BANCA D'ITALIA
EUROSISTEMA

Temi di Discussione
(Working Papers)

What will Brexit mean for the British and euro-area economies?
A model-based assessment of trade regimes

by Massimiliano Pisani and Filippo Vergara Caffarelli

BANCA D'ITALIA

EUROSISTEMA

Temi di discussione

(Working Papers)

What will Brexit mean for the British and euro-area economies?
A model-based assessment of trade regimes

by Massimiliano Pisani and Filippo Vergara Caffarelli

The purpose of the Temi di discussione *series is to promote the circulation of working papers prepared within the Bank of Italy or presented in Bank seminars by outside economists with the aim of stimulating comments and suggestions.*

The views expressed in the articles are those of the authors and do not involve the responsibility of the Bank.

WHAT WILL BREXIT MEAN FOR THE BRITISH AND EURO-AREA ECONOMIES? A MODEL-BASED ASSESSMENT OF TRADE REGIMES

by Massimiliano Pisani* and Filippo Vergara Caffarelli*

Abstract

This paper evaluates the macroeconomic effects on the UK and the euro area of an increase in trade tariffs associated with Brexit, by simulating a dynamic general equilibrium model of the UK, the euro area, and the rest of the world (RW). Our results are as follows: first, the imposition of tariffs reduces UK exports and economic activity by a non-negligible amount; second, the macroeconomic costs for the UK are reduced if it decides unilaterally not to increase tariffs on imports from the euro area and to reduce those on imports from the RW; third, the macroeconomic costs are particularly high if the lower UK trade openness resulting from the imposition of tariffs reduces the UK's total factor productivity; and fourth, Brexit has negative, but quite limited, effects on euro area economic activity.

Contents

* Bank of Italy, Directorate General for Economics, Statistics and Research, Via Nazionale 91, 00184 Rome. E-mail: M. Pisani: massimiliano.pisani@bancaditalia.it; F. Vergara Caffarelli (corresponding author): filippo.vergaracaffarelli@bancaditalia.it.

1 Introduction[1]

On June 23rd 2016 the British people voted in favour of the United Kingdom (UK) withdrawing from the European Union (EU) and the British Government subsequently pledged[2] to implement the British exit from the EU (Brexit). On March 29th 2017 the UK formally notified its intention to withdraw from the EU, starting the exit process.

Before the referendum, the British Foreign and Commonwealth Office had published a paper on the possible alternatives to the EU membership.[3] The following options were explicitly mentioned: a) membership of the European Economic Area (as for Norway), b) a bilateral trade agreement (as for Switzerland, Canada, Turkey, and Korea) and c) no agreement at all, in which case UK-EU trade would be subject to World Trade Organization (WTO) rules. On January 17th 2017 the British Prime Minister clarified that the United Kingdom is seeking a "bespoke" bilateral trade agreement with the EU rather than participation in the European Economic Area, but argued that it could well cope with the lack of any agreement.[4] This position was confirmed in the notification letter.

In this paper we evaluate the macroeconomic effects on the UK and the euro area (EA) economies of implementing alternative trade-tariff regimes, following Brexit, by simulating a New Keynesian dynamic general equilibrium (DSGE) model of the world economy featuring the UK, the EA, and a third economy encompassing the rest of the world (RW). The model presents a rather exhaustive description of international trade. Each intermediate tradable good and service is used for the production of final nontradable consumption and investment goods and enters, together with local capital and labour, into the production of every intermediate good and service. This feature is a key novel aspect for an open-

---

[1]We thank for useful suggestions an anonymous referee, Pietro Catte, Paola Conconi, Giancarlo Corsetti, Stefano Neri, Gianmarco Ottaviano and seminar participants at the Bank of Italy. The opinions expressed in this paper are the sole responsibility of the authors and do not necessarily represent the official position of the Bank of Italy.

[2]Prime Minister Theresa May famously stated that "Brexit means Brexit". See T. May's speech, on July 11th 2016, launching her (successful) national campaign to become Leader of the Conservative Party and Prime Minister of the United Kingdom.

[3]See Foreign and Commonwealth Office (2016)

[4]See also Department for Exiting the European Union (2017).

economy New-Keynesian model like ours. Moreover, there are also nontradable intermediate services, that mainly capture the role of retailing services. Other features of the model are in line with the existing literature.

We analyze four scenarios. In all of them, tariffs are calibrated in line with OECD (2016).[5] Moreover, it is assumed that tariff revenues are rebated in a lump-sum manner to domestic households, so as to focus only on their distortionary effects. The first scenario, named "Most Favoured Nation", corresponds to no trade agreement being stipulated between the EU and the UK. Thus, the bilateral UK-EA trade will be charged the respective (EU or British) so-called Most Favoured Nation (MFN) tariffs, as prescribed by WTO rules. Obviously the EA, as a part of the EU, shares EU tariffs. The changes in EU tariffs also affects those of the RW, which also includes non-EA EU Member States.[6] Upon exit from the EU, the UK also ceases its membership in all the trade agreements the EU has with third countries and hence also bilateral trade between the UK and the RW will be on MFN basis, bringing British tariffs on RW imports to the levels charged to EA imports, again as a consequence of the MFN clause of WTO rules.[7] Thus bilateral UK-RW tariffs increase both in the UK and in the RW. As far as EU-RW trade is concerned, all existing trade agreements are retained and tariffs are unchanged.

We then consider two "mitigating" scenarios. In our second scenario, it is assumed that an EU-UK bilateral free trade agreement (FTA) is concluded: as a result bilateral tariffs increase by significantly less. While the hypothetical EU-UK trade agreement covers both goods and services, in fact trade in goods is much freer than that in services. Indeed we take the set of agreements between the EU and Switzerland as a benchmark: trade in goods is practically free while services are restricted. Also tariffs on UK-RW trade are lower than in the MFN scenario because non-EA EU Member States (that are included in the RW region) will apply the EU-UK FTA tariffs while third countries will continue to charge MFN rates. Bilateral EA-RW tariffs are assumed to be unchanged.

---

[5]For the methodology used to construct the tariffs, see Appendix A.

[6]This modelling choice is motivated by the common monetary policy and nominal exchange rate of the EA Member States vis-a-vis all the other economies.

[7]The Most Favoured Nation clause prohibits any discrimination among trading partners, except in cases where a bilateral agreement has been concluded: a State pledges to grant each trading partner an equally favourable treatment to that conceded to any other State with which no trade agreement exists.

In the third scenario, "UK open for trade" (OUK), the UK does not apply tariffs to EA and RW goods and services. By contrast, the EA and the RW do raise tariffs on UK goods and services as in the MFN scenario. Thus, this scenario is equivalent to assuming that the UK unilaterally sets its MFN rates to zero and applies them to both the EU and the RW. Again, bilateral EA-RW tariffs are unchanged. While admittedly politically controversial (IMF, 2016a), this scenario is a useful term of reference, since it allows us to further analyze the implications of UK tariffs and that of non-EU markets (i.e. the ability of UK to substitute non-EU markets for the EU market) for our results.

A fourth scenario is also analyzed, in which it is assumed that in the case of MFN – the most protectionist among the three simulated tariff regimes – the imposition of tariffs also has an adverse effect on the efficiency frontier of the UK economy.[8] Higher tariffs would in fact decrease the international openness of the UK economy. Lower UK imports (and, most likely, lower foreign direct investment) would reduce the UK's access to international technology. There would be negative consequences for British total factor productivity (TFP).[9] As we do not model the channel through which reduced openness affects TFP (in the model, the latter is exogenous), we implicitly capture it by imposing, in line with a scenario reported by OECD (2016), that the TFP in the UK tradable sectors gradually decreases, over a five-year period, to a new lower level equal to 96% of the initial (pre-tariff) value, i.e. the TFP shock in the UK is equal to -4%. Thus, a permanent negative shock to the UK TFP is added on top of the MFN tariff increase.[10]

In all scenarios the increase in tariffs is sudden, permanent, announced by the authorities, and fully credible. Following the announcement, households and firms fully anticipate the future path of tariffs (perfect foresight assumption).

Our results are as follows.

First, the imposition of tariffs reduces UK exports and economic activity by a

---

[8]Given the lower level of import barriers in the FTA and the OUK scenarios, the UK would maintain – at least to a large extent – its openness and hence there would be no (or limited) negative effects on its efficiency frontier.

[9]For the link between international openness, access to international technology and country-specific TFP, see OECD (2016) and Finicelli et al. (2013).

[10]We focus on the trade channel. Thus, we do not explicitly consider the role of international direct and portfolio investment, relocation of banking and financial sectors, immigration, uncertainty, and risk premia on UK foreign borrowing and nominal exchange rate.

non-trivial amount. In particular, in the MFN scenario, real exports and real GDP decrease (in the long run) by about 7 and 2% (of the corresponding initial levels), respectively; in the FTA scenario by roughly 3 and 1%, respectively. Second, the macroeconomic costs would be somewhat reduced if the UK did not increase tariffs on imports from the EA and reduced those on imports from the RW (OUK scenario), even though the EA and the RW would increase tariffs on imports from UK: exports would increase by 2% while GDP would decrease by 0.4%, because production of UK goods and services would benefit from the reduction in tariffs on intermediate imports from the RW. Third, macroeconomic costs are particularly sizeable if the lower UK trade openness, associated with the MFN tariffs, induces a fall in UK TFP. In the long run, the combination of higher tariffs and lower TFP induce a fall in export and GDP equal to 16 and 11%, respectively. Fourth, Brexit spillovers to the EA economy are negative but small. Our results are in line with those reported by other studies and, in particular, by OECD (2016).

The paper is organized as follows. Section 2 reports results of the related literature. Section 3 describes the main features of the model, in particular how tradable goods and tariffs affect firms and households. Section 4 presents the simulated scenarios and section 5 reports the results. Section 6 concludes. The appendices contain additional material.

2 Related literature

DSGE models are extensively used to address issues related to (international) business cycle fluctuations and international trade linkages. For instance Corsetti et al. (2008) investigate the empirical puzzle of the lack of consumption risk sharing across countries, while Faruqee et al. (2008) analyze the macroeconomic effect of protectionism. Recently Johnson (2014) extended the open-economy dynamic-equilibrium framework to include trade and production linkages across countries, without however explicitly accounting for nontradable services, which we manage to introduce in our model. The impacts of protectionism and structural reforms have been widely addressed using DSGE models in institutional research as well.[11]

---

[11]See IMF (2016b, chapter 1), ECB (2009), D'Auria et al. (2009) and Annicchiarico et al. (2011).

Hence a DSGE model is an adequate tool to assess the macroeconomic effects of Brexit tariff regimes.

Before the referendum many studies were published to assess the possible consequences of Brexit. Among them it is worth recalling those by Dhingra et al. (2017), the OECD, the IMF and the British HM Treasury.[12] Despite wide differences in the range and specification of the scenarios, most other estimates indicated that Brexit would have negative effects on trade and, potentially, on financial flows and FDI between the UK and the EU.

Dhingra et al. (2017) estimate the permanent costs for the UK, in terms of per-capita income, to be in a range between 1.3 and 2.7%. These loss estimates are based only on the contraction in UK-EU trade flows. The more optimistic scenario assumes that the UK secures an agreement similar to the one in place between the EU and Norway, which implies no tariffs but still allows for the possibility of non-tariff barriers to trade. In such a case, the UK would continue to benefit also in the future from further improvements of trade integration within the EU. The more pessimistic scenario assumes the absence of any trade agreement, and the imposition of tariffs according to the rules of the WTO (MFN clause).

The estimated cost of Brexit greatly increases (to between 6.3 and 9.4%, again in terms of per-capita income) once one takes into account the potential dynamic consequences associated with the weaker competitive drive for efficiency and innovation (Dhingra et al., 2017). In the authors' opinion, these estimates still exclude the potentially very large negative effects associated with the impact of reduced trade in financial and professional services, smaller FDI inflows and lower immigration from the EU: for instance, in a different context, di Giovanni et al. (2015) estimate that, absent migration, UK real GDP per capita would be 1.5% lower.

Similar estimates are provided by the OECD, the IMF and the HM Treasury. According to OECD (2016), the long-run cost of Brexit would be between 2.7 and 7.7% of GDP. The OECD also provides an estimate of the GDP loss in the medium term: 1.3% in 2018, 3.3% in 2020 and 2.5% in 2023; the UK being an important trade partner, there would also be a negative effect on the output of the rest of the EU, amounting in the same years to 1.1, 0.9 and 0.8%, respectively.

---

[12]HM Treasury analyzes both immediate (HM Treasury, 2016b) and long-terms consequences (HM Treasury, 2016a) of leaving the EU.

According to IMF (2016a) there would be sizeable long-run losses in incomes, as increased barriers would reduce trade, investment, and productivity; in 2019 the UK GDP would be 1.4% lower in the more favourable scenario, 5.6% lower in the more severe scenario.

The estimates in HM Treasury (2016a) refer to the three scenarios described by the Foreign and Commonwealth Office,[13] and combine several analytical approaches: in the long run the UK GDP would be between 3.4 and 9.5% smaller.

More recently Mulabdic et al. (2017) show that, in a gravity model augmented with a measure of the depth of trade agreements, based on the number of provisions they contain, post-Brexit UK-EU trade in value added may decline by 6 to 28%. The drop is sharper, particularly for services and global value chain trade, the lower is the depth of the future arrangement relative to the considerable depth of the current EU membership.

3 The model

In this section we first provide an overview of the model. Subsequently, we illustrate in greater detail the features that are particularly crucial for the simulations (bundles and production functions). Finally, we report the calibration.

3.1 Overview

The model is New Keynesian and represents the world economy, composed of three regions: UK, EA, and RW. Its main features are in line with those of similar open-economy DSGE models developed in main central banks and international institutions.[14]

The size of the world economy is normalized to one. UK, EA, and RW have sizes equal to n^{UK}, n^{EA}, and $(1 - n^{UK} - n^{EA})$, with $n^{UK}, n^{EA} > 0$ and $n^{UK} + n^{EA} < 1$.[15]

---

[13]Outlined in section 1 above; see Foreign and Commonwealth Office (2016).

[14]See, for example, the IMF Global Economomy Model (Pesenti, 2008) and Eurosystem Euro Area and Global Economy Model (Gomes et al., 2010). To the best of our knowledge our model is the first one calibrated to the UK economy, featuring internationally traded intermediate goods and services in the production function.

[15]For each region, size refers to the overall population and to the number of firms operating in each sector (intermediate tradable goods, intermediate tradable services, intermediate nontrad-

Each region has its own monetary authority. The latter sets the nominal short-term interest rate according to a Taylor rule, in which it reacts, in a gradual way, to domestic inflation and economic activity. The presence of the RW outside the EA allows us to assess the role of the extra-EA trade for the transmission of Brexit to the UK and EA economies.

All households maximize their intertemporal utility, separable in (the log of) consumption and in labour (supplied to domestic firms). Households can invest in physical capital, supplied to domestic firms, and in one internationally traded one-period riskless bond (exchanged among households), denominated in the RW currency.[16] UK and EA households also invest in a domestically traded one-period riskless bond, denominated in the respective domestic currency. All households supply differentiated labour services to domestic firms and act as wage setters in monopolistically competitive labour markets by charging a mark-up over their marginal rate of substitution between consumption and leisure.

On the production side, in each region there are perfectly competitive firms that operate in three final sectors – private consumption, public consumption, and investment – and monopolistically competitive firms that operate in three intermediate sectors – tradable goods, tradable services, nontradable services.

In each region, the final consumption and investment bundles and exports of intermediates are produced combining all available (domestic and imported) intermediate goods and tradable and nontradable services using constant-elasticity-of-substitution (CES) production functions.

Each intermediate good and service is produced combining domestic capital, labour, and all intermediate goods and services. Thus, intermediate goods and services enter as an input not only the production function of the final goods, but also their own production function, jointly with capital and labour (according to a CES production function). Capital and labour are assumed to be mobile across sectors, but not across countries.[17] Intermediate tradable goods and services can

---

able services, final nontradable consumption, final nontradable investment, and final nontradable public expenditure).

[16]Thus international financial markets are incomplete.

[17]We are aware that immigration in the UK was a key issue in the referendum vote and that the UK government pledged to curb immigration from the EU after Brexit. As our focus is on tariff changes we do no address this issue in this paper.

be sold domestically and abroad. Because intermediate goods are differentiated, firms have market power and restrict output to create excess profits. We also assume that markets for tradable goods and services are segmented, so that firms can set a different price for each of the three markets (UK, EA, and RW), i.e. the local-currency-pricing assumption holds.

In line with other dynamic general equilibrium models, we include adjustment costs on real and nominal variables, ensuring that consumption, production, wages, and prices react in a gradual way to a given shock. On the real side, habits and quadratic costs prolong the adjustment of households consumption and investment, respectively. On the nominal side, quadratic costs make nominal wages and prices sticky.[18]

In each region, the monetary authority sets the (short-term) monetary policy rate according to a 'Taylor' rule. The policy rate reacts in a gradual way to changes in domestic inflation and output. The gradual response is due to the presence of an inertial term in the rule (the one-period lagged policy rate, weighted by a lower-than-one coefficient).

In what follows, we report the main new equations for the UK. Similar equations hold in the EA and in the RW.

3.2 Final goods and services

In UK, the CES consumption bundle C^{UK} is

$$C_t^{UK} = \left[\left(a_T^{UK} \right)^{\frac{1}{\rho}} \left(C_{T,t}^{UK} \right)^{\frac{\rho-1}{\rho}} + \left(1 - a_T^{UK} \right)^{\frac{1}{\rho}} \left(C_{N,t}^{UK} \right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}, \qquad (1)$$

where $\rho > 0$ is the elasticity of intratemporal substitution among goods and tradable services on the one hand, and nontradable services on the other, $0 < a_T^{UK} < 1$ is a parameter representing the weight of goods and tradable services, C_T^{UK}, and $\left(1 - a_T^{UK} \right)$ the weight of nontradable services, C_N^{UK}.

---

[18]See Rotemberg (1982).

The UK nontradable consumption good is a Dixit-Stiglitz aggregator

$$C_{N,t}^{UK} = \left[\left(\frac{1}{\theta^{UK}} \right) \int_{0}^{n^{UK}} \left(C_N^{UK} \left(j \right) \right)^{\frac{\theta^{UK}-1}{\theta^{UK}}} dj \right]^{\frac{\theta^{UK}}{\theta^{UK}-1}}, \qquad (2)$$

where $C_N^{UK} \left(j \right)$ is consumption of the intermediate brand produced by the generic firm j in the UK intermediate nontradable services sector, and $\theta^{UK} > 1$ is a parameter measuring the elasticity of substitution among different intermediate nontradable services.

The consumption of tradables is

$$C_{T,t}^{UK} = \left[\left(a_G^{UK} \right)^{\frac{1}{\rho^T}} \left(C_{G,t}^{UK} \right)^{\frac{\rho^T-1}{\rho^T}} + \left(1 - a_G^{UK} \right)^{\frac{1}{\rho^T}} \left(C_{S,t}^{UK} \right)^{\frac{\rho^T-1}{\rho^T}} \right]^{\frac{\rho^T}{\rho^T-1}}, \qquad (3)$$

where C_G^{UK} and C_S^{UK} are consumption of goods and tradable services, respectively. The bundle of (tradable) goods is

$$C_{G,t}^{UK} = \left[\begin{array}{c} \left(a_{G,UK}^{UK} \right)^{\frac{1}{\rho^G}} \left(C_{G,UK,t}^{UK} \right)^{\frac{\rho^G-1}{\rho^G}} + a_{G,EA}^{UK} \left(C_{G,EA,t}^{UK} \right)^{\frac{\rho^G-1}{\rho^G}} \\ + \left(1 - a_{G,UK}^{UK} - a_{G,EA}^{UK} \right)^{\frac{1}{\rho^G}} \left(C_{G,RW,t}^{UK} \right)^{\frac{\rho^G-1}{\rho^G}} + \end{array} \right]^{\frac{\rho^G}{\rho^G-1}}, \qquad (4)$$

where $C_{G,UK,t}^{UK}$, $C_{G,EA,t}^{UK}$, and $C_{G,RW,t}^{UK}$ are consumption of goods produced in UK, EA, and the RW, respectively. Parameters $a_{G,UK}^{UK}, a_{G,EA}^{UK}$ are the weights of UK- and EA-produced goods, respectively, $(0 < a_{G,UK}^{UK}, a_{G,EA}^{UK} < 1, a_{G,UK}^{UK} + a_{G,EA}^{UK} < 1)$. A similar bundle holds for the consumption of tradable services,

$$C_{S,t}^{UK} = \left[\begin{array}{c} \left(a_{S,UK}^{UK} \right)^{\frac{1}{\rho^S}} \left(C_{S,UK,t}^{UK} \right)^{\frac{\rho^S-1}{\rho^S}} + a_{G,EA}^{UK} \left(C_{S,EA,t}^{UK} \right)^{\frac{\rho^S-1}{\rho^S}} \\ + \left(1 - a_{G,UK}^{UK} - a_{G,EA}^{UK} \right)^{\frac{1}{\rho^S}} \left(C_{S,RW,t}^{UK} \right)^{\frac{\rho^S-1}{\rho^S}} \end{array} \right]^{\frac{\rho^S}{\rho^S-1}}. \qquad (5)$$

The UK-produced consumption good in Equation 4 is the Dixit-Stiglitz aggregator:

$$C_{G,UK,t}^{UK} = \left[\left(\frac{1}{\theta^{UK}} \right) \int_{0}^{n^{UK}} \left(C_{G,UK,t}^{UK} \left(j \right) \right)^{\frac{\theta^{UK}-1}{\theta^{UK}}} dj \right]^{\frac{\theta^{UK}}{\theta^{UK}-1}}, \qquad (6)$$

where $C_{G,UK,t}^{UK}(j)$ is consumption of the intermediate brand produced by the generic firm j in the UK intermediate goods sector, and $\theta^{UK} > 1$ is a parameter measuring the elasticity of substitution among different brands. We define $C_{G,EA,t}^{UK}$, $C_{G,RW,t}^{UK}$, $C_{S,UK,t}^{UK}$, $C_{S,EA,t}^{UK}$ and $C_{S,RW,t}^{UK}$ analogously.

Similar bundles hold for UK investment and for EA and RW consumption and investment. In all regions, the public consumption bundle is instead fully biased towards (domestic) nontradable services, in line with the existing literature.

Firms producing the final goods operate under perfect competition. They minimize production costs by optimally choosing inputs subject to the above nested CES technology and taking the prices as given.

3.3   Intermediate goods and services

There are three intermediate sectors producing intermediate goods, intermediate tradable services, and intermediate nontradable services, respectively. For the sake of brevity, in what follows we describe the main equations of intermediate goods' sector. Similar equations hold for each of the other two intermediate sectors.

The generic firm j in the UK produces its brand $Y_{G,t}^{UK}(j)$ according to the CES production function

$$
Y_{G,t}^{UK}(j) = \left[\begin{array}{c} \left(a_{G,VA}^{UK}\right)^{\frac{1}{\rho^Y}} \left(VA_{G,t}^{UK}(j)\right)^{\frac{\rho^Y-1}{\rho^Y}} \\ + \left(1 - a_{G,VA}^{UK}\right)^{\frac{1}{\rho^Y}} \left(INT_{G,t}^{UK}(j)\right)^{\frac{\rho^Y-1}{\rho^Y}} \end{array} \right]^{\frac{\rho^Y}{\rho^Y-1}}, \tag{7}
$$

where $VA_{G,t}^{UK}$ is the value added, $INT_{G,t}^{UK}$ the intermediate goods and services, $a_{G,VA}^{UK}$ and $\left(1 - a_{G,VA}^{UK}\right)$ the corresponding weights ($0 < a_{G,VA}^{UK} < 1$), and $\rho^Y > 0$ is the elasticity of substitution. Thus, each intermediate brand enters as an input its own production function and the production function of all other intermediate brands.

The value added is

$$
VA_{G,t}^{UK}(j) = \left[\begin{array}{c} \left(a_{G,K}^{UK}\right)^{\frac{1}{\rho^{VA}}} \left(K_{G,t}^{UK}(j)\right)^{\frac{\rho^{VA}-1}{\rho^{VA}}} + \\ \left(1 - a_{G,K}^{UK}\right)^{\frac{1}{\rho^{VA}}} \left(L_{G,t}^{UK}(j)\right)^{\frac{\rho^{VA}-1}{\rho^{VA}}} \end{array} \right]^{\frac{\rho^{VA}}{\rho^{VA}-1}}, \tag{8}
$$

where $K_{G,t}^{UK}$ and $L_{G,t}^{UK}$ are physical capital and labour (hours worked), respectively.

The bundle of intermediate goods and services is

$$INT_{G,t}^{UK}(j) = \left[\begin{array}{c} \left(a_{G,INTT}^{UK}\right)^{\frac{1}{\rho^{INT}}} \left(INTT_{G,t}^{UK}(j)\right)^{\frac{\rho^{INT}-1}{\rho^{INT}}} \\ + \left(1 - a_{G,INTT}^{UK}\right)^{\frac{1}{\rho^{INT}}} \left(INTN_{UK,t}^{UK}(j)\right)^{\frac{\rho^{INT}-1}{\rho^{INT}}} \end{array} \right]^{\frac{\rho^{INT}}{\rho^{INT}-1}}, \quad (9)$$

where $INTT_{G,t}^{UK}$ are intermediate goods and tradable services and $INTN_{UK,t}^{UK}$ intermediate nontradable services.

The generic intermediate nontradable $INTN_{UK,t}^{UK}(j)$ is the Dixit-Stiglitz aggregator

$$INTN_{UK,t}^{UK}(j) = \left[\left(\frac{1}{\theta^{UK}}\right) \int_0^{n^{UK}} \left(INTN_{UK,t}^{UK}(x)\right)^{\frac{\theta^{UK}-1}{\theta^{UK}}} dx \right]^{\frac{\theta^{UK}}{\theta^{UK}-1}}, \quad (10)$$

where x is the generic firm producing intermediate nontradable services. This bundle is the same across all sectors.

The intermediate tradable goods and services bundles is

$$INTT_{G,t}^{UK}(j) = \left[\begin{array}{c} \left(a_{G,INTG}^{UK}\right)^{\frac{1}{\rho^{INTT}}} \left(INTG_{G,t}^{UK}(j)\right)^{\frac{\rho^{INTT}-1}{\rho^{INT}_T}} \\ + \left(1 - a_{G,INTG}^{UK}\right)^{\frac{1}{\rho^{INTT}}} \left(INTS_{G,t}^{UK}(j)\right)^{\frac{\rho^{INTT}-1}{\rho^{INTT}}} \end{array} \right]^{\frac{\rho^{INTT}}{\rho^{INTT}-1}}, \quad (11)$$

where $INTG_{G,t}^{UK}$ and $INTS_{G,t}^{UK}$ are intermediate tradable goods and services, respectively.

The intermediate goods' bundle is

$$INTG_{G,t}^{UK}(j) = \left[\begin{array}{c} \left(a_{G,INTG,UK}^{UK}\right)^{\frac{1}{\rho^{INTG}}} \left(INTG_{UK,t}^{UK}(j)\right)^{\frac{\rho^{INTG}-1}{\rho^{INTG}}} \\ + \left(a_{G,INTG,EA}^{UK}\right)^{\frac{1}{\rho^{INTG}}} \left(INTG_{EA,t}^{UK}(j)\right)^{\frac{\rho^{INTG}-1}{\rho^{INTG}}} \\ + \left(1 - a_{G,INTG,UK}^{UK} - a_{G,INTG,EA}^{UK}\right)^{\frac{1}{\rho^{INTG}}} \\ \times \left(INTG_{RW,t}^{UK}(j)\right)^{\frac{\rho^{INTG}-1}{\rho^{INTG}}} \end{array} \right]^{\frac{\rho^{INTG}}{\rho^{INTG}-1}}, \quad (12)$$

where $INTG_{UK,t}^{UK}$, $INTG_{EA,t}^{UK}$ and $INTG_{RW,t}^{UK}$ are the bundles of intermediate goods,

domestically produced, imported from the EA, and imported from the RW, respectively, used in the production of UK goods.

The UK-produced intermediate good is the Dixit-Stiglitz aggregator

$$INTG_{G,UK,t}^{UK}(j) = \left[\left(\frac{1}{\theta^{UK}} \right) \int_0^{n^{UK}} \left(INTG_{G,UK,t}^{UK}(x) \right)^{\frac{\theta^{UK}-1}{\theta^{UK}}} dx \right]^{\frac{\theta^{UK}}{\theta^{UK}-1}}, \qquad (13)$$

where $INTG_{G,UK,t}^{UK}(x)$ is the intermediate brand produced by the generic firm x. We define $INTG_{G,EA}^{UK}$, $INTG_{G,RW}^{UK}$, $INTS_{G,UK}^{UK}$, $INTS_{G,EA}^{UK}$, and $INTS_{G,RW}^{UK}$ analogously.

Each firm j minimizes production costs by optimally choosing the inputs capital, labour, and intermediate goods subject to the above nested CES technology and taking the prices as given.

As a seller, firm j operates under monopolistic competition. It optimally chooses the price of its brand in the currency of the destination market taking as given the marginal costs and the demand for the brand and subject to short-run quadratic price adjustment costs. Crucially, when setting its before-tariff local price, the firm also takes into account the import tariff that affects the final price $p_t^{UK}(j)$. The latter is given by

$$p_t^{UK}(j) = \bar{p}_t^{UK}(j) \left(1 + \tau_t^{UK} \right), \qquad (14)$$

where $\bar{p}_t^{UK}(j)$ is the optimal before-tariff price of the brand j and $\tau_t^{UK} > 0$ the tariff paid to export in the UK.[19]

3.4 Model calibration

The model is calibrated to match EA, UK, and RW great ratios (e.g. consumption, investment and imports as a ratio to GDP; Table 1), intermediate sectors' structure (Table 2) and bilateral trade flows (Table 3). According to the 2016 release of the WIOD database[20] which contains data for 2014, while the EA and

---

[19]We abstract from the effect of geographical distance on trade costs, which would affect merchandise trade more than trade in services.

[20]See Timmer et al. (2015) .

the UK have a similarly large nontradable services sectors (about 50% of GDP), the size of manufacturing and tradable service sectors differ substantially between the two economies: in the UK tradable services account for almost 29% of GDP (manufacturing for the remaining 22%), whereas in the EA tradable service are just 23% of GDP (manufacturing almost 27%). [21] Moreover there are also large differences in the intermediate sectors' structures and in the imports' patterns. In particular UK imports from the EA amount to 12.8% of GDP, and those from the RW to 14.4%; at the same time the EA imports from the UK are just 1.8% of GDP and those from the RW 18.3%; finally the RW imports 0.8% from the UK and 4.8% from the EA. These large differences in import shares play a crucial role in determining the severity of the Brexit shock. For this reason we expect the UK to be hit more than the EA by tariff shocks.

We calibrate the tariffs the EA, the UK and the RW charge to goods' and services' imports according to WTO et al. (2015) and OECD (2016). While normally goods face a tariff on crossing a border, in the case of services an explicit tariff does not exist: protection from foreign services is usually achieved by imposing administrative restrictions to service providers, such as requiring a specific authorisation.[22] For simplicity we bundle all the tariffs and non-tariff barriers into a single tariff measure, i.e. we consider the *ad-valorem tariff equivalent* to both tariffs and non-tariff barriers. Appendix A explains in much greater detail the calibration of the tariffs.

Tradable services are identified as those services whose exports are at least 10% of output in one of the regions. According to this criterion tradable services are transportation, publishing, ICT, finance, insurance, and professional services.[23]

We report key parameters for the dynamics in Table 4, i.e., the elasticity of substitution among intermediate goods and services in the production functions, the elasticity of substitution among goods and services in the final consumption and investment bundles. We also report the calibration of the Taylor rules (the

---

[21]Sectoral shares of GDP in the RW are 36.8% for manufacturing, 21.2 % for tradable services and 42% for nontradable services.

[22]Indeed protection from goods' imports is performed not only by means of simple tariffs, there exist other instruments such as quotas, tariff-rate quotas, etc., as well as non-tariff measures (some of which are used for services too).

[23]Our list of tradable services is consistent with Jensen and Kletzer (2005), whose classification criterion is based on geographical agglomeration, rather than on an export threshold.

coefficient of the autoregressive component, that captures inertia in setting the policy rate, the weights of inflation and output). Finally, the table contains parameters measuring nominal price rigidities and nominal wage rigidities. Both prices and wages are rather sticky in the short run. Given the possible relevance of the reported parameters and that their estimates are surrounded by some degree of uncertainty, we conduct a sensitivity analysis on them.

4   Simulated scenarios

In all scenarios the UK and the EU are assumed to announce an immediate and permanent change in tariffs on their bilateral trade. Since we analyze the EA and include the non-EA EU countries in the RW region, tariff changes at the EU level affect not only the EA tariffs on a one-to-one basis, but also, pro quota, the UK-RW tariffs. The latter also vary as a result of the fact that Brexit automatically implies the UK's withdrawal from all the FTAs signed by the EU with other countries.[24] In all scenarios, bilateral EA-RW tariffs are unchanged relative to the *status quo.* The tariff changes (defined as the differences between the final and the initial tariffs, in percentage points) are presented in Table 5.

In the first scenario, named the "most favoured nation" (MFN), the UK permanently increases tariffs on EA goods and services to 3.6% and 20.0%, respectively (from zero).[25] Simultaneously, the EA increases tariffs on UK goods to 3.2% and 20%, respectively (again, from zero). UK tariffs on merchandise imports from the RW increase from 2.4% to 3.6% and those on RW services from 17.8% to 20%. British goods in the RW face a 3.7% tariff (up from 2.4%) and British services one equal to 20% (from 18.4).[26]

In the second scenario, named "free trade agreement" (FTA), UK increases tariffs on EA goods and services to 0.3% and 10%, respectively (from zero).[27] The same increases apply to the EU tariffs on UK goods and services. UK-RW bilateral tariffs also increase: the UK tariffs on RW goods and services are 3.1% and 18.9%

---

[24]EU's existing FTAs mainly cover trade in goods and not in services.

[25]The tariff on services is in line with the assumption in OECD (2016)

[26]For a sectoral disaggregation of the UK-EU post-Brexit tariffs, see Cappariello (2017).

[27]The EU tariff on goods' imports from the UK represents the non-tariff barriers, such as rules of origin, that would apply in an FTA.

(from 2.4 and 17.8% respectively); RW tariffs on British goods and services are 3.3 and 19.2% (from 2.4 and 18.4% respectively).

In the third scenario, "UK open for trade" (OUK), the UK does not apply tariffs to imports of EU and RW goods and services. By contrast, tariffs on UK goods and services increase, as in the MFN scenario, both in the EA (to 3.6 and 20%, respectively) and in the RW (to 3.7 and 20%, respectively).

In the fourth scenario (production inefficiency), it is assumed that the switch to MFN, which is the most protectionist among the three simulated tariff regimes, also has an adverse effect on the efficiency frontier of the UK economy.[28] In fact, higher tariffs would decrease the international openness of the UK economy, and lower UK imports would hamper UK access to international technology. All this would negatively affect the British TFP. As we do not model the channel through which trade openness affects TFP (it is exogenous in our model), we implicitly capture it by imposing, in this scenario, that the UK TFP gradually decreases, over a five-year period, to a new lower level equal to 96% of the initial value, i.e. the TFP shock in the UK is equal to -4%.[29] Hence a permanent negative shock to the UK TFP is added on top of the MFN tariff increase.

In all scenarios the implementation of tariffs on trade begins in the first period of the simulations and households and firms anticipate that it will be permanent (perfect foresight assumption). Thus, the announced policy measures (i.e. the changes in tariffs) are fully credible. It is assumed that revenues from tariffs are rebated to domestic households in a lump-sum (non-distortionary) manner.

5   Results

5.1   Most Favoured Nation

Figure 1 displays the (quarterly) responses of UK exports and imports of goods and services in the MFN scenario.

UK exports to the EA permanently decline. The response is quick, given the sudden imposition of tariffs. EA households and firms substitute domestic and RW

---

[28]In this scenario tariff shocks are the same as in the MFN scenario.

[29]The shock is smaller than the one reported in OECD (2016).

goods and services for UK products, because the tariffs make the former cheaper than the latter. Given that before-tariff nominal prices are sticky in the short-run (nominal prices are subject to quadratic adjustment costs and the local currency pricing assumption holds for exported goods), the increase in tariffs implies a rather rapid increase in after-tariff nominal prices. Thus, the drop in exports is rather sudden. Exports of services to the EA decrease to a larger extent than those of goods because of the larger increase in the corresponding tariff.

UK exports to the RW also decrease to some extent, because of the increase in the corresponding tariff. The drop in UK exports to the RW is less significant, as the increase in tariffs is smaller.

Figure 1 also shows the responses of UK imports. Responses are broadly similar to those of exports. UK households substitute domestic and RW goods for EA goods. Imports of services decrease to a larger extent again because of the larger increase in services tariffs. The overall drop in imports is mainly due to the reduction in imported goods and services from the EA. The drop in imports of RW goods and services is smaller, given the smaller tariff increase. The responses of UK imports and exports of services from/to the EA are very similar to each other since the tariff shock on services in both economies is the same (20%); this is not the case for UK imports and exports vis-a-vis the RW: tariff shocks differ between the two regions.

Figure 2 shows the effects on EA-RW bilateral exports and imports. EA exports to the RW are virtually unaffected. EA imports from the RW experience a mild decline, due to the fall in EA aggregate demand, reflecting the negative income effect of the tariff increase.

Figure 3 reports the responses of the other UK macroeconomic variables. GDP permanently decreases, not only because of the drop in exports, but also because of the contraction in consumption and investment. Within these two demand components, the share of imported goods and services is not negligible (the UK is a small open economy), and households cannot easily substitute domestic for imported goods and services, as the corresponding elasticities of substitution have been calibrated to relatively low values. Firms reduce labour demand, inducing a decrease in both labour (hours worked) and real wages.

UK (year-on-year) inflation temporarily increases because of the higher tariffs,

since nominal rigidities imply that, in the short run, the before-tariff prices do not immediately adjust. In the medium run inflation falls slightly below the baseline, as before-tariff prices gradually decrease responding to the permanently-lower aggregate demand in the UK. Given the initial increase in inflation and its large weight (relative to domestic output stabilization) in the Taylor rule, the UK central bank temporarily tightens, in a rather mild way, monetary policy. The higher policy rate induces an appreciation of the exchange rate in both nominal and real terms, which is, however, rather modest.

Figure 4 shows the responses of the EA macroeconomic variables. There is a mild but permanent decrease in EA GDP, associated with lower consumption and investment. Both exports and imports also decrease. The reduction in economic activity in the EA is much smaller than in the UK, because the relevance of bilateral UK-EA trade for the EA economy is smaller than for the UK. EA inflation slightly increases in the initial quarters, following the increase in tariffs, and thereafter decreases to values just below the baseline: given the small impact of the tariff increase on EA aggregate demand, firms do not greatly change before-tariff prices.

Tables 6 and 7 report the long-run (steady-state) responses of the main UK and EA variables, respectively. They are negative and larger for UK variables. Moreover, it is mainly UK trade which is affected the most by the imposition of tariffs.

Overall, we do find that the increase in tariffs has negative effects on UK export performance and economic activity. There are also negative effects on EA activity but they are small, in general.

5.2   Free Trade Agreement and UK Open for Trade

The Free Trade Agreement (FTA) scenario is characterized by a smaller tariff increase than the MFN regime. UK increases tariffs on EU imported goods and services by 0.3 and 10pp, respectively. The same tariff increases are applied by the EU on UK goods and services. In the UK Open for Trade (OUK) regime, the UK does not apply any tariff increase on EU goods and services. Moreover, it reduces to zero tariffs on goods and services produced in the RW. On the contrary, the EU and the RW apply on UK tradables the same tariffs as in the MFN regime.

Figures 5-9 display the responses of the main UK and EA trade variables in the FTA scenario (red dashed line), the OUK scenario (blue continuous line), and, for the sake of comparison, the MFN scenario (black continuous line).

In the FTA regime, UK exports to the EA fall to a lesser extent than in the MFN scenario (see Figure 5), consistent with the lower increase in tariffs, while exports to the RW decrease in a similar way in the two scenarios, because the increase in tariffs is almost the same in both regimes.

In the OUK regime UK exports of services to the EA decrease sharply, while UK exports of goods to the EA and the RW and UK exports of services to RW increase. The large increase in tariffs on UK exports of services implies a permanent drop in EA demand for UK services. The lower production of UK services implies lower demand for inputs and, thus, lower production costs. Crucially, the reduction in UK production costs is also favoured by the fact that the UK does not raise tariffs on EA goods and services and reduces to zero its tariffs on RW goods and services (all are inputs in the production of UK intermediates). The lower production costs are passed-through to the final prices of UK exports, that therefore decrease. Both the lower prices and the lower increase in tariffs on UK goods, compared to that on UK services, favour the increase in UK exports of goods to the EA, in spite of the higher tariffs. Similarly, UK exports of goods and services to the RW increase.

Consistent with the positive price-competitiveness effect on UK goods and services, UK imports of goods decrease more in the OUK than in the two other scenarios (see Figure 6). By contrast, UK imports of EA and RW services decrease to a lower extent and increase, respectively. The reduction in tariffs implies that RW services gain competitiveness with respect to EA services in the UK.

Bilateral trade between the EA and the RW is is not greatly affected in either scenario (see Figure 7).

In the FTA scenario, the macroeconomic effect on the UK is recessionary, yet to a much smaller extent than in the MFN regime (see Figure 8 and Table 6). The effects on UK GDP in the OUK case are virtually nil in the medium run, thanks to the increase in net exports. In the short and medium run investment mildly increases at the expense of consumption, because the higher share of imports in the investment bundle implies a lower cost of investment goods when tariffs are lowered. Investment is somehow favoured by the lower after-tariff prices of

intermediates faced by firms. Thus, firms have a larger incentive to accumulate physical capital. Consistent with the reduction in tariffs, inflation in the UK temporarily falls, the central bank reduces the policy rate and the exchange rate depreciates.

In either scenario EA GDP slightly declines in the medium run, because of the reduction in investment and net exports; yet the effects are really small (Figure 9 and Table 7).

Tables 6 and 7 report the long-run (steady-state) responses of the main UK and EA variables, respectively. It is interesting to note that even in the most favourable scenario, OUK, there is a UK GDP loss.

Overall, the simulations suggest that, for the UK, there are non-negligible macroeconomic costs associated with the imposition of higher tariffs on its exports (and imports). Those macroeconomic costs can be mitigated, but they cannot be fully counterbalanced, if the UK favours the supply-side of its economy and, thus, its price competitiveness by unilaterally choosing not to raise tariffs on imported goods and services.

5.3   Production inefficiency

The MFN scenario is the most protectionist among the three scenarios evaluated in the previous subsections. The tariff increase, by making the economy less open to international trade and (foreign) investment, can be a source of production inefficiency, i.e. it can induce a backward shift in the country efficiency frontier. We assess the macroeconomic effects of this efficiency loss by simulating the MFN scenario with the addition, on top of the tariff increases, of a gradual and permanent decrease of total factor productivity in the production functions of both UK intermediate tradable goods and services. In the spirit of OECD (2016), it is assumed that the TFP falls by 4% over a five-year period.

Figures 10 and 11 illustrate the effects on UK exports and imports, respectively. All bilateral exports and imports decrease to a larger extent than in the MFN (tariff-only) scenario. The efficiency loss exacerbates the negative supply-side effects of the increase in tariffs. It implies that the UK economy produces less of tradable goods at a higher price for a given amount of inputs. This price-

competitiveness loss puts UK exports at disadvantage. At the same time, the lower efficiency has negative implications for UK national income and aggregate demand. UK imports decline as a consequence.

Figures 13 and 14 show the responses of the main UK and EA macroeconomic variables, respectively. UK GDP, consumption, and investment decrease more than in the MFN scenario (Figure 13). Inflation decreases further below its baseline level, in line with the large decrease of UK aggregate demand. The UK central bank reduces the policy rate by more, in the attempt to stabilize inflation and economic activity. Labour (hours worked) decreases as well, more than in the MFN scenario, in line with the larger drop in UK GDP.

The negative permanent shock to the UK TFP has negative spillovers to the EA economy (Figure 14). EA households and firms import fewer UK goods and services at a higher price. The implied negative income effect induces an additional decrease in EA GDP, consumption and investment relative to the MFN scenario. Both EA exports and imports decrease. In the medium run, EA exports to the RW increase, as EA tradables become cheaper than UK ones, whose price is negatively affected not only by the tariffs but also by the lower efficiency.

Tables 6 and 7 report the long-run (steady-state) macroeconomic effects of the efficiency loss (and MFN tariffs) for the UK and the EA, respectively. UK GDP and its components decrease by a large extent. EA GDP and its components also decrease more than in the other scenarios, because of the larger negative spillovers from the UK economy.

Overall, the loss in production efficiency, associated with the reduction in UK trade openness, can be a relevant source of further reduction in UK economic activity after Brexit.

5.4   Sensitivity

We report the results of the sensitivity analysis by simulating the MFN scenario (our benchmark scenario) under alternative calibrations of some key parameters. Specifically, in one case we increase both the elasticity of substitution among intermediate (domestic and imported) tradable goods and that among intermediate tradable services to 2.5 (from 1.2) in every region's production functions. In the

second scenario, instead, we reduce the nominal price rigidities of all exported and imported goods and services (from 600 to 6), so that prices of exports and imports are rather flexible already in the short run and quickly react to the increase in tariffs. In third scenario, we increase the weight of UK output in the UK monetary policy rule (from 0.4 to 0.8). In the fourth scenario we assume that it is credibly announced at the beginning of the simulation period that MFN tariffs will be introduced two years later and that those tariffs will then become permanent.

Figure 15 reports the responses of the main UK variables in the case of higher elasticity. It is now easier than in the benchmark case for firms to substitute among tradables for a given change in international relative prices. Thus, EA firms substitute domestic and RW tradables for UK tradables and, consequently, UK exports decrease. The same is true for UK firms. They can substitute domestic and RW goods and services for EA ones. This implies that both British exports and imports decrease. However, exports are rather relevant for the UK economy. The result is a larger decrease in UK economic activity than in the benchmark case. UK labour (hours worked) decreases more, driving down UK real wage, investment, consumption, and, thus, GDP. UK inflation increases more, reacting to the larger shift of domestic firms' demand towards domestic intermediate goods and service, whose prices increase much more.

Figure 16 contains the macro responses in the case of low import price rigidities in every region. The increase in tariffs induces a more rapid increase in the price of UK exports. The latter decrease more rapidly than in the benchmark scenario. Thus, the real GDP decreases more in the very short run than in the case of MFN with benchmark calibration.

Figure 17 reports the responses under the assumption of UK monetary policy reacting more to domestic output. The weight of output in the British Taylor rule is increased from 0.4 (benchmark) to 0.8. The new calibration of the monetary rule, which implies that the monetary policy stance is more accommodative (i.e., reacts relative more to the output decrease) than in the benchmark case, favours domestic consumption and investment, which decrease less than under the benchmark calibration. Thus, UK GDP decreases less in the short and medium run. This shows that monetary policy has a role in softening the impact of the tariff shocks along the transition (even if it cannot affect the long-run equilibrium, in

which prices are fully flexible).

Finally, Figure 18 shows the responses of the UK macroeconomic variables in the fourth alternative scenario. As the announcement of new tariffs is credible, agents anticipate the future increase in tariffs and immediately react. GDP and all its components start falling mildly immediately after the announcement and when tariff are introduced (period 9) they quickly adjust to the dynamics of the benchmark case. This is due to the a negative wealth effect connected with the anticipation by UK households and firms of the long-run effect of tariffs. The recession causes the British central bank to temporarily lower the policy rate, until the period in which inflation picks up when tariffs are effectively introduced.

Overall, we do find that international relative prices (i.e., elasticity of substitution and nominal rigidities) and the response of the monetary policy authority can be quite important in shaping the short-run responses of the UK economy to the increase in tariffs. In particular, the monetary authority can make the transition smoother and, thus, reduce the macroeconomic short-run costs in terms of economic activity if it can reduce the policy rate. Finally the announcement of the introduction of tariffs in the future bears negative macroeconomic effects to the UK current economic conditions.

6   Conclusions

We have developed and calibrated a New Keynesian model of the United Kingdom (UK), the euro area (EA), and the rest of the world (RW) to evaluate the impact of tariffs imposed on the UK and EA trade after Brexit.

We analyze three tariff scenarios: in the first, UK exporters and importers face the WTO Most Favoured Nation (MFN) tariffs; in the second, the UK and the EU sign a free trade agreement (FTA); in the third, the UK fully liberalizes imports (hence the name "UK open for trade", OUK). Finally we simulate again the MFN scenario augmented by a shock to total factor productivity (TFP) in the UK stemming from lower international openness, i.e. we address the impact of production inefficiency in the UK.

We find that Brexit will be costly for the UK. First, the imposition of tariffs damages UK exports and macroeconomic activity in both the short and long run

(MFN and FTA scenarios). Second, such macroeconomic costs would be reduced, but not eliminated, if the UK were to liberalize imports from the EA and the RW (OUK scenario). Third, macroeconomic costs are particularly large if in the MFN scenario lower UK trade openness were compounded by a lower UK productivity. Finally, across all scenarios Brexit spillovers to the EA economy are negative but relatively modest.

We have focused only on the trade channel of Brexit. However Brexit can affect the British and EA economies also through other channels, as relevant as trade, which fall beyond the scope of this paper. Namely we abstract from international direct and portfolio investment, relocation of banking and financial sectors, immigration, uncertainty, and risk premia on UK international borrowing, that could also affect the behaviour of the nominal and real exchange rates. We leave these issues for future research.

References

Annicchiarico, B., F. Di Dio, F. Felici, and F. Nucci (2011): "Macroeconomic Modelling and the Effects of Policy Reforms: an Assessment for Italy using ITEM and QUEST," Working Papers 1, Department of the Treasury, Ministry of the Economy and of Finance.

Cappariello, R. (2017): "Brexit: estimating tariff costs for EU countries in a new trade regime with the UK," Questioni di Economia e Finanza (Occasional Papers) 381, Bank of Italy, Economic Research and International Relations Area.

Corsetti, G., L. Dedola, and S. Leduc (2008): "International Risk Sharing and the Transmission of Productivity Shocks," *Review of Economic Studies*, 75, 443–473.

D'Auria, F., A. Pagano, M. Ratto, and J. Varga (2009): "A comparison of structural reform scenarios across the EU member states - Simulation-based analysis using the QUEST model with endogenous growth," European Economy - Economic Papers 2008 - 2015 392, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Department for Exiting the European Union (2017): *The United Kingdom's exit from and new partnership with the European Union*, HM Government.

Dhingra, S., H. Huang, G. Ottaviano, J. Paulo Pessoa, T. Sampson, and J. Van Reenen (2017): "The costs and benefits of leaving the EU: trade effects," *Economic Policy*, 32, 651–705.

di Giovanni, J., A. A. Levchenko, and F. Ortega (2015): "A Global View Of Cross-Border Migration," *Journal of the European Economic Association*, 13, 168–202.

ECB (2009): "Assessing global trends in protectionism," *Monthly Bulletin*.

Faruqee, H., D. Laxton, D. Muir, and P. Pesenti (2008): "Would protectionism defuse global imbalances and spur economic activity? A scenario

analysis," *Journal of Economic Dynamics and Control*, 32, 2651 – 2689, dynamic Stochastic General Equilibrium (DSGE) modeling.

Finicelli, A., P. Pagano, and M. Sbracia (2013): "Ricardian selection," *Journal of International Economics*, 89, 96–109.

Foreign and Commonwealth Office (2016): *Alternatives to membership: possible models for the United Kingdom outside the European Union*, HM Government.

Gomes, S., P. Jacquinot, and M. Pisani (2010): "The EAGLE. A model for policy analysis of macroeconomic interdependence in the euro area," Working Paper Series 1195, European Central Bank.

HM Treasury (2016a): *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*, HM Government.

——— (2016b): *HM Treasury analysis: the immediate economic impact of leaving the EU*, HM Government.

Hüttl, P. and S. Merler (2016): *Fog in the Channel: Brexit through the eyes of international trade*, Bruegel Blog Post.

IMF (2016a): "United Kingdom," Country Report 16/169, International Monetary Fund.

——— (2016b): *World Economic Outlook*, International Monetary Fund.

Jensen, J. B. and L. G. Kletzer (2005): "Tradable Services: Understanding the Scope and Impact of Services Offshoring," *Brookings Trade Forum*, 75–133.

Johnson, R. C. (2014): "Trade in Intermediate Inputs and Business Cycle Comovement," *American Economic Journal: Macroeconomics*, 6, 39–83.

Mulabdic, A., A. Osnago, and M. Ruta (2017): "Deep Integration and UK-EU Trade Relations," Policy Research Working Paper 7947, World Bank.

OECD (2016): "The Economic Consequences of Brexit: A Taxing Decision," Economic Policy Papers 16, OECD.

Pesenti, P. (2008): "The Global Economy Model: Theoretical Framework," *IMF Staff Papers*, 55, 243–284.

Rotemberg, J. J. (1982): "Monopolistic price adjustment and aggregate output," *Review of Economic Studies*, 49, 517–31.

Timmer, M. P., E. Dietzenbacher, B. Los, R. Stehrer, and G. J. de Vries (2015): "An Illustrated User Guide to the World InputOutput Database: the Case of Global Automotive Production," *Review of International Economics*, 23, 575–605.

WTO, ITC, and UNCTAD (2015): *Tariff Profiles*, Word Trade Organization, International Trade Centre and UNCTAD.

Table 1: Great Ratios (% GDP)

	UK	EA	RW
goods	22.0	26.7	36.8
tradable services	28.9	23.0	21.2
nontradable services	49.1	50.3	42.0
consumption	62.0	53.1	56.7
investment	17.7	19.3	28.3
public expenditure	21.0	22.4	16.0
import	27.4	21.0	5.7
trade balance	0.0	0.0	0.0
net foreign assets	0.0	0.0	0.0
share of world GDP	3.6	21.1	75.3

Source: calculations on WIOD data.

Table 2: Intermediate sectors' structure (% GDP)

	UK	EA	RW
Intermediate goods sector			
dom. goods	18.0	29.0	59.0
dom. trad. serv.	5.0	8.0	8.0
dom. non trad. serv.	3.0	7.0	8.0
imports	8.3	9.5	2.1
value added	22.0	26.7	36.8
Interm. trad. serv. sector			
dom. goods	5.0	2.0	4.0
dom. trad. serv.	14.0	12.0	8.0
dom. non trad. serv.	4.0	4.0	4.0
imports	3.1	2.3	0.5
value added	28.9	23.0	21.2
Interm. non trad. serv. sector			
dom. goods	7.0	6.0	8.0
dom. trad. serv.	10.0	8.0	8.0
dom. non trad. serv.	8.0	8.0	7.0
imports	4.4	2.2	0.7
value added	49.1	50.3	42.0

Source: calculations on WIOD data.

Table 3: Imports (% GDP)

	UK Imports from		EA Imports from		RW Imports from	
	EA	RW	UK	RW	UK	EA
Intermediate goods sector						
goods	2.9	4.2	0.5	7.3	0.2	1.4
trad. serv.	0.7	0.5	0.2	1.5	0.1	0.4
Interm. trad. serv. sector						
goods	0.4	0.6	0.0	0.5	0.0	0.1
trad. serv.	1.1	1.0	0.3	1.5	0.1	0.3
Interm. non trad. serv. sector						
goods	1.2	1.3	0.1	0.9	0.0	0.3
trad. serv.	0.9	1.0	0.2	1.0	0.1	0.3
Consumption sector						
goods	3.2	3.1	0.2	2.9	0.1	0.8
trad. serv.	1.0	1.1	0.2	1.0	0.1	0.4
Investment sector						
goods	1.2	1.5	0.1	1.4	0.1	0.7
trad. serv.	0.2	0.1	0.0	0.3	0.0	0.1
TOTAL	12.8	14.4	1.8	18.3	0.8	4.8

Source: calculations on WIOD data.

Table 4: Main parameters

Preferences	
Discount factor	0.995
Intertemporal elasticity of substitution	1.0
Habit	0.6
Labour disutility	2 .0
Production of intermediate goods	
Elasticity of substitution among intermediate tradable goods	1.2
$\cdots$ among intermediate tradable services	1.2
$\cdots$ between intermediate trad. goods and services	
and non-trad. services	1.2
$\cdots$ between value added and intermediate (goods and services)	1.2
$\cdots$ between intermediate tradables goods and services	1.2
$\cdots$ between capital and labour	1
$\cdots$ among brands (Dixit aggregator)	6
Capital accumulation	
Depreciation rate	0.025
Adjustment cost on investment	3.5
(Final) consumption and investment bundles	
Elasticity of substitution btw. domestic and imported tradables	1.2
$\cdots$ between tradables and nontradables	0.8
Nominal rigidities	
Rotemberg adj. costs on:	
wage	300
price	
domestic tradables	600
imported tradables	600
nontradables	600
Indexation on:	
wage	0.8
price	
domestic tradables	0.8
imported tradables	0.8
nontradables	0.8
Monetary policy	
Inertia	0.9
Weight of inflation	1.4
Weight of output	0.4
International bond position	
Adjustment cost	$(0.001, 0.001)'$

Note: parameters values are the same across countries.

Table 5: Tariff changes

| | MFN | | | FTA | | | OUK | | |
	EA	UK	RW	EA	UK	RW	EA	UK	RW
EA goods	–	3.6	0.0	–	0.3	0.0	–	0.0	0.0
EA services	–	20.0	0.0	–	10.0	0.0	–	0.0	0.0
UK goods	3.2	–	1.3	0.3	–	0.9	3.2	–	1.3
UK services	20.0	–	1.6	10.0	–	0.8	20.0	–	1.6
RW goods	0.0	1.2	–	0.0	0.7	–	0.0	-2.4	–
RW services	0.0	2.2	–	0.0	1.1	–	0.0	-17.8	–

Note: reported values are pp deviations from the initial steady-state (before-Brexit) tariff levels. Tariff shocks in the production inefficiency scenario are the same as in the MFN scenario.

Table 6: Tariff regimes. Long-term macroeconomic effects on UK

	MFN	FTA	OUK	MFN +TFP
GDP	-1.96	-0.90	-0.40	-10.59
Consumption	-1.32	-0.67	-2.31	-7.49
Investment	-2.82	-1.33	-1.61	-11.61
Exports	-6.81	-3.04	1.88	-15.93
Imports	-5.58	-2.70	-4.00	-7.40
Exports of goods to EA	-5.63	-0.93	2.84	-15.37
Exports of services to EA	-20.98	-11.22	-13.23	-28.29
Exports of goods to RW	-3.42	-1.63	5.21	-13.35
Exports of services to RW	-3.15	-1.26	6.26	-12.08
Labour	-0.71	-0.31	0.60	-0.56
Real wage	-2.02	-0.98	-1.72	-8.01
Real exch. rate vs EA	-1.37	-0.38	6.18	-5.04
Real exch. rate vs RW	-1.62	-0.50	5.96	-5.36

Note: reported values are % deviations from the initial steady state. Real exch. rate: +=depreciation.

Table 7: Tariff regimes. Long-term macroeconomic effects on EA

	MFN	FTA	OUK	MFN +TFP
GDP	-0.33	-0.14	-0.15	-0.54
Consumption	-0.28	-0.11	0.02	-0.61
Investment	-0.46	-0.20	-0.15	-0.79
Exports	-1.40	-0.62	-1.05	-1.85
Imports	-1.30	-0.56	-0.38	-2.32
Labour	-0.10	-0.05	-0.10	-0.09
Real wage	-0.38	-0.16	-0.08	-0.70

Note: reported values are % deviations from the initial steady state.

Figure 1: MFN tariff regime: UK trade
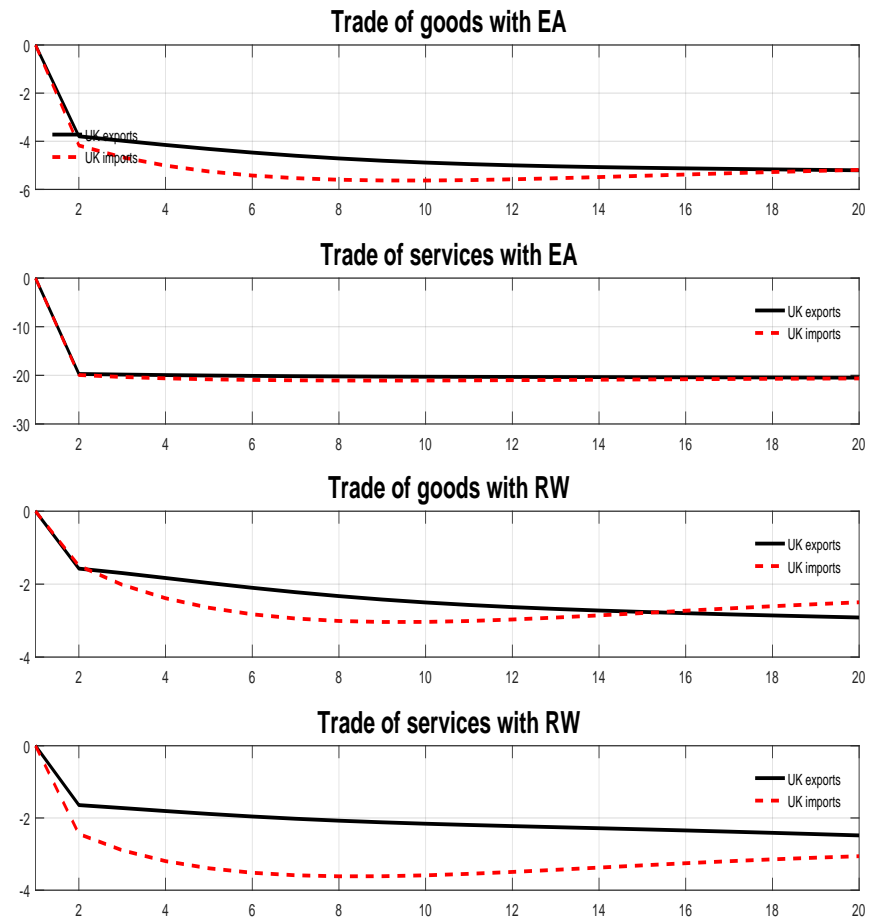
Trade of goods with EA

Trade of services with EA

Trade of goods with RW

Trade of services with RW

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values.
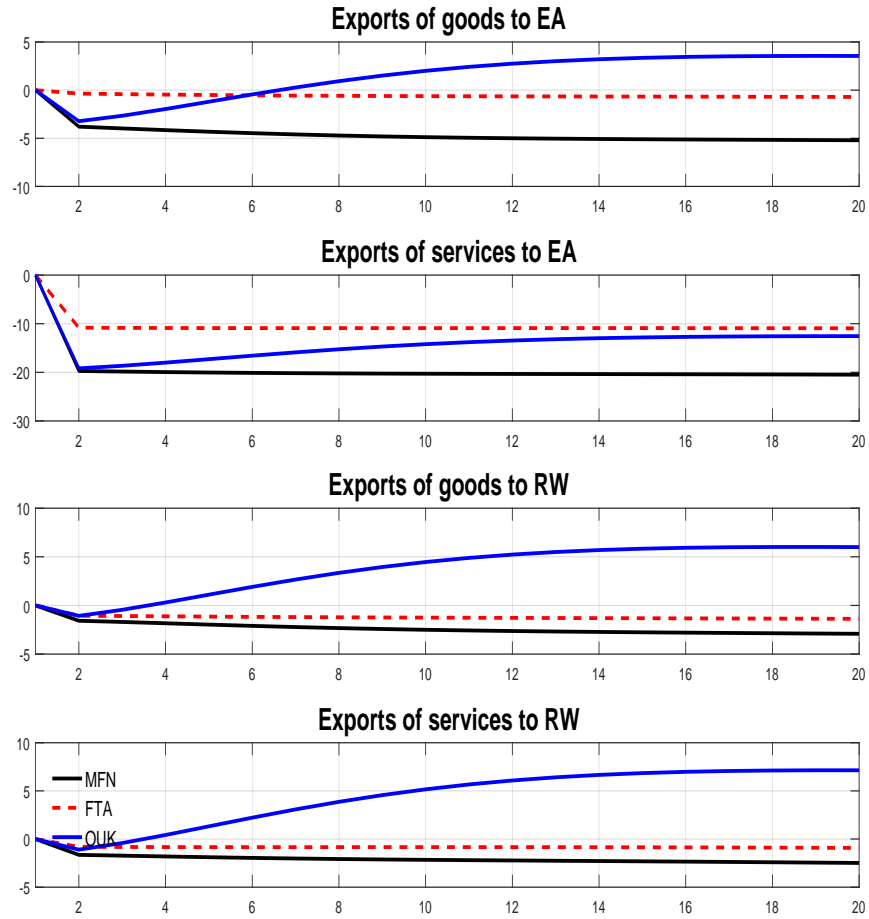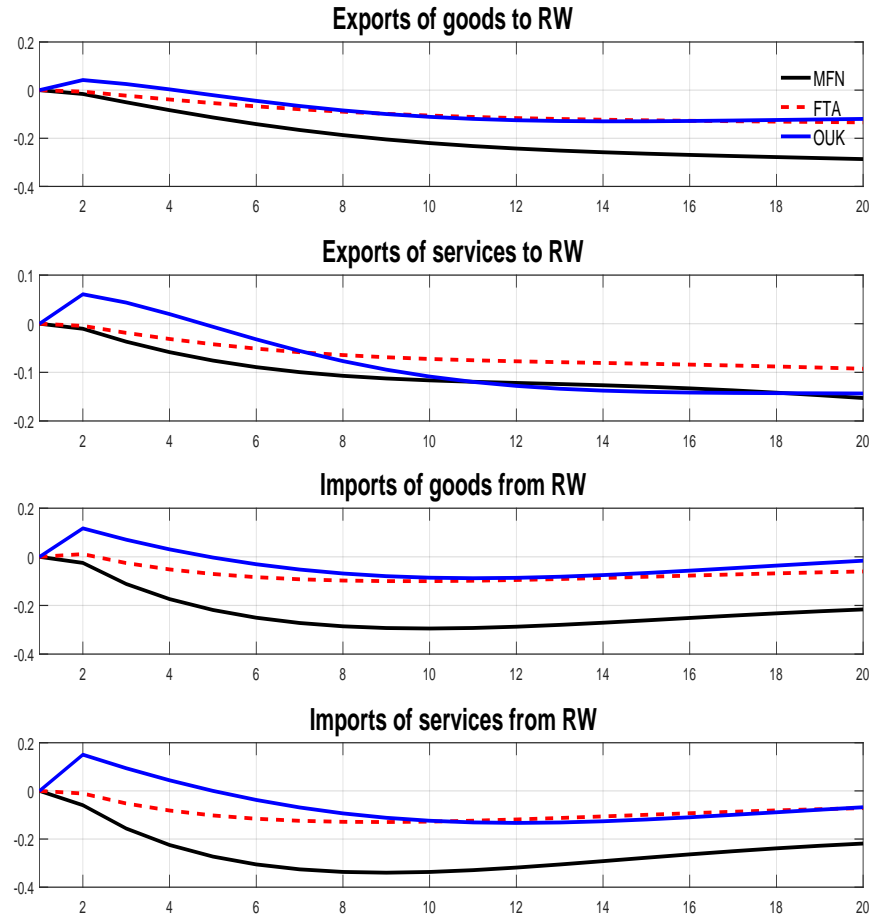
Figure 2: MFN tariff regime: EA-RW trade
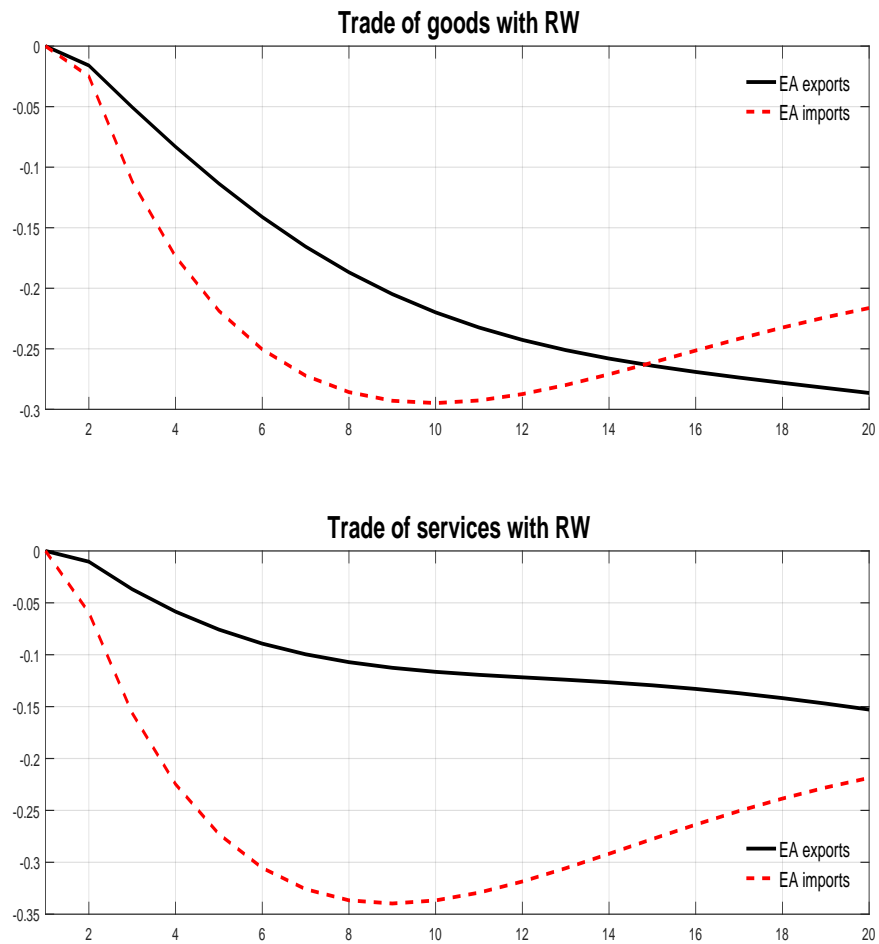
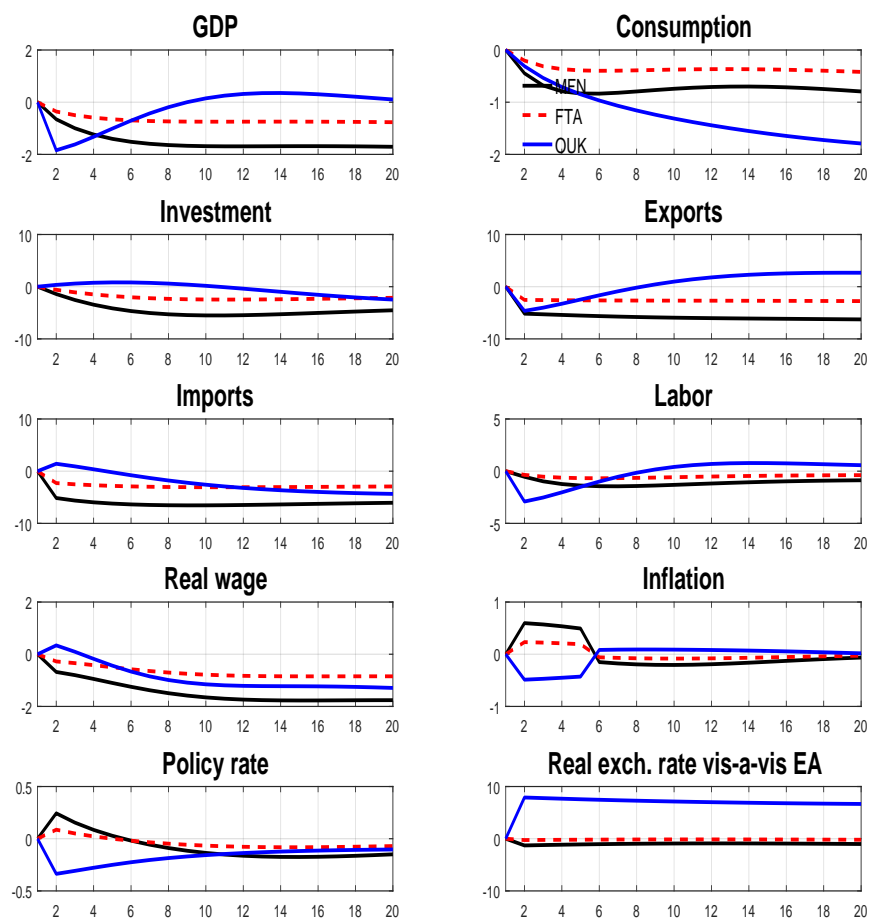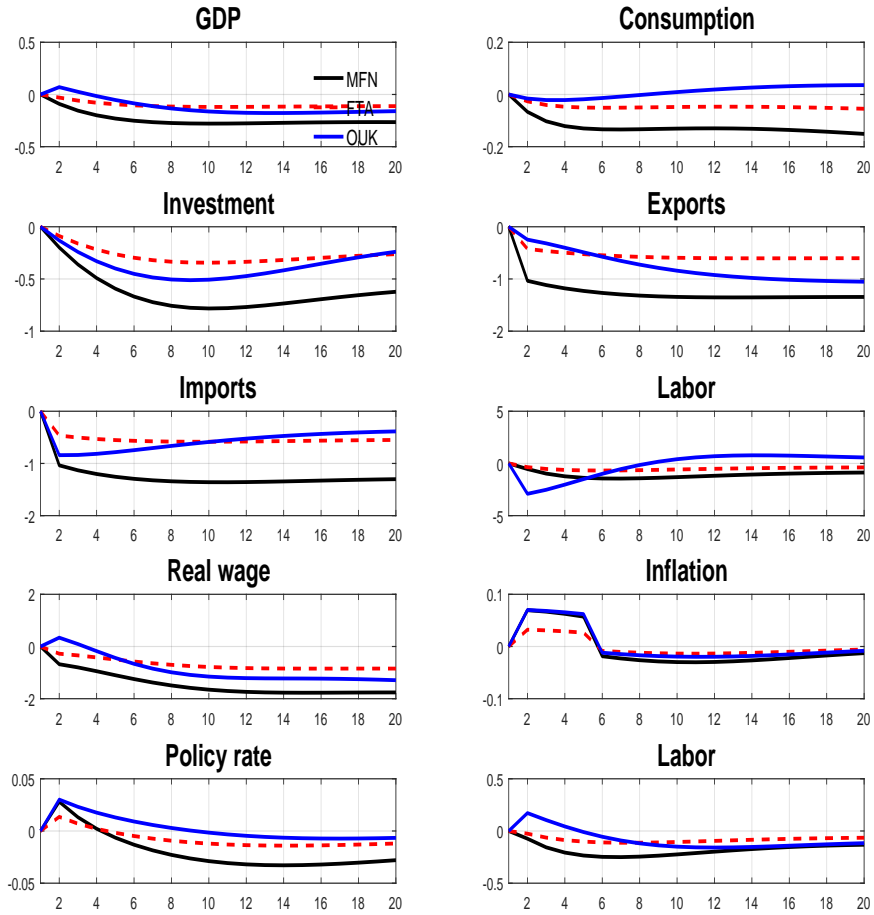**Trade of goods with RW**

Trade of services with RW

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values.

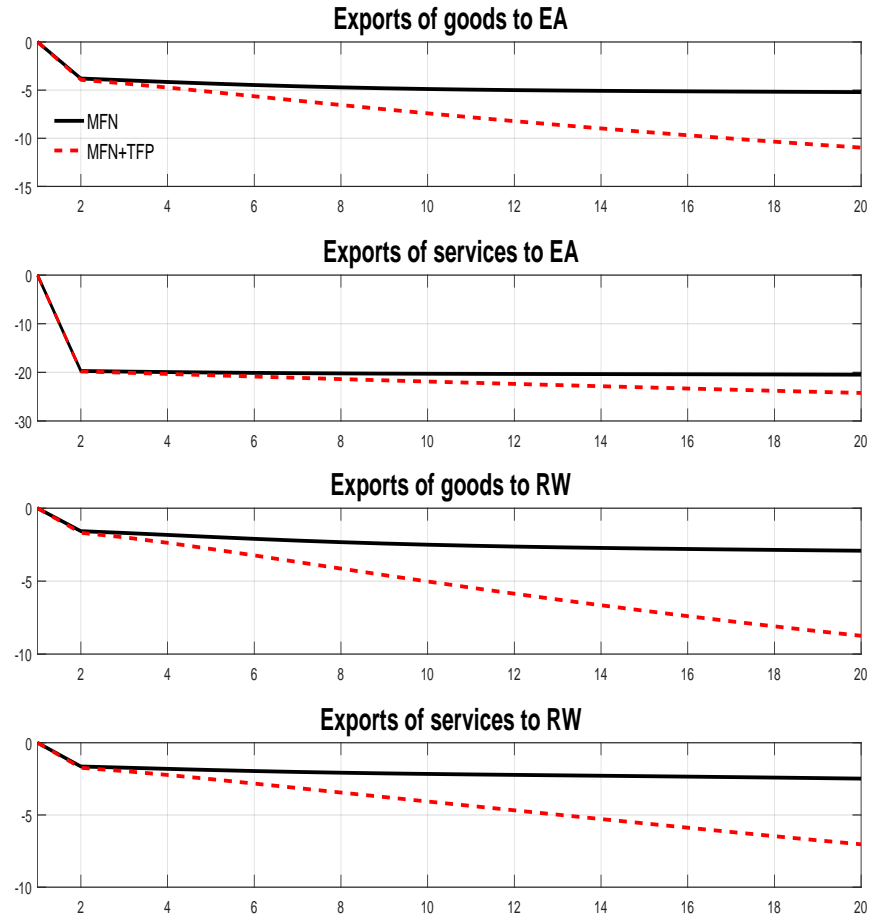Figure 3: MFN tariff regime: UK macroeconomic variables
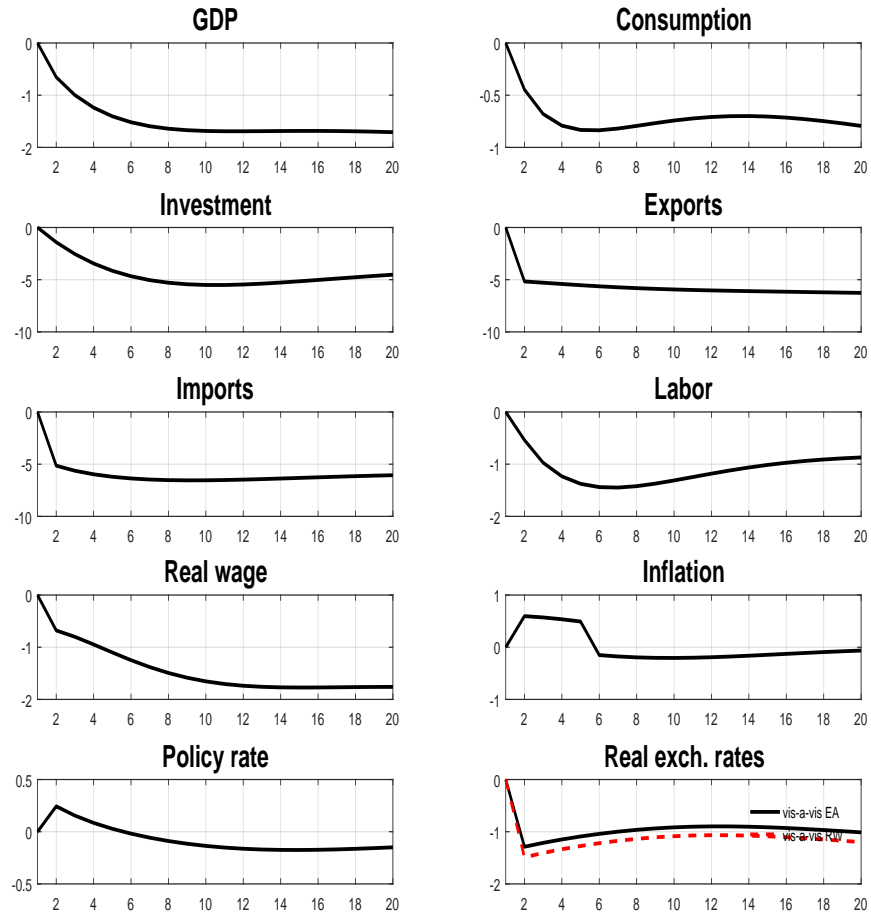
Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values, interest rate as annualized pp deviation. Inflation: year-on-year. Real exchange rate: +=depreciation.
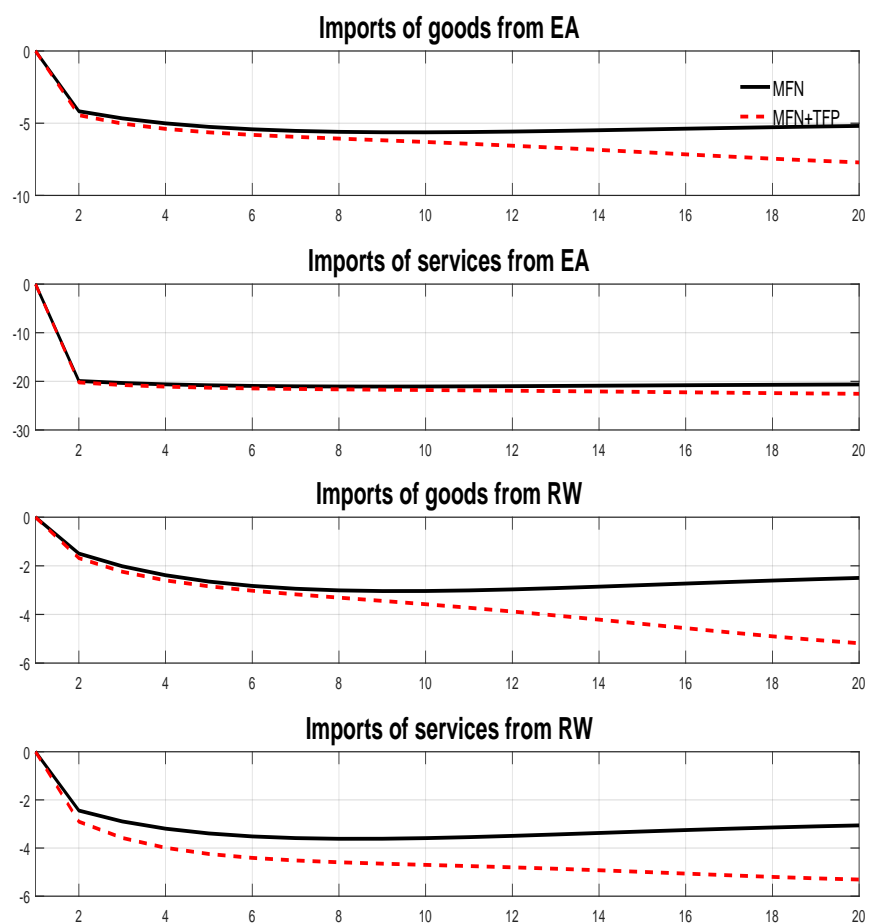
Figure 4: MFN tariff regime: EA macroeconomic variables
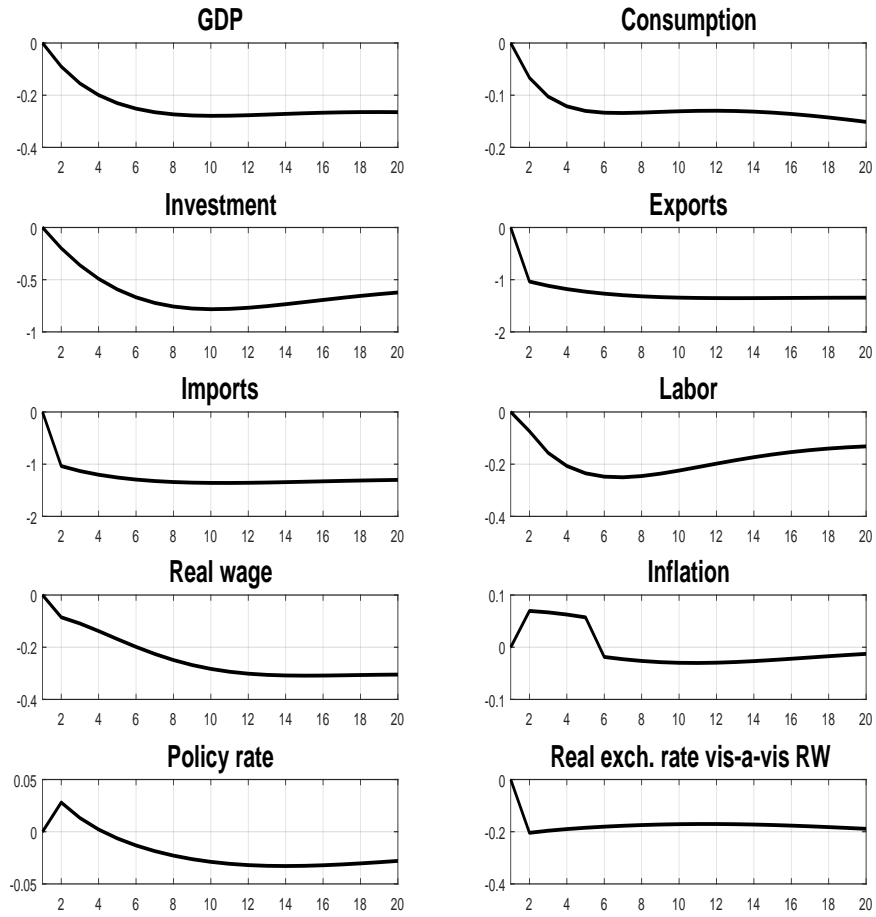
Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values, interest rate as annualized pp deviation. Inflation: year-on-year. Real exchange rate: +=depreciation.

Figure 5: UK exports and tariff regimes

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values.

Figure 6: UK imports and tariff regimes
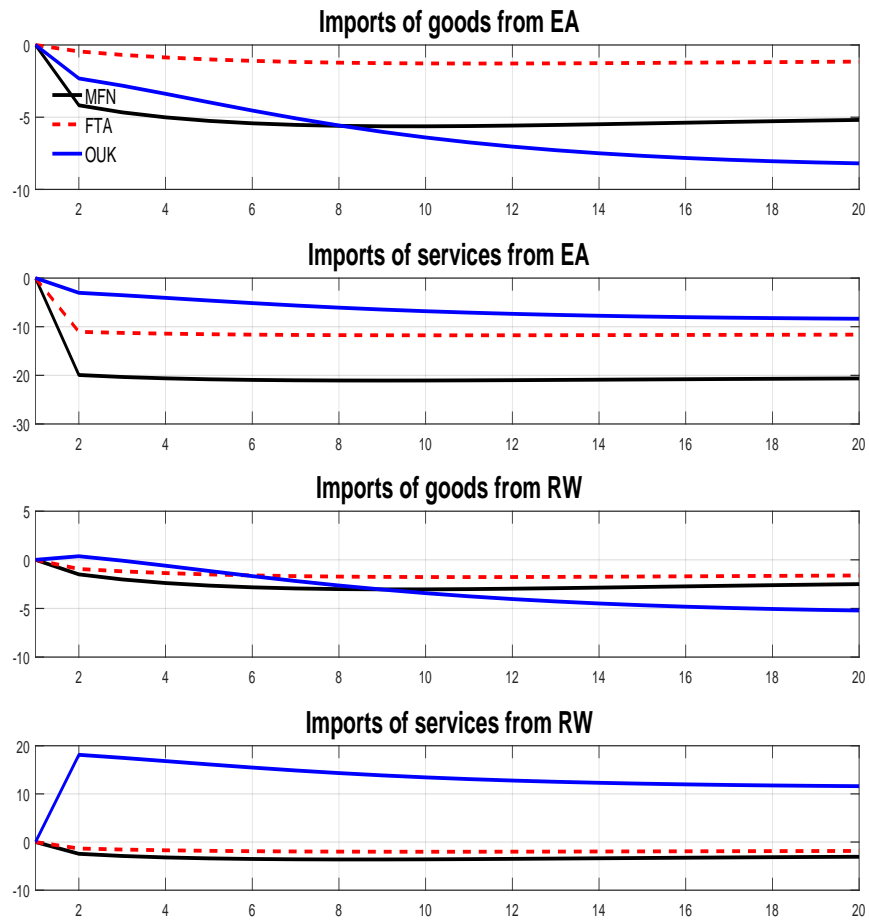
Imports of goods from EA

MFN
FTA
OUK

Imports of services from EA

Imports of goods from RW

Imports of services from RW

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values.
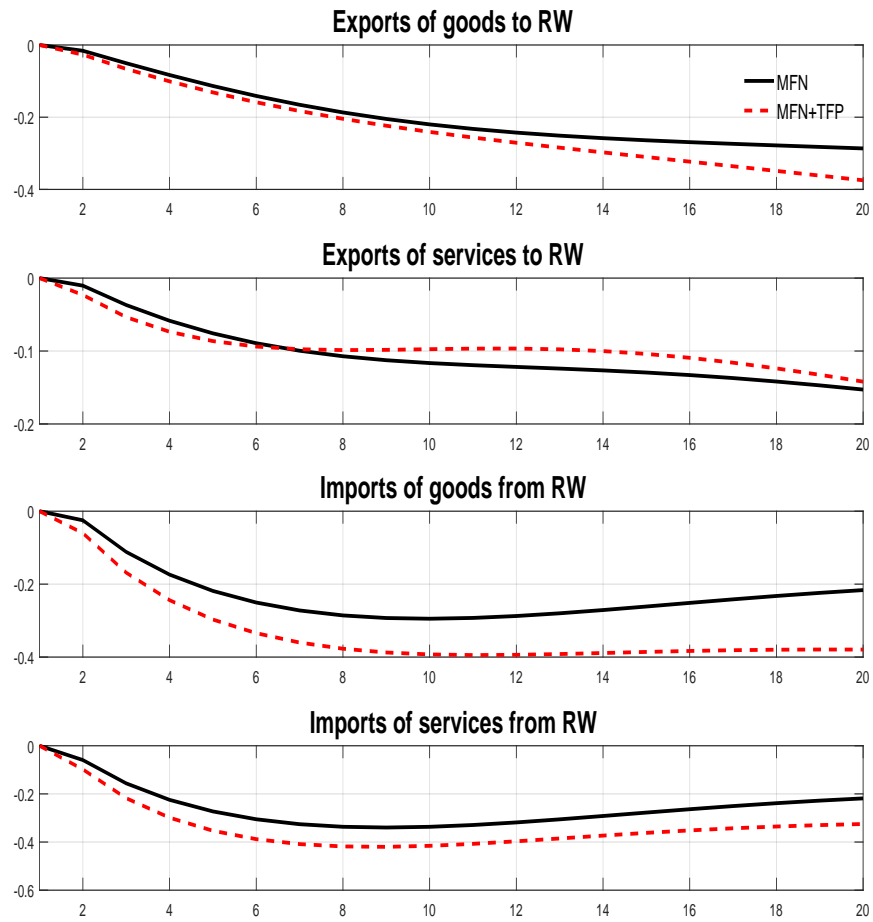
Figure 7: EA trade with RW and tariff regimes

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values.

Figure 8: UK macroeconomic variables and tariff regimes

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values, interest rate as annualized pp deviation. Inflation: year-on-year. Real exchange rate: +=depreciation.

Figure 9: EA macroeconomic variables and tariff regimes

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values, inflation and interest rate as annualized pp deviation.

Figure 10: UK exports and production inefficiency

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values.

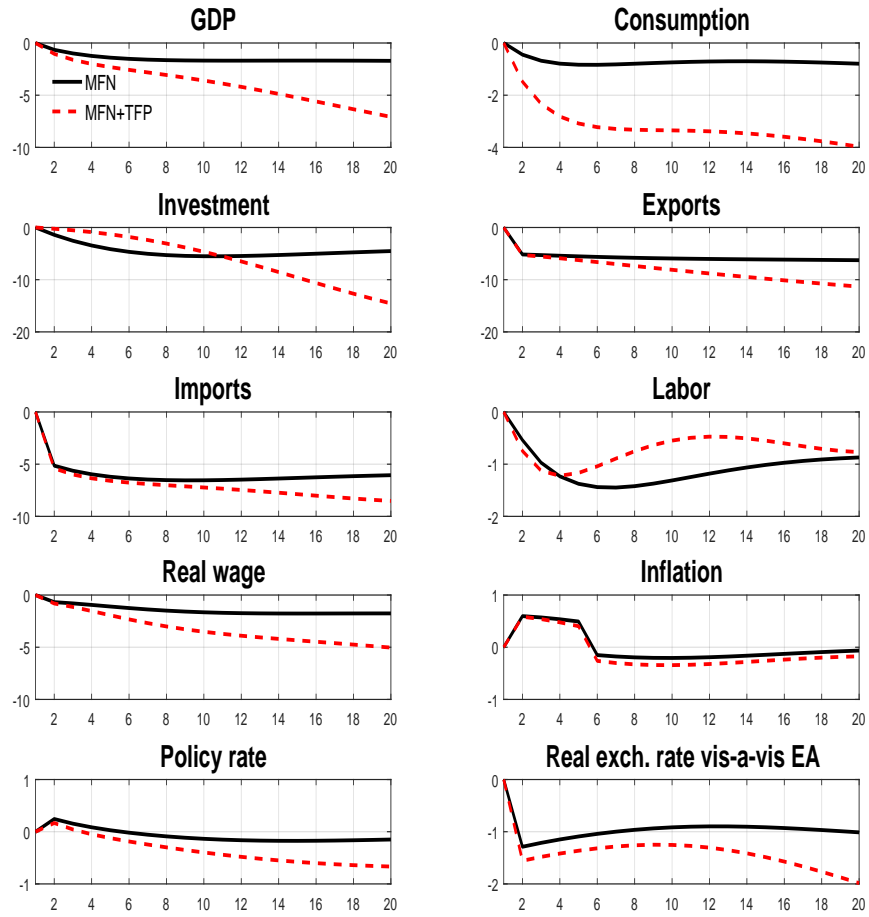Figure 11: UK imports and production inefficiency

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values.
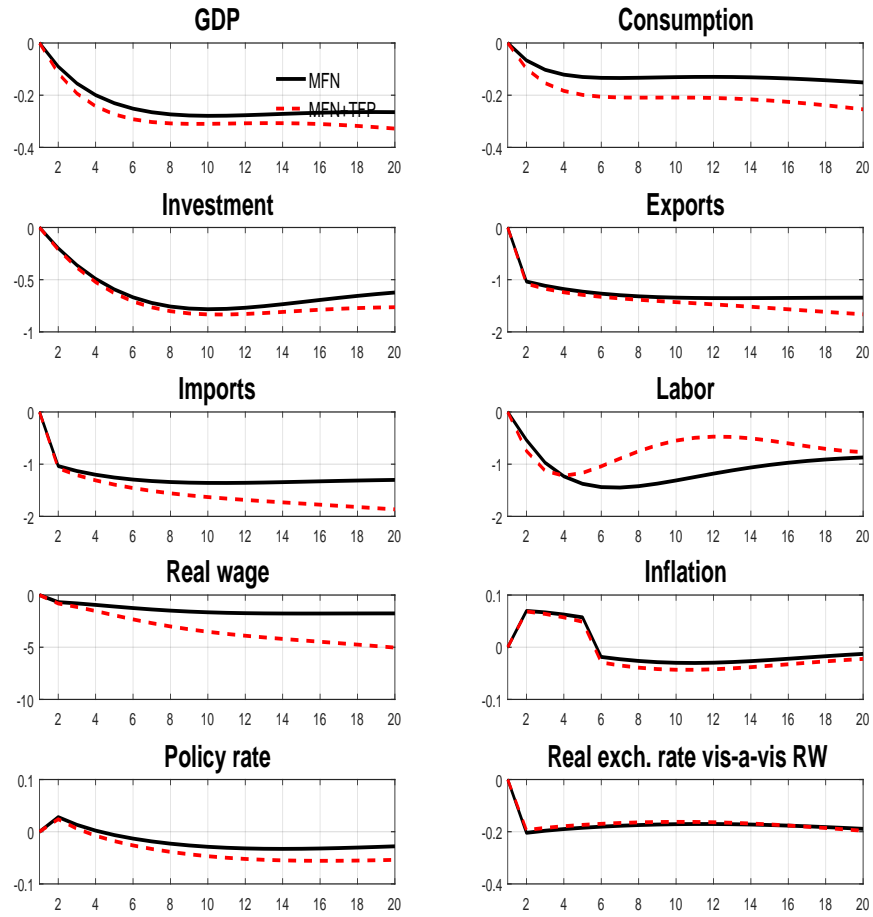
Figure 12: EA trade with RW and production inefficiency

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values.

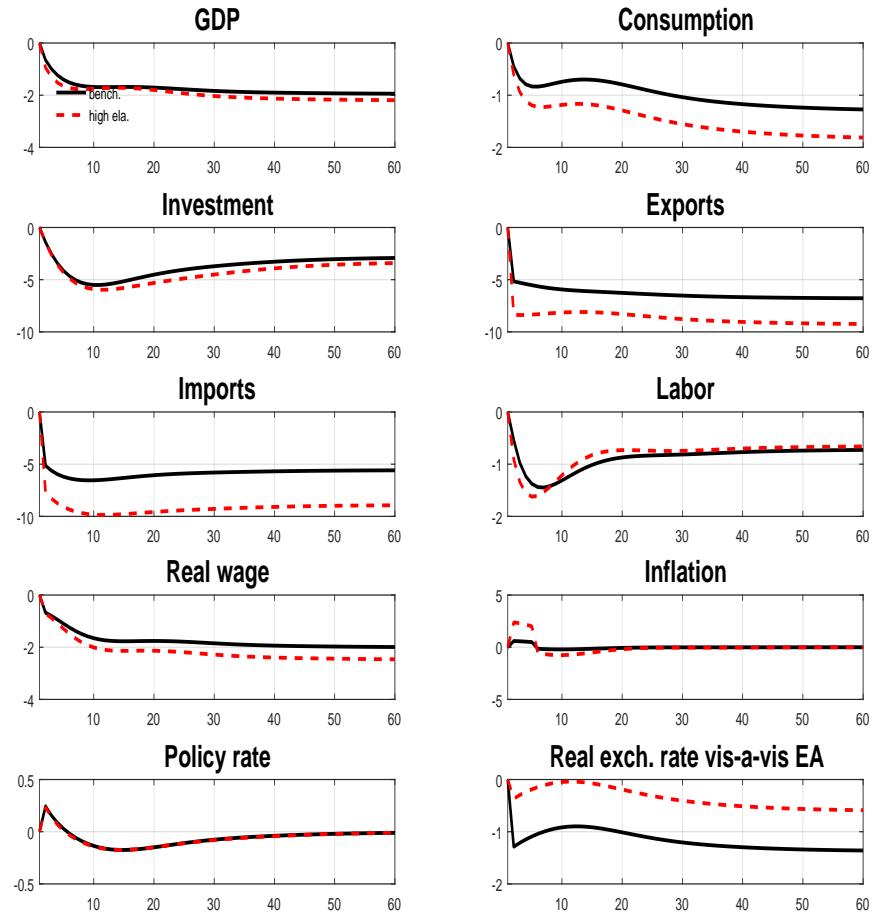Figure 13: UK macroeconomic variables and production inefficiency

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values, interest rate as annualized pp deviation. Inflation: year-on-year. Real exchange rate: +=depreciation.

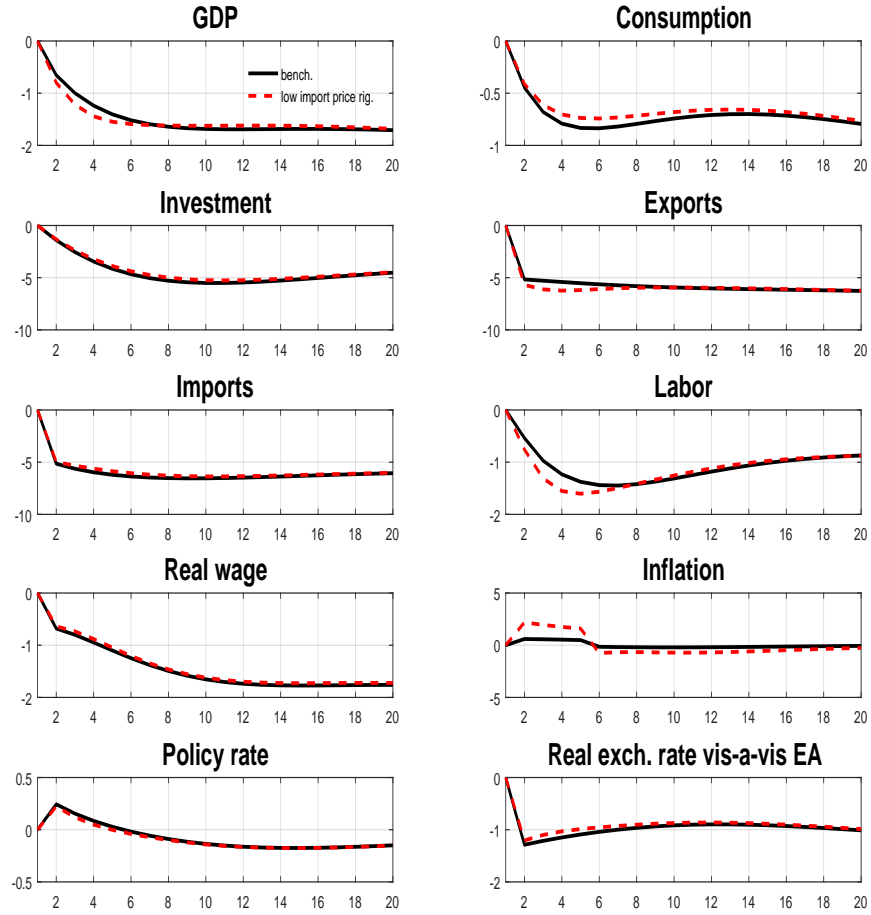Figure 14: EA macroeconomic variables and production inefficiency

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values, inflation and interest rate as annualized pp deviation. Real exchange rate: +=depreciation.

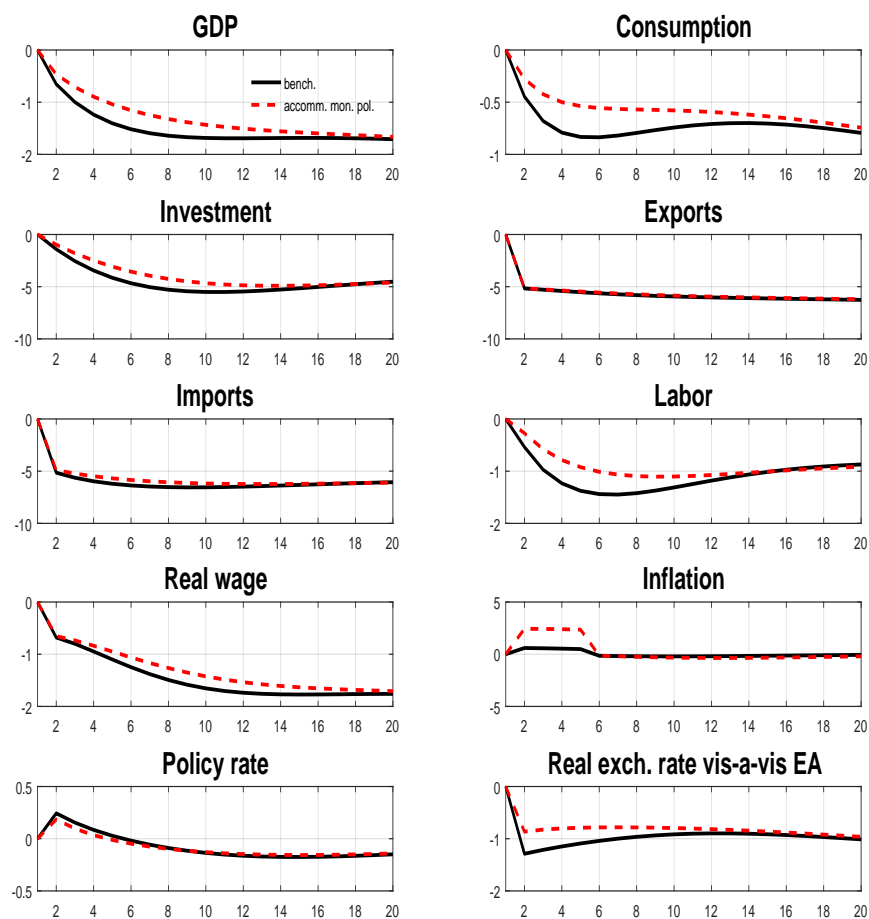Figure 15: UK macroeconomic variables and elasticity of substitution

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values, inflation and interest rate as annualized pp deviation. Real exchange rate: +=depreciation.

Figure 16: UK macroeconomic variables and import price rigidities

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values, inflation and interest rate as annualized pp deviation. Real exchange rate: +=depreciation.

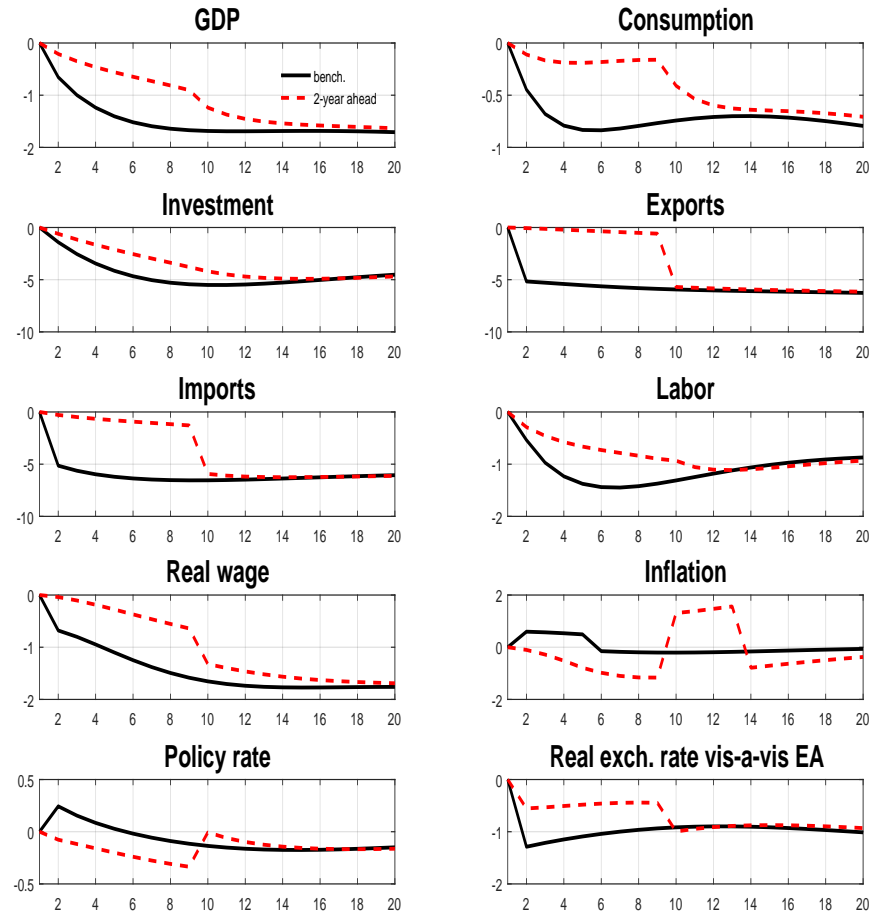Figure 17: UK macroeconomic variables and UK monetary policy stance

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values, inflation and interest rate as annualized pp deviation. Real exchange rate: +=depreciation.

Figure 18: UK macroeconomic variables and 2-year anticipation

Note: horizontal axis: quarters; vertical axis: % deviation from the before-shock corresponding values, inflation and interest rate as annualized pp deviation. Real exchange rate: +=depreciation.

A Tariff Scenarios

In each scenario we calibrate for each country the tariffs for goods' and services' imports from the other two. Goods face both tariff and non-tariff barriers on crossing a border, whereas in the case of services protection is usually attained imposing non-tariff measures, such as administrative restrictions. Hence we consider the *ad-valorem tariff equivalent* to both tariffs and non-tariff barriers.

The first step is to analyze the current trade arrangements of the UK and the EA. Due to the common EU membership, the UK and the EA charge no tariff on respective imports of goods and services and charge the current EU tariff profile to imports from the RW: the average trade-weighted NFM tariff for goods charged by the EU is 3.6% (WTO et al., 2015), but the effective tariff charged by the EA to the RW imports is 1.9%, calculated as the import-weighted average tariff for the top 35 countries of origin of imports, setting, for simplicity, to zero the tariff for imports from countries with whom the EU has a trade agreement (and keeping 3.6% for the others); for the UK the effective import tariff is 2.4%, calculated in in a similar manner.[30] For imports of services we follow OECD (2016) and assume that the (*ad-valorem equivalent*) tariff is 20% for both the EA and the UK.[31] Hence the effective tariff charged by the EA and the UK for imports of services from the RW is the weighted average of 0 on imports from non-EA EU Member States and 20% on those from the other countries, i.e. 17.3% for the EA and 17.8% for the UK.[32] Also EA and UK merchandise exports to the RW are charged the effective protection rate, i.e. the MFN rate for the countries with whom no agreement is in place and the preferred rate for those with an agreement; we again set the preferred rate to zero. For the EU the effective tariff charged by the RW is 2.0%, calculated as the average of trade weighted MFN tariffs (WTO et al., 2015) for the top 35 countries of destination of exports, weighted by their export share; for the UK it is 2.4%. We finally assume that the RW reciprocates the 20% tariff on service imports from both the UK and the EA. Hence in the RW services imported

---

[30]Obviously imports from non-EA EU Member States are charged a 0 tariff.

[31]OECD (2016) assumes 20% as the *ad-valorem equivalent* tariff charged by the EU to the UK in case of WTO regime: since this means that the UK is treated as a "third country" we use the same tariff for RW service imports to the EU.

[32]The higher effective tariffs for the UK reflect the larger imports from the RW.

are charged an effective tariff equal to 17.1% if they come from the EA and 18.4% if they come from the UK.

In the MFN scenario we assume no trade agreement between the EA and the UK: then all economies trade on MFN terms with each other (except for the EU trading with the RW on the basis of the existing FTAs). We further assume that the UK unilaterally adopts the EU tariff profile, hence the MFN tariff for goods' imports from both the EU and the RW is set at 3.6% and that for services at 20%. Hence tariffs are set at 20% for bilateral UK-EU services' trade while tariffs on goods are 3.2% for British imports to the EU (Hüttl and Merler, 2016) and 3.6% for EU imports to the UK. Bilateral merchandise trade between the UK and the RW would be charged 3.6% entering the UK borders and 3.7% entering the RW borders and bilateral service trade will face a tariff equal to 20% in either region.[33] All other tariffs are unchanged.

In the case of a bilateral trade agreement the UK and the EU would set preferential tariffs (lower than the default MFN tariffs) on bilateral trade: in this case we assume, following OECD (2016), that the tariffs would be symmetric and equal to 0.3% for goods and 10% for services. Tariffs with the RW are lower than in the MFN scenario because the EU countries not belonging to the EA are included in the RW and apply the FTA tariffs: hence the tariff becomes 3.3% for UK goods' exports and 3.1% for goods' imports in the UK. For the same reason UK's services' imports from the RW will be charged an effective tariff equal to 18.9%, while UK services in the UK will pay a tariff of 19.2%. All other tariffs are unchanged.

Finally, in the UK Open for trade scenario we assume that the UK charges no tariffs on imports of goods and service from both the EA and the RW. All other tariffs, i.e. those set by the EA and the RW on imports, are unchanged with respect to the MFN scenario.

Table 8 summarizes tariff levels in the *status quo* and in the three scenarios.

---

[33]This is because tariffs for services' imports will be equal to 20% across the board.

Table 8: Tariffs

	EU (*status quo*)			MFN			FTA			OUK		
	EA	UK	RW	EA	UK	RW	EA	UK	RW	EA	UK	RW
EA goods	–	0.0	2.0	–	3.6	2.0	–	0.3	2.0	–	0.0	2.0
EA services	–	0.0	17.1	–	20.0	17.1	–	10.0	17.1	–	0.0	17.1
UK goods	0.0	–	2.4	3.2	–	3.7	0.3	–	3.3	3.2	–	3.7
UK services	0.0	–	18.4	20.0	–	20.0	10.0	–	19.2	20.0	–	20.0
RW goods	1.9	2.4	–	1.9	3.6	–	1.9	3.1	–	1.9	0.0	–
RW services	17.3	17.8	–	17.3	20.0	–	17.3	18.9	–	17.3	0.0	–

Note: tariffs are in percentage points.

B List of Countries

This appendix lists the country groupings used in the paper.

Euro Area (EA): Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain.

Rest of EU: Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Poland, Romania, Sweden.

Rest of World:[34] Australia, Bulgaria, Brazil, Canada, Chile, China, Czech Republic, Denmark, Croatia, Hungary, India, Indonesia, Japan, Mexico, Norway, Poland, Romania, Russia, South Korea, Sweden, Turkey, Taiwan, USA, Rest of the World

Countries with a FTA[35] with the EU:[36] Albania, Algeria, Andorra, Antigua and Barbuda, Bahamas, Barbados, Belize, Benin, Bosnia and Herzegovina, Botswana, Burkina Faso, Cameroon, Cape Verde, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Egypt, El Salvador, Faeroe Islands, FYR Macedonia, Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea Bissau, Guinea, Guyana, Haiti, Honduras, Iceland, Israel, Ivory Coast, Jamaica, Jordan, Kazakhstan, Kosovo, Lebanon, Lesotho, Liberia, Madagascar, Mali, Mauritania, Mauritius, Mexico, Moldova, Montenegro, Morocco, Mozambique, Namibia, Nicaragua, Niger, Nigeria, Norway, Palestine, Panama, Peru, Saint Christopher and Nevis, Saint Lucia, Saint Vincent and the Grenadines, San Marino, Senegal, Serbia, Seychelles, Sierra Leone, South Africa, South Korea, Suriname, Swaziland, Switzerland, Syria, Togo, Trinidad and Tobago, Tunisia, Turkey, Ukraine, Zimbabwe.

---

[34]We consider all the countries included in the WIOD database.

[35]We consider all the agreements in force (including those provisionally applied) on 30th November 2016 and exclude those classified by the EU Commission as "Partnership and Cooperation Agreements" since they do not determine a reduction in tariffs.

[36]We include EFTA countries (Switzerland, Norway, Iceland and Lichtenstein) and non-EU EU Customs Union countries (Turkey, Andorra and San Marino) in this list.

RECENTLY PUBLISHED "TEMI" (*)

N. 1139 – *Credit misallocation during the European financial crisis*, by Fabiano Schivardi, Enrico Sette and Guido Tabellini (September 2017).

N. 1140 – *Natural rates across the Atlantic*, by Andrea Gerali and Stefano Neri (September 2017).

N. 1141 – *A quantitative analysis of risk premia in the corporate bond market*, by Sara Cecchetti (October 2017).

N. 1142 – *Monetary policy in times of debt*, by Mario Pietrunti and Federico M. Signoretti (October 2017).

N. 1143 – *Capital misallocation and financial development: a sector-level analysis*, by Daniela Marconi and Christian Upper (October 2017).

N. 1144 – *Leaving your mamma: why so late in Italy?*, by Enrica Di Stefano (October 2017).

N. 1145 – *A Financial Conditions Index for the CEE economies*, by Simone Auer (October 2017).

N. 1146 – *Internal capital markets in times of crisis: the benefit of group affiliation in Italy*, by Raffaele Santioni, Fabio Schiantarelli and Philip E. Strahan (October 2017).

N. 1147 – *Consistent inference in fixed-effects stochastic frontier models*, by Federico Belotti and Giuseppe Ilardi (October 2017).

N. 1148 – *Investment decisions by European firms and financing constraints*, by Andrea Mercatanti, Taneli Mäkinen and Andrea Silvestrini (October 2017).

N. 1149 – *Looking behind the financial cycle: the neglected role of demographics*, by Alessandro Ferrari (December 2017).

N. 1150 – *Public investment and monetary policy stance in the euro area*, by Lorenzo Burlon, Alberto Locarno, Alessandro Notarpietro and Massimiliano Pisani (December 2017).

N. 1151 – *Fiscal policy uncertainty and the business cycle: time series evidence from Italy*, by Alessio Anzuini, Luca Rossi and Pietro Tommasino (December 2017).

N. 1152 – *International financial flows and the risk-taking channel*, by Pietro Cova and Filippo Natoli (December 2017).

N. 1153 – *Systemic risk and systemic importance measures during the crisis*, by Sergio Masciantonio and Andrea Zaghini (December 2017).

N. 1154 – *Capital controls, macroprudential measures and monetary policy interactions in an emerging economy*, by Valerio Nispi Landi (December 2017).

N. 1155 – *Optimal monetary policy and fiscal policy interaction in a non-Ricardian economy*, by Massimiliano Rigon and Francesco Zanetti (December 2017).

N. 1156 – *Secular stagnation, R&D, public investment and monetary policy: a global-model perspective*, by Pietro Cova, Patrizio Pagano, Alessandro Notarpietro and Massimiliano Pisani (December 2017).

N. 1157 – *The CSPP at work: yield heterogeneity and the portfolio rebalancing channel*, by Andrea Zaghini (December 2017).

N. 1158 – *Targeting policy-compliers with machine learning: an application to a tax rebate programme in Italy*, by Monica Andini, Emanuele Ciani, Guido de Blasio, Alessio D'Ignazio and Viola Salvestrini (December 2017).

N. 1159 – *Banks' maturity transformation: risk, reward, and policy*, by Pierluigi Bologna (December 2017).

N. 1160 – *Pairwise trading in the money market during the European sovereign debt crisis*, by Edoardo Rainone (December 2017).

2015

AABERGE R. and A. BRANDOLINI, *Multidimensional poverty and inequality,* in A. B. Atkinson and F. Bourguignon (eds.), Handbook of Income Distribution, Volume 2A, Amsterdam, Elsevier, **TD No. 976 (October 2014).**

ALBERTAZZI U., G. ERAMO, L. GAMBACORTA and C. SALLEO, *Asymmetric information in securitization: an empirical assessment,* Journal of Monetary Economics, v. 71, pp. 33-49, **TD No. 796 (February 2011).**

ALESSANDRI P. and B. NELSON, *Simple banking: profitability and the yield curve,* Journal of Money, Credit and Banking, v. 47, 1, pp. 143-175, **TD No. 945 (January 2014).**

ANTONIETTI R., R. BRONZINI and G. CAINELLI, *Inward greenfield FDI and innovation,* Economia e Politica Industriale, v. 42, 1, pp. 93-116, **TD No. 1006 (March 2015).**

BARONE G. and G. NARCISO, *Organized crime and business subsidies: Where does the money go?,* Journal of Urban Economics, v. 86, pp. 98-110, **TD No. 916 (June 2013).**

BRONZINI R., *The effects of extensive and intensive margins of FDI on domestic employment: microeconomic evidence from Italy*, B.E. Journal of Economic Analysis & Policy, v. 15, 4, pp. 2079-2109, **TD No. 769 (July 2010).**

BUGAMELLI M., S. FABIANI and E. SETTE, *The age of the dragon: the effect of imports from China on firm-level prices*, Journal of Money, Credit and Banking, v. 47, 6, pp. 1091-1118, **TD No. 737 (January 2010).**

BULLIGAN G., M. MARCELLINO and F. VENDITTI, *Forecasting economic activity with targeted predictors,* International Journal of Forecasting, v. 31, 1, pp. 188-206, **TD No. 847 (February 2012).**

BUSETTI F., *On detecting end-of-sample instabilities,* in S.J. Koopman, N. Shepard (eds.), Unobserved Components and Time Series Econometrics, Oxford, Oxford University Press, **TD No. 881 (September 2012).**

CESARONI T., *Procyclicality of credit rating systems: how to manage it,* Journal of Economics and Business, v. 82. pp. 62-83, **TD No. 1034 (October 2015).**

CIARLONE A., *House price cycles in emerging economies,* Studies in Economics and Finance, v. 32, 1, **TD No. 863 (May 2012).**

CUCINIELLO V. and F. M. SIGNORETTI, *Large bank, loan rate markup and monetary policy,* International Journal of Central Banking, v. 11, 3, pp. 141-177, **TD No. 987 (November 2014).**

DE BLASIO G., D. FANTINO and G. PELLEGRINI, *Evaluating the impact of innovation incentives: evidence from an unexpected shortage of funds,* Industrial and Corporate Change, v. 24, 6, pp. 1285-1314, **TD No. 792 (February 2011).**

DEPALO D., R. GIORDANO and E. PAPAPETROU, *Public-private wage differentials in euro area countries: evidence from quantile decomposition analysis,* Empirical Economics, v. 49, 3, pp. 985-1115, **TD No. 907 (April 2013).**

DI CESARE A., A. P. STORK and C. DE VRIES, *Risk measures for autocorrelated hedge fund returns,* Journal of Financial Econometrics, v. 13, 4, pp. 868-895, **TD No. 831 (October 2011).**

FANTINO D., A. MORI and D. SCALISE, *Collaboration between firms and universities in Italy: the role of a firm's proximity to top-rated departments,* Rivista Italiana degli economisti, v. 1, 2, pp. 219-251, **TD No. 884 (October 2012).**

FRATZSCHER M., D. RIMEC, L. SARNOB and G. ZINNA, *The scapegoat theory of exchange rates: the first tests,* Journal of Monetary Economics, v. 70, 1, pp. 1-21, **TD No. 991 (November 2014).**

NOTARPIETRO A. and S. SIVIERO, *Optimal monetary policy rules and house prices: the role of financial frictions,* Journal of Money, Credit and Banking, v. 47, S1, pp. 383-410, **TD No. 993 (November 2014).**

RIGGI M. and F. VENDITTI, *The time varying effect of oil price shocks on euro-area exports,* Journal of Economic Dynamics and Control, v. 59, pp. 75-94, **TD No. 1035 (October 2015).**

TANELI M. and B. OHL, *Information acquisition and learning from prices over the business cycle,* Journal of Economic Theory, 158 B, pp. 585–633, **TD No. 946 (January 2014).**

ALBANESE G., G. DE BLASIO and P. SESTITO, *My parents taught me. evidence on the family transmission of values,* Journal of Population Economics, v. 29, 2, pp. 571-592, **TD No. 955 (March 2014).**

ANDINI M. and G. DE BLASIO, *Local development that money cannot buy: Italy's Contratti di Programma,* Journal of Economic Geography, v. 16, 2, pp. 365-393, **TD No. 915 (June 2013).**

BARONE G. and S. MOCETTI, *Inequality and trust: new evidence from panel data,* Economic Inquiry, v. 54, pp. 794-809, **TD No. 973 (October 2014).**

BELTRATTI A., B. BORTOLOTTI and M. CACCAVAIO, *Stock market efficiency in China: evidence from the split-share reform,* Quarterly Review of Economics and Finance, v. 60, pp. 125-137, **TD No. 969 (October 2014).**

BOLATTO S. and M. SBRACIA, *Deconstructing the gains from trade: selection of industries vs reallocation of workers,* Review of International Economics, v. 24, 2, pp. 344-363, **TD No. 1037 (November 2015).**

BOLTON P., X. FREIXAS, L. GAMBACORTA and P. E. MISTRULLI, *Relationship and transaction lending in a crisis*, Review of Financial Studies, v. 29, 10, pp. 2643-2676, **TD No. 917 (July 2013).**

BONACCORSI DI PATTI E. and E. SETTE, *Did the securitization market freeze affect bank lending during the financial crisis? Evidence from a credit register,* Journal of Financial Intermediation , v. 25, 1, pp. 54-76, **TD No. 848 (February 2012).**

BORIN A. and M. MANCINI, *Foreign direct investment and firm performance: an empirical analysis of Italian firms,* Review of World Economics, v. 152, 4, pp. 705-732, **TD No. 1011 (June 2015).**

BRAGOLI D., M. RIGON and F. ZANETTI, *Optimal inflation weights in the euro area,* International Journal of Central Banking, v. 12, 2, pp. 357-383, **TD No. 1045 (January 2016).**

BRANDOLINI A. and E. VIVIANO, *Behind and beyond the (headcount) employment rate,* Journal of the Royal Statistical Society: Series A, v. 179, 3, pp. 657-681, **TD No. 965 (July 2015).**

BRIPI F., *The role of regulation on entry: evidence from the Italian provinces,* World Bank Economic Review, v. 30, 2, pp. 383-411, **TD No. 932 (September 2013).**

BRONZINI R. and P. PISELLI, *The impact of R&D subsidies on firm innovation,* Research Policy, v. 45, 2, pp. 442-457, **TD No. 960 (April 2014).**

BURLON L. and M. VILALTA-BUFI, *A new look at technical progress and early retirement,* IZA Journal of Labor Policy, v. 5, **TD No. 963 (June 2014).**

BUSETTI F. and M. CAIVANO, *The trend–cycle decomposition of output and the Phillips Curve: bayesian estimates for Italy and the Euro Area,* Empirical Economics, V. 50, 4, pp. 1565-1587, **TD No. 941 (November 2013).**

CAIVANO M. and A. HARVEY, *Time-series models with an EGB2 conditional distribution,* Journal of Time Series Analysis, v. 35, 6, pp. 558-571, **TD No. 947 (January 2014).**

CALZA A. and A. ZAGHINI, *Shoe-leather costs in the euro area and the foreign demand for euro banknotes,* International Journal of Central Banking, v. 12, 1, pp. 231-246, **TD No. 1039 (December 2015).**

CESARONI T. and R. DE SANTIS, *Current account "core-periphery dualism" in the EMU,* The World Economy, v. 39, 10, pp. 1514-1538, **TD No. 996 (December 2014).**

CIANI E., *Retirement, Pension eligibility and home production,* Labour Economics, v. 38, pp. 106-120, **TD No. 1056 (March 2016).**

CIARLONE A. and V. MICELI, *Escaping financial crises? Macro evidence from sovereign wealth funds' investment behaviour,* Emerging Markets Review, v. 27, 2, pp. 169-196, **TD No. 972 (October 2014).**

CORNELI F. and E. TARANTINO, *Sovereign debt and reserves with liquidity and productivity crises,* Journal of International Money and Finance, v. 65, pp. 166-194, **TD No. 1012 (June 2015).**

D'AURIZIO L. and D. DEPALO, *An evaluation of the policies on repayment of government's trade debt in Italy,* Italian Economic Journal, v. 2, 2, pp. 167-196, **TD No. 1061 (April 2016).**

DE BLASIO G., G. MAGIO and C. MENON, *Down and out in Italian towns: measuring the impact of economic downturns on crime,* Economics Letters, 146, pp. 99-102, **TD No. 925 (July 2013).**

DOTTORI D. and M. MANNA, *Strategy and tactics in public debt management,* Journal of Policy Modeling, v. 38, 1, pp. 1-25, **TD No. 1005 (March 2015).**

ESPOSITO L., A. NOBILI and T. ROPELE, *The management of interest rate risk during the crisis: evidence from Italian banks,* Journal of Banking & Finance, v. 59, pp. 486-504, **TD No. 933 (September 2013).**

LIBERATI D., M. MARINUCCI and G. M. TANZI, *Science and technology parks in Italy: main features and analysis of their effects on hosted firms*, Journal of Technology Transfer, v. 41, 4, pp. 694-729, **TD No. 983 (November 2014).**

MARCELLINO M., M. PORQUEDDU and F. VENDITTI, *Short-Term GDP forecasting with a mixed frequency dynamic factor model with stochastic volatility,* Journal of Business & Economic Statistics , v. 34, 1, pp. 118-127, **TD No. 896 (January 2013).**

RODANO G., N. SERRANO-VELARDE and E. TARANTINO, *Bankruptcy law and bank financing,* Journal of Financial Economics, v. 120, 2, pp. 363-382, **TD No. 1013 (June 2015).**

ZINNA G., *Price pressures on UK real rates: an empirical investigation,* Review of Finance,v. 20, 4, pp. 1587-1630, **TD No. 968 (July 2014).**

2017

ADAMOPOULOU A. and G.M. TANZI, *Academic dropout and the great recession,* Journal of Human Capital, V. 11, 1, pp. 35–71, **TD No. 970 (October 2014).**

ALBERTAZZI U., M. BOTTERO and G. SENE, *Information externalities in the credit market and the spell of credit rationing,* Journal of Financial Intermediation, v. 30, pp. 61–70, **TD No. 980 (November 2014).**

ALESSANDRI P. and H. MUMTAZ, *Financial indicators and density forecasts for US output and inflation,* Review of Economic Dynamics, v. 24, pp. 66-78, **TD No. 977 (November 2014).**

BARBIERI G., C. ROSSETTI and P. SESTITO, *Teacher motivation and student learning,* Politica economica/Journal of Economic Policy, v. 33, 1, pp.59-72, **TD No. 761 (June 2010).**

BENTIVOGLI C. and M. LITTERIO, *Foreign ownership and performance: evidence from a panel of Italian firms,* International Journal of the Economics of Business, v. 24, 3, pp. 251-273, **TD No. 1085 (October 2016).**

BRONZINI R. and A. D'IGNAZIO, *Bank internationalisation and firm exports: evidence from matched firm-bank data,* Review of International Economics, v. 25, 3, pp. 476-499 **TD No. 1055 (March 2016).**

BRUCHE M. and A. SEGURA, *Debt maturity and the liquidity of secondary debt markets,* Journal of Financial Economics, v. 124, 3, pp. 599-613, **TD No. 1049 (January 2016).**

BURLON L., *Public expenditure distribution, voting, and growth,* Journal of Public Economic Theory,, v. 19, 4, pp. 789–810, **TD No. 961 (April 2014).**

BURLON L., A. GERALI, A. NOTARPIETRO and M. PISANI, *Macroeconomic effectiveness of non-standard monetary policy and early exit. a model-based evaluation,* International Finance, v. 20, 2, pp.155-173, **TD No. 1074 (July 2016).**

BUSETTI F., *Quantile aggregation of density forecasts,* Oxford Bulletin of Economics and Statistics, v. 79, 4, pp. 495-512, **TD No. 979 (November 2014).**

CESARONI T. and S. IEZZI, *The predictive content of business survey indicators: evidence from SIGE,* Journal of Business Cycle Research, v.13, 1, pp 75–104, **TD No. 1031 (October 2015).**

CONTI P., D. MARELLA and A. NERI, *Statistical matching and uncertainty analysis in combining household income and expenditure data,* Statistical Methods & Applications, v. 26, 3, pp 485–505, **TD No. 1018 (July 2015).**

D'AMURI F. and J. MARCUCCI, *The predictive power of google searches in forecasting unemployment,* International Journal of Forecasting, v. 33, 4, pp. 801-816, **TD No. 891 (November 2012).**

DE BLASIO G. and S. POY, *The impact of local minimum wages on employment: evidence from Italy in the 1950s,* Journal of Regional Science, v. 57, 1, pp. 48-74, **TD No. 953 (March 2014).**

DEL GIOVANE P., A. NOBILI and F. M. SIGNORETTI, *Assessing the sources of credit supply tightening: was the sovereign debt crisis different from Lehman?,* International Journal of Central Banking, v. 13, 2, pp. 197-234, **TD No. 942 (November 2013).**

DELLE MONACHE D. and I. PETRELLA, *Adaptive models and heavy tails with an application to inflation forecasting,* International Journal of Forecasting, v. 33, 2, pp. 482-501, **TD No. 1052 (March 2016).**

DEL PRETE S., M. PAGNINI, P. ROSSI and V. VACCA, *Lending organization and credit supply during the 2008–2009 crisis,* Economic Notes, v. 46, 2, pp. 207–236, **TD No. 1108 (April 2017).**

LOBERTO M. and C. PERRICONE, *Does trend inflation make a difference?,* Economic Modelling, v. 61, pp. 351–375, **TD No. 1033 (October 2015).**

MANCINI A.L., C. MONFARDINI and S. PASQUA, *Is a good example the best sermon? Children's imitation of parental reading,* Review of Economics of the Household, v. 15, 3, pp 965–993, **D No. 958 (April 2014).**

MEEKS R., B. NELSON and P. ALESSANDRI, *Shadow banks and macroeconomic instability,* Journal of Money, Credit and Banking, v. 49, 7, pp. 1483–1516, **TD No. 939 (November 2013).**

MICUCCI G. and P. ROSSI, *Debt restructuring and the role of banks' organizational structure and lending technologies,* Journal of Financial Services Research, v. 51, 3, pp 339–361, **TD No. 763 (June 2010).**

MOCETTI S., M. PAGNINI and E. SETTE, *Information technology and banking organization,* Journal of Journal of Financial Services Research, v. 51, pp. 313-338, **TD No. 752 (March 2010).**

MOCETTI S. and E. VIVIANO, *Looking behind mortgage delinquencies,* Journal of Banking & Finance, v. 75, pp. 53-63, **TD No. 999 (January 2015).**

NOBILI A. and F. ZOLLINO, *A structural model for the housing and credit market in Italy,* Journal of Housing Economics, v. 36, pp. 73-87, **TD No. 887 (October 2012).**

PALAZZO F., *Search costs and the severity of adverse selection,* Research in Economics, v. 71, 1, pp. 171-197, **TD No. 1073 (July 2016).**

PATACCHINI E. and E. RAINONE, *Social ties and the demand for financial services,* Journal of Financial Services Research, v. 52, 1–2, pp 35–88, **TD No. 1115 (June 2017).**

PATACCHINI E., E. RAINONE and Y. ZENOU, *Heterogeneous peer effects in education,* Journal of Economic Behavior & Organization, v. 134, pp. 190–227, **TD No. 1048 (January 2016).**

SBRANA G., A. SILVESTRINI and F. VENDITTI, *Short-term inflation forecasting: the M.E.T.A. approach,* International Journal of Forecasting, v. 33, 4, pp. 1065-1081, **TD No. 1016 (June 2015).**

SEGURA A. and J. SUAREZ, *How excessive is banks' maturity transformation?,* Review of Financial Studies, v. 30, 10, pp. 3538–3580, **TD No. 1065 (April 2016).**

VACCA V., *An unexpected crisis? Looking at pricing effectiveness of heterogeneous banks,* Economic Notes, v. 46, 2, pp. 171–206, **TD No. 814 (July 2011).**

VERGARA CAFFARELI F., *One-way flow networks with decreasing returns to linking,* Dynamic Games and Applications, v. 7, 2, pp. 323-345, **TD No. 734 (November 2009).**

ZAGHINI A., *A Tale of fragmentation: corporate funding in the euro-area bond market,* International Review of Financial Analysis, v. 49, pp. 59-68, **TD No. 1104 (February 2017).**

FORTHCOMING

ADAMOPOULOU A. and E. KAYA, *Young Adults living with their parents and the influence of peers,* Oxford Bulletin of Economics and Statistics, **TD No. 1038 (November 2015).**

ALBANESE G., G. DE BLASIO and P. SESTITO, *Trust, risk and time preferences: evidence from survey data,* International Review of Economics, **TD No. 911 (April 2013).**

BOFONDI M., L. CARPINELLI and E. SETTE, *Credit supply during a sovereign debt crisis,* Journal of the European Economic Association, **TD No. 909 (April 2013).**

CASIRAGHI M., E. GAIOTTI, L. RODANO and A. SECCHI, *A "Reverse Robin Hood"? The distributional implications of non-standard monetary policy for Italian households,* Journal of International Money and Finance, **TD No. 1077 (July 2016).**

D'AMURI F., *Monitoring and disincentives in containing paid sick leave,* Labour Economics, **TD No. 787 (January 2011).**

FEDERICO S. and E. TOSTI, *Exporters and importers of services: firm-level evidence on Italy,* The World Economy, **TD No. 877 (September 2012).**

GIACOMELLI S. and C. MENON, *Does weak contract enforcement affect firm size? Evidence from the neighbour's court,* Journal of Economic Geography, **TD No. 898 (January 2013).**

NATOLI F. and L. SIGALOTTI, *Tail co-movement in inflation expectations as an indicator of anchoring,* International Journal of Central Banking, **TD No. 1025 (July 2015).**

RIGGI M., *Capital destruction, jobless recoveries, and the discipline device role of unemployment,* Macroeconomic Dynamics, **TD No. 871 (July 2012).**

SEGURA A., *Why did sponsor banks rescue their SIVs?,* Review of Finance, **TD No. 1100 (February 2017).**