncertainty, however, emerges as a significant factor suppressing trade volumes, especially during periods of heightened unpredictability in global trade relations. While non-eurozone EU members show higher trade flows with China, the immediate impact of the BRI on EU trade remains limited, suggesting that infrastructure investments under the initiative have yet to produce substantial gains for European countries.

The robustness of our results is confirmed through various model specifications, including quantile regression analysis, which examines how covariates influence trade across the distribution. Given the anticipatory nature of trade policy uncertainty and its relationship with economic growth, our results underscore the importance of incorporating trade uncertainty indicators. Such measures can serve as useful tools for the early detection of periods of increased bilateral trade, offering valuable guidance for policymakers to design trade policies that help promote economic integration.

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UBIREA
Institut de Recerca en Economia Aplicada Regional i Pública
Research Institute of Applied Economics
WEBSITE: www.ub.edu/irea • **CONTACT:** irea@ub.edu

AQR
Grup de Recerca Anàlisi Quantitativa Regional
Regional Quantitative Analysis Research Group
WEBSITE: www.ub.edu/aqr/ • **CONTACT:** aqr@ub.edu

Universitat de Barcelona
Av. Diagonal, 690 • 08034 Barcelona