**UNIVERSIDAD COMPLUTENSE DE MADRID**
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# TESIS DOCTORAL

# Foreign Direct Investment, migration and trade in economic integration and desintegration processes: a CGE analysis

# Inversión Extranjera Directa, migración y comercio en los procesos de integración y desintegración económica: un análisis de Equilibrio General Aplicado

MEMORIA PARA OPTAR AL GRADO DE DOCTOR

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**To my mother,**

**Rosabel Ortiz Valverde**

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## Contents

# Resumen

## 1. Introducción

Uno de los mecanismos de integración económica más recientes es la negociación de mega acuerdos regionales (MRTAs), los cuales pasan a formar parte del complejo sistema del comercio mundial. Ejemplo de ello es la Acuerdo Transpacífico de Cooperación Económica (TPP).

Aunque la tendencia mundial ha sido hacia una mayor integración económica, la salida del Reino Unido de la Unión Europea (Brexit) deja claro que los procesos de integración implican un conjunto de compromisos y responsabilidades que los países miembros pueden reconsiderar en algún momento. De ahí la importancia de analizar no sólo el impacto de los procesos de integración sino también los procesos de desintegración económica.

Este trabajo analiza las implicaciones económicas del TPP en México y el impacto del Brexit en el Reino Unido y la Unión Europea (UE), los Estados Unidos (EE. UU) y China. Para ello, se aplica un análisis de equilibrio general computable (CGE) basado en los modelos estático y dinámico del Proyecto de Análisis del Comercio Mundial (Global Trade Analysis Project, GTAP) (Hertel y Tsigas, 1997; McDougal, 2003; Corong et al, 2017; Aguiar et al, 2019a).

El uso de estas técnicas permite ofrecer respuestas cuantitativas a preguntas como: ¿La integración económica, entendida como reducción o eliminación de las barreras económicas entre países, mejora las condiciones comerciales y económicas? ¿El TPP llevaría a un aumento o una caída en la producción total en México? ¿Qué sectores ganarían y cuáles perderían? ¿Cómo afectaría el acuerdo a los flujos de comercio sectoriales, agregados y a otras variables macroeconómicas como el PIB, el bienestar y los salarios? ¿Qué impacto tendrán las restricciones en el comercio, la inmigración y la IED del Brexit a nivel micro y macroeconómico en Reino Unido y en la Unión Europea?

Esta tesis consta de cinco capítulos, de los cuales, el capítulo 2 se centra en el análisis del acuerdo transpacífico y su impacto potencial en la economía mexicana, mientras que los

capítulos 3, 4 y 5 ofrecen una evaluación detallada del impacto del Brexit en el Reino Unido y la UE.

## 2. Objetivos y resultados

Como se mencionó en el apartado anterior, el capítulo 2 analiza el impacto potencial del TPP en la economía mexicana. Extiende los estudios de ese tratado porque pocos de ellos han evaluado de forma exhaustiva los efectos del TPP (Oduncu et al.,2014; Cororaton and Orden, 2015; Lee and Itakura, 2014; Petri et al., 2012; Petri and Plummer, 2016; Ciuriak et al, 2016; USITC, 2016) y la mayoría se han centrado en el impacto en los Estados Unidos, sin incluir los impactos de las reducciones de las barreras no arancelarias (BNAs) (Cheong, 2013; Cheong and Thongzon, 2013; Narayanan and Sachin, 2014; Xin, 2014; Masudur and Arjuman, 2016).

El capítulo 2 aborda estos vacíos en la literatura incorporando al análisis la reducción de las BNAs y la evaluación del impacto del TPP en una economía de ingreso medio-alto como la mexicana. Se cuantifica la afectación del acuerdo en términos de la producción total, los flujos comerciales sectoriales y agregados, así como en el bienestar, el PIB, y los salarios. Esto es posible ya que los modelos equilibrio general aplicado permiten identificar no sólo la direccionalidad del impacto, sino también su magnitud cuantitativa.

Los resultados del análisis sugieren que México y EE.UU. se beneficiarían ligeramente del acuerdo. Además, el TPP seguiría siendo beneficioso para México, sin la presencia de EE.UU., ya que prevalece la integración comercial con el resto de los miembros del acuerdo. Nótese que en el momento de elaboración de este primer capítulo todavía el Presidente Trump no había sacado a EE.UU. del TPP y que este acuerdo no había tomado la nueva forma del Tratado Integral y Progresivo de Asociación Transpacífico (CPTPP o TPP-11).

La reducción de los obstáculos arancelarios y las BNAs produciría un aumento del PIB del 0,16 y el 0,77 por ciento en México y los EE. UU. respectivamente. Más allá de las estimaciones a nivel macroeconómico una de las grandes ventajas de los modelos de

equilibrio general aplicado es poder ofrecer resultados a nivel sectorial, consistentes con los agregados. Así derivamos que el TPP produciría un incremento en la producción de bienes manufacturados duraderos, transporte comercial, construcción y servicios públicos, en México. El sector de bienes manufacturados duraderos depende en gran medida del mercado mundial (el 59 por ciento de su producción total se orienta a las exportaciones), el ahorro de costos que experimentará con el TPP impulsaría sus exportaciones hacia el resto de los miembros del acuerdo, lo que llevaría a un aumento en la producción total del sector. Por otra parte, el aumento de la producción en el transporte comercial, los servicios públicos y la construcción, estaría explicado por el aumento del ingreso nacional producto de la reducción en las barreras al comercio, lo que aumentaría la demanda de servicios e inversiones.

Por otra parte, los capítulos 3, 4 y 5 analizan el impacto del Brexit en el Reino Unido y la UE. El capítulo 3 se enfoca en la estimación del efecto potencial de la aplicación de políticas migratorias restrictivas en el Reino Unido tomando en consideración las negociaciones preliminares del "acuerdo conjunto" alcanzado por el Reino Unido y la UE el 8 de diciembre de 2017. El capítulo 4 incorpora al análisis el impacto de la aplicación de barreras comerciales entre el Reino Unido y la UE, así como la actualización de los escenarios en política migratoria de acuerdo con los cambios presentados respecto al tema durante las negociaciones. En este capítulo, presentamos adicionalmente un escenario que supone que el Reino Unido elimina unilateralmente todos sus aranceles a las importaciones provenientes resto de sus socios comerciales. Así mismo, extendemos el análisis de las restricciones de migración del capítulo previo considerando tanto trabajos calificados como no calificados. Además de proporcionar nuevas estimaciones para el impacto de las restricciones comerciales y migratorias relacionadas con Brexit, otra contribución de este capítulo es que comparamos los resultados de un enfoque econométrico (NQTM) con un modelo computacional (CGE). En particular, comparamos los resultados del modelo de Brexit más influyente y ampliamente citado (Dhingra et al., 2017) con un CGE estándar, bien conocido y ampliamente utilizado, a saber, el modelo GTAP. En este sentido, la presente tesis, va más allá de las estimaciones utilizando técnicas de equilibrio general computable, para realizar comparaciones entre metodologías cuantitativas que se encuentran en la frontera de la ciencia.

Por último, el capítulo 5 estima el impacto del Brexit en el comercio y la Inversión Extranjera Directa (IED). Adicionalmente, en este último capítulo se analiza el impacto del Brexit desde una perspectiva no sólo estática sino también dinámica. También utilizamos la última versión de la base de datos GTAP10 para 2014 (Aguiar et al., 2019b), que se actualiza a 2020 a través de una simulación de referencia. Por lo tanto, proporcionamos estimaciones en la base de datos más actualizada.

Con respecto a los resultados macroeconómicos, presentamos estimaciones para las cinco regiones en las que hemos dividido la economía mundial (es decir, Reino Unido, UE, China, EE. UU. y ROW) en los capítulos 4 y 5. Sin embargo, el impacto del Brexit parece limitarse a las dos regiones directamente involucradas en él, mientras que para el resto de los países el efecto sería insignificante.

La mayoría de los estudios que estiman el impacto del Brexit incorporan los efectos en el comercio (Aichele et al., 2015; Booth et al., 2015; CEPR, 2013; Ciuriak and Xiao, 2015; Dhingra et al, 2016b, 2017; UK Government, 2016a, 2016b; Jafari and Britz, 2018; Latorre et al., 2018a; OECD, 2016; Oxford Economics, 2016 and PwC, 2016). Sin embargo, solo unos pocos incluyen otros aspectos tales como el impacto de la Inversión Extranjera Directa (Dhingra et al., 2017; OECD, 2016; Pain and Young, 2004; Ciuriak and Xiao, 2015; UK Government 2016b; Jafari and Britz, 2018 and Latorre et al., 2018a), la incertidumbre (UK Government, 2016a, 2016b) o la migración (Dhingra et al., 2016a; UK Government, 2016a; Jafari and Britz, 2018; OECD, 2016; Portes and Forte, 2017 and PwC, 2016). Sin embargo, de los estudios que incluyen migración solo unos pocos proporcionan el impacto de la migración (Dhingra et al., 2016; Portes and Forte, 2017) por separado del impacto al comercio. Por otra parte, la mayoría de los estudios proporcionan estimaciones del impacto sobre el PIB y el bienestar, pero no ofrecen resultados para otras variables macroeconómicas o a nivel sectorial, como se hace a lo largo de esta tesis.

El análisis del capítulo 3 proporciona resultados para las variables macroeconómicas como el PIB, el PIB per cápita, los salarios y el bienestar, así como el impacto de la inmigración en

los 21 sectores incluidos en el modelo. También amplía el conjunto de diferentes políticas migratorias que el Reino Unido podría adoptar después del Brexit.

Entre los principales resultados se pueden mencionar, que la reducción del número de trabajadores deprimiría la capacidad de producción del Reino Unido y, por lo tanto, su PIB y su ingreso nacional. Cuanto más restrictivas sean estas políticas, mayor será la pérdida en términos de PIB, PIB per cápita y bienestar. Por ejemplo, bajo la política más restrictiva y poco probable que se podría adoptar, lo que ofrece el máximo impacto derivable de la inmigración, como es la reducción de todos los migrantes de la UE, el Reino Unido se enfrentaría a una pérdida de PIB, PIB per cápita y de bienestar de 4,71, 1.06 y 4,62 por ciento, respectivamente. Mientras que en los escenarios más suaves (escenarios de la OCDE) la reducción de la entrada de inmigrantes de la UE entre 42.000 y 87.000 personas llevaría a una pérdida de beneficios de 0,08 y 0,17 por ciento del PIB en el Reino Unido, por año y que, por tanto, se irían acumulando conforme avanzaran los años.

Respecto al análisis conjunto de restricciones al comercio y políticas migratorias restrictivas el capítulo 4 proporciona resultados no sólo para los agregados macroeconómicos sino también para el impacto en los 21 sectores de la economía. Además, ofrece resultados del impacto del Brexit en el comercio y la migración por separado, lo que permite identificar la contribución de cada elemento en el impacto total del Brexit y estima el impacto de las restricciones tanto en trabajadores cualificados como no cualificados, considerando las condiciones acordadas en el Acuerdo de Salida (WA) aprobado por los líderes de la UE el 25 de noviembre de 2018.

Los resultados bajo dos de los escenarios más discutidos en la literatura (Brexit blando o Brexit duro) sugieren que tanto el Reino Unido como la UE se verían afectados negativamente. Sin embargo, el Brexit sería más perjudicial para el Reino Unido que para la UE. Por ejemplo, bajo el Brexit duro, el Reino Unido se enfrentaría a una reducción del PIB de 1,14 por ciento, mientras que la UE experimentaría una caída de 0,14 por ciento. Además, las restricciones a la migración sumarían pérdidas de alrededor de 0,34 y 0,56 por ciento a la caída del PIB de Reino Unido.

Por otro lado, aunque los resultados sugieren que las reducciones de la inmigración aumentarían los salarios en el Reino Unido, un menor número de trabajadores también ejercería una presión a la baja sobre el PIB per cápita y no podría compensar las pérdidas derivadas del comercio en un Brexit duro.

Con la incorporación de la Inversión Extranjera Directa (IED) en el capítulo 5, se logra obtener una visión más amplia de los efectos potenciales del Brexit. Se estima que el coste salir de la UE sea mayor al que sugieren las estimaciones previas que se basan únicamente en el comercio y la migración.

Como se mencionó con anterioridad, en el capítulo 5 se aborda el impacto con un modelo estático y otro dinámico. El escenario dinámico refleja el impacto simultáneo del comercio y la acumulación de capital, permitiendo ofrecer resultados de largo plazo. El modelo estático permite separar el impacto del comercio del de la acumulación de capital. Por lo tanto, no sólo se proporcionan estimaciones para el largo plazo, en concreto para el período de 2021 a 2030, sino que también se arrojan luces sobre el papel de la IED en el Brexit.

Adicionalmente, se incorpora un nuevo escenario, que comprende el nuevo acuerdo de Brexit alcanzado por Boris Johnson en Bruselas el pasado noviembre de 2019. Hasta donde sabemos, sólo Menon (2019) introduce el nuevo acuerdo en sus estimaciones. En este capítulo también utilizamos la última versión de la base de datos GTAP10 para 2014 (Aguiar et al., 2019b).

El impacto de un aumento simultáneo de los obstáculos al comercio y la reducción de la entrada de IED implican una caída del PIB en el Reino Unido del 2,15 por ciento para el 2030 en el marco de un Brexit duro, comparado con la evolución que habría tenido el PIB si no hubiera habido Brexit.

Las estimaciones reflejan que los resultados del PIB y las tendencias de ajuste sectorial en un entorno estático y dinámico son similares. Por lo tanto, los resultados obtenidos bajo el modelo estático arrojan luz para comprender mejor el impacto del modelo CGE dinámico.

En cuanto a la propuesta de Boris Johnson, el Reino Unido se enfrentaría a una reducción del 1,43 por ciento del PIB para el 2030 en el marco de un Brexit duro, comparado con la evolución que habría tenido el PIB si no hubiera habido Brexit. Aunque esta propuesta implica mayores barreras al comercio que el acuerdo de salida anterior, alcanzado por Theresa May, y que el escenario blando del Brexit, la propuesta de Boris Johnson sería menos perjudicial que abandonar la UE sin un acuerdo de salida.

## 3. Conclusiones

Respecto al análisis del TPP y su impacto en la economía mexicana, se puede concluir que el TPP proporcionaría beneficios a la economía mexicana, aunque EE.UU. no participe del acuerdo, esto se debe, a que México podría reforzar sus relaciones comerciales con los otros miembros del acuerdo, sin tener que competir con EE. UU. por estos nuevos mercados.

Con relación al impacto del Brexit, la reducción del flujo de inmigrantes de la UE generaría una caída de la producción y del PIB y PIB per cápita en el Reino Unido. Cuanto más restrictivas sean las políticas de migración, mayores serán las pérdidas. El aumento gradual de las restricciones a los inmigrantes sería menos perjudicial, ya que permite la aplicación de políticas complementarias a medio plazo que ayudan a cubrir la falta de trabajadores con las competencias requeridas por la industria británica.

El impacto negativo del Brexit en el Reino Unido aumenta cuando se incorporan al análisis las restricciones al comercio. El aumento de los aranceles y las BNAs incrementa los costes de exportación e importación entre Reino Unido y la UE, afectando especialmente a las exportaciones de los sectores manufactureros (por ejemplo, vehículos de motor, productos químicos, textiles y otros primarios) en el Reino Unido. Las estimaciones de esta tesis proveen de estimaciones cuantitativas para cada uno de los sectores.

En lo que respecta a la IED, los efectos de una reducción de la IED contrastan con los efectos del aumento en las barreras al comercio. Esto es particularmente notable cuando se analiza el impacto sobre las rentas del capital y los ajustes sectoriales. Por ejemplo: una caída en la IED conduce a un aumento en las rentas de capital, mientras que el aumento de las barreras al comercio las reduce.

En términos de ajustes sectoriales, una menor IED sugiere una caída general de la producción en la mayoría de los sectores de la economía, lo que lleva a una caída de las exportaciones y a un aumento de las importaciones. Por otra parte, el aumento de las barreras al comercio reduce las importaciones en todos los sectores y las exportaciones de varios sectores manufactureros. Por lo tanto, el ajuste de la producción total en algunos sectores sería positivo.

En resumen, la caída de la IED contribuye a la disminución de la producción de servicios e intensifica el impacto negativo de las barreras al comercio en los sectores manufactureros. Aunque las estimaciones del nuevo acuerdo alcanzado por Boris Johnson sugieren que el impacto de Brexit en el Reino Unido sería menos perjudicial que con un Brexit duro, el impacto sigue siendo negativo.

Las pérdidas bajo un Brexit duro implican una reducción acumulativa del PIB de 2,15 por ciento para 2030, comparada con la evolución en la que no hubiera habido un Brexit. Esta pérdida contempla el aumento de las barreras comerciales, así como una caída del 16,77 por ciento en el stock de IED. Según la propuesta de Boris Johnson, el Reino Unido se enfrentaría a una pérdida de PIB de 1.43 por ciento. Claramente, el impacto del Brexit a largo plazo aumentaría, si incluimos en el análisis el impacto potencial de las restricciones migratorias. Como se señaló con el modelo estático, la aplicación de políticas migratorias restrictivas producirá perdidas en términos del PIB, PIB per cápita y el bienestar.

# Summary

# 1. Introduction

One of the most recent economic integration mechanisms is the negotiation of mega regional trade agreements (MRTAs), which have become part of the complex world trade system. One of them is the Trans-Pacific Economic Cooperation Agreement (TPP).

Although the global trend has been towards greater economic integration in the last decades, the United Kingdom's exit from the European Union (Brexit) makes it clear that integration processes involve a set of commitments and responsibilities that member countries may at some point reconsider. Hence the importance of analysing not only the impact of integration processes but also the processes of economic disintegration.

This PhD dissertation analyses the economic implications of the TPP in Mexico and the impact of Brexit in the UK and the Rest of the European Union (EU), the United States (USA) and China. It applies a computable general equilibrium (CGE) analysis based on the static and dynamic models of the Global Trade Analysis Project (GTAP) (Hertel and Tsigas, 1997; McDougal, 2003; Corong at al., 2017; Aguiar et al., 2019a).

This allows us to offer quantitative estimations to answer the following questions: Does economic integration, i.e., the reduction or elimination of economic barriers between countries, improve their commercial and economic conditions? Would the TPP lead to an increase or a drop in overall production in Mexico? Which sectors would gain, and which would lose? How would the agreement affect sectoral, aggregate trade flows, and other macroeconomic aggregates, such as GDP, welfare, and wages? How will Brexit-related restrictions on migration, trade, and FDI affect the UK and the European Union at the sectoral and macroeconomic level?

The document consists of five chapters, Chapter 2 focuses on the analysis of the TPP agreement and its potential effects in Mexico, while Chapters 3, 4 and 5 provide a detailed assessment of the impact of Brexit on the United Kingdom and the EU.

## 2. Objectives and results

As mentioned above, Chapter 2 analyses the potential impact of TPP in Mexico. To the best of our knowledge few studies have comprehensively evaluated the effects of TPP (Oduncu et al., 2014; Cororaton and Orden, 2015; Lee and Itakura, 2014; Petri et al., 2012; Petri and Plummer, 2016; Ciuriak et al, 2016; USITC, 2016) and most of them focus on the impact in the USA, and do not include the impacts of non-tariff barrier (NTBs) reductions (Cheong, 2013; Cheong and Thongzon, 2013: Narayanan and Sachin, 2014: Xin, 2014: Masudur and Arjuman, 2016).

The analysis in Chapter 2 addresses these gaps in the literature by incorporating into the analysis the reduction of NTBs and the assessment of the impact of TPP in an upper-middle income economy, such as Mexico. We quantify the TPP impact in terms of total production, sectoral and aggregate trade flows, as well as on welfare, GDP and wages. This is possible since CGE models not only allow us to identify the direction of the impacts but also to quantify them.

The results suggest that Mexico and the United States would benefit slightly from the agreement. In addition, the TPP without the presence of the United States, would still be beneficial to Mexico, since Mexico would still benefit from the trade integration with the rest of the members of the TPP.

The reduction of tariffs and NTBs would lead to an increase in GDP of 0.16 and 0.77 percent in Mexico and the United States, respectively. It would also bring about a rise in the production of non-durable manufactured goods, trade transport, construction, and utilities, in Mexico. Regarding the durable manufactured goods, this sector depends to a large extent on the world market (59 percent of its total production is export-oriented), the cost savings that it will experience with the TPP would push up its exports towards the rest of the members of the agreement. That would lead to an increase in the total production of the sector. On the other hand, production increase in trade transport, utilities, and construction would be

explained by the rise in national income as a result of the reduction in trade barriers, which would increase the demand for services and investments.

Note that at the time of writing this first chapter, President Trump had not yet withdrawn the United States from the TPP and that this agreement had not taken the new form of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP or TPP-11).

Chapters 3, 4 and 5 analyse the impact of Brexit in the UK and the EU. Chapter 3 focuses on estimating the potential impact of restrictions on migration policies, considering the "joint agreement" reached by the UK and the EU on 8 December 2017. Chapter 4 incorporates the impact of trade barriers between the UK and the EU, as well as updated migration scenarios according to changes presented during the negotiations. In this chapter, we run one scenario which assumes that the UK unilaterally removes all its tariffs on imports from the rest of its trade partner. In addition, we analyse migration restrictions considering both, skilled and unskilled workers. Apart from providing new estimations for the impact of trade and migration restrictions related to Brexit, another contribution of this chapter is that we compare the results of an econometric (NQTMs) approach with a computational (CGE) model. In particular, we compare the outcomes of the most influential and widely cited model of Brexit (Dhingra et al., 2017) with a well known and extensively used CGE, namely, the GTAP model.

Finally, chapter 5 estimates the impact of Brexit on trade and Foreign Direct Investment (FDI). In addition, in this last chapter, the impact of Brexit is analysed not only from a static but also a dynamic perspective. We also use the latest version of GTAP 10 database for the world economy in 2014 (Aguiar et al., 2019b), which is updated to 2020 throughout a baseline simulation. Hence, we provide estimates based on the most updated database.

Regarding macroeconomic results, we present estimates for five regions (i.e., UK, EU, China, USA, and ROW) in chapters 4 and 5. However, the impact of Brexit seems confined to the two regions directly involved in it, while for the rest the effect would be negligible.

Most studies estimating the impact of Brexit incorporate trade effects (Aichele et al., 2015; Booth et al., 2015; CEPR, 2013; Ciuriak and Xiao, 2015; Dhingra et al, 2016b, 2017; UK Government, 2016a, 2016b; Jafari and Britz, 2018; Latorre et al., 2018a; OECD, 2016; Oxford Economics, 2016 and PwC, 2016). However, only a few include other aspects such as the impact of FDI (Dhingra et al., 2017; OECD, 2016; Pain and Young, 2004; Ciuriak and Xiao, 2015; UK Government, 2016b; Jafari and Britz, 2018 and Latorre et al, 2018a), uncertainty (UK Government, 2016a, 2016b) or migration (Dhingra et al., 2016a; UK Government, 2016a; Jafari and Britz, 2018; OECD, 2016; Portes and Forte, 2017 and PwC, 2016). Among the ones that include the migration (Dhingra et al., 2016; Portes and Forte, 2017) very few separate its impact from the trade effects. In addition, most studies provide estimates of the impact on GDP and welfare, but do not provide results for other macroeconomic and microeconomic variables.

The analysis in Chapter 3 provides results for macroeconomic variables such as GDP, GDP per capita, wages and welfare, as well as the impact of migration on the 21 sectors included in the model. It also expands the set of migration policies that the United Kingdom could apply after Brexit.

The reduction in the number of workers would depress the United Kingdom's production capacity and therefore its GDP, GDP per capita and national income. The more restrictive these policies are, the greater the loss in terms of GDP, GDP per capita and welfare.

For example, under the most restrictive policy one could think of, which thus provides the strongest possible effects such as a reduction of all EU migrants, the UK would face a loss of GDP, GDP per capita, and welfare of 4.71, 1.06 and 4.62 percent, respectively. Under the softer (OECD, 2016) scenarios the reduction of the annual inflow of EU migrants by 42,000 to 87,000 people would lead to a loss of benefits equivalent to 0.08 and 0.17 percent of GDP, per year.

Regarding to the joint analysis of restriction on trade and migration policies, chapter 4 provides the results not only for macroeconomic aggregates but also for the impact on the 21 sectors of the economy. In addition, it provides results for trade and migration restrictions separately, which allows to determinate the contribution of each element in the total impact of Brexit and also estimates for the impact on both skilled and unskilled workers, considering the conditions agreed in the Withdrawal Agreement (WA) approved by EU leaders on 25 November 2018.

The results under two of the most debated scenarios in the literature (i.e., soft Brexit or hard Brexit) suggest that both the UK and the EU would be negatively affected. However, Brexit would be more harmful to the UK than to the EU. For example, under a hard Brexit, the UK would face a reduction in GDP of 1.14 percent, while the EU would experience a fall of -0.14 percent. In addition, restrictions on migration would imply additional losses of 0.34 and 0.56 percent in GDP in the UK.

On the other hand, although the results suggest that reductions in migration would increase wages in the UK, they would also put downward pressure on GDP per capita and would not compensate for the trade losses of a hard Brexit.

With the incorporation of FDI in chapter 5, it is possible to obtain a broader view of the potential effects of Brexit. The cost of leaving the EU is expected to be higher than previous estimates based on trade and migration alone. As mentioned above, chapter 5 applies both a static and a dynamic perspective. The dynamic scenario reflects the simultaneous impact of trade and capital accumulation, allowing for the estimation of long-term outcomes. The static model allows to separate the impact of trade from that of capital accumulation. Hence, chapter 5 not only provides estimates for a long-term period from 2021-2030, but also sheds light on the role of FDI in the UK.

In addition, a new scenario is incorporated, namely, the new Brexit agreement reached by Boris Johnson in Brussels last November 2019. To the best of our knowledge, only Menon

(2019) has estimated the impact of this new agreement. In this chapter, we also use the latest release of GTAP10 data base for the world economy in 2014 (Aguiar et al., 2019b).

The impact of a simultaneous increase in trade barriers and a reduction in FDI inflows implies a fall in UK's GDP of 2.15 percent under a hard Brexit by 2030, compared to the Business as usual (BAU) scenario.

Regarding Boris Johnson's proposal, the UK would face a 1.43 percent reduction in GDP by 2030, compared to the BAU. Although this proposal implies higher barriers to trade than the previous withdrawal agreement reached by Theresa May and the soft Brexit scenario, Boris Johnson's proposal would be less harmful than leaving the EU without a withdrawal agreement.

## 3. Conclusions

Regarding the analysis of the potential impact of TPP in Mexico, it can be concluded that the TPP would provide benefits for Mexico, even if the United States does not participate in the agreement. This is because Mexico could strengthen its trade relations with the other members of the agreement, without having to compete with the United States for these new markets.

The impact of a reduction in tariffs contrasts with that of a decrease in NTBs. With the decrease in tariffs, the United States and Mexico become more integrated with the rest of the members of the agreement. On the other hand, Mexico would integrate more with the USA in the face of a decline in NTBs.

Regarding the impact of Brexit, the reduction in the flow of immigrants from the EU would generate a fall in production and GDP in the UK. The more restrictive the migration policies are the greater the losses. Gradual increases on immigration restrictions would be less harmful, because it would allow to adopt complementary policies in the medium term, which

would help to cover the lack of workers with the skills required by the British productive system.

The negative impact of Brexit in the UK increases when trade restrictions are incorporated into the analysis. The rise in tariffs and NTBs increase export and import costs between the UK and the EU. This affects more exports of manufacturing sectors (e.g. motor vehicles, chemicals, textiles and other primary products) than from other sectors in the United Kingdom. The particular quantitative outcomes for each sector are estimated in this PhD dissertation.

Regarding FDI, the effects of a reduction in FDI contrasts with the effects of the increase in trade barriers. This is particularly important when the impact on capital rents and sectoral adjustments is analysed. For example, a fall in FDI leads to an increase in capital rents, while the rise of barriers to trade reduces it.

In terms of sectoral adjustments, a reduction of FDI brings about a general fall in output in most sectors of the economy, leading to a fall in exports and to an increase in imports. On the other hand, higher trade barriers reduce imports in all sectors and exports in several manufacturing sectors. Therefore, the adjustment of total output in other sectors would be positive.

To sum up, the fall in FDI contributes to the decline in services and intensifies the negative impact of trade barriers in the manufacturing sectors. Although estimates of the new agreement reached by Boris Johnson suggest that the impact of Brexit on the UK would be less harmful than with a hard Brexit, the impact remains negative.

Losses under a hard Brexit imply a cumulative reduction in GDP of 2.15 percent by 2030, compared to the BAU scenario. This contraction includes the increase in trade barriers, as well as a 16.77 percent drop in the FDI stock. With the Brexit agreement proposed by Prime Minister Boris Johnson, the UK would face a GDP loss of 1.43 percent by 2030, compared to the BAU scenario. Clearly, if we also include in the analysis the potential impact of

migration restrictions, the negative effects of Brexit in the long term will be larger. As noted with the static model, the impact of migration policies would produce losses in terms of GDP, GDP per capita, and welfare.

# Chapter 1. Introduction

## 1. Economic integration and disintegration processes

There are at least six levels of economic integration in the world: (1) preferential trade area, (2) free-trade area, (3) customs union, (4) economic union, (5) economic and monetary union and (6) complete economic integration. The level of integration depends on the degree of trade liberalization and the homogeneity of economic policies among the countries involved.[1]

Economic integration implies that country members have agreed to comply with a set of commitments and responsibilities to improve their economic and social conditions. Among the benefits of economic integration, we can find access to new markets that improve production, investment and employment opportunities. However, it also has some costs such as the loss of national sovereignty and trade diversion. That is why a country member can ask to renegotiate the previous conditions of the agreement, reconsider to remain in it or even leave the agreement.

One of the most recent mechanisms which has boosted economic integration is the negotiation of mega-regional trade agreements (MRTAs). In contrast to the more traditional trade agreements, which only involve tariff elimination, MRTAs are very ambitious and complex. This type of deals implies deep integration among countries or regions and encompass several topics, such as state-owned enterprises, cooperation and capacity building, competitiveness and business facilitation, property rights, Foreign Direct Investment, trade in services, public procurement, etc.

Although international economic integration seems to be the global trend, there is an example of an economic disintegration process that is currently being negotiated, the United Kingdom's exit from the EU[2] (Brexit). In June 2016 the UK voted to leave the EU and they

[1] There are several countries that are immersed in a process of regional integration, e.g. the North American Free Trade Agreement (NAFTA) which includes Canada, Mexico and the USA; and the Southern Common Market (MERCOSUR) which involves Argentina, Brazil, Paraguay, Uruguay, Venezuela and Bolivia.

[2] The EU was born in 1957 with the Treaty of Rome. It is an example of an ambitious and complex process of economic integration, which involves 28 member states. The UK became a member of the EU in 1973 with Denmark and Ireland.

formally notified the EU of its intention to leave on March 29, 2017, triggering the start of the negotiations on a withdrawal agreement.

This dissertation provides a detailed analysis of the impact of one of the most hotly debated MRTAs in the last years, namely, the Trans-pacific Partnership (TPP), together with the impact of Brexit. The former is an example of an economic integration process and the latter is an economic disintegration event.

Beyond the specific policy implications for the trade agreement (TPP) or Brexit that we study, our aim is to analyse the structure and behaviour of CGE models in the analysis of policies related to migration, foreign trade and Foreign Direct Investment and put them in perspective with other methodological approaches.

## 2. Methodology

As mentioned above, this research analyses the impact of two economic integration and disintegration processes, the Trans-pacific Partnership (TPP) and the exit of the United Kingdom from the European Union (Brexit).

Regarding the analysis of TPP, the study focuses on the potential impact of a reduction of tariffs and Non-tariffs barriers (NTBs) in the Mexican economy. For the analysis of Brexit, the study considers not only the impact of trade costs but also the potential impact of migration and Foreign Direct Investment (FDI).

We conduct our analysis by means of two well-known Computable General Equilibrium (CGE) models, namely, the Global Trade Analysis Project (GTAP) model (Hertel et al., 1997, updated in McDougall, 2003 and Corong et al., 2017) and the Recursive Dynamic (RD-GTAP) model (Aguiar et al., 2019a).

General Equilibrium models provide quantitative micro and macroeconomic impacts of different shocks on the economy. Several studies analyse the impact of trade policies on the

whole economy using this class of models. Some of them use CGE models, while others apply econometrically estimated structural gravity models called "New quantitative trade models" (NQTMs).

CGE models provide a comprehensive representation of the economy, since they capture the interaction of households, firms and the government. These connections among those different economic agents are presented as a system of equations, which are derived from microeconomic optimization theory.

With respect to the demand side of the economy, all categories are explicitly modelled, private consumption, investment, public consumption, exports and imports. Regarding the supply side, a representative firm in each sector decides the optimal combination of intermediates inputs and factors of production to produce goods or services.

All economic agents are in contact with one another through the markets of factors and goods and services. There are a representative household and a government. Both consume goods and services offered by producers in the goods and services markets. The income that producers receive is used to remunerate factors of production and to buy imported or domestic intermediates in order to produce goods and services that will be allocated in the commodity markets. Therefore, producers are related to one another through the demand of intermediates and are also related to households through the demand of factors of production (labour and capital). In turn, the representative household receives a remuneration (through wages and rents) that will be used latter to buy goods and services, in order to maximize its utility. These microeconomic optimization decisions are then comprised in a framework representing national accounts identities, which also define the equilibrium in the economy.

By contrast, NQTMs include much less detail on the working of the economy than CGE models (Latorre et al., 2019b, p. 78). Latorre et al. (2019b) explain how NQTMs estimate the Brexit impact on trade using a small group of structural gravity-type variables, such as national income, geographical distance, technology, and trade obstacles like tariff and NTBs. This is line with the analysis that Bekkers and Rojas-Romagosa (2019) do. According to

these authors many effects of trade policy changes are omitted in small scale, structural gravity models due to the fact that the latter include less detailed modelling features compared to CGEs.

Although an advantage of NQTMs models is that they obtain most of their structural parameters from the same database with which they conduct their simulations, for a particular case like Brexit, the reliance of this type of model on past trade flows to predict future trade trends is problematic. Brexit has no precedents. Hence, previous data will miss effects that would only appear in the first disintegration process (Latorre et al, 2019b). In addition, compared to CGE models, NTQMs do not offer much information on sectoral results, which is one of the strengths of CGE models. A thorough comparison between these two methodologies (NQTMs vs. CGEs) is undertaken in Chapter 5. In fact, one of the contributions of this PhD Thesis is the close inspection of the results obtained using both methodologies in the context of Brexit.

The literature over several decades has proved that CGE models are one of the most powerful tools to assess impacts of worldwide trade policies, starting from the GATT Tokyo round negotiations, continuing with the WTO and the World Bank co-sponsored two conferences on the so-called Millennium Round of Multilateral Trade talks in Geneva in 1999. Virtually all of the quantitative, global economic analyses presented in those conferences were based on the GTAP framework (GTAP, 2020). In addition, one of the most comprehensive analysis on the revision of the NAFTA agreement, namely, the "US, México Canada Agreement (USMCA)" relies heavily on CGE modelling (USITC, 2019). "Since its inception in 1960 with the publication of Johansen's book (A multisectoral study of economic growth), CGE Modelling has proved a remarkably fruitful technique for combining data with economic theory to project implications for macro, industry, regional, occupational, environmental and distributional variables of a wide range of policy changes and other shocks to the economy" (Dixon and Rimmer, 2016, p. 432).

CGE models belong to the economy-wide class of models, which provide industry disaggregation in a quantitative description of the whole economy, whose defining feature

compared to other earlier economy-wide models is the definition of the behaviour of individual agents, which was undertaken by Johansen's work. However, according to Dixon and Rimmer (2016), there were other starting points in CGE modelling besides Johansen's work. For example, in 1974, Hudson and Jorgenson were the first to include in a CGE model flexible functional forms for production, while Jorgerson and Yun (1986a, 1986b) embedded Jorgenson theory of investment and the models of Jorgenson and Wilcoxen (1993) and Ho and Jorgenson (1994) included econometrically estimated consumer demand functions. On the other hand, Adelman and Robinson (1978) made important contributions to CGE modelling during their work in the World Bank. They showed that when their model was fed base-period values for the exogenous variables then it closely reproduced base-period values for the endogenous variables. In other words, they successfully calibrated their recursive dynamic model.

According to Dixon and Rimmer (2016) early CGE modellers including Johansen (1960, 1974), Hudson and Jorgenson (1974), Adelman and Robinson (1978) and Taylor, Bacha, Cardoso, and Lysy (1980) gave their results a real-time dimension, either historical or future, while the subsequent generation of modellers worked mainly in a comparative static framework.

The Johansen style model and the Adelman-Robinson style model have grown and spread throughout the world. The wide-spread adoption of both styles of modelling was possible with the implementation of specific software, GEMPACK for the Johansen style models and GAMS for the models from the Adelman-Robinson. One basic difference between both types of modelling approaches is that GEMPACK software works with linearized equations, while GAMS software works in levels using the straight algebraic formulation of the equations, without linearizing them. If properly used, GEMPACK and GAMS should yield the same results. In this PhD Dissertation GEMPACK software is used to solve the models we use.

The Johansen style model was adopted by the IMPACT project set up by the Australian Government in 1975, which seek to build an economy-wide model of Australia for assessing the effects of reductions in tariffs on manufactured imports. The IMPACT project team has

taken on various institutional guises, and since 1991 it is being implemented in the Centre of Policy Studies (CoPS) at Monash University. Since that year CoPS has been undertaking major model development and application tasks for organizations outside Australia. It worked on the construction of USAGE (U.S. Applied General Equilibrium), a policy-oriented model of the U.S. economy, which is now widely recognized in Washington DC.

A final conduit of Johansen-style modelling from Australia to the rest of the world is the Global Trade Analysis Project (GTAP) founded in 1992 by Tom Hertel at Purdue University (Dixon and Rimmer, 2016, p. 432). Hertel adopted the SALTER model (from the IMPACT project), a Johansen -style multi-country model (GTAP, 2020).

The development of the GTAP model started simultaneously with the development of the GTAP Data Base. The first full documentation of the model became available in the book of Hertel (1997), with model modifications and additions described in Hertel et al. (2000), Huff and Hertel (2001), and McDougall (2003). The last additions and model streamlining were consolidated in a new model description in Corong et al. (2017), which is well-known as the GTAP model version 7.0. Finally, the development of the new GTAP recursive dynamic (GTAP-RD) model is built on the latest version of the core GTAP trade model. (Aguiar et al., 2019a).

Some of the latest developments in the frontier in CGE modelling have been presented at the latest GTAP conference of 2020. We have found that, at least, five promising lines of research shown during the conference are of particular relevance: 1) Analyses of the impact of different closure rules in recursive dynamic models (Bekkers and Orlov, 2020); 2) Papers dealing with how to include firm heterogeneity (Akgul and Saad, 2020) or including *de facto* heterogeneity (Latorre et al., 2020); 3) Approaches aimed at including analyses at the product level in CGE models (Pelikan et al., 2020 with her TASTE model); 4) Multinationals affiliates sales and Foreign Direct Investment modelling (Hosoe, 2020); and 5) Studies on the impact of trade on workers under different assumptions for reallocation (Tsigas and Bernard, 2020).

The capacity to obtain insights from firm heterogeneity emanates from the original contribution of Melitz (2003) and constitutes one of the latest advances in international economics in the last decades. It allows models to grasp that within each sector firms differ in size and productivity and whether they export, or they do not. This has important consequences about how shocks affect firms' entry and exit and sectoral productivity, among other important aspects. For a comprehensive analysis of these new original features in CGE modelling see Akgul (2017) and (Akgul and Saad, 2020). There is an ongoing debate on the role of closure rules. In practice, the choice of closure rules should depend on the policy issues being analysed and the time frame for the analysis. Bekkers and Orlov (2020) offer a deep review of many alternative specifications. In this PhD Dissertation we use their preferred specification.

Sectoral aggregation in CGE models can be considered to yield big aggregate sectors with many products behind, particularly when compared with firm-level data analysis. As a consequence, researchers may be interested in obtaining general equilibrium aspects for very specific products, which are very important in the export basket of some countries or are subject to specific tariffs or regulations. There is work conducted now in this direction to try to descend to a very specific product level even at HS-6 digit and to be able to isolate the impact at that level. The work conducted at the Thünen Institute by Janine Pelikan and others is pioneering in this line of research. In addition, as we have already mentioned and will be discussed in length, there are still many challenges for properly modelling multinationals' operations and FDI in a CGE framework and in using other methodologies. The dynamic approach of Hosoe (2020) constitutes one of the most prominent in this line of research. Finally, an important aspect of the research we conduct, which is sometimes overlooked, is the impact on workers. An interesting contribution in this line is the modelling of costly labour reallocation across sectors after trade shocks (Tsigas and Bernard, 2020).

## 3. Structure of the Dissertation

The structure of this dissertation is as follows. As we have mentioned above, we consider two different events that have attracted attention in the last years, the TPP and Brexit.

In chapter 2 we analyse the economic impact of TPP in an upper-middle income economy, namely, Mexico. We estimate the economic effect of a reduction in tariff and non-tariff barriers (NTBs) and provide a wide set of macro and microeconomic results.

Chapters 3, 4 and 5 estimate the impact of Brexit in the UK and the EU. Due to the complexity of Brexit as an economic disintegration process, each chapter analyses the impact of Brexit in at least one of the four freedoms of the European Union Single Market.

Chapter 3 explains the potential impact of migration restrictions in the UK. We run six scenarios, three of them correspond to the most restrictive migration policies that the UK could apply after Brexit and the other three correspond to milder scenarios.

In chapter 4 we extend our study incorporating the increase of barriers to trade and updating estimates of migration policies. This chapter displays a comprehensive analysis of the impact of tariffs and NTBs in the UK as well as the impact of migration considering the presence of skilled and unskilled workers. We also compare in detail our results with the ones of an influential study, Dhingra et al. (2017), which analyse the impact of Brexit using a NQTM.

Chapter 5 incorporates the impact of a reduction in the inflow of FDI in the UK after Brexit to the analysis. We also provide estimates of the impact of barriers to trade. In this chapter, we apply the static and dynamic setting for the GTAP model to capture the role of FDI in the short and long term. The static model enables us to separate the impact of trade from that of capital accumulation. Hence, it allows us to understand the dynamic results in a better way.

# Chapter 2. The impact of the Trans-Pacific Partnership in Mexico [1]

[1] This chapter has been presented at the International Conference on Economic Modelling – EcoMod 2016, that took place in the Lisbon School of Economics and Management, on 6 -8 July 2016, in Lisbon, Portugal.

A paper related to the content of this chapter has been published in The Journal of International Trade Law and Policy, Vol. 16, No. 2, pp. 106-123. (2017).

**Abstract**

The Trans-Pacific Partnership (TPP) is an ambitious multilateral agreement going beyond trade policy instruments. Only a few studies have comprehensively evaluated its quantitative economic effects. However, they have mainly focused on the impact of TPP for the United States of America (USA) and several of them do not include estimates of the impact of non-tariff barriers (NTBs).

This chapter explains the economic implications of the trans-pacific partnership (TPP) on an upper-middle economy, namely Mexico. The analysis incorporates the study of both, tariffs and NTBs to estimate the economic impact of the agreement.

The analysis is performed using a Computable General Equilibrium (CGE) model, which provide results for a broad set of micro and macroeconomic variables. It also provides macroeconomic results for the USA.

The results suggest that in the short run, both Mexico and the USA would slightly benefit from the TPP. Tariff reductions would lead to less bilateral trade between Mexico and the USA and to stronger integration of both countries with the rest of the TPP members. The opposite is true after a decrease in non-tariff barriers (NTBs). Overall, in terms of the impact on Mexico, trade integration with the rest of the TPP member prevails. This suggest that a TPP without the USA could still be beneficial.

## 1. Introduction

In his first week in office, President Donald Trump announced that the USA would be withdrawing from the Trans-pacific partnership (TPP) agreement. Some countries expressed their interest in moving forward without the USA (Dube, 2016), while Canadian officials suggested that, given the way the accord was designed, it would be difficult to do so (Baliño, 2017).

The world trade system has become increasingly complex in recent years. The uncertainly that now surrounds the TPP is making it more so. In the last decade, an increasing number of mega-regional trade agreements (MRTAs) have been negotiated, such as the TPP and the Transatlantic Trade and Investment Partnership (TTIP), the latter of which was considered to be a continuation of the trend in regional cooperation that began, in the mid-1990s, with the USA and the EU as the driving nations. These regions wanted to maintain a decisive say in the rules that were applicable to trade and investment in the twenty-first century. Moreover, these initiatives of the USA and the EU could also have been responses to the perception of the inefficiency of policymaking, at the multilateral level, under the World Trade Organisation (WTO); they could also be seen as efforts to temper the emergence of China (World Economic Forum, 2014, p. 7).

MRTAs have specific characteristics that distinguish them from more traditional trade agreements (which would only involve tariff elimination). MRTAs imply a deep integration among countries or regions and cover several topics, such as temporary entry of workers, state-owned enterprises, cooperation and capacity building, competitiveness and business facilitation, development, small- and medium-sized enterprises and regulatory coherence.

The WTO, and its periodic rounds of multilateral negotiations, has served to reduce import tariffs to relatively low levels. Policymakers have now become interested in the potential effects of a different trade policy instrument, namely, the non-tariff barrier (NTB), which has become an important issue in trade negotiations. NTBs somehow reflect a heterogeneous group of requirements, procedures and regulations that affect the businesses environment. In

this chapter, we pay special attention to the impact of potential reductions in NTBs under the TPP.

Only a few previous studies have comprehensively evaluated the effects of the TPP (Oduncu et al., 2014; Cororaton and Orden, 2015; Lee and Itakura, 2014; Petri et al., 2012; Petri and Plummer, 2016; Ciuriak et al., 2016; USITC, 2016). However, most of them focus on the impact on the USA, and several do not include the effects of NTB reductions (Cheong, 2013; Cheong and Thongzon, 2013; Narayanan and Sachin, 2014; Xin, 2014; Masudur and Arjuman, 2015). This chapter aims to address these gaps in the literature.

We analyse what could have been the potential economic impact of the TPP for an upper-middle income economy, namely Mexico, while also covering the impact for the USA. We address the following questions: Would the TPP lead to an increase or a drop in overall production? Which sectors would gain, and which would lose? How would the agreement affect sectoral, aggregate trade flows and macroeconomic aggregates (i.e. for GDP, welfare and wages)? To this end, we use a computable general equilibrium (CGE) model. This has become the most commonly used methodology for economic institutions that assess the impact of trade agreements. It can quantify the effects of a shock in the economy as a whole, and in economic relationships across sectors. Indeed, in a CGE model, the macroeconomic figures arise from the aggregation of the outcomes that take place across sectors (see, Latorre, 2013, 2012, for more details). We, thus, offer a rich set of consistent micro- and macro-economic results on the impact of the TPP.

The chapter is organized as follows. The next section presents an overview of the TPP. Section 3 provides a description of the model. In Section 4, the data and simulations are explained. In Section 5, we analyse the micro- and macro-economic effects. Section 6 offers the main conclusions. An appendix closes the chapter with a sensitivity analysis.

## 2. The trans-pacific partnership agreement

The TPP was created as an expansion of the Trans-Pacific Strategic Economic Partnership and was signed, on October 5, 2015, by 12 countries: Malaysia, Singapore, Brunei, Vietnam, Japan, Australia, New Zealand, Chile, Peru, the USA, Canada and Mexico.

This agreement is recognized by the Asia Pacific Economic Cooperation (APEC) forum, as one among other pathfinders, for a comprehensive free trade area of the Asia Pacific (FTAAP) (Devadason, 2014); the TPP is also considered to be the potential vehicle for establishing a vision for economic cooperation in the trans-pacific region (Barfield, 2011)[1]. This is because the TPP includes tariff and quota reductions, regulatory standards, a judicial agreement on dispute resolution and minimum standards on labour and the environment competition policy, public procurement and regulatory convergence. Moreover, the agreement allows for further membership expansion, through its accession clause. For a detailed and succinct discussion of these issues, see Hufbauer and Cimino-Isaacs (2015).

The TPP encompasses one of the most dynamic economic regions in the world. It represents 36 percent of global GDP and around 25 percent of international trade (Table 1), according to the most recent data available in World Development Indicators (World Bank, 2016).

This agreement could allow Mexico to strengthen its position in the US market, and to consolidate itself as a strategic centre of production and the bridge between North America and the Pacific Alliance. While, Mexico's production structure is highly linked to the USA, the TPP would also imply that Mexico could gain access to export markets in other TPP members, such as Japan. On the other hand, if Mexico does not integrate into the TPP, and other countries along the Pacific Rim do, then it will lose its competitiveness in the trans-Pacific region.

[1] APEC views itself as an "incubator" for an eventual Free Trade Area of the Asian-Pacific (FTAAP). Therefore, they support the TPP (Kuriyama, 2011).

New projections show that Mexico and Central America are now in a good position to lead the Latin American region. Mexico's recent diversification into the manufacturing of sophisticated electronics and its growing automobile industry mean that it is poised to, quite literally, regain its role as the economic engine of Latin America (Hausmann et al., 2011).

According to Petri et al. (2012), Mexico would substantially benefit from the TPP. Gains from membership are mainly attributable to the creation of new markets, especially due to the presence of Japan. The income gain alone could be by as much as US$21bn by 2025, (i.e. a one percent change from the baseline[2]). This increase, although remarkable, is not predicted to be larger because many of the trade flows that are related to the TPP are already covered by high-quality free trade agreements (FTAs). Petri and Plummer (2016) estimate a 0.6 percent rise in Mexico's income gain by 2025.

Lee and Itakura (2015) evaluated the welfare and sectoral output effects of the TPP, under various scenarios. They derived that Mexico's welfare will increase slightly in the range of 0.44 to 0.86 percent from the baseline, while considering the elimination of non-tariff barriers (NTBs) on services, a reduction of 20 percent on logistics time in merchandise trade and the exclusion of rice from trade liberalization. Mexico's welfare gains range from 0.87 to 2.79 percent in scenarios in which these researchers added a productivity gain, other trade cost reductions and Japan's agricultural policy reforms.

Ciuriak et al. (2016) estimate that Mexico's GDP would increase by only about 0.006 percent, in 2018, generating an economic welfare loss close to US$35m. In 2025 and 2035, its GDP will increase by only about 0.01 percent and 0.008 percent respectively, while welfare will fall by around US$286 and US$854, respectively, over the same period. With such small GDP increases, that welfare may even fall. Ciuriak et al. (2016) consider that the TPP does not have the mechanisms to elicit significant regulatory harmonization. Thus, they apply lower tariff and NTB reductions than the ones considered in other analyses.

[2]See, Table 4.1 and Table 2 in Petri and Plummer (2016, p. 41 and p. 20).

## 3. The model

The effects of the TPP are estimated, using a multi-region and multi-sector CGE model of the world economy namely the Global Trade Analysis Project (GTAP) model (Hertel and Tsigas, 1997). CGE models describe different parts of an economy and how these parts interact simultaneously with each other. CGEs are based on the efficiency-maximizing behaviour of firms and the utility-maximizing behaviour of consumers.

We estimate the results using an extension of the GTAP model that includes NTBs. We focus on the short-run impact of a partial implementation of the TPP, thus avoiding any assumptions about future behaviour. This contrasts with the analyses of Petri et al. (2016; 2012), Ciuriak et al. (2016), Lee and Itakura (2015) and USITC (2016), all of whom concentrate on the impact of a fully developed TPP in the long run, without generally discussing any short-run effects[3].

The GTAP specifies all economic relationships in mathematical terms and puts them together in a form that, when calculated, predicts the changes in variables, such as prices, output and welfare, that are caused by economic policy shocks.

A central feature of the approach in this chapter is the simulation of reductions in NTBs. The continual decrease in tariff rates has increased the relative importance of NTBs (both as trade protection and regulatory instruments) and their potential to reduce the benefits of tariff liberalization (Fugazza and Maur, 2008). According to UNCTAD (2005), the number of countries using NTBs increased from 52 in 1994 to 97 in 2004.

The most straightforward way to model an NTB is to treat it as a "tariff equivalent" (Adriamananjara et al., 2003). This implies that the existence of NTBs increases the costs of

[3] The USITC study focuses on the effects for the USA, without presenting them for Mexico. One interesting feature of the studies of Petri and Plummer (2016), Petri et al. (2012), Ciuriak et al. (2016) and USITC (2016) is that they deal with foreign direct investment (FDI). Very few CGE models include multinationals and FDI, due to the complexity of this issue. Nonetheless, other exceptions are Latorre and Yonezawa (2018) for the analysis of the TTIP, Balistreri et al. (2015) and Latorre (2016) for its impact on development, and Latorre and Hosoe (2016) and Gómez-Plana and Latorre (2014) for the neglected issue of reductions in FDI.

importing goods, and that this scenario can be modelled similarly to the way in which we deal with tariffs. However, unlike tariffs, NTBs do not provide revenues to governments. By contrast, the wedge between the world price and the domestic one created by an NTB may result in economic rents but also trade inefficiencies. Rents are generated because NTBs reduce competition from other firms and allow inefficient firms to increase their prices. On the other hand, if NTBs create red tape or other unjustified bureaucratic processes, they cause a waste of resources. Unfortunately, it is difficult to obtain the exact share of rents and inefficiencies attributed to NTBs for all sectors across countries. Therefore, we follow the approach of Petri and Plummer (2016), as will be explained below.

The USA is a large economy with high bargaining power. By comparison, Mexico is a relatively smaller, open economy. Trade theory shows that tariffs result in an unambiguous welfare loss (Baldwin and Freund, 2011). However, the analysis is more complex in the multilateral context of a preferential agreement, when both the USA and Mexico apply trade liberalization with more than two signatories. In this case, a country could face a "trade-creation" or "trade-diversion" effect, due to the discriminatory tariff liberalization of the TPP (i.e. because tariffs are reduced only with respect to the trading partners that have signed the agreement and not to the rest of the trading countries outside the agreement). The trade-creation effect occurs when a country shifts its import demand from the high-cost partner to the low-cost partner, thus leading to a welfare improvement. The trade-diversion effect occurs when trade liberalization reduces imports from the most-efficient country while increasing them from the high-cost country, not because of reasons of efficiency but due to the lower tariffs. Trade diversion would, therefore, reduce the welfare of the country that has signed the preferential trade agreement. The idea is that for preferential trade agreements to be beneficial, imports should increase from the most efficient partner and not from the high cost countries that are becoming more competitive, exclusively due to tariff or NTB reductions.

Despite the increasing complexity of the analysis of the effects of preferential trade agreements (PTAs) on small economies, relatively few theoretical studies have addressed this issue. Some exceptions include Park, (2000), Limão and Saggi (2013) and Bagwell et al.

(2007). However, while all of these studies highlight the special small-economy case, none analyses the PTA effect on small economies in a multi-regional framework.

## 4. Data and simulations

The database for micro- and macro-economic variables and the model's input-output framework come from the GTAP 9 data set for 2011 (Aguiar et al., 2016).

Table 2 presents the details on the sectors used in the model and Mexico's GDP, capital and employment structure. The first column shows the abbreviation for each sector. The second column provides further details regarding each sector's composition.

The service sector, as a whole, accounts for 66.7 percent of Mexico's GDP. Within this sector, social services and trade-transport are the most important activities, with GDP shares of 26.97 percent and 19.30 percent, respectively. Utilities, communication and finance are less important. Regarding the goods-producing industries, durables manufacturing is the most important and accounts for 14.29 percent of GDP. Most Mexican labour is employed in social services, trade transport and durable manufacturing. Therefore, a decline in production in these sectors would, a priori, have a larger effect on national employment and wages than would production reductions in other sectors.

Table 3 offers more details on these sectors. Column 1 shows the intermediate demand structure, in which primary products, non-durable manufacturing and trade transport account for the largest shares (50.60, 16.07 and 9.76 percent, respectively).

With regard to private consumption (column 2), the most important sectors are social services, trade transport and non-durable manufacturing, whose shares are 30.49; 23.69 and 23.32 percent, respectively.

Durable manufacturing is, by far, the largest sector in terms of Mexico's imports and exports. It accounts for 53.24 and 66.84 percent of the country's aggregate imports and exports

(columns 5 and 6). Further, in this sector Mexico is highly dependent on world markets, as 59 percent of its overall production is exported, and 51.36 percent of its domestic demand relies on imports (columns 7 and 8). For instance, metal household goods, manufactured goods, automobiles, photographic equipment and petroleum products are at the top of Mexican exports. While the most important Mexican imports are metalworking machinery, steel products, agricultural machinery, electrical equipment, car parts for assembly, repair parts for motor vehicle parts and aircraft and aircraft parts. Primary products and non-durable manufactured goods also make important contributions to Mexican exports, with 15.55 and 11.81 percent shares, respectively (columns 5 and 6). As can be seen, the bulk of trade is concentrated in manufacturing, with service sectors playing a much smaller role. This is consistent with the world's overall trade patterns. Latorre and Yonezawa (2018) show that for the world economy, manufacturing goods account for 80 percent of total trade.

It is important to highlight that once NTBs and tariffs decrease, the impact on production and labour demand outcomes will depend on the orientation of the sectors that are directly related to exports and domestic demand, as is shown in previous analyses (Zhou and Latorre, 2014a; 2014b) and as will be analysed below.

With respect to NTBs, we use the same bilateral NTBs as Petri and Plummer (2016)[4]. As a first step, they estimated that only three-quarters of existing NTBs could be reduced in the TPP, as the rest of the NTBs are considered to be quality-increasing regulations. Moreover, they assume that only 50 percent of the NTBs on services and 75 percent of those in goods are "actionable"[5]. The rest are beyond the reach of politically viable trade policies. Combining these assumptions, the actionable portion of NTBs is 56.3 percent for goods and 37.5 percent for services.

They simulate a small ratio of the overall 56.3 and 37.5 percent reductions in NTBs that are projected to be gradually taking place, year by year, over the period 2015 to 2030. This is

[4] These authors collected information on NTBs on services from Fontagné et al. (2011) and for the goods sectors from Kee et al. (2009).
[5] According to Petri and Plummer (2016), all these percentage reductions are based on textual analyses of trade agreements and expert analyses.

relevant for the comparison of our results with the ones of Petri and Plummer (2006). Our study concentrates on the short-run impact of the TPP; therefore, we simulate a smaller reduction in NTBs. In fact, we only simulate the reductions that are estimated to take place for the first five years, from 2015 to 2020, which is, therefore, only 5.6 percent of Mexico's total NTBs on goods and services[6].

Regarding NTBs and the impact on trade inefficiencies and economic rents, we also follow Petri and Plummer's (2016) assumptions and divide the impact of NTBs equally between trade inefficiencies and rents[7].

Our model has three regions, so the rest of the TPP members are included in the region labelled "Rest of the World" (ROW)[8]. Because of this, we calculated an average of the bilateral NTBs by sector, between Mexico and ROW, and between the USA and ROW. This permits us to capture the potential effects on trade diversion and creation. The share of each geographical origin and destination in Mexico's import and export sectors is multiplied by their corresponding bilateral NTBs, and thus, we obtain "weighted bilateral NTBs by sector[9]". The latter are shown in Table 4.

We analyse the following scenarios:

*Tariffs*: complete elimination of import tariffs and export tax/subsidies
*NTBs*: non-tariff measures reductions
*Total*: complete elimination of import tariffs and export tax/subsidies, combined with reductions in NTBs (i.e. simultaneous reductions in tariffs and NTBs)

[6] Reductions by sector appear in Table 5 below.
[7] There are no other estimates available. Furthermore, by adopting their approach, we can put our results in perspective with what they obtain.
[8] The inclusion of several regions, in a unique ROW region, is a very common practice in CGE modelling. It allows us to simplify the analysis and the exposition of results.
[9] Because, in our model, one of the NTBs is applied to flows coming from the ROW, which consists of TPP members and other non-TPP members, the reductions in the NTBs amount to only a fraction of the reductions in the NTBs agreed to in the TPP. That fraction is based on the shares of trade flows coming from TPP members to overall flows coming from the ROW, on a sector-by-sector basis.

Because we estimate the performed short-run impact (and not the full implementation) of the TPP, Table 5 shows the exact cost savings, in imports, that are related to the three scenarios we have just explained. The data are separated by type of instrument, namely, tariffs, subsidies and NTBs, as well as the total.

The three-dimension bars of Table 5 suggest that protection (either through tariffs or NTBs) tends to be larger on non-durable manufactured goods than on durable manufactured goods. This reflects a global trend. As many countries need to import the machinery, they are unable to produce, they tend to not increase the price of the imports that are necessary for production.

Exports of primary products, and non-durable and durable manufactured goods, from the USA to Mexico, face larger cost savings (with totals of 1.27, 2.46 and 1.26 percent, respectively) than do the same Mexican exports to the US market (with totals of 0.8, 1.5 and 0.3 percent, respectively). These cost savings are related to NTBs, as NAFTA has practically eliminated tariffs between the USA and Mexico.

Regarding non-durable manufactured goods exports, the rest of the TPP's members face total cost savings of 5 percent, compared to the total cost savings of just 1.1 percent experienced by Mexican exporters in the rest of TPP members. In the bilateral relationship between ROW and Mexico, tariffs on manufactured goods are more important than NTBs are.

In general, the cost savings estimated for the TPP are rather limited. As mentioned above, many TPP partners already have trade agreements among themselves. The low level of barriers to trade, under these other agreements, becomes particularly clear when they are compared to the estimations of the barriers in the TTIP. For example, Latorre and Yonezawa (2018, Table 1) provide the cost savings in exports for the TTIP. For all the sectors, these cost savings are more than double than the ones presented for the TPP, on Table 5, except for construction[10].

[10] However, our lower barriers are also related to the fact that we simulate the short-run impact and, therefore, assume only a partial implementation of the agreement.

The lower the reductions in barriers are, the smaller the increase in trade flows will be. Accordingly, with small changes in trade flows, production and labour demand will also adjust less across sectors. Let us turn to the analysis of how this causality works among all these economic variables.

## 5. Results

This section examines what would have been the effects for Mexico of the original TPP that was signed in October 2015.

### 5.1 Aggregate results

#### 5.1.1 Gross domestic product, wages and welfare

Table 6 presents the evolution of GDP, wages and welfare for the scenarios of reductions in tariffs, NTBs and their "total" in Mexico. The increase in national income is a proxy for the increase in welfare, which is technically called the "Hicksian equivalent variation[11]". The results reflect an aggregation of all the earlier-described sectoral outcomes. Being able to come up with results across sectors and regions also shows why a CGE model is said to be consistent at the micro- and macro-economic level.

We present the impact for the three regions. In Mexico, tariffs reductions would lead to a small loss in GDP of 0.02 percent. This decrease can be explained by the decrease in the output of non-durable manufactured goods, trade transport, construction, communication and social services, which all account for 64.60 percent of Mexico's GDP. Further, these sectors employ 73.95 percent of the Mexican work force. Consequently, there is a decrease in wages and private consumption. Welfare is also reduced by 0.11 percent, in Mexico, after tariff reductions. As we have seen in the microeconomic results, tariff reductions lead to a

[11] The equivalent variation measures how much extra income a country would require, without the TPP, to undertake real expenditures made after the TPP. This measure provides a precise evaluation of welfare because both income and prices change after the TPP.

reduction in trade flows between the USA and Mexico. Hence, the increase in both countries' aggregate exports and imports is a response to these countries' stronger integration with ROW. For Mexico, tariff reductions would lead to a "trade-diversion" effect. In fact, the model shows that Mexico would divert its goods imports from the USA by substituting them with imports from the less-efficient members of the TPP agreement. This would negatively affect Mexico's welfare.

By contrast, the reduction in NTBs leads to trade-efficiency gains (i.e. more trade with the USA), which results in overall increases in production, as we have seen in the sectoral results. Thus, there is an increase in Mexico's GDP of 0.19 percent and in welfare of 0.14 percent. Comparing the impact of tariff elimination with the decrease in NTBs, we can see that the reduction in NTBs is the more important element of the agreement. Therefore, in the study of the overall impact of the agreement, the "total" scenario tends to reflect the impact of the NTB scenario.

While it is easier to understand our results for Mexico, given our previous analysis, we see that the USA does not derive any negative impact from either the elimination of tariffs or NTBs. As a result, since all the elements of the TPP agreement positively contribute to its positive impact in the USA, welfare and wages increase more in the USA than in Mexico. However, this is not the case for GDP. In the "total" scenario, GDP would increase slightly more in Mexico (0.16 percent) than in the USA (0.11 percent). As will be noted in the next section, the harmful impact of tariff elimination in Mexico takes place in sectors, such as non-durable manufactured goods, construction and social services, which employ important shares of labour. Therefore, it turns out that wages and national income, in Mexico, are more negatively affected than GDP is.

Finally, in general, our estimations are consistent with previous studies. Recall that we use the same original NTBs of Petri and Plummer (2016) but cut them by less because we estimate the short-run impact. As a consequence, our effects are smaller, compared to the one percent increase in the GDP of Mexico and the 0.50 percent increase of GDP in the USA, after full implementation of the agreement, as derived by Petri and Plummer (2016). Ciuriak

et al. (2016) estimated very small gains of 0.01 percent in Mexico's GDP and a 0.03 percent gain in GDP for the USA. This is considerably below ours results because they simulate lower NTBs reductions than the ones of our study and of Petri and Plummer (2016). The comparison with the results of Lee and Itakura (2014) is more difficult, as they estimate other extra scenarios, such as productivity gains and reductions in logistics time in trade. In any case, their long-run results are larger than we obtained, because they computed full NTBs reductions, which lead to larger percentage impacts than the ones we derived.

## 5.2 Sectoral results

### 5.2.1 Production, trade flows and labour demand.

The main sectoral effects are shown in Table 7, which is divided into an upper and a lower part. On the top, there are four blocks of columns, presenting the evolution of output, labour demand, exports and imports. At the bottom, the four blocks offer the bilateral details of Mexico's imports and exports from and to the USA and ROW. In each of the blocks, the results are shown for the scenarios of "tariffs", "NTBs" and the "total", which combine both types of trade barriers.

As regards tariffs, the most remarkable result is the decrease in the production of non-durable manufactured goods. This would be related to an increase in the imports of non-durable manufactured goods coming from ROW, due to the elimination of an import tariff of 4.71 percent on these goods coming from ROW to the Mexican market. The tariff reduction results in more import competition, which reduces the production of these goods in Mexico.

This is also related to the fact that the US tariff for imports coming from ROW (2.42 percent) is larger than the one faced by US imports coming from Mexico (0.06 percent). As a result, ROW would have gained more competitiveness than Mexico in the US market. In fact, Mexico would have considerably reduced its exports of non-durable manufactured goods to the USA (4.06 percent). Additionally, in Mexico, real income is reduced after the elimination of these tariffs. This pushes down production in social services, which account for an important share of private consumption (Table 2).

On the other hand, durable manufactured goods are the sector that experiences the largest increase in output. As mentioned above, durable manufactured goods are highly dependent on the world market. Thus, this sector's output increases because Mexican exports exceed its imports (the change in Mexican exports in this sector, in absolute value, is US$2380m, compared to the US$1241m change in imports). Mexican exports of products produced in this sector increase due to the cost savings of 1.10 percent in ROW.

As regards the impact of NTBs, production in the primary sector decreases by 0.20 percent. This result is a rather indirect effect for Mexico. The US NTBs faced by ROW decrease by 1.70 percent. This will result in an increase in ROW exports to the USA, which crowds out Mexican exports going to the USA.

As in the simulation on tariffs, non-durable manufactured goods output also decreases, but now only by 0.06 percent. With the reduction in NTBs, the cost savings for the Mexican exports in the USA are larger than the cost savings that come from the actual tariff reductions (1.40 vs 0.06 percent), thereby pushing up exports in this sector.

With NTBs reductions, national income goes up and, thereby, an increase in the demand for services and services production. Some exceptions are finance, business and social services. With respect to the first two sectors, there are higher cost savings in Mexico than in ROW and the USA (finance exports face cost savings in the range of 1.10-1.31 percent, in Mexico, vs 0.10-0.50 percent, in ROW or the USA). As a consequence, imports coming from the USA and ROW to Mexico increase, while Mexican exports lose their competitiveness and decrease, thereby further depressing finance and business production in Mexico. Thus, now that the NTBs are reduced, foreign competition increases.

For Mexico, the simultaneous reduction in tariffs and NTBs (i.e. "total") bring about an increase in the production of durable manufactured goods, trade transport, construction, and utilities. For most sectors, the effects of NTBs tend to prevail over the effects of tariffs. We now turn to an analysis of labour demand. It is easy to check that it follows the evolution of

production, which has just been explained. This is because capital is sector-specific[12], while labour is fully mobile. In other words, changes in production can only be obtained by changes in labour demand in our short-run analysis.

Overall, we see that the elimination of NTBs generates a very small increase in aggregate production, in Mexico, of 0.03 percent. The same applies to tariffs, which also leave aggregate production basically unaffected (0.01 percent). These small impacts are understandable, given the fact that aggregate imports and exports, in Mexico, experience increases of around 2 percent in the overall scenario.

To sum up, the impact of the TPP varies across sectors and scenarios (tariffs vs. NTBs). However, one pattern clearly emerges. Among the sectors most exposed to trade, non-durable manufactured goods lose slightly, while the production of durable manufactured good gains a little in all scenarios. This is related to the fact that the production of non-durable manufactured goods is more protected than is the production of durable ones. Fortunately, durable manufactured goods production employs more workers and accounts for a larger share of GDP than non-durables.

Furthermore, looking at the total bilateral trade flows between Mexico and the USA and ROW, another important pattern becomes clear. After tariffs reductions, Mexico becomes more integrated with ROW and less integrated with the USA. Both its imports and exports with ROW increase significantly, by 7.13 and 7.50 percent, respectively. By contrast, Mexico's imports from and exports to the USA fall by 4.05 and 1.36 percent, respectively, and both areas increase their trade with ROW once the larger tariffs, with respect to ROW, are eliminated. This implies that after tariff elimination, there is a trade-diversion effect between the USA and Mexico, while trade increases between Mexico and ROW. Because the USA is a high-efficiency trade partner, it will become clear, in our aggregate outcomes, that this reduces both welfare and GDP in Mexico.

[12] When capital is sector specific, it can only be used in a particular sector and cannot move across sectors. This assumption is appropriate for short-run estimations.

The story is the reverse when we analyse NTB reductions. In this case, there is scope for the USA and Mexico to increase their integration. Because NAFTA does not cover NTBs, these are still high in North America compared to ROW. As a result, when NTBs are reduced, trade flows between the USA and Mexico increase. Mexican bilateral trade with the USA increases by 1.77 percent for exports and 2.45 percent for imports. By contrast, Mexican bilateral trade with ROW decreases by 1.22 percent for exports and by 1.08 percent for imports. Thus, for Mexico, after NTB reductions, there is a trade-creation effect with the USA and trade diversion with respect to ROW. This will result in overall welfare improvement for Mexico, as will be seen below.

The combination of both tariff and NTBs reductions leads to increases in aggregate Mexican imports and exports. In the case of exports, our findings show that these would increase for Mexico in terms of its trade with both ROW and the USA. But, in the case of imports, while imports from ROW would increase imports coming from the USA would decrease.

## 6. Conclusions

In this chapter, we have described the economic effects of the original TPP. Our analysis focused on the case of an upper-middle-economy, namely, that of Mexico. Thus, unlike other studies, we do not concentrate on the impact of the TPP on the USA, even though we also offer several estimations for this economy. We estimated the quantitative impact of the TPP by means of a CGE model. In particular, we investigated how a reduction in tariffs and NTBs affects a broad set of micro- and macro-economic variables in Mexico.

Regarding sectoral benefits, the TPP could improve production in the durable manufactured goods sector. This is the largest manufacturing sector in terms of GDP and employment shares. By contrast, the non-durable manufactured goods sector faces negative effects in all the scenarios due to increased competition from the imports of the rest of the TPP members and the USA. The non-durable manufactured goods sector is protected by one of the largest tariffs (around 4.71 percent) and NTBs (2.16 percent) of Mexico. When they are eliminated or reduced, due to the TPP, Mexican production in this sector falls.

Our results suggest that both GDP and welfare in Mexico would be negatively affected if tariffs were lowered (0.02 and 0.11 percent, respectively). This is because of a trade-diversion effect on Mexico, which would result in lower imports of goods from the USA. Tariffs between the USA and Mexico are already very low due to NAFTA. When they are further reduced, both the USA and Mexico become more integrated with the rest of the TPP members with whom they experience larger tariff reductions. By contrast, a reduction in NTBs would lead to a higher integration of Mexico with the USA, thereby increasing Mexico's welfare and GDP by 0.14 and 0.19 percent respectively. Because NAFTA does not cover NTBs, these trade barriers remain relatively high between Mexico and the USA. As a result, when they are lowered, the USA and Mexico become more integrated, while their trade with the rest of the TPP members declines. This differential impact of tariffs compared to NTBs implies that it is important to analyse both trade instruments to evaluate the impact of new trade agreements, such as the TPP.

Our joint estimate of tariffs and NTBs suggests that if the TPP agreement had been ratified by the USA, the Mexican economy would have benefited only slightly. At the macroeconomic level, Mexico could have experienced an increase in GDP (0.16 percent), welfare (0.03 percent) and wages (0.06 percent). This could have helped it reach an annual GDP growth rate of 2 percent, as the World Bank (2017) projections suggest that Mexico will expand at an annual rate of 1.80 percent in 2017. This small rate of growth of GDP and welfare is related to the already existing preferential trade agreements Mexico has signed with several TPP members. Another reason for the reduced impact obtained from reductions in tariffs and NTBs is that we estimated only the short-run effects. This means that we do not model the impact of a full implementation of NTB reductions, as other studies have done. In that sense, our results are consistent with the estimates of Petri and Plummer (2016) and Lee and Itakura (2015).

Unlike Mexico, for the USA, reductions in both tariffs and NTBs would yield positive effects on GDP and welfare. US GDP could be 0.11 percent higher, and welfare and wages would increase by around 0.26 and 0.89 percent, respectively. Hence, the TPP would not be a "potential disaster" for the USA, as was noted by the US president. Under the TPP, Mexico

would have become more integrated with ROW than with the USA due to its remarkable increase in imports from and exports to the former. This result is consistent with the findings of Petri et al. (2012), in which Mexico's gains are attributed to the creation of new markets, especially in Japan. Therefore, if the agreement can move forward without the USA, Mexico could reinforce its relationship with the other TPP members and take advantage of part of the potential benefits of the agreement. In other words, Mexico could export to ROW, without competing with the USA, and could import from ROW goods produced by the TPP's most efficient members, such as Japan, due to the fact that the USA market would keep its trade barriers intact. However, our analysis also shows that a reduction in integration with the USA economy is not positive for Mexico. A diminished trade with an efficient partner, such as the USA, may be welfare-diminishing for Mexico.

Finally, possible future extensions of this model consist of the introduction of the impact of foreign direct investment. If we had included this, very probably, the impact would have been larger for the USA and Mexico than the one we have obtained.

**Appendix**.

## A1. Sensitivity analysis

Table A1 presents the results for an unconditional systematic sensitivity analysis. Following Harrison et al. (1993), each of the elasticities have been varied, one by one, while keeping the rest fixed at their initial level. To simplify, this analysis includes the strongest possible impact of the TPP (NTB and tariff reductions, simultaneously) and focuses on the effects for GDP, welfare and aggregate imports and aggregate exports, in the three regions considered.

The first column shows the different elasticities considered in this analysis. The elasticity of substitution between labour and capital reflects how easy it is to substitute labour and capital in the production of different sectors in an economy. The results are quite robust to changes in elasticity.

The Armington substitution among imports and domestics goods, between regions, reflects the feasibility with which consumers and producers can choose between imported varieties and domestic products. The largest values of this elasticity imply that they are more interchangeable. However, the Armington substitution among imports by origin shows how easy it is to change the source of the imported varieties.

Different specifications for the Armington elasticities affect the outcomes for the USA and Mexico. Larger values of the elasticity of substitution among imports and domestic production lead to larger increases in GDP, welfare and export and import flows. In other words, a higher value for this elasticity enhances the TPP impacts. By contrast, smaller values would make it more difficult to perceive benefits for the overall positive impact for the TPP because it reduces trade flows.

If the elasticity of substitution among imports from different origins is larger, then we obtain a smaller increase in GDP and even a decrease in Mexico's welfare. This can be explained by trade diversion. We have already seen that in the tariff-reduction scenarios, the outcomes for Mexico were negative.

Overall, the results suggest that the positive outcomes for the TPP derived for the US economy are more robust to different elasticity specifications than are the ones for Mexico or ROW. For welfare, some changes in the elasticities could lead to negative impacts for both Mexico and ROW, and, for all elasticities, GDP turns out to be positive in both Mexico and ROW.

## Tables

**Table 1.** GDP, population, exports and imports (2015)

| Country | GDP (current US$billion) | GDP per capita (current US$) | Population (million) | Exports of goods and services (current US$billion) | Exports of goods and services (% of GDP) | Imports of goods and services (current US$billion) | Imports of goods and services (% of GDP) |
|---|---|---|---|---|---|---|---|
| Australia | 1,454.68 | 61,995.83 | 23.46 | 304.09 | 20.90 | 311.27 | 21.40 |
| Brunei Darussalam | 17.10 | 40,979.64 | 0.42 | 12.14 | 70.98 | 6.10 | 35.66 |
| Canada | 1,783.78 | 50,185.48 | 35.54 | 564.68 | 31.66 | 581.51 | 32.60 |
| Japan | 4,596.16 | 36,152.69 | 127.13 | 815.52 | 17.74 | 958.44 | 20.85 |
| ***Mexico*** | ***1,297.85*** | ***10,350.81*** | ***125.39*** | ***419.38*** | ***32.31*** | ***433.26*** | ***33.38*** |
| Peru | 202.86 | 6,549.39 | 30.97 | 45.45 | 22.41 | 48.60 | 23.96 |
| United States | 17,348.07 | 54,398.46 | 318.91 | 2,341.93 | 13.50 | 2,871.93 | 16.55 |
| Chile | 258.73 | 14,566.15 | 17.76 | 86.46 | 33.42 | 84.16 | 32.53 |
| Vietnam | 186.20 | 2,052.32 | 90.73 | 160.89 | 86.40 | 154.79 | 83.13 |
| Malaysia | 338.10 | 11,307.06 | 29.90 | 249.68 | 73.85 | 218.45 | 64.61 |
| Singapore | 306.34 | 56,007.29 | 5.47 | 588.52 | 192.11 | 513.63 | 167.66 |
| New Zealand | 200.14 | 44,380.43 | 4.51 | 55.98 | 27.97 | 54.57 | 27.26 |
| Total TPP | 27,990.01 | 34,547.20 | 810.20 | 5,644.73 | 20.17 | 6,236.70 | 22.28 |
| ***Share of TPP/ World*** | ***35.84*** | | ***11.16*** | ***23.77*** | | ***27.02*** | |
| World | 78,088.52 | 10,754.84 | 7,260.78 | 23,751.19 | 30.35 | 23,082.04 | 29.82 |

Source: World Bank (2016)

**Table 2.** Sectors definitions and Mexico GDP structure and factor employment (2011)

| Sector | | Industry GDP ($US mill.) | Industry shares in GDP | Industry shares in factor employment | |
|---|---|---|---|---|---|
| | | | | Labour | Capital |
| Primary products | Grains, Other agriculture, Mining | 106,706.76 | 9.12 | 6.30 | 4.67 |
| Non-durable manufacturing | Food, Beverages, Tobacco, Textiles, Apparel, Footwear, Chemicals, Other manufacturing | 115,720.04 | 9.89 | 7.62 | 9.66 |
| Durable manufacturing | Metals, Transport equipment, Computers and Electronics, Machinery, Other manufacturing | 167,155.37 | 14.29 | 12.51 | 15.00 |
| Utilities | Electricity, Gas manufacture, and distribution, Water. | 11,477.82 | 0.98 | 0.74 | 0.72 |
| Construction | Construction | 72,713.86 | 6.21 | 8.24 | 6.08 |
| Trade-Transport | Trade, Water and Air transport. | 225,843.00 | 19.30 | 16.80 | 23.49 |
| Communication | Communications | 26,146.00 | 2.23 | 1.83 | 2.42 |
| Finance | Financial services | 35,034.80 | 2.99 | 2.84 | 3.23 |
| Business Services | Business services | 93,709.15 | 8.01 | 8.55 | 8.81 |
| Social Services | Recreational, Public Administration, Defense, Education, Health. | 315,578.85 | 26.97 | 34.57 | 25.92 |
| **Total** | | **1,170,085.65** | **100.00** | **100.00** | **100.00** |

Source: Authors' estimations based on GTAP 9 data base.

**Table 3.** Sectoral information of the Mexican economy

| Sector | Commodity shares in: | | | | | | Import share of domestic consumption | Export share of domestic production |
|---|---|---|---|---|---|---|---|---|
| | Domestic demand | | | | Trade | | | |
| | Intermediate demand | Private consumption | Government consumption | Investment demand | Imports | Exports | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Primary products | 50.60 | 5.53 | 0.00 | 3.96 | 14.03 | 15.55 | 25.85 | 29.11 |
| Non-durable manufacturing | 16.07 | 23.32 | 0.31 | 0.02 | 26.96 | 11.81 | 28.28 | 15.85 |
| Durable manufacturing | 4.89 | 8.24 | 0.01 | 31.78 | 53.24 | 66.84 | 51.36 | 59.00 |
| Utilities | 4.73 | 1.07 | 0.00 | 0.00 | 0.07 | 0.04 | 0.59 | 0.41 |
| Construction | 0.37 | 0.02 | 0.00 | 56.44 | 0.03 | 0.30 | 0.07 | 0.68 |
| Trade-Transport | 9.76 | 23.69 | 0.06 | 6.88 | 2.18 | 2.81 | 2.20 | 2.61 |
| Communication | 0.45 | 3.43 | 0.01 | 0.00 | 0.14 | 0.18 | 1.02 | 1.58 |
| Finance | 3.64 | 2.66 | 3.12 | 0.00 | 1.11 | 1.07 | 6.39 | 6.88 |
| Business Services | 8.53 | 1.55 | 1.19 | 0.29 | 0.47 | 0.48 | 1.12 | 1.25 |
| Social Services | 0.96 | 30.49 | 95.31 | 0.62 | 1.78 | 0.92 | 1.51 | 0.87 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **16.97** | **17.77** |

Source: Authors' estimations based on GTAP 9 data base.

**Table 4.** Ad valorem equivalents of NTBs between Mexico, the USA and the rest of TPP members

| Sector | Mexican barriers on imports from USA | Mexican barriers on imports from TPP | USA barriers on imports from Mexico | USA barriers on imports from TPP | TPP barriers on imports from USA | TPP barriers on imports from Mexico |
|---|---|---|---|---|---|---|
| Primary products | 19.75 | 2.42 | 14.40 | 31.00 | 12.36 | 1.37 |
| Non-durable manufacturing | 38.51 | 4.36 | 25.77 | 7.53 | 15.64 | 1.16 |
| Durable manufacturing | 21.08 | 2.29 | 6.05 | 3.93 | 11.24 | 0.71 |
| Utilities | 1.33 | 0.09 | 1.33 | 1.38 | 0.80 | 0.05 |
| Construction | 56.88 | 9.72 | 39.19 | 9.24 | 9.85 | 1.53 |
| Trade-Transport | 16.34 | 1.24 | 3.70 | 3.43 | 6.43 | 0.75 |
| Comunnicaction | 19.40 | 1.06 | 20.44 | 2.62 | 4.88 | 1.61 |
| Finance | 23.40 | 1.90 | 9.70 | 4.80 | 7.74 | 1.24 |
| Business services | 19.16 | 1.86 | 21.48 | 3.59 | 5.84 | 1.02 |
| Social services | 33.80 | 0.69 | 17.94 | 0.79 | 3.91 | 1.07 |

Source: Based on Petri and Plummer (2016)

**Table 5.** Cost Savings related to initial trade barriers (percentages of total import costs)

| Sectors | USA bilateral trade policies to Mexico | | | | Mexico bilateral trade policies to USA | | | |
|---|---|---|---|---|---|---|---|---|
| | Tariff | Subsidies | NTBs | Total | Tariff | Subsidies | NTBs | Total |
| Primary products | 0.01 | - | 0.81 | 0.81 | 0.17 | (0.00) | 1.11 | 1.27 |
| Non-durable manufacturing | 0.06 | - | 1.44 | 1.50 | 0.31 | - | 2.16 | 2.46 |
| Durable manufacturing | - | - | 0.34 | 0.34 | 0.08 | - | 1.18 | 1.26 |
| Utilities | - | - | 0.07 | 0.07 | - | - | 0.07 | 0.07 |
| Construction | - | - | 2.19 | 2.19 | - | - | 3.19 | 3.19 |
| Trade-Transport | - | - | 0.21 | 0.21 | - | - | 0.91 | 0.91 |
| Comunnicaction | - | - | 1.14 | 1.14 | - | - | 1.09 | 1.09 |
| Finance | - | - | 0.54 | 0.54 | - | - | 1.31 | 1.31 |
| Business services | - | - | 1.20 | 1.20 | - | - | 1.07 | 1.07 |
| Social services | - | - | 1.00 | 1.00 | - | - | 1.89 | 1.89 |
| **Sectors** | **ROW (Rest of TPP) bilateral trade policies to USA** | | | | **USA bilateral trade policies to ROW (Rest of TPP)** | | | |
| | Tariff | Export Tax | NTBs | Total | Tariff | Export Tax | NTBs | Total |
| Primary products | 1.42 | 0.02 | 0.69 | 2.13 | 0.03 | 0.05 | 1.74 | 1.81 |
| Non-durable manufacturing | 0.61 | 0.31 | 0.88 | 1.80 | 2.42 | 0.08 | 0.42 | 2.92 |
| Durable manufacturing | 0.61 | 0.36 | 0.63 | 1.60 | 0.50 | 0.31 | 0.22 | 1.03 |
| Utilities | - | - | 0.04 | 0.04 | - | - | 0.08 | 0.08 |
| Construction | - | - | 0.55 | 0.55 | - | - | 0.52 | 0.52 |
| Trade-Transport | - | - | 0.36 | 0.36 | - | - | 0.19 | 0.19 |
| Comunnicaction | - | - | 0.27 | 0.27 | - | - | 0.15 | 0.15 |
| Finance | - | - | 0.43 | 0.43 | - | - | 0.27 | 0.27 |
| Business services | - | - | 0.33 | 0.33 | - | - | 0.20 | 0.20 |
| Social services | - | - | 0.22 | 0.22 | - | - | 0.04 | 0.04 |
| **Sectors** | **ROW (Rest of TPP) bilateral trade policies to Mexico** | | | | **Mexico bilateral trade policites to ROW (Rest of TPP)** | | | |
| | Tariff | Subsidies/Tax | NTBs | Total | Tariff | Subsidies/Tax | NTBs | Total |
| Primary products | 0.04 | (0.0001) | 0.08 | 0.11 | 0.18 | (0.07) | 0.14 | 0.25 |
| Non-durable manufacturing | 1.06 | 0.02 | 0.06 | 1.14 | 4.71 | - | 0.24 | 4.95 |
| Durable manufacturing | 1.10 | 0.10 | 0.04 | 1.24 | 1.09 | 0.00 | 0.13 | 1.22 |
| Utilities | - | - | 0.00 | 0.00 | - | - | 0.05 | 0.05 |
| Construction | - | - | 0.09 | 0.09 | - | - | 5.44 | 5.44 |
| Trade-Transport | - | - | 0.04 | 0.04 | - | - | 0.70 | 0.70 |
| Comunnicaction | - | - | 0.09 | 0.09 | - | - | 0.59 | 0.59 |
| Finance | - | - | 0.07 | 0.07 | - | - | 1.07 | 1.07 |
| Business services | - | - | 0.06 | 0.06 | - | - | 1.04 | 1.04 |
| Social services | - | - | 0.06 | 0.06 | - | - | 0.39 | 0.39 |

Source: Authors' estimations based on Petri and Plummer (2016).

**Table 6.** Impact on GDP, welfare and wages (percentage change).

| GDP | Stemming from: | | Total |
|---|---|---|---|
| | Tariffs | NTBs | |
| USA | 0.03 | 0.08 | 0.11 |
| Mexico | -0.02 | 0.19 | 0.16 |
| ROW | 0.01 | 0.02 | 0.03 |
| **Welfare (percentage of baseline GDP)** | **Stemming from:** | | **Total** |
| | **Tariffs** | **NTBs** | |
| USA | 0.09 | 0.17 | 0.26 |
| Mexico | -0.11 | 0.14 | 0.03 |
| ROW | 0.00 | -0.01 | -0.01 |
| **Wage** | **Stemming from:** | | **Total** |
| | **Tariffs** | **NTBs** | |
| USA | 0.29 | 0.60 | 0.89 |
| Mexico | -0.50 | 0.58 | 0.06 |
| ROW | -0.06 | -0.16 | -0.22 |

Source: Authors' estimations.

**Table 7.** Impact on Mexico's output, exports, imports and labour demand across sectors (percentage change)

| Sectors | Output | | | Labor demand | | | Aggregate exports | | | Aggregate imports | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tariffs | NTBs | Total | Tariffs | NTBs | Total | Tariffs | NTBs | Total | Tariffs | NTBs | Total |
| Primary products | 0.10 | -0.20 | -0.09 | 0.3 | -0.6 | -0.28 | -0.02 | 0.11 | 0.14 | -0.74 | 1.27 | 0.52 |
| Non-durable manufacturing | -0.37 | -0.06 | -0.43 | -1.21 | -0.19 | -1.42 | 2.17 | 4.65 | 6.50 | 2.12 | 2.49 | 4.51 |
| Durable manufacturing | 0.38 | 0.01 | 0.39 | 1.22 | 0.02 | 1.24 | 1.00 | 0.76 | 1.75 | 0.70 | 1.20 | 1.87 |
| Utilities | 0.00 | 0.08 | 0.08 | 0.01 | 0.21 | 0.22 | 2.15 | 0.91 | 3.05 | -1.01 | -0.39 | -1.37 |
| Construction | -0.05 | 0.29 | 0.23 | -0.12 | 0.67 | 0.53 | 1.52 | -1.77 | -0.23 | -0.86 | 2.39 | 1.48 |
| Trade-Transport | -0.01 | 0.03 | 0.02 | -0.03 | 0.1 | 0.07 | 1.80 | -0.86 | 0.97 | -1.04 | 1.29 | 0.21 |
| Communication | -0.04 | 0.02 | -0.02 | -0.12 | 0.07 | -0.05 | 2.05 | -0.38 | 1.70 | -0.95 | 1.32 | 0.34 |
| Finance | 0.07 | -0.11 | -0.03 | 0.22 | -0.33 | -0.1 | 1.69 | -0.81 | 0.89 | -0.88 | 1.32 | 0.42 |
| Business services | 0.02 | -0.02 | 0.00 | 0.05 | -0.05 | 0 | 2.01 | -0.41 | 1.63 | -0.88 | 1.27 | 0.37 |
| Social services | -0.08 | -0.02 | -0.09 | -0.19 | -0.04 | -0.22 | 2.31 | 0.57 | 2.93 | -1.18 | 2.21 | 0.98 |
| **Total** | **0.01** | **0.03** | **0.04** | | | | **1.03** | **1.03** | **2.03** | **0.78** | **1.58** | **2.32** |

| Sectors | Bilateral exports to USA | | | Bilateral exports to ROW | | | Bilateral imports from USA | | | Bilateral imports from ROW | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tariffs | NTBs | Total | Tariffs | NTBs | Total | Tariffs | NTBs | Total | Tariffs | NTBs | Total |
| Primary products | 0.34 | -0.45 | 0.05 | -1.14 | 1.82 | 0.38 | -1.61 | 1.77 | 0.15 | 3.43 | -3.77 | -0.30 |
| Non-durable manufacturing | -4.06 | 7.33 | 2.85 | 12.12 | -0.57 | 11.41 | -6.48 | 3.67 | -2.85 | 17.12 | -2.67 | 14.17 |
| Durable manufacturing | -1.53 | 1.54 | 0.04 | 9.41 | -2.03 | 7.23 | -3.73 | 2.01 | -1.76 | 5.00 | -0.43 | 4.58 |
| Utilities | 2.61 | 1.94 | 4.57 | 1.75 | 0.04 | 1.74 | -2.39 | -2.63 | -4.96 | -0.52 | 0.38 | -0.12 |
| Construction | 2.55 | 6.57 | 9.37 | 1.48 | -1.78 | -0.28 | -1.69 | 6.54 | 4.60 | -0.83 | 2.03 | 1.15 |
| Trade-Transport | 2.02 | -0.09 | 1.96 | 1.64 | -1.95 | -0.30 | -1.74 | 0.95 | -0.83 | -0.66 | 1.17 | 0.49 |
| Communication | 2.20 | 2.32 | 4.61 | 1.91 | -1.84 | 0.06 | -1.54 | 1.74 | 0.15 | -0.65 | 0.83 | 0.16 |
| Finance | 1.94 | 1.44 | 3.44 | 1.57 | -1.49 | 0.09 | -1.43 | 1.37 | -0.09 | -0.41 | 0.69 | 0.26 |
| Business services | 2.19 | 2.38 | 4.67 | 1.85 | -1.86 | -0.01 | -1.70 | 2.00 | 0.25 | -0.82 | 1.13 | 0.29 |
| Social services | 2.27 | 2.77 | 5.14 | 2.13 | -2.02 | 0.10 | -1.37 | 2.23 | 0.81 | -0.47 | -0.20 | -0.68 |
| **Total** | **-1.36** | **1.77** | **0.41** | **7.50** | **-1.22** | **6.13** | **-4.05** | **2.45** | **-1.64** | **7.31** | **-1.08** | **6.17** |

Source: Author's estimations.

**Table A1.** Sensitivity analysis: impact on GDP, welfare and aggregated imports

| | | GDP | | | Welfare | | | Exports | | | Imports | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | United States | Mexico | ROW | United States | Mexico | ROW | United States | Mexico | ROW | United States | Mexico | ROW |
| Reference | | 0.11 | 0.16 | 0.03 | 0.26 | 0.03 | -0.01 | 3.61 | 2.03 | 0.47 | 5.58 | 2.32 | 0.12 |
| A) Elasticity of substitution between labor and capital | Half | 0.11 | 0.16 | 0.03 | 0.26 | 0.03 | -0.01 | 3.75 | 1.98 | 0.45 | 5.5 | 2.27 | 0.13 |
| | Double | 0.11 | 0.16 | 0.03 | 0.26 | 0.03 | -0.01 | 3.57 | 2.08 | 0.48 | 5.63 | 2.4 | 0.12 |
| B)Armington elasticity of substution between imports and domestic goods at regions. | Half | 0.09 | 0.1 | 0.01 | 0.37 | -0.14 | -0.06 | -0.69 | 1.23 | 0.51 | 4.01 | 0.84 | -0.06 |
| | Double | 0.13 | 0.27 | 0.05 | 0.17 | 0.19 | 0.04 | 8.23 | 4.2 | 0.73 | 7.42 | 5.05 | 0.62 |
| C) Armington elasticity of subtitution among imports from differents regions. | Half | 0.09 | 0.2 | 0.03 | 0.16 | 0.13 | 0.01 | 3.33 | 2.06 | 0.44 | 4.22 | 2.71 | 0.26 |
| | Double | 0.12 | 0.09 | 0.03 | 0.32 | -0.10 | -0.03 | 3.76 | 2.01 | 0.49 | 6.51 | 1.94 | 0.03 |

Source: Authors' estimations.

# Chapter 3. The economic impact of Brexit in the United Kingdom: restrictive immigration policies[1]

[1] This chapter has been presented at the conferences: (1) The XIII Economic Policy International Conference, that took place in the Universidad Rey Juan Carlos, on 25-26 May 2017, in Madrid, Spain. (2) The 20th Annual Conference on Global Economic Analysis, organized by the Center for Global Trade Analysis GTAP – Purdue University, on 7th-9th June 2017, in West Layette, Indiana – United States.

A paper of this chapter has been published on the Journal Contemporary Social Science, Vol. 14, No. 2, pp. 208-225, (2018).

**Abstract**

The bulk of studies which attempt to quantify the effects of Brexit focus on trade issues; however, very few of them have analysed migration. In this chapter, we analyse the impact of several migration policies on GDP, GDP per capita, wages, national income and sectoral production in the UK, using what is technically called a general equilibrium analysis. We also analyse the impact at the macroeconomic level on the EU. We find that migration has the potential of deeply affecting economic activity in the UK. The more restrictive immigration policies are, the greater the losses in terms of GDP and Welfare.

However, according to the text of the 'joint agreement' reached by the UK and EU on December 8 (2017), very restrictive policies seem to be ruled out. Nevertheless, after the 'Windrush scandal' some doubts about the final implementation of future UK migration policies remain. We also analyse mild migration policies which would only reduce the number of migrants received. Reductions in the number of EU immigrants between 42,000 and 87,000 per year would lead to foregone GDP increases in the UK between 0.08 and 0.17 percent. This impact should be considered cumulative across years in which the net inflows are reduced, so that negative effects for GDP and welfare can be substantial if the reduction in workers takes place during many years in a row.

The UK has easy access to a large pool of workers coming from other EU member states currently, and UK managers have expressed that it is hard to replace EU talent in the short term. This suggests that if the political imperative for tighter immigration control cannot be avoided, gradual immigration restrictiveness will be less harmful for the UK's economy and should be accompanied by additional efforts in education and workers' training.

## 1. Introduction

One of the most recurrent arguments along the exit campaign was the negative impact of EU labour migration on jobs, wages and the quality of life of UK-born workers. The discussion also focused on access of foreign population to the British social system. According to the last opinion poll conducted by Eurobarometer (European Commission, 2015), 44 percent of the British population have a negative perception of the effects of EU immigrants. By contrast, a recent report based on interviews conducted with UK firms reveals managers' worries due to their dependency on foreign workers and the difficulty to substitute them in the short term (Sands et al., 2017).

The UK already has full control over immigration from non-EU countries. By contrast, while an EU member it has limited control over immigration from EEA (i.e. the EU, Norway, Iceland and Lichtenstein) and Switzerland, because, the latter have the right to live and work in any other EU country, with some exceptions (Full Fact, 2016a)[1].

According to the Citizens' Directive, in principle, an EEA national from outside the UK can automatically qualify for 'Permanent residence' after living for five years in the UK, if he is a worker, self-employed person, self-sufficient person or a student or family member of one of these categories. This 'Permanent residence' is the right to live permanently in the UK.

Since Brexit negotiations have begun, the UK government has talked about a '5-year policy', which seems related to the process we have just described. Depending on the "cut-off date' to accumulate five years, a significant number of EU migrants that have come during the recent crisis to the UK, could or could not qualify for the 'Permanent residence' and eventually exit from the UK. However, on December 8 (2017) the UK and EU reached a 'joint agreement', in which the 5-years policy and massive deportation seem to be ruled out[2].

[1] Nevertheless, travellers who hold EEA passports cannot cross the UK border without having their passport checked, much in the same way as travellers from non-EU countries. UK has retained full border controls because together with Ireland it is the only EU state which is not part of the "Schengen passport-free area". (Full Fact, 2016b).

[2] According to the last "joint report" between UK and the EU, those EU citizens who have arrived in UK before 29 March 2019 will be guaranteed "settled status". This will give them access to public funds and services and

Nevertheless, reductions in the number of future migrants going to the UK should be expected as a result of tighter controls for these EU migrants arriving after Brexit implementation (i.e. after 29 March 2019). Indeed, the conditions for post-Brexit EU migrants are still to be agreed upon.

Despite the "joint agreement" mentioned above, some level of uncertainty surrounds the UK's future immigration policies. On the one hand, Michael Barnier, the EU chief negotiator, has mentioned, 'Nothing is agreed until everything is agreed' (Pop, V. 2018a). On the other hand, there has been a recent scandal related to how the UK government has dealt with non-EU migrants while David Cameron was Prime Minister. In order to create a 'hostile environment' for illegal migrants and reduce the annual net migration below 100.000, a very restrictive law was released in 2012. This law established that employers, landlords and hospitals should verify the immigration status of prospective tenants, employees and patients. An important group of immigrants coming from non-EU countries, known as the 'Windrush generation', have been affected. Many of these immigrants have even been deported because they never obtained formal proof of their immigration status and the landing cards slips, which recorded their arrival dates in the UK, have disappeared. These immigrants arrived from the British colonies when the UK was seeking workers to rebuild the economy after World War II. Hundreds of thousands of immigrants and their children worked hard, paid taxes and were granted permanent residence in the UK with a path to citizenship by a law enacted in 1971 (Wall Street Journal, 2018a and Gross, 2018). It seems that deportations would not be new after the Windrush scandal.

Several studies have analysed the economic impact of migration on the UK. Dhingra and Sampson (2016, p. 61) claim that, "Research has failed to find any robust evidence that immigration has hurt the UK economy". In fact, Dhingra et al. (2016a, p. 2) and Petrongolo (2016, p. 115) note that those areas with a large increase in EU migrants have not experienced deeper fall in wages or any greater increase in UK born unemployment. Petrongolo (2016) also argues that, "At the aggregate level, immigration has a positive impact on net fiscal

the right to apply for British citizenship after Brexit. By contrast, EU immigrants who arrive after 29 March 2019, can live, work and study in the UK, but under a different registration scheme, which is still in negotiation (GOV.UK website, 2017).

receipts without hurting the labour market prospects of natives, although it can result in problems for some local workers and pre-existing immigrants". Similarly, Dustmann and Frattini (2014) also estimate a positive fiscal contribution by the EU migrants living in the UK. However, they obtain a net negative fiscal contribution for non-EU immigrants who have more children than EU migrants, and consequently imply larger expenses in public education. By contrast, Nickell and Saleheen (2015) find that migration has a small negative impact on average British wages (irrespective of whether it is EU or non-EU migration) and that the biggest impact of immigration on wages is within the semi/unskilled services occupational group. The debate about the potential adverse effects of migration remains a public and political issue.

Most of the quantitative studies estimating the effects of Brexit cover its trade effect[3] (Aichele et al., 2015; Booth et al., 2015; CEPR, 2013; Ciuriak et al., 2015; Dhingra et al., 2016b, 2017; UK Government, 2016a, 2016b; Jafari and Britz, 2018; Latorre et al., 2018a; OECD, 2016; Oxford Economics, 2016; PwC, 2016). Busch and Matthes (2016), Fernández-Pacheco et al. (2018) and Latorre et al. (2019a) review them pointing out that only a few include other aspects such as the impact of Foreign Direct Investment (Ciuriak et al., 2015; UK Government, 2016b; Jafari and Britz, 2018; Latorre et al., 2018a), uncertainty[4] (UK Government, 2016a, 2016b) or migration (e.g. Dhingra et al., 2016a; UK Government, 2016a; Jafari and Britz, 2018; OECD, 2016; Portes and Forte, 2017; PwC, 2016). Unfortunately, the few that include migration rarely present its impact in isolation. Therefore, it becomes difficult to assess the importance of this issue in Brexit, which is the main purpose of this chapter.

[3] The impact of trade after Brexit has been found to be much more negative on the UK than in the EU across most studies. Any possible trade agreement will always generate some sort of trade barriers compared to the single market situation. Those barriers imply that UK (and to a lesser extent EU) firms will lose potential customers and face smaller markets than with the single market. Therefore, it will be more difficult for firms to benefit from economies of scale and productivity will fall heavily in the UK and more mildly in the EU (i.e., Latorre et al., 2018a). The introduction of modern trade theory with firms with different productivity levels in each sector is crucial for this result that to the best of our knowledge has only been directly estimated by Latorre et al. (2018a) extending the analyses of Latorre et al. (2018b) and Latorre and Yonezawa (2018).

[4] Is found to have a very strong negative effect, which surpasses by far the negative impact of trade. However, so far, uncertainty has not materialized with such negative outcomes.

To be more precise, to the best of our knowledge, only three studies provide the impact of migration alone. Portes and Forte (2017) forecast a reduction of net EU migration between 91,000 and 150,000 people over the period from 2016 to 2020. In their central scenario, they estimate a fall between −0.63 and −1.19 percent in UK's GDP, while in their most extreme scenario that reduction ranges between −0.8 and −1.8 percent. Dhingra et al. (2016a) estimate a reduction in UK's GDP per capita by −1.6 percent, arising from cuts in EU migration of 80,000 per year. Finally, Lisenkova and Sanchez-Martinez (2016) develop an overlapping generations computable general equilibrium model (OLG-CGE) in which they compare two migration scenarios: leave and remain in the EU. They assume that total future UK net migration will be −70,000 a year. As a result, the aggregate GDP for the UK in 2065 would be 9 percent lower in the leave scenario compared to the remain scenario. In this model, the authors differentiate between natives and different categories of immigrants. Interestingly, the model is disaggregated into 21 generations (groups of age), 3 qualifications (low, medium and high) and 4 groups of origin (UK, EU15, New EU, non-EU), which implies a very rich characterization of migration in a dynamic context.

Compared to previous papers on migration, the present study provides contributions along three main fronts. First, our study provides results not only for macroeconomic variables (i.e. GDP, GDP per capita, welfare and wages) but also the impact of immigration across the 21 sectors that we include in the model. In this way, we can analyse which sectors are more affected by immigration policies. Second, we expand the set of different immigration policies that the UK could have adopted when leaving the common market[5]. We cover three very restrictive migration policies which are unlikely, according to the December 8 (2018) joint agreement, and three different scenarios of reductions in the net inflows of EU migrants. Third, although we focus on the explanation of immigration impact on the UK, we provide results for both the UK and the EU. The latter are absent in many analyses of Brexit, and not only in the ones focusing on migration.

[5] If the UK remains in the common market and, therefore, ends up being part of the EEA or signs an agreement like the one of Switzerland, it will maintain its current migration policies. However, if it reaches a shallower agreement, such as a customs union (Turkey), a Free Trade Agreement, or if the relation falls under World Trade Organization rules the UK will be able to set its own migration policies.

The chapter is organized as follows. The next section provides a summary of the evolution of migration in the UK and the available estimations of its importance. In section three and four, we explain our model and the different policy scenarios we analyse. Section five presents the micro and macroeconomic results; and the conclusions close the chapter.

## 2. International migration in the United Kingdom

There are several databases which offer information on population and employment by citizenship for the UK and for the EU. However, many of them contain a lot of gaps. In Table 1 we have gathered the information for the latest year available across most sources, namely 2015. In terms of population (top of Table 1), only Eurostat and the OECD provide data for both the UK and the EU. Information for employment (bottom of Table 1) is scarcer than for population. In the figures shown below, we use the Office for National Statistics (ONS, 2017a, 2017b) database, which provides population and employment statistics by nationality group for the period 2000-2016. Unfortunately, these long series are only available for the UK. ONS (2017b) has released estimations on the number of UK citizens in the EU in January 2017, but they are for 2011. Their figures and the ones of United Nations (2017) are based on the same original data. However, United Nations extrapolates them to 2015, while ONS (2017b) has kept them for the year 2011[6].

The number of EU migrants in the UK in 2015 was 3 million (5 percent of UK's population) approximately. The estimations on UK citizens in the EU are more problematic. Eurostat and the OECD provide a rather reduced number (700,000), which would be around 0.15 percent of total EU population. Sturge, G. (2017) and United Nations (2017) provide a considerable larger estimate of 1,200,000 UK citizens, approximately.

Regarding employment, Eurostat (2017) and ONS (2017a, 2017b) estimate that EU workers in the UK would be approximately 2 million (or 6.5 percent of total UK employment). It is

[6] In addition, United Nations (2017) uses information based on UK-born population rather than UK citizens, while ONS (2017) offers information for both concepts. Since, EU regulation is based on citizenship, in principle that would be a better measure.

much harder to obtain the exact number of UK workers in the EU. Migration Watch UK (2016) calculates it could be 800,000. We have done our own calculation using the updated figures for UK migrants in the EU with data from United Nations (2017), i.e. 1,175,494 UK-born in 2015. According to the ONS (2017b), 69.4 percent of UK migrants in the EU are under working age. This is a lower percentage than the one that United Nations (2017) calculates for population of working-age in general in Europe, which is of 78.3 percent. Given the significant number of UK migrants that we know are of retirement age[7], it makes sense that the percentage calculated by ONS for the UK is smaller than that of Europe. Taking the 69.4 percent over the UK migrants in the EU (1,175,494 UK-born), we obtain a total of 815,793 people of working age. It seems reassuring that it is very close to the estimation of Migration Watch, so we will use the estimation of Migration Watch UK (2016) in our policy analysis.

Figure 1 shows the evolution of total UK population by nationality group for the longest period available (i.e. 2000-2016). It offers the evolution of EU and non-EU migration, which is very relevant, since Brexit will only affect EU-migration. In turn, the inflow of EU migrants is composed of several groups:

- EU14 embraces the long-standing members of the EU (i.e. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Republic of Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and Sweden).

- EU8 involves the countries of Eastern Europe that joined the EU in 2004 (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia).

- EU2 consists of the two countries that joined the EU in 2007 (Bulgaria and Romania).

[7] According to ONS (2017b) Table 1, the top destination of UK migrants is Spain and the percentage of migrants of working age (15-65 years) in that country is 59.6 percent. Migrants under retirement age in Spain constitute a huge share of 32.7 percent, while the remaining share of migrants under 15 years is 9.4 percent. France is the next most important destination and the percentage of UK migrants under retirement age is 19.2 percent (13.2 percent are under 15 and 67.6 percent of working age). Other touristic countries such as Portugal, Greece, Malta and Cyprus exhibit important shares of UK retirees with percentages of 26.3, 19.5, 32.5 and 30.8 percent, respectively. The costs for UK's welfare system if all these UK migrants return are likely to be considerable and certainly larger than the ones involved by the return of workers, who pay more taxes than retirees.

- ‘Other-EU’ includes the two Mediterranean countries that joined the EU in 2004 (Malta and Cyprus) and Croatia which joined in 2013.

Figure 1 reveals that there has been a change in the pattern of UK’s migration in the last years. Namely, EU migration flows have surpassed those of non-EU migration since 2013 onwards. There has been a prominent acceleration of EU migration during the crisis. In this sense, people’s perceptions regarding the increase of EU migrants are correct. On the other hand, the number of total immigrants living in the UK has increased from 2.4 to 5.9 million between 2000 and 2016. This implies an increase in the share of total UK’s population from 1.48 (in 2000) to 5.51 percent (in 2016). In 2016, 3.5 million (i.e. 60.21 percent) of UK’s total foreign population came from the EU.

Between 2002 and 2006 the EU migrants living in the UK went up by 560 thousand. This augmentation was driven by the entry of migrants coming from EU countries (EU14) and, more importantly, by those coming from the eight new member states (EU8). The latter contributed to an increase of 410,000 people. From 2007 to 2016 the number of EU migrants living in the UK escalated by 1.9 million people. This heavy increase was driven by a rise of 1.3 million people coming from the EU8 and EU2 and of 574,000 people coming from EU14. The strong rise in the inflow of EU migrants has been driven to a great extent by the entry of people coming from EU8 and EU2[8]. By contrast, during the financial crisis the number of migrants from countries outside the EU has remained fairly constant.

The number of migrants coming from the EU8 has equalized the weight of EU14 in the total foreign population living in the UK in a short period of time. This is relevant information since EU14 contains the largest European countries in terms of population (Germany, France,

[8] The removal of transitional restrictions in the labour market for Bulgarian and Romanian workers pushed up the inflow of migrants from these countries since the end of 2013. According to Gower and Hawkins (2013), the accession treaties to EU allowed existing Member States to impose transitional restrictions on the free movement rights of those workers coming from Bulgaria and Romania. These restrictions could be applied for up to seven years since the accession date (1 January 2007). The UK`s Government has applied them during the full period.

Italy, Spain), while EU8 has in general much smaller populations with the exception of Poland.

In addition, the recent 'Windrush scandal' has revealed that tight and irregular migration policies with respect to non-EU migrants may be behind the reduction in their number from 2012 onwards (Figure 1). It may also have discouraged the arrival of more non-EU migrants, which was the trend before 2012. In 2012 David Cameron introduced a very restrictive law for non-EU migrants (Wall Street Journal, 2018a and Gross, 2018).

Regarding employment in the UK (Figure 2), in June 2017 the number of employed persons amounted to 31 million according to ONS (2017b). Approximately 3.5 million (11.14 percent) were foreign workers, of which 2.3 million were from EU countries. 1 million were from the old EU members (EU14) and another million from countries that became members in 2004.

Moreover, the number of EU employees is larger than that of non-EU employees working in the UK, since 2011. This is mainly explained by the rebound in recruitment of workers from EU8 and EU2 (e.g. the number of EU8 workers has even surpassed the one of EU14 workers employed in the UK since 2009). According to OECD (2016, p. 26) "those migrants from countries that acceded to the EU in 2004 (EU8) have a higher employment rate than the EU migrants in general, and wages of immigrants from EU8 countries are rather low". In addition, the number of non-EU migrants in the UK went down slightly from 2012 onwards, due to the aforementioned law of 2012.

## 3. The model

Because migrants are both workers and consumers, they have a role in the supply and the demand of the economy. In addition, they are distributed across different sectors of the economy, which also has implications for the impact of migration. We try to capture all these simultaneous dimensions of migrants' behaviour using what is technically called a general equilibrium analysis. This methodology includes aggregate and sectoral supply and demand,

together with labour and capital markets consistently within the same model. To be more precise, we use a well-known multi-region and multi-sector Computable General Equilibrium (CGE) model, namely, the Global Trade Analysis Project (GTAP) model. It is a static CGE of the world which is appropriate to grasp the impact of short-run estimations.

The GTAP model assumes a perfect competition structure which is in line with an extended range of previous studies that analyse Brexit (e.g. Ciuriak et al., 2015; Dhingra et al., 2017; UK Government, 2016a, 2016b; Lisenkova and Sanchez-Martinez, 2016; OECD, 2016; Ortiz-Valverde and Latorre, 2017, 2018; Portes and Forte, 2017; PWC, 2016).

In the function of production, land and capital are introduced as specific factors, while labour is considered fully mobile across sectors within the economy. This implies that changes in production can only be obtained by changes in labour demand, which is reasonable for short run simulations. Detailed descriptions of the model can be found in the books of Hertel (1997) and Burfisher (2016). Zhou and Latorre (2014a, 2014b) provide a shorter description including a mathematical appendix with all model equations. CGE models provide a coherent framework to assess the economic impact of different government policies in the entire economy. According to PwC (2016, p. 12), "a CGE model combines economic data and a complex system of equations in order to capture the interactions of the three main elements in an economy – households, businesses and the government. Each element is defined and linked through labour market or capital market flows, household consumption, intermediate product demand, taxes or government transfers".

## 4. Data and simulations

We use the GTAP 9 dataset for 2011 (Aguiar et al., 2016). The data is disaggregated in 21 sectors, 5 regions (UK, EU, USA, China and ROW) and 3 factors (labour, land and capital).

Modelling a disintegration process such as Brexit constitutes a rather original approach. During the last decades, research has focused on the impact of integration processes (e.g.

Ortiz-Valverde and Latorre, 2017) and the deepening of globalisation[9]. In order to analyse the potential impact of the reduction of EU migrants in the UK we simulate six possible policy scenarios. Three of them reflect quite extreme reductions in the UK's labour supply, which could not be ruled out before the agreement of December 8 (2017). A second set of three scenarios captures reductions in the net inflow of migrants, i.e. the potential impact for the UK if it had allowed those migrants to come in. In this latter case, we explore three milder migration policies. We model them as increases in the UK's labour supply, but once we have obtained their impact, we interpret them as forgone benefits or losses the UK could have derived if it had admitted those extra workers.

These three scenarios are more likely according to the 'joint agreement' of December 8 (2017). Table 2 provides the percentages and number of workers associated with these six scenarios, as well as the percentage changes in population that the reductions in the number of workers would imply[10].

The three shocks of reductions in the UK's labour supply are the following:

- A reduction in 'all EU migrants': all EU workers living in the UK return to their country of origin. This scenario involves a reduction of −7.39 percent in the UK labour supply according to the latest ONS data (2017a) and a corresponding increase of labour supply of 1.28 percent in the EU. This is the most extreme policy we could derive and, therefore, provides the most sizeable potential effects. It is unlikely that this policy would be adopted after Brexit.

- A reduction of "net EU-migrants": a fall of −3.49 percent in the UK labour supply. This decline combines the return to their origin of all EU workers living in the UK

[9] With only a few exceptions, such as multinationals disinvestments (Gómez-Plana and Latorre, 2014) and the fall in foreign direct investment during the crisis (Latorre and Hosoe, 2016).

[10] In Table 1 we have three different possible sources for total population in the UK. When we use the reduction in the number of workers to calculate the percentage change in population, the three different sources yield very similar percentages. We have kept Eurostat population as a reference because in the UK it yields an intermediate percentage, compared to the slightly larger obtained from ONS and to the slightly smaller obtained taking OECD population. In addition, using Eurostat Figures for population is consistent with our data on employment which come also from Eurostat.

and of all UK workers living in the EU. It assumes that if the UK adopted a mass deportation policy the EU would retaliate (Busch and Matthes, 2016, p. 28). As shown in Table 1, according to Eurostat database, in UK there are 1,982,600 EU citizens employed. If we subtract from them the 800.000 UK workers that could return to UK from the EU, according to Migration Watch (2016), the net reduction in UK employment would be of 1,182,600. This latter figure accounts for 3.94 percent (0.52 percent) of total labour supply in the UK (EU).

- "5-years policy": In this scenario we simulate a reduction of 2.99 percent in the UK labour supply (ONS, 2017a) and an increase of 0.52 percent of labour supply in the EU. We assume that all the EU workers who lived in the UK during the latest period available (from April 2012 to June 2017) are not granted permanent residence and go back to their country of origin. Note that because migration has accelerated during the final years of the crisis, if we choose other previous years the percentage reduction in the labour supply will be slightly smaller. For example, they will be −2.85 and −2.83 percent for the periods 2011–2016 and 2010-2015, respectively.

The last 'joint report' between the UK and the EU from December 8, 2017, seems to guarantee that EU citizens who have arrived in the UK before 29 March 2019, will obtain the 'settled status' easily once they have accumulated 5 years living in the UK. Moreover, if having arrived before 29 March 2019, they still have not lived for 5 years in the UK, they can obtain a temporary residence permit to achieve the 5 years. By contrast, EU immigrants arriving to the UK after 29 March 2019, will have to abide by new migration policies which are still under discussion. This means that the 5-years policy that Theresa May had been talking about for many months prior to the 'joint report' seems to be ruled out and that the reduction in migrants will be lower than the 5-years policy scenarios we simulate[11].

[11] The 'Windrush scandal' poses some doubts on whether promises to obtain 'settled status' can be later overturned (Wall Street Journal, 2018a and Gross, 2018). In addition, as we have already noted, Michael Barnier seems to leave open the door to changes in the final Brexit agreement, when he says, 'nothing is agreed until everything is agreed' (Pop, 2018).

That is why we also run three milder scenarios, which follow the study of the OECD (2016). The latter assumes that net migration flows (in terms of labour force) in the UK would be reduced by 42,000, 63,000, and 87,000 persons per year in what they call an optimistic, central or negative scenario, respectively. The OECD assumes inflows of workers would still be positive, but smaller than before Brexit. We replicate these OECD estimations of reduction in migration, which imply an increase of 0.13, 0.20, 0.27 percent over total UK's labour according to ONS (2017a) and negligible percentages for EU's employment. We model them as labour force increases in the UK but consider their impact as forgone benefits or losses for the UK. These estimations correspond to one-year impact, but its effects should be considered cumulative across years in which the net inflows are reduced, similarly to the approach of Portes and Forte (2017), (see below).

In order to understand the impact of immigration policies across sectors, it is important to highlight some relevant aspects related to factor remunerations and employment in the UK.

Table 3 shows two sets of columns. In the first set we present the share of labour and capital in total factor remuneration of each sector (i.e. a measure of labour intensity), while the second set displays the share of the sector in the aggregate stock of each factor of production.

For the UK economy as a whole, labour factor represents 60.18 percent of the total, while capital and land account for 39.82 percent (last row in Table 3). A priori, UK sectors with larger labour shares, such as textiles, metals, motor vehicles, and water transport could be the most affected by the fall in immigration since they are labour intensive. By contrast, the 'other primary' sector would benefit since it is very capital intensive and capital would become more abundant (and therefore cheaper) relative to labour.

On the other hand, we know that service sectors employ more labour than manufactures. However, the smaller labour shares in services compared to manufacturing imply that wages in services are lower than those received in manufactures. Thus, taking into account labour costs (represented by labour shares) manufactures turn out to be more labour intensive than services and could be more affected by a migration decline.

## 5. Results

### 5.1 Aggregate results

Table 4 shows the impact in GDP, GDP per capita, welfare (i.e. changes in national income) and average wages[12] under the six migration policies we consider (Table 2). The more restrictive immigration policies are, the greater the impact on the macroeconomic aggregates. If the UK adopted the most restrictive policy (i.e. the reduction in "All EU migrants") its GDP would fall by −4.71 percent with a welfare loss of US$−113,690.41 million (or −4.62 percent of GDP). Restrictions in migration would lead to reductions in the labour supply and, consequently, to a fall in GDP. Because labour becomes less abundant, wages go up by 2.50 percent under the 'All EU migrants' scenario. However, national income (i.e. welfare) goes down because even though the remaining workers earn more, what prevails is that a significant number of workers have left the UK. The effects are the opposite in the EU since it receives the migrants that leave the UK. EU GDP would increase by 0.72 percent. In the 'Net migration' scenario, UK's GDP would fall by 2.50 percent (with a welfare loss of US$−60,278.02 billion), while under the "5-years policy" scenario GDP would diminish by 1.89 percent with a welfare loss of US$−45,660.68 million (or −1.85 percent of GDP).

As already noted, our model grasps the short run impact of these migration policies[13]. However, if the cuts in UK's labour force are not offset by future increases in the number of workers, UK's productive capacity would remain constrained. In this sense, the large reductions in UK employment (all EU migrants, 5 years policy and net migration scenario) would continue to shrink GDP in subsequent years by the amount offered in Table 4, compared to a situation in which employment had not been cut. Our model does not differentiate among different types of workers. In this sense it probably underestimates the costs of not having access to more talented (skilled) workers who cannot be easily substituted by other workers.

[12] It is hard to estimate the impact on wages of workers with different labour qualifications, because we do not know how migrants with different skills are distributed throughout the UK sectors of production. Potentially our methodology would allow us to differentiate the impact across workers (e.g., Latorre, 2016).

[13] We indeed model the percentage change between the economy prior to the immigration policy and the economy after the policy has been implemented.

With the moderate reductions in migration assumed by the OECD (2016) we derive that if those workers had come into the UK, they would have mildly increased GDP and welfare and slightly reduced wages. If restrictions banned these workers' entry, GDP and welfare gains would be forgone, while wages would rise slightly as reflected in Table 4. The potential loss per year in terms of GDP would be between 0.08 and 0.17 percent, while welfare losses would be between US$−1,982.65 and US$−4,116.89 million.

Because OECD scenarios are reductions in net inflows of migrants per year the interpretation of the results is different than the one of the All EU migrants, 5-years policy and net migration scenarios. For the OECD scenarios, we should consider the forgone impact of the cumulative reduction in the number of potential workers (migrants). More workers would have expanded UK's productive capacity. The reduction would be larger if a restrictive migration policy is applied for more years. Because increases in the labour force in the OECD scenarios are very small, their cumulative impact through the years can be approximated by the percentage changes shown in Table 4 for these scenarios' times the number of years.

GDP per capita in Table 4 has been not been obtained directly from our model, in contrast to the rest of results of this chapter. The GDP per capita is a back of the envelope calculation, taking into account the evolution of GDP and a rough calculation of the decrease in population associated with the reduction in the number of workers[14]. The evolution of GDP per capita in UK and EU is notoriously different from the one of GDP for the very restrictive policies. Percentage changes in GDP per capita are considerably less sizeable than the ones of GDP. However, GDP per capita clearly contracts when immigrants leave the UK or when their inflows are reduced. Recall that in this latter case of inflow reductions the impacts shown in the table should be multiplied by the number of years in which those flows are cut.

[14] The values for GDP per capita in Table 4 are obtained subtracting from the rate of variation of GDP (in Table 4) the rate of variation of population (from Table 2). As is well known, the properties of logarithms (i.e., Ln(A/B) = Ln(A) – Ln(B)) can be applied to the rates of growth. In Table 2, we take the exact decreases in the number of workers as reductions in population. However, the reduction in population may be more sizeable than the decrease in workers itself, since workers may leave together with other family members.

The opposite effects are found in the EU, which would benefit from the arrival of migrants leaving the UK. In the case of the OECD scenario, the impact for the EU as a whole is negligible. However, we believe that if we were to analyse the impact in a country by country basis across EU nations, the results would look more similar to those of the UK (although with the opposite sign). Lumping all regions together (in a unique EU region) increases the size of the overall region and lets diminishing returns come into play. Because the overall amount of workers is very large in the EU, additions tend to fall in the area of production in which diminishing returns holds[15]. In other words, because there are already many workers a few more tend to increase production very little. However, if those workers returned to different smaller individual countries, which would be the case in the real world, diminishing returns may well not hold.

Table 4 suggests that the impact on the UK is broadly proportional to the number of workers involved in the shock. Negative effects for GDP and welfare can be substantial if an important percentage of labour supply is involved or if the reduction in workers takes place during many years in a row.

### 5.2 Sectoral results

Table 5 shows that the decrease in labour migration generates a decline in total production that, logically, is more sizeable depending on the total number of workers involved. The reduction in the number of workers available for production results in output declines which are particularly intense in the sectors which are labour intensive (i.e. sectors in Table 3 in which labour factor represents more than 60 percent of their total factor remuneration). This is because, according to the Rybczynski (1955) theorem, an increase (decrease) in the endowment of one factor leads to an absolute increase (decrease) in the production of the good that uses that factor intensively. By contrast, after an increase (decrease) in the endowment of one factor, the sectors that do not use that factor intensively would face an absolute decrease (increase) in their production. This explains why 'other primary', which is

[15] Diminishing returns in production is the property by which the benefit from an extra unit of output declines as the quantity of labour increases.

capital intensive, faces an output rise after capital becomes relatively more abundant because labour decreases. In the same line, production reductions in manufactures tend to be larger than in services because they turn out to spend a larger share of costs in labour than services do. In that sense, they are labour intensive and suffer more from the reductions in labour supply as the Rybczynski theorem predicts.

However, UK sectors will not only be affected by the relative abundance of labour or capital, but also by a decrease in overall intermediate and final demand. Intermediate demand refers to the goods or services that are used to produce other goods or services, while final demand refers to private and public consumption, investment and exports. The large fall in production in Construction is due to its strong dependency on investment, which falls heavily. Chemicals and water transport experience relatively small production decreases and face a lower production fall, even though they are labour intensive. Nearly 71 percent of total production in chemicals and 80.92 percent in water transport is used as intermediates in those sectors that experience rather small declines in production. Chemicals and water transport depend more on the demand from other sectors that are less negatively affected and, therefore, experience lighter decreases for the demand of their products than other sectors of the economy. These effects are captured by the input-output structure that forms part of our general equilibrium model.

All in all, the reduction in labour supply would lead to a contraction in production across the board.

## 6. Conclusions

In this chapter we estimate the macro and microeconomic impact of different migration policies. The more restrictive these policies are, the greater the loss in terms of GDP, GDP per capita and welfare (i.e. national income) in the UK. Such policies imply reductions in labour supply which lead to higher wages. However, we find that what prevails is the reduction in the number of workers, which turns out to depress the UK's capacity of production and, therefore, its GDP and national income. If the UK had decided to expel all

the EU migrants and the EU had retaliated that policy, the UK would have faced a GDP loss of −2.50 percent, while EU GDP would have increased by 0.36 percent. With a more moderate policy such as the '5-years policy', the losses (gains) would have been smaller in the UK (the EU). If the UK and the EU had agreed on a cut-off date of 29 March 2017, for which we have data, the UK (EU) would have faced a fall by 1.90 percent (gains by 0.29 percent) in GDP and a Welfare loss of US$45,660.84 (gains of US$44,110.39) million. That period would imply the largest reduction in the labour supply with the available statistics since during the crisis the number of EU migrants has not ceased to increase. Migrants from the relatively small economies from Eastern Europe would have been the most affected, under the 5-year policy, because they account for more than the half of the EU migrants that have arrived in the UK during the crisis. All these sizeable reductions in the number of workers would constrain the UK's capacity of production. Thus, they should be viewed as GDP reductions per year as long as the number of workers does not increase compared to a situation in which the number of workers had not been cut.

As noted, according to the 'joint agreement' of December 8 (2017) between the UK and the EU, the previous scenarios seem to be ruled out. However, after the 'Windrush scandal' and given the assertions of the chief EU negotiator, some doubts about the final implementation of future UK migration policies remain (Wall Street Journal, 2018a; Pop, 2018 and Gross, 2018). In any case, we can expect a reduction in the inflow of EU migrants due to the controls that the UK will establish for those immigrants that arrive after 29 March 2019, which are still to be agreed upon. Our milder scenarios suggest that a reduction of the inflow of EU immigrants between 0.13 and 0.27 percent of total number of workers (i.e. between 42,000 and 87,000) would lead to foregone increases of 0.08 and 0.17 percent of GDP in the UK, per year. This impact should be considered cumulative across years in which the net inflows are reduced, so that the total number of years in which the net inflows of migrants are constrained should multiply those GDP reductions to obtain the overall impact. A back of the envelope calculation implies that after two years of constraints the foregone GDP would be between 0.16 percent (2 × 0.08 percent) and 0.34 percent (2 × 0.17 percent) and after three years it would be between 0.24 percent (3 × 0.08 percent) and 0.51 percent (3 × 0.17 percent).

Concerning GDP per capita, in the unlikely scenario in which all the EU migrants living in the UK would go back to the EU, the UK would experience a GDP per capita loss of 1.06 percent. Under milder scenarios (i.e., pessimistic, central and optimistic OECD scenarios) the GDP per capita would experience an impact of -0.11, -0.03, and 0.05 percent, respectively.

Our results suggest that migration reductions would increase wages in the UK. Due to the fact that manufactures tend to pay higher wages than service sectors, and are therefore more labour intensive, they would be more negatively affected than services by reductions in the number of workers.

The UK currently has easy access to a large pool of workers coming from other EU member states. UK managers have expressed that there is a skill gap in the UK and that it is hard to replace EU talent in the short term (Sands et al., 2017). In the same line, it is not easy to find blue-collar workers happy to work with such low wages. This suggests that if the political imperative for tighter immigration control cannot be avoided, gradual immigration restrictiveness will be less harmful for the UK's economy and should be accompanied by additional efforts in education and workers' training.

## Tables

**Table 1.** Overview of available databases

| 2015 | | | | |
|---|---|---|---|---|
| **Source** | **United Kingdom** | | **European Union** | |
| | **Total population** | **EU nationality** | **Total population** | **UK nationality** |
| Eurostat | 64,875,165 | 2,988,279<br>4.61% | 508,504,320 | 690,033<br>0.14% |
| House of Commons | | 3,200,000 | | 1,200,000 |
| ONS | 64,265,000 | 3,159,000<br>4.92% | N.A. | 890.299 (2011) |
| United Nations | | 2,882,836.00 | | 1,216,041 |
| OECD database | 65,421,080 | 3,612,000<br>5.52% | 446,016,120 | 663,171<br>0.15% |
| | | | | |
| **Source** | **United Kingdom** | | **European Union** | |
| | **Total employment** | **EU nationality** | **Total employment** | **UK nationality** |
| Eurostat | 30,027,500 | 1,982,600<br>6.60% | 1,844,801,000 | N.A. |
| Migration Watch UK | N.A. | N.A. | | 800,000 |
| ONS | 31,603,846 | 2,052,180<br>6.49% | N.A. | N.A. |

Source: Author's elaboration based on Office for National Statistics (ONS, 2017), Eurostat (2017), United Nations (2017), OECD statistics (2017), House of Commons (2017), and Migration Watch UK (2016).

**Table 2.** Migration scenarios under Brexit

| Scenarios | Percentage | Number of workers |
|---|---|---|
| **All EU migrants** | -7.39% | 2,365,051 |
| **Net EU migration** | | |
| United Kingdom | -3.94% | 1,182,600 |
| European Union | 0.64% | |
| **5-years policy** | | |
| United Kingdom | -2.99% | 957,636 |
| **OECD (2016) scenarios** | | |
| Optimistic | -0.13% | 42,000 |
| Intermediate | -0.20% | 63,000 |
| Pessimistic | -0.27% | 87,000 |

Source: Author's estimations based on Eurostat (2015) and ONS (2017a, 2017b) database.

**Table 3.** The UK factor remuneration distribution by category and sectors

| Sectors / Factors | Factor remuneration by category | | | Industry share in employment | | |
|---|---|---|---|---|---|---|
| | Labour | Capital/Land | Total Remuneration by sector | Labour | Land | Capital |
| Agriculture | 57.02 | 42.98 | 100.00 | 1.05 | 100.00 | 0.69 |
| Other primary | 8.22 | 91.78 | 100.00 | 0.29 | 0.00 | 4.84 |
| Food | 61.19 | 38.81 | 100.00 | 2.76 | 0.00 | 2.66 |
| Textiles | 77.56 | 22.44 | 100.00 | 1.14 | 0.00 | 0.50 |
| Wood and paper | 68.76 | 31.24 | 100.00 | 2.35 | 0.00 | 1.62 |
| Chemicals | 69.23 | 30.77 | 100.00 | 2.89 | 0.00 | 1.95 |
| Metals | 80.92 | 19.08 | 100.00 | 2.05 | 0.00 | 0.73 |
| Motor vehicles | 80.83 | 19.17 | 100.00 | 1.33 | 0.00 | 0.48 |
| Other transport | 73.60 | 26.40 | 100.00 | 1.07 | 0.00 | 0.59 |
| Electronics | 62.05 | 37.95 | 100.00 | 0.56 | 0.00 | 0.52 |
| Other machinery | 72.15 | 27.85 | 100.00 | 3.15 | 0.00 | 1.85 |
| Other manufactures | 65.86 | 34.14 | 100.00 | 1.33 | 0.00 | 1.05 |
| Construction | 51.44 | 48.56 | 100.00 | 4.54 | 0.00 | 6.51 |
| Water transport | 76.69 | 23.31 | 100.00 | 0.71 | 0.00 | 0.33 |
| Air transport | 54.05 | 45.95 | 100.00 | 0.39 | 0.00 | 0.50 |
| Communications | 54.31 | 45.69 | 100.00 | 2.69 | 0.00 | 3.43 |
| Finance | 58.29 | 41.71 | 100.00 | 2.45 | 0.00 | 2.66 |
| Insurance | 66.04 | 33.96 | 100.00 | 1.29 | 0.00 | 1.01 |
| Business services | 57.56 | 42.44 | 100.00 | 15.88 | 0.00 | 17.79 |
| Personal services | 57.41 | 42.59 | 100.00 | 3.26 | 0.00 | 3.67 |
| Other services | 61.41 | 38.59 | 100.00 | 48.83 | 0.00 | 46.62 |
| **Total remuneration by category** | **60.18** | **39.82** | 100.00 | **100.00** | **100.00** | 100.00 |

Source: Authors' estimations based on GTAP database (2011)

**Table 4.** Macroeconomic impact of different migration policies in the UK

| | All EU Migrants | | OECD-pesimisstic | |
|---|---|---|---|---|
| | **United Kingdom** | **European Union** | **United Kingdom** | **European Union** |
| **GDP** | -4.71 | 0.72 | -0.17 | -0.0001 |
| **GDP per capita** | -1.06 | 0.25 | -0.11 | -0.0101 |
| **Welfare (billions of $)** | -113690.69 | 108418.52 | -4116.89 | -71.31 |
| **Welfare (% of GDP)** | -4.62 | 0.0071 | -0.17 | -0.0005 |
| **Wages** | 2.5 | -0.44 | 0.09 | -0.002 |
| | | | | |
| | **Net migration** | | **OECD-central** | |
| | **United Kingdom** | **European Union** | **United Kingdom** | **European Union** |
| **GDP** | -2.5 | 0.36 | -0.13 | -0.0001 |
| **GDP per capita** | -0.68 | 0.13 | -0.03 | -0.0101 |
| **Welfare (billions of $)** | -60278.02 | 54209.08 | -3049.89 | -52.82 |
| **Welfare (% of GDP)** | -2.45 | 0.36 | -0.12 | -0.0003 |
| **Wages** | 1.31 | -0.22 | 0.06 | -0.001 |
| | | | | |
| | **5-years policy** | | **OECD-optimistic** | |
| | **United Kingdom** | **European Union** | **United Kingdom** | **European Union** |
| **GDP** | -1.89 | 0.29 | -0.08 | -0.00005 |
| **GDP per capita** | -0.41 | 0.1 | 0.05 | -0.02005 |
| **Welfare (billions of $)** | -45660.68 | 44110.39 | -1982.65 | -34.33 |
| **Welfare (% of GDP)** | -1.85 | 0.29 | -0.08 | -0.0002 |
| **Wages** | 0.99 | -0.18 | 0.04 | 0.001 |

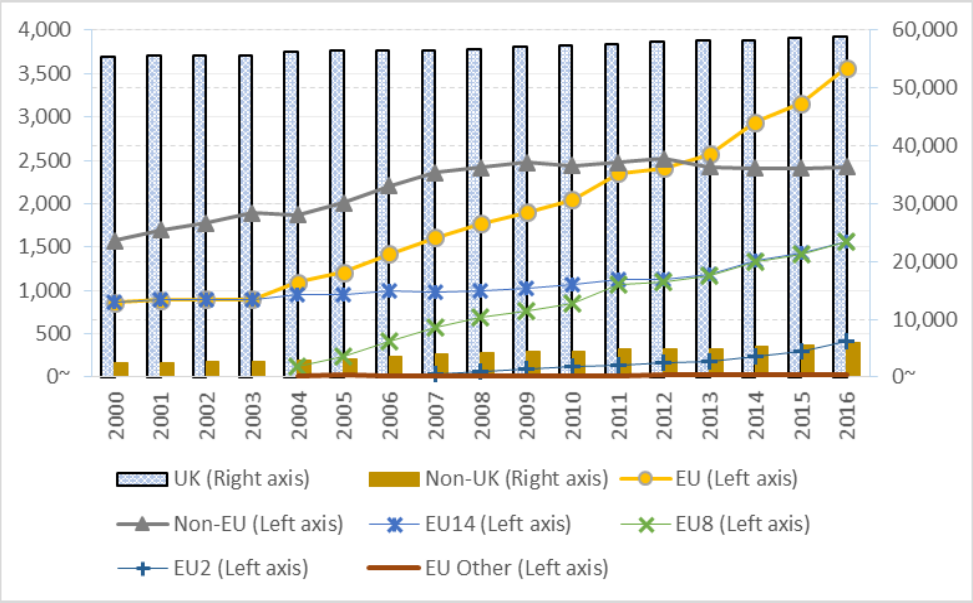
Source: Authors' estimations

**Table 5.** Effects of United Kingdom migration in output across sectors (percentage change)

| Sectors /Scenarios | All EU migrants | Net migration | 5 years policy | OECD-pesimisstic | OECD-central | OECD-optimistic |
|---|---|---|---|---|---|---|
| Agriculture | -2.63 | -1.36 | -1.05 | -0.09 | -0.07 | -0.05 |
| Other primary | 1.84 | 0.96 | 0.71 | 0.06 | 0.05 | 0.03 |
| Food | -3.92 | -2.05 | -1.57 | -0.14 | -0.10 | -0.07 |
| Textiles | -5.89 | -3.18 | -2.38 | -0.22 | -0.16 | -0.10 |
| Wood and paper | -5.11 | -2.73 | -2.06 | -0.19 | -0.14 | -0.09 |
| Chemicals | -3.36 | -1.75 | -1.35 | -0.12 | -0.09 | -0.06 |
| Metals | -5.83 | -3.18 | -2.35 | -0.21 | -0.16 | -0.10 |
| Motor vehicles | -4.79 | -2.54 | -1.93 | -0.17 | -0.13 | -0.08 |
| Other transport | -5.54 | -3.07 | -2.24 | -0.20 | -0.15 | -0.10 |
| Electronics | -4.45 | -2.40 | -1.80 | -0.16 | -0.12 | -0.08 |
| Other machinery | -5.58 | -3.08 | -2.25 | -0.20 | -0.15 | -0.10 |
| Other manufactures | -5.30 | -2.85 | -2.13 | -0.19 | -0.14 | -0.09 |
| Construction | -7.37 | -3.93 | -2.92 | -0.26 | -0.19 | -0.13 |
| Water transport | -1.28 | -0.67 | -0.51 | -0.05 | -0.03 | -0.02 |
| Air transport | -2.76 | -1.46 | -1.11 | -0.10 | -0.07 | -0.05 |
| Communications | -4.10 | -2.15 | -1.65 | -0.15 | -0.11 | -0.07 |
| Finance | -3.17 | -1.68 | -1.28 | -0.12 | -0.09 | -0.06 |
| Insurance | -4.39 | -2.34 | -1.77 | -0.16 | -0.12 | -0.08 |
| Business services | -4.24 | -2.22 | -1.70 | -0.15 | -0.11 | -0.07 |
| Personal services | -4.70 | -2.48 | -1.89 | -0.17 | -0.13 | -0.08 |
| Other services | -5.08 | -2.69 | -2.05 | -0.18 | -0.14 | -0.09 |
| **Total** | **-4.99** | **-2.65** | **-2.00** | **-0.18** | **-0.13** | **-0.09** |

Source: Authors' estimations

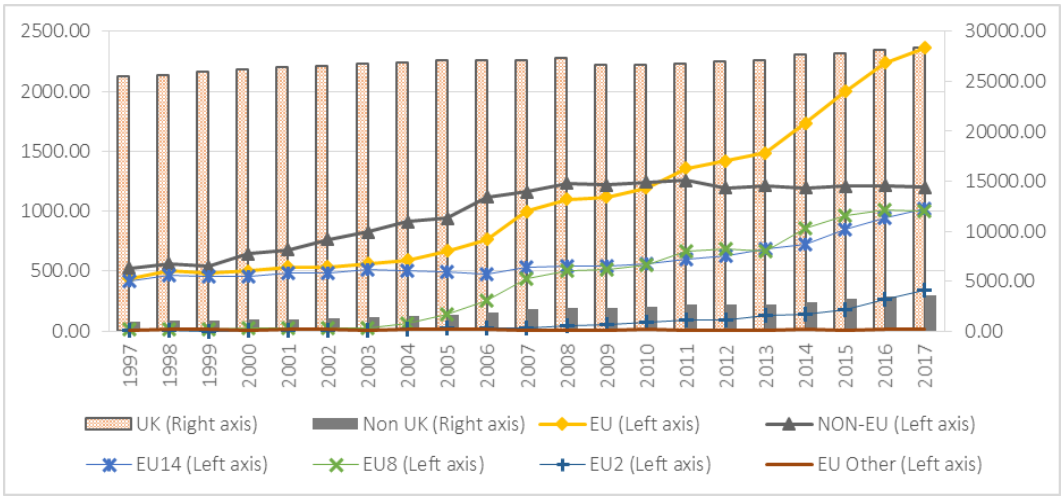
**Figure 1.** Population in the United Kingdom by nationality group (in thousands)




Source: Authors' elaboration based on ONS several years).

Note: For the composition of EU14, EU8, EU2 and other EU see main text.

**Figure 2**. Employment in the United Kingdom by nationality group (in thousands)




Source: Authors' elaboration based on ONS (several years).

Note: see Figure 1.

# Chapter 4. The economic impact of Brexit in the United Kingdom: barriers to trade and immigration restrictions[1]

[1] This chapter has been presented at the conferences: (1) The XIX Conference on International Economic - CIE (2018), held at University Jaume I, on 28-29 June 2018 in Castellón de la Plana, Spain; (2) The XXI Applied Economic Meeting, organized by Asociación Libre de Economía (ALDE), on 7 – 8 June 2018 in Alcalá de Henares, Spain.

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**Abstract**

This chapter estimates the economic effects of different types of restrictions on trade and immigration in the United Kingdom after Brexit. Regarding trade restrictions, we focus on UK-EU increases of tariffs and non-tariff barriers. We also analyse the removal of all tariffs in the UK to all its trading partners. Concerning immigration, we run a 5-year cumulative annual reduction in net migrants by 87.000 workers following OECD estimations.

The study is conducted using a Computable General Equilibrium (CGE) Model, which allows us to estimate the impact on GDP, welfare, wages and capital remuneration, together with the evolution of aggregate and sectoral output, exports and imports.

We obtain a more sizeable negative impact on the UK than other previous influential studies. Trade restrictions would generate welfare reductions between 0.38 and 1.94 percent for the UK, while they would be between -0.03 and -0.14 percent in the EU. This is because the EU is a crucial trade partner for the UK, which cannot be easily substituted through trade with other regions in the world. Restrictions to migrants would bring additional contractions in the range between 0.55 and 0.34 percent for welfare, depending on whether they affect skilled or unskilled workers, respectively.

## 1. Introduction

The United Kingdom's (UK) withdrawal from the European Union (EU) has raised concerns about its potential impact on the living standards in both regions. The exit of the UK from the EU single market will necessarily lead to restrictions on trade and migration between the UK and the EU. According to the majority of economic studies this will reduce trade, production and welfare (Busch and Matthes, 2016; Latorre et al., 2019a, Fernández-Pacheco et al., 2018 for reviews).

The exit of the UK from the EU has been surrounded by uncertainty. The Withdrawal Agreement (WA) negotiated by the Prime Minister (PM) Theresa May, which was approved by the 27 EU leaders on November 2018, was rejected three times by the UK's parliament. The main issue in the discussion was the 'backstop' provision for Northern Ireland (NI). Theresa May resigned on May 4 (2019). She was substituted by Boris Johnson, who was elected as the new UK's PM on July 24 (2019). With him, a new WA proposal has been born, which seeks to remove the 'backstop' provision from the deal and allow the UK to take control of its regulatory affairs and trade policy. Under this WA, if the UK and EU do not agree on a new future relationship deal at the end of the transition period, an open border between NI and Ireland will be maintained. However, NI will apply many EU regulations and there will be customs border between the UK and the NI in the Irish Sea. The rest of the UK will not be subject to EU regulations and will not form part of the EU customs union.

The political declaration released together with Johnson's WA states that the future relationship with the EU should be based on an FTA, which ensures no tariffs, fees, charges or quantitative restrictions across sectors. Its disciplines on Technical Barriers to Trade and Sanitary and Phyto-sanitary controls and services liberalization should be based on and go beyond the World Trade Organization arrangements. Nevertheless, this declaration is not politically binding.

Although the new WA and its Political Declaration were approved by the European Council on 17 October (2019), the UK Parliament wanted more time to be able to ratify it. As a result, the UK asked for a further extension of the Brexit deadline until 31 January 2020, which the

EU has accepted. This was due to the fact that a new departure date of October 31 (2019) had been set in case no WA was approved by that date. Boris Johnson has called for an early election for December 12 and the Parliament has voted in favour. If he gets a stronger weigh in Parliament, he may be able to obtain the approval for his WA agreement.

In this chapter, we evaluate the impact of Brexit along two dimensions: barriers to trade and restrictions to migration. Most of the previous studies have focused on trade (e.g., Aichele et al., 2015; Booth et al., 2015; Dhingra et al., 2016b; 2017; Minford et al., 2015; Ottaviano et al., 2014). Other studies concentrate on the effects of migration and capital movement in the UK. However, they do not include trade (e.g., Oxford Economics, 2016; Dustman and Frattini, 2014 and Di Giovanni et al., 2015). By contrast, Ciuriak et al., (2017) and Latorre et al. (2018a) include trade and foreign direct investment (FDI) but not immigration. Finally, OECD (2016), Jafari and Britz (2018), and PricewaterhouseCoopers PWC (2016) include trade and migration (among other elements), as we do.

In comparison to OECD. (2016) and PwC (2016), our study provides results not only for macroeconomic aggregates but also the impact across 21 sectors in the UK economy. Moreover, unlike OECD (2016), we analyse the effects of Brexit in trade and migration in turn. This allows us to identify their contribution in isolation. On the other hand, PwC (2016) simulates the entry of skilled workers, which, they argue would increase due to a small liberalization in visa requirements in the UK. By contrast, we estimate the impacts of restrictions on both skilled and unskilled workers separately. Our approach takes into account the conditions agreed in the WA approved by EU leaders on November 25, 2018. This agreement did not specify any preferential condition for skilled workers. In addition, according to Szary and McEnaney (2018), there are signs that the Brexit vote may have already significantly slowed the influx of foreign workers. The decline reflects both fewer EU citizens arriving in the country and more leaving.

We also run a scenario in which the UK eliminates all tariffs with respect to all its trading partners. This setting has received less attention in the literature. Only Dhingra et al. (2017) and Minford et al., (2015) estimate it. Interestingly, while Dhingra et al. (2017) obtain that

its impact is very small, Minford et al. (2015) argue that the UK would experience a 4 percent rise in welfare. According to Minford et al. (2015) the rise of trade with other regions would by far compensate the losses of trade with the EU under the World Trade Organization (WTO) conditions. Their estimates have been criticized because they assume that the UK's prices of manufactures and agricultural goods would fall by 10 percent after Brexit and that trade flows would respond disproportionately heavily to trade costs (for more details, see Sampson et al., 2016 and Latorre et al., 2018a). As Dhingra et al. (2017), we also derive that the unilateral tariff elimination would have a very small impact. By contrast, the negative trade outcomes we obtain from non-tariff barriers (NTBs) surpass, by far, the ones derived by Dhingra et al. (2017). This is of particular interest given the fact that we also employ a static[1], general equilibrium approach in a perfectly competitive setting with a comprehensive input-output structure (i.e., with imported intermediates and sectoral linkages) and the same barriers that Dhingra et al. (2017) use. The difference between both approaches lies is the fact that Dhingra et al. (2017) run a New Quantitative Trade Model (NQTM) based on structural gravity and we use a well-known Computable General Equilibrium (CGE), namely, the Global Trade Analysis Project (GTAP) model. Both are multiregional and multisectoral models, although the number of sectors and regions differ between them. Dhingra et al. (2017) have 35 sectors, 1 factor of production and 40 regions and our CGE features 21 sectors, 4 factors (skilled and unskilled labour, land, and capital) and 5 regions.

In the model of Dhingra et al. (2017) the impact of Brexit takes place through trade, which is determined by structural gravity type variables, including national income, distance, technology (proxied by wages) and trade obstacles such as tariff and NTBs[2]. By contrast, in our CGE model Armington functions govern the shares of expenditures allocated to domestically produced or imported goods, together with trade barriers, consumers' preferences and detailed productions functions describing each sector's technology. Dhingra

[1] Dhingra et al. (2017) also estimate the dynamic losses from Brexit, which triple the ones from the static framework, using a reduced-form model. According to Gancía (2017, p. 694) in general "the reduced-form approach suffers from well-known identification issues".

[2] This approach has been criticized on the grounds that past trade flows may not predict well future trade flows (Thomas, 2015; Wagner, 2015). This problem may be particularly relevant in the case of Brexit, since this phenomenon has no precedents and trade data may be missing effects that only appear in a disintegration process.

et al. (2017), and NQTMs in general, obtain most of their structural parameters directly from the same database with which they conduct their simulations[3]. This contrasts with CGEs in which more structural parameters need to be taken from the literature, partly because the CGE is more detailed with respect to production functions and preferences. In fact, the GTAP model incorporates more realistic features and data of the economies, such as the real trade imbalances, several factors of production and heterogeneous NTBs across sectors. By contrast, Dhingra et al. (2017) assume that trade is balanced, model only one factor of production (labour) and their NTBs increase "uniformly to UK-EU trade in all sectors of the economy" (Dhingra et al., 2017, p. 668). The complexity and richness of CGEs models allows us to introduce not only trade but also migration, making the results more comparable than if they are obtained with different models[4].

Caliendo and Parro (2015, p. 2-3) say that: "adding detail into a model comes at the cost of losing track of the mechanisms that deliver the main results" and that the structural gravity model "simulations are performed with few data and parameter requirements". Costinot and Rodríguez-Clare (2014, p. 198) point out that "NQTMs put more emphasis on transparency than on realism". Balistreri and Tarr (2017, p. 23) highlight that CGEs provide analysis on levels, contrasting to the percentage changes of NQTMs. Therefore, CGEs fully capture the benchmark and counterfactual data. "In this way, all the data from the benchmark accounts can be used and results important to policy makers, such as output changes by sector and relative factor prices can be easily extracted". Thus, our CGE approach allows us to offer a

[3] Gancía (2017) suggests that Dhingra et al. (2017) should have estimated the value of the trade elasticity, which plays a central role in their approach, at least for UK sectors. He explains that there is no consensus in the literature regarding the value of this elasticity, while Melitz and Redding (2015) point out that its value may not be constant, which would challenge the analysis of Dhingra et al. (2017).

[4] Some of the authors in the paper of Dhingra et al. (2017) have also worked on the impact of Brexit on migration in Wadsworth et al. (2016). This latter paper forms part of a book comprising a broad analysis of Brexit, elaborated by the Center for Economic Performance (2016). In contrast with the analysis of trade provided in the book, which is included in a technical paper and is the predecessor of Dhingra et al. (2017), for migration no general equilibrium modelling exercise is carried out. Wadsworth et al. (2016) provides a detailed, but mostly descriptive, analysis on migration. This same comment applies to the accompanying technical paper of Wadsworth et al. (2016), which is also included in the book and to Wadsworth (2015; 2017a; 2017b). Although in the technical papers some correlations are included, like the ones between EU immigration and the UK-born unemployment rate and wages, suggesting no statistically significant relationship (negative or positive), descriptive data are their main focus.

very detailed assessment of the impact of Brexit for a rich set of micro and macroeconomic variables, which extends the results of most previous available studies of Brexit.

Apart from providing new estimations for the impact of trade and migration restrictions related to Brexit, another contribution of this chapter is that we compare the results of an econometric (NQTMs) approach with a computational (CGE) model. In particular, we compare the outcomes of the most influential and widely cited model of Brexit (Dhingra et al., 2017) with a well-known and extensively used CGE, namely, the GTAP model[5].

The rest of the chapter is organized as follows. The next section explains the model and the simulations. Section 3 describes the data used for our approach. In the results section, we depict the macro and microeconomic quantitative effects of Brexit. That leads to the final section, in which we present some concluding remarks. Two appendixes close the chapter. One explains the origin of data on EU migrants' skill levels and the other one carries out a sensitivity analysis.

## 2. The Model

There are several ways through which the UK's exit from the EU could result in economic impacts. In this chapter we focus on two dimensions: trade and migration. As noted in the introduction, our study is conducted by means of a well-known CGE, namely, the GTAP model. CGE models have the ability to capture the interactions among households, firms and the government. They use production functions which describe the requirements on intermediates and factors to produce a unit of output in each sector and the inter-sectoral input-output linkages, which reflect the different sources of intermediates in goods and services. They also include a utility function, which describes the preferences of all consumers in the economy, as well as taxes and government transfers to other agents of the economy. In addition, they have equations describing national account identities, which have

[5] Kehoe et al. (2017) also compare the performance of NQTMs and CGEs. However, in contrast to our approach, they do not apply the same trade policy shock to both models, while here the analysis of Brexit is common to both methodologies.

to be fulfilled together with the microeconomic optimization behaviour of firms and households. Thus, the CGE model offers a comprehensive representation of the economy by incorporating real data of the economies into a rigorous theoretical framework.

In our model, we disaggregate the world economy in 21 sectors, 5 regions (UK, EU, USA, China, and ROW) and 4 factors (skilled and unskilled labour, land, and capital). Capital and land are introduced as sector specific, while labour is considered fully mobile across sectors within each region. This is a common assumption to calculate the short run impact of economic phenomena, since it implies that capital and land can only be used in the sectors in which they are, according to the initial dataset, and cannot move across sectors. Therefore, changes in production are mostly driven by changes in labour demand. On the other hand, sectors are related to one another through domestic and imported intermediate inputs, cross-border trade in final goods and through competition in attracting labour. A detailed explanation of the model is available in the book of Hertel (1997) and has been updated in McDougall (2003) and Corong at al. (2017). A more succinct explanation, including model equations can be found in Zhou and Latorre (2014a; 2014b).

We run the model with a perfect competition setting, such as the one of Ottaviano et al. (2014) and Dhingra et al. (2017). According to Arkolakis et al. (2012) Armington, Krugman and Melitz models yield the same welfare gains (even when the number of sources of gains from trade varies across models). Welfare predictions in these trade models depend on only two sufficient statistics, the share of expenditure on domestic goods and the trade elasticity[6]. However, this welfare equivalence is sensitive to model assumptions and the type of trade policy instrument that is used in quantifying the economic effect of a shock[7].

On the other hand, Balistreri and Tarr (2017) argue that including intermediate input trade (even in one-sector and one-factor models) alters the welfare equivalences of Arkolakis et al. (2012). They also find that adding multiple sectors magnifies the differences in the welfare

[6] The share of expenditure on domestic goods is equal to one minus the import penetration ratio, while trade elasticity is the elasticity of imports with respect to variable trade costs.
[7] See Akgul (2017), for an extensive analysis of the impact on welfare equivalence across models of relaxing the model assumptions.

predictions across models. In addition, Melitz and Redding (2014; 2015) consider that Arkolakis et al. (2012) underestimate the contribution of new theories of heterogeneous firms to the aggregate welfare implications of trade. Melitz and Redding (2014, 2015) indicate there is a potential channel (i.e., the endogenous changes in domestic productivity) which increases the welfare gains from trade. Therefore, they suggest that the share of expenditure on domestic goods and the trade elasticity are not enough to predict welfare gains from trade. According to their view, Ottaviano et al. (2014), Dhingra et al. (2017) and all models that do not incorporate heterogenous firms, including ours, would provide lower bound estimates for the impact of Brexit on welfare.

## 3. Data and simulations

The database for micro and macroeconomic variables and the model's input-output framework come from the GTAP 9 dataset for 2011 (Aguiar et al., 2016). Table 1 shows the share of each sector in total production, exports and imports. The first set of columns at the right of the table shows data for the UK, while the second set of columns corresponds to information for the EU.

In both regions, the weight of services in total production is well beyond 60 percent, while their share is much smaller in trade.

Other services[8], business services, construction, and chemicals are the most important sectors in the UK's total production, with a share of 35.42, 13.07, 5.91 and 5.68 percent, respectively. In the three former sectors a large percentage of production goes to the domestic market (i.e., as intermediates, investment, private or public consumption). This implies that a drop in domestic demand would generate an important fall in their total production. By contrast, the increase in foreign trade costs arising from Brexit will diminish the UK's total production of manufactures that export and import an important share of their total output (e.g., motor vehicles, chemicals, textiles, and other primary).

[8] Do note that the sector of other services includes public services.

Table 2 shows the bilateral trade flows of the UK with the EU, United States, China, and the rest of the world. According to the data, the most important destinations of UK exports are EU and ROW, which account for 51.73 and 32.58 percent of its total exports, respectively. Regarding the origin of UK's imports, 49.41 percent come from the EU and 32.85 percent from ROW. Consequently, the increase in barriers to trade between the EU and UK will affect very important shares of the UK's trade. By contrast, the EU sells (buys) 54.23 percent (53.82 percent) of its total exports (imports) within the EU and only 3.47 percent (5.75 percent) of its trade flows are with the UK. Note that these data for the EU are not presented in Table 2.

Migration policies would more intensively affect those sectors with the largest labour shares. Except for other primary, most sectors are labour intensive. Hence, the latter could be more affected by a migration decline.

Regarding our simulations, in trade we run four scenarios, namely, zero tariffs, very soft, soft, and hard Brexit. With zero tariffs, we assume that the UK and the EU continue to enjoy a free trade agreement; this means that Brexit does not lead to any change in tariffs barriers between both regions. In addition, in this scenario we also assume that the UK unilaterally removes all its tariffs on imports from the rest of its trade partners. In the very soft and soft Brexit, we consider that the UK and the EU remain tariffs at zero and apply NTBs with levels of 1/10 and 1/4 of the ones that Ecorys (2009) estimate for the EU [9].

A "hard Brexit" would reflect the possibility of "no deal". This is a possible scenario, given that the UK's Parliament has rejected the WA on January 16 (2019), and is seeking to change it according to the vote of January 29 (2019), while the EU says it cannot be changed. The hard Brexit consists of two sub-scenarios. First, we increase import tariffs between the UK and the EU to the Most Favoured Nation (MFN) level, and second, we assume an emergence of NTBS whose level is 1/2 of the ones that Ecorys (2009) estimates exist in the EU,

[9] We follow the approach of Ottaviano et al. (2014) and Dhingra et al. (2017), see below.

following Ottaviano et al. (2014) and Dhingra et al. (2016b, 2017).[10] Modelling a disintegration process such as Brexit is a rather uncommon exercise given that in the last decades, we have been analysing the effects of globalization[11] (e.g., Ortiz-Valverde and Latorre, 2017; Latorre and Yonezawa, 2018). However, the logic is analogous and just the opposite; in one case barriers to trade go down and in the other they increase.

The exact values for the barriers we run appear in Table 3, which shows the NTBs and MFN tariffs for every sector in the UK and in the EU. The percentages shown in Table 3 indicate the increase that the import price experiences when crossing the borders. Columns 1 and 2 show the NTBs under a very soft and a soft scenario of Brexit, respectively. Columns 3 and 4 show the NTBs and MFN tariffs with a hard Brexit scenario. The three dimensions bars suggest that NTBs would guide the bulk of Brexit's impact on trade. Additionally, we can see in column 5, that the most protected sectors are agriculture, other primary and food; and to a lesser extent; textiles, motor vehicles, other transport, business services, and chemicals. Therefore, the UK's exit from the EU would potentially harm these sectors more than others. These barriers should be viewed as the maximum barriers that could emerge between the UK and the EU. Some of these would appear soon after Brexit but others would take more time, as long as UK and EU regulations drift apart. However, if the UK´s parliament eventually approves the WA and includes the "backstop" clause, North Ireland would be part of the EU customs union. In case the entire UK follows EU regulations in goods markets, NTBs in agriculture and manufactures would not emerge. Tariffs would also be zero since a customs union is also a free trade area. But hard NTBs would appear in services, since they are not covered in the customs union.

Regarding trade itself, because services sectors are less trade oriented than manufactures and agriculture, the impact of Brexit would considerably diminish. By contrast, financial services

[10] They consider that the UK will face only a share of the NTBs that the EU applies to the USA and simulate the emergence of barriers we have just described. We keep their simulations because by doing so we run the same barriers using a different approach. This may also be of interest from a methodological point of view.
[11] Some exceptions include the reduction in FDI inflows to China during the crisis (Latorre and Hosoe, 2016) and disinvestments by foreign multinationals (Gómez-Plana and Latorre, 2014).

could be considerably harmed because they would be less competitive in the EU[12]. However, it seems that for UK MPs the main trouble with the backstop is that the promises of sovereignty and of "taking back control" would not be fulfilled because the UK would have to follow EU regulation and would not be able to develop its own trade policy.

While economists have a lot of experience in analysing tariffs, modelling NTBs is more complicated.[13] Both MFN tariffs and NTBs increase the costs of foreign trade. However, the latter do not provide revenues to governments, and the wedge between the world and domestic price may reflect economic rents for importers and exporters and also inefficiencies. Because NTBs will reduce competition from foreign firms, this will allow other firms to increase their prices and rents. In addition, if the NTBs create red tape or other unjustified bureaucratic processes, they cause a waste of resources. To simulate the rents and inefficiencies attributed to NTBs, we rely on the estimations of Ecorys (2009)[14] which quantified the ad valorem tariff equivalents[15] (AVEs) of NTBs. They found that 60 percent of the NTBs would bring about efficiency losses, which are modelled as iceberg trade costs and 40 percent would generate rents. Additionally, they estimated that 2/3 of the rents were earned by importers and 1/3 by exporters.

Regarding migration, we extend previous analyses of Brexit (e.g., Ortiz-Valverde and Latorre, 2018) by differentiating workers with respect to skill levels (skilled vs. unskilled).

[12] Note that Swiss banks, which do not have passporting rights, operate often through UK affiliates, even though Switzerland has a relatively close relationship with the EU based on many different sectoral agreements.
[13] NTBs are any measure different to tariffs that may be an obstruction to international trade. They comprise regulations, requirements and rules that impose how to manufacture, handle or advertise a good, the amount of a specific product that can be sold in a market, licenses or any specific sanitary certifications, among others. Because they are usually expressed as norms and rules, contrasting with the percentages costs associated with tariffs, it is difficult to quantify the costs they involve.
[14] Ecorys (2009) relied on literature reviews, business surveys, gravity models and extensive consultations with regulators and businesses to calculate the ad valorem equivalents (AVEs) of the NTBs perceived by U.S. and EU firms across a wide variety of products. Because Ecorys (2009) did not provide values for agriculture, other manufacturing and other services, we take them from Latorre and Yonezawa (2018).
[15] The most straightforward way to model an NTB is to treat it as "tariff equivalent" (i.e., as an ad valorem equivalent, AVE). This is because NTBs increases the costs of importing goods and therefore they can be modelled similarly to tariffs with the nuances explained above. However, note that tariffs produce revenues for governments, while NTBs do not. Our model grasps this differential impact of both instruments.

Most of the uncertainty that has surrounded the immigration policy that the UK would apply diminished with the last 8 December 2017 "joint report" between the UK and the EU[16], whose conditions are included in the WA. Previous proposals showed more restrictive migration policies (for more details see Ortiz-Valverde and Latorre, 2018).

The WA greatly facilitates that EU migrants in the UK and UK migrants in the EU remain in the same situation after Brexit. However, those EU citizens who arrive to the UK after the transition period (31 December 2020) will be subject to different migration conditions.

In the event of no deal, the EU citizens will be able to enter the UK to visit, work or study only for 3 months. In the case that they want to stay for more than 3 months, they should apply for a European Temporary Leave, which will be valid for 3 more years. EU citizens who want to stay for longer than 3 years will need to apply under the new immigration skills-based future immigration system, which will begin in 2021 (GOV.UK, 2019) and it is unknown. According to GOV.UK (2019), this policy is not applicable to EU migrants that already live or those who arrive at the UK before the exit day.

Under these conditions it is clear that Brexit will not generate a massive exit of immigrants. That is why, regarding migration, we run an OECD (2016) scenario in which they estimate that the maximum possible reduction in migration flows would be of 116.000 persons per year. We follow their approach and interpret it as the maximum possible impact. In addition, this figure is in line with the 100.000 target of inflows of migrants that the UK government has sought for years, without success (Wadsworth, 2017b).

OECD (2016) simulate three scenarios, optimistic, central, and pessimistic, in which the annual net migration into the UK would decline by 56.000, 84.000 and 116.000 persons per year. They also assume that 75 percent of the immigrants (independent of the scenario) would be in the labour force. This assumption is consistent with evidence of the participation of

[16] This "joint report" is a summary of the process made in the first phase of negotiations toward the "Withdrawal Agreement". Both parties have committed on some issues such as EU citizens' rights. However, the negotiations are not completed, and the implementations of such commitments will depend on the successful talks in the second phase (for an extended explanation see Peers, 2017).

recent EU immigration inflows (OECD 2016). Applying this 75 percent to the maximum number of migrants (116.000) we obtain the 87.000 reduction in the number of workers per year. Because controls on migration will in principle remain for some time, we accumulate this reduction in the inflow of workers throughout five years. This would be equivalent to a 1.45 percent of the stock of workers in the UK. First, we model two extreme simulations: one in which all migrants are skilled and another one in which all of them are unskilled. This means that we apply the increase of 1.45 percent to skilled and unskilled workers in turn. Then, we model a central scenario, labelled as "Mix" in the tables, in which we disaggregate the shock of 1.45 percent between both skills in proportion to their share in total EU immigrants that are employed in the UK. The latter shock involves 0.66 percent of skilled workers and 0.79 percent of unskilled workers (Appendix 1 for a detailed explanation).[17] Note that we do not know to which extent skilled and unskilled EU immigrants would be affected by migration restrictions.

We model the shock of 1.45 percent as an increase in the stock of workers and interpret the results as the foregone impact of the arrival of immigrants. This is because we follow the OECD estimations of a decline in the annual net inward migration into the UK. However, we have also modelled a decrease of 1.45 percent of labour and found that the results are the same. This means that our simulations can also be interpreted as the effects of EU migrants leaving the EU, which are also taking place already, according to Szary and McEnaney (2018).

In addition, we analyse the impact of migration taking into account two different set of parameter values for the elasticity of substitution among factors of production in all the sectors.[18] First, we run the simulations using the current default values (standard elasticities) that GTAP Database (Aguiar et al., 2016) provides. Then, in order to simulate the same scenarios, but with a smaller impact on wages, we re-run them assuming a higher elasticity

[17] Note that the 1.45 percent is run as an increase in the share of labour in value added (i.e., in labour remuneration), which is a common approach since CGEs do not model the exact number of workers but rather measures them as efficiency units (e.g., Latorre, 2016).

[18] This elasticity governs how easy it is to substitute factors of production within each sector. Because we assume that capital and land are specific, they remain fixed and cannot move across sectors. Thus, in the present modelling exercise this elasticity only determines the substitutability between skilled and unskilled labour.

of substitution among factors. To this aim, we follow the exercise done by Burfisher (2016, p. 317), in which she also analyses the effects of migration considering different categories of workers and different elasticities of substitution among factors using the GTAP model. The latter simulations are in line with the findings of the literature on UK migration.

According to Wadsworth (2015), Wadsworth et al. (2016), Wadsworth (2017a, 2017b) and Alfano et al., (2016), there is no evidence of negative impacts of immigration on jobs, housing or the crowding out of public services, and negative impacts on wages of less skilled groups are small. In addition, there is evidence suggesting that EU immigrants in the UK are initially "downgraded" and work in occupations which require lower skills than those they have (Alfano et al., 2016). This can be due to discrimination, lack of language skills and other factors. However, after some years they are usually "upgraded". This empirical trend provides support to the simulations that assume a higher elasticity of substitution between skilled and unskilled workers. The scenarios we have just described are summarized in Table 4.

# 4. Results

## 4.1 Aggregate results

### 4.1.1 International trade policy impacts on GDP, welfare and factors remuneration

Table 5 shows the evolution of GDP, welfare (measured as Hicks equivalent variation), wages and capital remuneration under all scenarios. The results reflect an aggregation of all of the sectoral outcomes that will be analysed below. Being able to come up with results across sectors and regions shows why a CGE model is said to be consistent at the micro- and macro-economic level (for more details see Latorre, 2012; 2013). We present the results for five regions (i.e., UK, EU, China, USA, and ROW). Interestingly, the impact of Brexit seems confined to the two regions directly involved in it, while for the rest the effect would be negligible.

Tariffs' elimination in the UK would lead to a tiny increase of its GDP by 0.04 percent. However, the UK would face small reductions in welfare and factors' remuneration. Concerning the welfare loss, after the increase of imported goods coming from third countries the UK reduces its trade with the EU. Because the EU is a very efficient partner this is a trade diversion effect which reduces welfare in the UK. The EU´s factors of production would also lose slightly after the UK´s tariffs elimination.

We will see below that aggregate production would experience a tiny increase (0.05 percent), with several sectors decreasing their production[19]. In particular, the UK's sectors that contract output employ more than 50 percent of the total stock of labour and capital. This explains the downward pressure on wages and capital rents.

Under the very soft and soft Brexit, the UK would experience a decrease in GDP, welfare, wages, and capital remuneration. The decline in GDP seems to be explained by the reduction of total production, due to the drop in output of industries such as motor vehicles, other primary, electronics, construction and other services. Some of them reduce their exports and face a reduction in domestic demand. This negatively affects their outcomes. On the other hand, these industries employ 59.70 percent of the UK's labour stock. As a consequence, there is a decrease in wages and private consumption. Increased trade barriers lead to a reduction of imports, allowing local firms to supply these goods and compete with imports. However, the increasing competitiveness of local industries is due to the emergence of tariffs and non-tariff restrictions, and not to a real efficiency improvement.

Welfare drops by 0.38 and 0.9 percent under the very soft and soft Brexit, respectively. This is because, as we mentioned above, both NTBs and import tariffs reduce competition from other firms and allow inefficient firms to increase their prices. Furthermore, NTBs create some red tape. Thus, they cause a waste of resources.

[19] The results appear in Table 6 which will be analysed below.

The negative effects of Brexit would be larger if the UK and the EU increased NTBs by more than in the soft Brexit and also include MFN tariffs. This is what happens in the hard Brexit, in which the UK would experience a GDP decrease of 1.14 percent. Interestingly, our results are close to the ones of Ciuriak et al. (2017). Their "Brexit scenario", which is the one that is more similar to our hard Brexit, yields a 1.35 percent reduction in GDP in the UK, and a -0.13 percent for the EU. On the other hand, their "Brefta scenario", the closest to our soft version, yields a 0.65 percent reduction for the UK and a 0.07 percent for the EU. The EU would face rather small negative effects in GDP, welfare, wages, and capital remuneration, too. In fact, the impact is considerably lower than in the UK. As happened in the case of the UK, however, factor remunerations tend to be more affected than GDP and welfare. Note that many studies on Brexit do not offer the impact on EU aggregates. In addition, as we can see, the magnitude of the impact of trade costs on skilled and unskilled labour remuneration is similar. This suggests that, at least, with respect to the income channels, the Brexit trade shocks are likely to be evenly distributed across income groups.

Our results are also in line with the others in the literature. This becomes clear when we decompose the total from other papers into the elements that are comparable with the ones of our model. For example, Jafari and Britz (2018) obtain in a Melitz framework an impact on GDP from NTBs and tariffs of -1.08 and -0.29 percent, respectively. This would be only slightly larger than our joint -1.14 percent impact on GDP (composed of -0.15 percent reduction due to tariffs and the rest being explained by NTBs -0.99 percent). What is more, we find that the welfare effects we derive are very similar to the ones for trade derived by Latorre et al. (2019a, 2019b, 2020), whose model includes a Melitz structure on several manufacturing sectors[20]. We also find that our estimations for GDP are only slightly smaller than the ones estimated by Latorre et al. (2019a, 2019b, 2020).

Finally, we derive even larger impacts than the ones of the influential study by Dhingra et al. (2017). For a hard Brexit our reduction is of 1.94 percent, while they obtain a reduction of 2.66 percent. However, in their more detailed welfare decomposition, shown in Table 4

[20] We do not include multinationals, as Latorre et al. (2019a, 2019b, 2020) do and, therefore, we should compare our results for tariffs and the total for trade impacts including NTBs to the same components analysed by Latorre et al. (2019a, 2019b, 2020).

(Dhingra et al., 2017. p.671)[21], we see that the most important contribution to their overall total welfare impact (-2.66 percent) is the absence of future EU integration (-1.61 percent). It surpasses the joint contribution of NTBs and tariffs (-1.31 and -0.13 percent, respectively)[22]. Our welfare reduction for the UK after the soft Brexit (-0.91 percent) is also larger than the impact of the increase in NTBs they obtain (-0.53 percent). We can hypothesize, in line with the findings of Balistreri and Tarr (2017) and Costinot and Rodríguez-Clare (2014), that the more structure we add to the model, the larger the impact obtained compared to a more stylized model, such as NQTM.

### 4.1.2 Impacts of the UK's migration policy on GDP, welfare and factors remuneration

Unlike other previous analyses (e.g., Ortiz-Valverde and Latorre, 2018), in this chapter, we describe the impact of a restriction on migration considering skilled and unskilled labour for 5 years. Therefore, Table 5 depicts potential results under the migration restrictions scenarios, i.e., all skilled, all unskilled, and a reduction proportional to the share of EU skilled and unskilled workers labelled as "mix" (columns 6 to 11). Recall that in this scenario we follow the OECD estimations of a decline in the annual net inward migration into the UK by 116.000 persons per year over 2019-2023 and that 75 percent of this would be reflected in the labour force. As mentioned above, we accumulate this reduction in the inflow of workers throughout five years. We model an equivalent increase of 1.45 percent of the stock of workers. The results can be interpreted as foregone impacts due to impediments to immigrants´ arrival or as the effects of EU migrants leaving the UK.

Due to the immigration restriction, the UK would face a potential GDP loss between 0.35 and 0.56 percent (or US$8,485.43 and US$13,570.76 million, respectively) depending on whether the shock in migration is only applied to all unskilled or all skilled workers. In our central scenario, in which we assume a simultaneous change in the flow of skilled and

[21] To the best of our knowledge this table was not in the working paper version of the paper (Dhingra et al., 2016c).
[22] The authors explain that their decomposition does not add up to the total of -2.66 percent because they are performing "three different counterfactual exercise (per scenario) instead of one" (Dhingra et al., 2017).

unskilled workers, the potential GDP loss would be of 0.45 percent (or US$11, 043.75 million).

In contrast to the rest of the results of this chapter, the GDP per capita has not been obtained directly from our model. The GDP per capita is a back of the envelope calculation, taking into account the evolution of GDP and a rough calculation of the decrease in population associated with the reduction in the number of workers.[23] Immigration restrictions would imply a rise in GDP per capita of 0.33, 0.44 or 0.54 percent if all skilled, both type of workers or only all unskilled workers were affected, respectively.

In the case of standard elasticities, restrictions on all skilled (all unskilled) labour, the wages of skilled (unskilled) workers increase by 0.70 percent (0.86 percent). Restrictions on workers of a particular labour category lead to a decline in the supply of that labour category and consequently to an increase of its remuneration. However, the other labour category and capital become relatively more abundant and their remunerations fall. These results suggest some trends for factors' inequalities arising from migration that would contradict the UK evidence on migration (Wadsworth, 2015, 2016).

On the other hand, the effect of a joint reduction in the number of skilled and unskilled workers (Mix scenario) would lead to a small and relatively balanced impact on their remunerations. Restrictions in both types of labour supply are more similar than before so that both types of workers become less abundant and slightly better remunerated. However, firms still suffer from labour scarcity and experience an average lower capital remuneration.

When we analyse the impact of migration restrictions, considering a higher elasticity of substitution among factors for production (i.e., with Burfisher's elasticities columns), the impact on factor remunerations is less intense than with default elasticities. When workers

[23] The values for GDP per capita are obtained subtracting from the rate of variation of GDP (in Table 5) the rate of variation of population in Table 1 (0.89 percent). As is well known, the properties of logarithms (i.e., Ln(A/B) = Ln(A) – Ln(B)) can be applied to the rates of growth. We take the exact decreases in the number of all immigrants (not only workers) as reductions in population, i.e., the annual amount is 116.000 as estimated by the OECD.

become more easily substitutable within each sector the impact on wages is much smaller (this is in line with the literature on UK migration) turning slightly positive across skill categories. More flexibility helps business on average and their remuneration also turns positive, although close to zero. The overall negative impact on welfare is slightly less negative now. Recall that capital is specific so that it cannot move across sectors. This dampens considerably the impact of any changes in elasticities dealing with factors´ substitutability, and that is why the outcomes in GDP and welfare are so similar.

The higher the elasticity of substitution among factors, the smaller the impact on wages is. Therefore, we can assume that a decrease or an increase of EU workers in the UK would not increase inequality. This is in line with the findings of Wadsworth (2015), who suggests that the pressure of immigrants in the UK is more likely to reduce inequality, due to the fact that they are more skilled than immigrants in other countries.

Our current results for migration indicate that small restrictions to the flows of migrants or reductions in their stock would be slightly positive for GDPpc. However, because they are not directly derived from our model, except for GDP itself, they should be taken with a pinch of salt. They suggest that in line with the literature, migration does not necessarily reduce wages. Interestingly, though, because not all migrants are workers, the arrival of the ones that do not work puts downward pressure on GDPpc.[24]

## 4.2 Sectoral results

### 4.2.1 International trade policy impacts on production and trade flows

Table 6 presents the evolution in production, exports and imports. On the top of the table, there are three blocks of columns, which depict the aggregate impact on those variables for the five regions of the model[25]. Below appear the details by sector in the UK. Each block of columns shows the results under four scenarios: zero tariffs, soft, hard Brexit tariffs and hard

[24] Note that in the trade scenarios percentage changes in GDP and in GDPpc coincide because there is no change in population

[25]We also present the results for bilateral trade for the UK and the EU.

Brexit (which includes both tariffs and NTBs simultaneously). We concentrate in these scenarios because they grasp the essence of the sector adjustment and keep the tables manageable.

The elimination of tariffs in the UK would generate a tiny increase in total production (0.05 percent), with small rises in overall exports and imports (by 1.47 and 1.12 percent, respectively). The EU would remain nearly unaffected across these aggregates.

Agriculture, food, textiles and motor vehicles are the sectors with the largest tariffs (Table 3). Therefore, removing them in the UK would imply that domestic firms in these sectors could face more competition than the rest of sectors and hence would reduce their production. Notice that zero tariffs lead to a lower cost of imported goods and hence consumers and producers in the UK would have access to cheaper final and intermediate imported goods. Zero tariffs would push up UK´s imports in agriculture (0.53 percent), food (6.06 percent), textiles (8.49 percent) and motor vehicles (0.63 percent). As we can see, production in the three former sectors would fall while motor vehicles would be positively affected. This is because motor vehicles exports more than 50 percent of its total production, while the other sectors sell a larger share of their total production in the domestic market.

Looking at the detail on bilateral data we see that removing tariffs in the UK would lead to an increase of its imports coming from third countries (5.38 percent). However, imports coming from the EU would fall (3.91 percent). This is due to the fact that imported goods coming from the EU do not experience any reduction in terms of tariffs. In other words, with zero UK tariffs, EU goods would face the same conditions they currently enjoy. Thus, the UK would divert its imports from the EU by substituting them with imports from third regions. This trade diversion would bring about a substitution from more-efficient trade partners to other less-efficient. Turning to the bilateral trade data of the EU, we observe that EU’s imports coming from third regions would fall (0.47 percent). The UK's market would be more attractive than the European, once UK’s tariffs barriers have been eliminated.

The emergence of NTBs would imply a reduction in the UK´s aggregate production of 0.27 percent, under a soft Brexit. This fall would be associated with the decline of total production in other primary, food, motor vehicles, electronics construction, and other services. As we will note below, the impact in most of these sectors would be larger under a hard Brexit scenario, in which NTBs double their values regarding soft Brexit scenario. The emergence of NTBs reduce imports in all sectors (6.18 percent), especially those coming from the EU (-13.53 percent). In addition, the aggregate exports would face a reduction of 2.95 percent, due to the decline in most of the manufactures sectors. The exports going to the EU fall by 12.79 percent.

On the other hand, the simultaneous increase of NTBs and tariffs (hard Brexit) leads to a fall in UK's total production by 0.71 percent.0.30 percent of the hard Brexit fall in aggregate output is explained by the emergence of tariffs (hard Brexit tariffs). The decline of 0.71 percent is due to the reduction of production in construction, other services, electronics, motor vehicles, textiles, chemicals, and other primary. The drop in the production of the latter five sectors would be related to the share of their total production that is sold abroad (mainly in the EU market). The existence of NTBs leads to an export decrease to the EU and hence a decrease in total production. By contrast, the fall in other services would be related to the behaviour of domestic demand. This is because on average 31 percent of their total production is used as intermediates in the industries which would experience a production decline. Construction would be affected because of a fall in aggregate investment after Brexit.

Although the UK increases exports to third regions by 14.59 percent (2.32 percent of this rise is due to the emergence of tariffs between the UK and the EU) in the hard Brexit scenario, the increase of 14.59 percent cannot compensate for the fall in exports to the EU (28.74 percent). In other words, the increase of UK's exports to other regions would be limited by the existence of tariffs and NTBs in those markets and the importance of the European market for UK's exports. In general, most sectors which sell a substantial share of their total exports to the EU (e.g. agriculture, other primary, food, textiles, motor vehicles, etc.) would face larger trade barriers costs, losing their previous preferential conditions.

Regarding the EU, it faces slight drops in its total production, exports, and imports of 0.04, 0.40, and 0.96 percent, respectively, after a hard Brexit. Even though the EU faces the same increase of NTBs as the UK, the effect of these trade barriers would be smaller because they are applied to a smaller share of total EU´s exports and imports, than the other way around (Table 2). In addition, the EU could and would increase its intra-EU trade to compensate its export losses with the UK (under the same preferential trade conditions). Intra-EU trade would experience a rise of 1.96 percent (of which 0.75 percent would be explained by the emergence of tariffs) that is equivalent to US$63, 239.39 in absolute terms. By contrast, the total bilateral exports to the rest of trade partners (U.S., China and ROW) would rise by 2.14 percent (i.e., US$49,464.52). However, that increase is not enough to compensate for the fall in trade with the UK by 33.2 percent (i.e., US$-137, 229.93) and overall EU trade would still decline, although very slightly (by 0.40 percent, which is equivalent to US$ -24,596.02). As we can see, the reduction of 12.85 percent in the EU trade with the UK (hard Brexit tariffs) would be explained by the increase in tariffs. This means that tariffs play an important role in the flow of goods between both the UK and the EU. These trade costs could be avoided if UK remained a member of the EU.

In terms of imports, both the UK and EU face a decline in their aggregate imports. In the case of the UK, hard Brexit leads to a reduction of imports coming from the EU of 33.20 percent, while the bilateral imports from the rest of its trading partners increase by 8.86 percent. By contrast, the EU would experience a tiny decrease (0.38 percent) in its imports coming from third regions. The adjustment suggests that the EU would replace its imports coming from the UK and from third regions with intra-EU trade, due to the existence of EU trade barriers with the UK, USA, China, and ROW.

To sum up, if the UK unilaterally removes all of its tariffs and continues to enjoy the current zero tariffs with the EU, UK's production and trade would remain nearly unaffected. These results are in line with the ones derived by Dhingra et al. (2016b) and are different than the very positive ones of Minford et al. (2015). By contrast, if a hard Brexit comes into force, the aggregate exports and imports in both regions would experience a drop, contracting total production. It is important to note that the emergence of tariff plays an important role in trade

costs increases. Motor vehicles would be one of the most affected sectors in the UK, due to the emergence of trade costs, while construction would be affected by the adjustment of investment. Moreover, as noted, the impact of Brexit would be much larger in the UK than in the EU.

### 4.2.2 Impacts of UK' migration policy on production and trade flows

Table 7 provides the results of immigration restrictions on production and trade flows. It shows both the impact of migration policy with the default GTAP parameter values and the larger ones of Burfisher (2016) for the elasticity of substitution between factors of production.

Most sectors in the UK employ skilled workers more intensively than unskilled ones[26]. In addition, most industries in the UK are labour-intensive (with the exception of other primary). According to the Rybczynski theorem (1955), an increase in the endowment of one factor leads to an increase in the production of the good that uses that factor intensively, while the goods that do not use it intensively would face a decrease in their production. This implies that a decline in the number of workers would lead to a large fall across most sectors except for other primary goods.

We again run the impact of migration as a forgone impact or as immigrants leaving the UK. We begin our analysis with the results using standard GTAP elasticities (on the left of Table 7). Restrictions on the number of workers would imply a potential loss in aggregate production, exports, and imports in the UK indistinctly of labour category. Unlike the impact on other-primary (in which production would remain nearly unaffected), most of the sectors in the UK would face a loss in their total production. In addition, the effects of an immigration restriction would be most harmful when workers who go back the EU are skilled.

[26] Recall that our measures within the CGE model are based on labour remuneration which are calculated multiplying the number of workers by their wages. We obtain that most sectors are skilled intensive due to the high wages.

The UK's production would face a loss of 0.58 percent if the restrictions are applied to skilled workers versus a 0.37 percent reduction if they are applied to unskilled ones, and of 0.47 percent in the Mix scenario, with large values for the elasticity of substitution among factors of production (right of Table 7), i.e., using Burfisher's elasticities. The fall in UK´s aggregate production is slightly lower than in our standard estimates. More flexibility dampens the contraction of production. In addition, welfare which shows both the evolution of national income and private consumption is contracting a bit less now (as we saw in Table 5). Therefore, with Burfisher's elasticities there is a somewhat larger (a smaller fall in) demand compared to the results with the standard elasticities. Thus, imports fall by less with Burfisher's elasticities than with the standard elasticities for two reasons. First, because demand is relatively larger, imports that satisfy final consumption are also a bit larger than with the standard elasticity. Second, since most of the imports are intermediates and production contracts less now, these imports also fall slightly less now than with the standard elasticity. By contrast, exports fall by more than in the standard case because factor prices are slightly larger with Burfisher's elasticities (as shown in Table 5). When they were lower, they helped to overcome the emergence of tariffs and NTBs dampening slightly the fall in exports, due to lower factor costs.

Given the abundant evidence suggesting that we should not expect strong impacts on wages due to immigration, the most likely outcomes seem to be the ones with Burfisher's elasticities. These outcomes suggest very slightly lower losses for migration, compared to the ones with standard elasticities.

## 5. Conclusions

In this chapter we have estimated the quantitative impact of Brexit by means of a CGE model. In particular, we have investigated how the emergence of MFN tariffs, NTBs, a unilateral removal of the UK's tariffs, as well as restrictions to migration affect a broad set of micro and macroeconomic variables in the UK, the EU, the U.S., China and the rest of the world. We obtain results that are in line with the previous literature (e.g., Ciuriak et al., 2017; Jafari and Britz, 2018) but considerably extend the outcomes that are usually analysed. One

exception is noteworthy, however. We derive a considerably larger impact on welfare than the one derived in the influential paper of Dhingra et al. (2017). Although both models have an important array of features in common, our CGE methodology yields deeper impacts than their New Quantitative Trade Model approach.

Our joint estimate of MFN tariffs and NTBs suggests that, if a hard or "no deal" Brexit comes into force, the UK would face a decrease in GDP (1.14 percent), welfare (1.94 percent), capital rents (4.77 percent), as well as 4.26 and 4.60 percent reductions in wages for skilled and unskilled workers, respectively.

If the UK eliminates all tariffs with respect to all its trading partners, it will not be able to compensate for the above-mentioned losses. Running this scenario in isolation, its GDP remains nearly unaffected. Tariffs' elimination in the UK would lead to a tiny increase of its GDP by 0.04 percent. However, the UK would face small reductions in welfare and factors' remuneration. Concerning the welfare loss, after the increase of imported goods coming from third countries the UK reduces its trade with the EU. Because the EU is a very efficient partner this is a trade diversion effect which reduces welfare in the UK. The EU´s factors of production would also lose slightly after the UK´s tariffs elimination. These results are in line with the ones derived by Dhingra et.al. (2016) and contrasts with the one of Minford et al. (2015) who derived a very positive impact for Brexit based on such a policy.

The immigration issue has played a very important role in the discussions previous to the referendum. The Withdrawal Agreement (WA) greatly facilitates that EU (UK) migrants may remain in the UK (EU). Even in a "no deal" Brexit, massive migration can be ruled out since the bulk of EU migrants that have arrived during the recent crisis would be able to stay. However, inflows of future migrants may be controlled after the transition period established in the WA and also after December of 2020 in a no deal case. We model these potential annual restrictions of 116.00 EU migrants accumulated through five years. We find that migration is compatible with wage increases but puts downward pressure on GDP per capita. However, immigration restrictions would not be able to compensate for the trade losses of a hard Brexit.

At the sectoral level, the number of industries that would be negatively affected would depend on the level of trade barriers that would emerge after Brexit. With zero tariffs, sectors like agriculture, food and textiles would face production falls. Tariffs' elimination increases the entry of more imported goods from regions, which are competitive in those sectors, thus increasing competition in the domestic market.

On the other hand, the emergence of barriers to trade (MFN tariffs and NTBs) would mainly affect the exports of the manufacturing industry. As a consequence, production in several industries fall (e.g. textiles, other primary, chemicals, motor vehicles, and electronics). Motor vehicles would be the most affected sector, with a drop of 7.7 percent in its output.

Even though estimates of migration and trade barriers allow us to have a clearer vision of the potential effects of Brexit, future extensions including foreign direct investment and multinationals would enrich the present analysis. We believe, however, that other elements considered in other studies like uncertainty (UK Government, 2016b; OECD, 2016; PWC, 2016) have so far failed to materialize to the degree that the (substantial) negative impact derived from them implied. The losses they suggested may have been overstated.

## Appendix

### A1. Definition of Skilled and Unskilled Labour Categories.

According to ILO (2012) and Liu et al. (1998), the education level can be categorized under four skill levels. As we can see in Table A1.1, levels 3 and 4 correspond to the highest education level (tertiary education) as well as to the highest skill occupations.

We convert the eight labour categories of GTAP database into two major categories, skilled and unskilled labour. According to Liu et al. (1998), the 3rd and 4th skill levels should go together in the skilled worker category (Table 1A, page 20). Therefore, we take the 3rd and 4th ISCO-08 skill levels as skilled labour and the 1st and 2nd ISCO-08 skill levels as unskilled.

We run a central estimate in which restrictions on migration are applied in proportion to skilled and unskilled EU migrants (labelled as "Mix" in the chapter). To this aim, we need to know the percentage of workers by education attainment level and citizenship.

No database provides the number of workers by skills and citizenship, together, to the best of our knowledge. Due to this restriction, we calculate these percentages using scattered statistics within the Labour Force Survey published by Eurostat. We have found discrepancies between this and other databases, but this seems to be the most updated information to calculate the data that we need[1].

We use the "total population from 15 to 64 years by citizenship" Eurostat (2019a), the "percentage of population from 16 to 64 years by educational attainment level and citizenship" Eurostat (2019b) and the "employment rates by educational attainment level and citizenship for people from 15 to 64 years" for 2017 Eurostat (2019c).

[1] According to Wadsworth et al. (2016), The Labour Force Survey (LFS) is the best source to evaluate immigration.

As we can see in the Table A1.2, 45.58 percent of EU workers in the UK are skilled. This percentage is in line with the findings of Alfano et al. (2016). According to these latter authors, 47 percent of immigrants in the ages of 16-64 years in the UK have achieved tertiary education, and 42.6 percent of immigrants from European Economic Area (EEA) have high-level education.

Taking into account that 45.58 percent of EU workers in the UK are skilled, the impact of 1.45 percent by immigration restrictions can be disaggregated as a joint shock of 0.66 and 0.79 percent of skilled and unskilled workers, respectively.

**A2. Sensitivity Analysis.**

In order to evaluate the robustness of our model, we perform a sensitivity analysis of the results obtained across our four simulations (i.e., zero tariffs, soft Brexit, hard Brexit and OECD migration scenarios). Following Harrison et al. (1993) and Latorre and Hosoe (2016), we employ an unconditional systematic sensitivity analysis. This consists of re-running the four scenarios mentioned above but changing the values of three crucial elasticities: the elasticity of substitution between labour and capital, the Armington substitution between imports and domestic goods and the Armington substitution among imports by origin. Each elasticity has been varied, one by one, while keeping the rest fixed at their initial level. To simplify, this analysis focuses on the effects for GDP. The results are displayed in Table A2.1.

As we can see, the results are robust to changes in the value of the elasticity of substitution between factors. We have already seen this in Table 5 because using Burfisher´s (2016) values, that take a value of 12, results on GDP are the same as with the default values.

On the other hand, the Armington substitution between imported varieties and domestic goods reveals the feasibility with which consumers and producers can choose between imported varieties and domestic goods, while the Armington substitution among imports by origin shows how easy it is to change the source of the imported varieties. As we can see, in

those scenarios in which we assume the increase of barriers to trade (soft and hard Brexit), larger values in both elasticities lead to lower GDP losses in the UK. In the same line, the GDP gains in UK would be very slightly larger under the zero-tariff scenario. In other words, if consumers and producers can very flexibly substitute goods, this would enhance the GDP gains under a trade liberalization process and reduce the losses due to restrictions to trade.

This is because with larger values of these elasticities the UK can more easily substitute the trade lost with the EU with imports from other regions or with domestic production, than with smaller values for these elasticities.

Overall, the results suggest that our previous results are very robust to different elasticities specifications.

## Tables

**Table 1.** Initial data: UK and EU shares in production, exports and imports by sector

| Sector | United Kingdom | | | European Union | | |
|---|---|---|---|---|---|---|
| | Output | Exports | Imports | Output | Exports | Imports |
| Agriculture | 0.79 | 0.78 | 2.06 | 1.62 | 1.40 | 2.39 |
| Other primary | 1.28 | 3.94 | 6.98 | 0.48 | 0.94 | 17.27 |
| Food | 3.59 | 4.18 | 6.08 | 4.62 | 5.10 | 3.10 |
| Textiles | 1.01 | 1.94 | 5.29 | 1.70 | 2.89 | 5.73 |
| Wood and Paper | 2.18 | 2.02 | 3.46 | 2.70 | 3.23 | 1.71 |
| Chemicals | 5.68 | 18.54 | 14.86 | 7.49 | 18.17 | 15.34 |
| Metals | 2.23 | 6.25 | 9.95 | 3.91 | 6.77 | 5.53 |
| Motor vehicles | 1.86 | 7.55 | 8.56 | 3.23 | 9.79 | 3.35 |
| Other transport | 1.15 | 4.00 | 2.94 | 1.01 | 3.45 | 2.90 |
| Electronics | 0.80 | 3.27 | 5.10 | 1.24 | 3.55 | 6.91 |
| Other machinery | 3.14 | 12.07 | 10.76 | 5.49 | 18.90 | 10.32 |
| Other manufactures | 1.50 | 2.35 | 3.31 | 1.97 | 2.73 | 2.38 |
| Construction | 5.91 | 0.40 | 0.28 | 6.55 | 1.18 | 0.71 |
| Water transport | 0.90 | 0.52 | 0.56 | 0.77 | 1.14 | 0.81 |
| Air transport | 0.97 | 3.01 | 2.75 | 0.75 | 2.78 | 2.03 |
| Communications | 2.32 | 0.78 | 1.01 | 1.85 | 0.54 | 0.83 |
| Finance | 3.62 | 5.92 | 2.19 | 2.97 | 0.90 | 2.45 |
| Insurance | 1.92 | 1.43 | 0.34 | 1.01 | 0.96 | 0.41 |
| Business services | 13.07 | 13.99 | 5.65 | 11.25 | 6.57 | 7.59 |
| Personal services | 2.92 | 1.66 | 1.55 | 2.42 | 1.43 | 1.21 |
| Other services | 35.42 | 5.42 | 6.32 | 27.97 | 7.59 | 7.03 |
| **Manufatures** | **25.20** | **66.87** | **79.35** | **35.45** | **76.91** | **76.93** |
| **Services** | **74.80** | **33.13** | **20.65** | **64.55** | **23.09** | **23.07** |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** |

Source: Author' estimations based on GTAP 9 data base.

**Table 2.** Initial data: UK bilateral exports and imports

| Sector | Exports to | | | | | Imports from | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EU27 | US | China | ROW | TOTAL | EU27 | US | China | ROW | TOTAL |
| Agriculture | 75.94 | 3.59 | 5.40 | 15.06 | 100.00 | 49.28 | 4.03 | 1.79 | 44.89 | 100.00 |
| Other primary | 72.89 | 4.57 | 0.09 | 22.45 | 100.00 | 11.90 | 1.52 | 0.07 | 86.52 | 100.00 |
| Food | 61.78 | 9.10 | 0.96 | 28.17 | 100.00 | 75.18 | 3.00 | 1.57 | 20.25 | 100.00 |
| Textiles | 66.15 | 4.98 | 2.15 | 26.72 | 100.00 | 33.27 | 1.65 | 25.61 | 39.48 | 100.00 |
| Wood and Paper | 53.99 | 9.48 | 7.11 | 29.42 | 100.00 | 63.40 | 7.43 | 14.04 | 15.13 | 100.00 |
| Chemicals | 58.77 | 14.45 | 2.09 | 24.69 | 100.00 | 58.51 | 10.37 | 3.87 | 27.25 | 100.00 |
| Metals | 46.26 | 7.23 | 5.24 | 41.27 | 100.00 | 35.78 | 17.00 | 4.14 | 43.08 | 100.00 |
| Motor vehicles | 53.25 | 9.70 | 7.92 | 29.14 | 100.00 | 84.59 | 1.61 | 1.12 | 12.68 | 100.00 |
| Other transport | 36.57 | 16.32 | 1.82 | 45.30 | 100.00 | 38.16 | 32.21 | 2.55 | 27.08 | 100.00 |
| Electronics | 63.04 | 6.80 | 2.42 | 27.74 | 100.00 | 44.41 | 7.95 | 26.09 | 21.55 | 100.00 |
| Other machinery | 40.06 | 14.98 | 4.73 | 40.23 | 100.00 | 56.32 | 13.27 | 9.93 | 20.49 | 100.00 |
| Other manufactures | 42.03 | 15.63 | 1.09 | 41.25 | 100.00 | 38.80 | 17.68 | 21.33 | 22.19 | 100.00 |
| Construction | 42.51 | 2.59 | 0.69 | 54.22 | 100.00 | 39.14 | 2.73 | 10.48 | 47.65 | 100.00 |
| Water transport | 46.62 | 1.36 | 0.23 | 51.79 | 100.00 | 60.63 | 2.79 | 0.88 | 35.71 | 100.00 |
| Air transport | 41.82 | 17.03 | 0.49 | 40.66 | 100.00 | 55.74 | 9.87 | 0.27 | 34.11 | 100.00 |
| Communications | 65.70 | 6.85 | 0.28 | 27.17 | 100.00 | 48.01 | 13.56 | 1.72 | 36.72 | 100.00 |
| Finance | 42.62 | 24.54 | 1.01 | 31.84 | 100.00 | 32.22 | 33.52 | 0.25 | 34.00 | 100.00 |
| Insurance | 22.26 | 43.99 | 1.72 | 32.03 | 100.00 | 53.29 | 20.46 | 1.38 | 24.87 | 100.00 |
| Business services | 60.78 | 4.70 | 2.12 | 32.39 | 100.00 | 40.73 | 12.29 | 3.56 | 43.42 | 100.00 |
| Personal services | 52.36 | 10.93 | 0.85 | 35.86 | 100.00 | 48.78 | 25.39 | 1.11 | 24.72 | 100.00 |
| Other services | 40.61 | 21.55 | 2.07 | 35.77 | 100.00 | 46.44 | 17.95 | 1.90 | 33.70 | 100.00 |
| **Manufacturing** | **53.18** | **11.64** | **3.49** | **31.69** | **100.00** | **51.20** | **9.38** | **7.88** | **31.55** | **100.00** |
| **Services** | **49.60** | **14.96** | **1.55** | **33.90** | **100.00** | **44.75** | **17.02** | **1.98** | **36.24** | **100.00** |
| **Total** | **51.73** | **12.98** | **2.70** | **32.58** | **100.00** | **49.41** | **11.50** | **6.24** | **32.85** | **100.00** |

Source: Authors' estimations based on GTAP 9 data base.

**Table 3.** Non-tariff barriers and MFN tariff under Brexit

| Sectors | Very Soft Brexit | Soft Brexit | Hard Brexit | | | | |
|---|---|---|---|---|---|---|---|
| | NTBs to Trade | NTBs to Trade | NTBs to Trade | MFN tariff | | Total | |
| | In EU and UK | In EU and UK | In EU and UK | In EU | In UK | In EU | In UK |
| Agriculture | 5.68 | 14.20 | 28.40 | 10.20 | 10.80 | 38.60 | 39.20 |
| Other primary | 5.68 | 14.20 | 28.40 | 0.00 | 0.10 | 28.40 | 28.50 |
| Food | 5.68 | 14.20 | 28.40 | 19.80 | 22.00 | 48.20 | 50.40 |
| Textiles | 1.92 | 4.80 | 9.60 | 10.00 | 9.50 | 19.60 | 19.10 |
| Wood and Paper | 1.12 | 2.80 | 5.70 | 0.50 | 1.00 | 6.20 | 6.70 |
| Chemicals | 1.36 | 3.40 | 6.80 | 2.80 | 2.70 | 9.60 | 9.50 |
| Metals | 1.20 | 3.00 | 6.00 | 1.90 | 2.00 | 7.90 | 8.00 |
| Motor vehicles | 2.56 | 6.40 | 12.80 | 8.00 | 8.80 | 20.80 | 21.60 |
| Other transport | 1.88 | 4.70 | 9.40 | 1.70 | 1.60 | 11.10 | 11.00 |
| Electronics | 1.28 | 3.20 | 6.40 | 0.90 | 1.50 | 7.30 | 7.90 |
| Other machinery | 0.00 | 0.00 | 0.00 | 1.70 | 1.80 | 1.70 | 1.80 |
| Other manufactures | 1.12 | 2.80 | 5.70 | 2.60 | 2.20 | 8.30 | 7.90 |
| Construction | 0.48 | 1.20 | 2.30 | | | 2.30 | 2.30 |
| Water transport | 0.80 | 2.00 | 4.00 | | | 4.00 | 4.00 |
| Air transport | 0.20 | 0.50 | 1.00 | | | 1.00 | 1.00 |
| Communications | 1.16 | 2.90 | 5.90 | | | 5.90 | 5.90 |
| Finance | 1.12 | 2.80 | 5.70 | | | 5.70 | 5.70 |
| Insurance | 1.08 | 2.70 | 5.40 | | | 5.40 | 5.40 |
| Business services | 1.48 | 3.70 | 7.50 | | | 7.50 | 7.50 |
| Personal services | 0.44 | 1.10 | 2.20 | | | 2.20 | 2.20 |
| Other services | 0.44 | 1.10 | 2.20 | | | 2.20 | 2.20 |

Source: Ecorys (2009) and Latorre et al. (2018).

**Table 4.** Trade and migration scenarios under Brexit

| Trade Scenarios | Conditions | |
|---|---|---|
| Zero Tariff | Unilateral tariffs' elimination in UK (including zero tariffs on EU products). | |
| Very Soft Brexit | Emergence of 1/10 of the reference NTBs and zero tariffs between UK and EU | |
| Soft Brexit | Emergence of 1/4 of the reference NTBs and zero tariffs between UK and EU | |
| Hard Brexit | Emergence of 1/2 of the reference NTBs and MFN tariff increase (WTO rules) between UK and EU27. | |
| **Migration Scenarios** | **Change in Number of Workers (% and absolute value)** | **Change in Population (%)** |
| OECD (2016) scenario | -1.45%<br>435,000 (i.e., 87,000 x 5) | 0.89% |
| | Skilled (-0.66%), Unskilled (-0.79%) | |

Source: Author's estimations based on Eurostat (2017) database
Note: The reference NTBs are the barriers provided by Ecorys (2009).

**Table 5.** Macroeconomic impact of Brexit in the UK

| GDP | Trade restrictions | | | | | Migration restrictions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | With Standard: | | | With Burfisher´s: | | |
| | | | | | | Elasticity of substitution among factors of production | | | | | |
| | Zero tariff | Very soft brexit | Soft brexit | Hard brexit tariff | Hard brexit | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| EU27 | 0.00 | -0.03 | -0.07 | -0.01 | -0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| UK | 0.04 | -0.20 | -0.49 | -0.15 | -1.14 | -0.56 | -0.45 | -0.35 | -0.56 | -0.45 | -0.35 |
| United States | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| China | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ROW | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | | | |
| **Welfare as a percentage of bechmark GDP** | **Zero tariff** | **Very soft brexit** | **Soft brexit** | **Hard brexit tariffs** | **Hard brexit** | **All skilled** | **Mix** | **All unskilled** | **All skilled** | **Mix** | **All unskilled** |
| EU27 | -0.02 | -0.03 | -0.07 | -0.03 | -0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| UK | -0.06 | -0.38 | -0.91 | -0.28 | -1.94 | -0.55 | -0.44 | -0.34 | -0.52 | -0.42 | -0.33 |
| United States | 0.01 | 0.00 | 0.01 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| China | 0.04 | 0.00 | 0.01 | 0.02 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ROW | 0.01 | 0.02 | 0.04 | 0.01 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| TOTAL | 0.00 | -0.01 | -0.03 | -0.01 | -0.06 | -0.02 | -0.02 | -0.01 | -0.02 | -0.02 | -0.01 |
| | | | | | | | | | | | |
| **Capital remuneration (average percentage change)** | **Zero tariff** | **Very soft brexit** | **Soft brexit** | **Hard brexit tariffs** | **Hard brexit** | **All skilled** | **Mix** | **All unskilled** | **All skilled** | **Mix** | **All unskilled** |
| EU27 | -0.12 | -0.11 | -0.25 | -0.22 | -0.60 | -0.01 | -0.01 | 0.00 | -0.01 | -0.01 | 0.00 |
| UK | -0.31 | -1.03 | -2.32 | -1.63 | -4.77 | -0.43 | -0.33 | -0.24 | 0.10 | 0.09 | 0.07 |
| United States | 0.05 | 0.07 | 0.15 | 0.10 | 0.36 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| China | 0.10 | 0.04 | 0.10 | 0.09 | 0.25 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| ROW | 0.03 | 0.06 | 0.14 | 0.10 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | | | |
| **Wages (percentage change)** | **Zero tariff** | **Very soft brexit** | **Soft brexit** | **Hard brexit tariffs** | **Hard brexit** | **All skilled** | **Mix** | **All unskilled** | **All skilled** | **Mix** | **All unskilled** |
| EU27 Skilled | -0.12 | -0.09 | -0.21 | -0.17 | -0.54 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| EU27 Unskilled | -0.13 | -0.10 | -0.24 | -0.20 | -0.61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| UK Skilled | -0.30 | -0.83 | -1.96 | -0.95 | -4.26 | 0.70 | 0.27 | -0.23 | 0.23 | 0.15 | 0.07 |
| UK Unskilled | -0.32 | -0.91 | -2.12 | -1.06 | -4.60 | -0.44 | 0.19 | 0.86 | 0.10 | 0.14 | 0.19 |

Source: Author's estimations

Note: The standard values for the elasticity of substitution between factors of production in each sector use the default GTAP values and the values of Burfisher (2016) are used in the other set of

**Table 6**. Effects of trade restrictions in total production, exports and imports in the United Kingdom by industry (percentage change)

| | Aggregate Production | | | | Aggregate Exports | | | | Aggregate Imports | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Zero tariff | Soft Brexit | Hard Brexit Tariffs | Hard Brexit | Zero tariff | Soft Brexit | Hard Brexit Tariffs | Hard Brexit | Zero Tariff | Soft Brexit | Hard Brexit Tariffs | Hard Brexit |
| UK | 0.05 | -0.27 | -0.30 | -0.73 | 1.47 | -2.95 | -3.89 | -7.31 | 1.12 | -6.18 | -8.39 | -13.49 |
| *to or from EU* | | | | | *1.38* | *-2.79* | *-3.70* | *-8.74* | *-3.91* | *-13.53* | *-17.86* | *-33.20* |
| *to or from Third Regions* | | | | | *1.72* | *7.14* | *2.32* | *14.59* | *5.38* | *2.83* | *3.61* | *8.86* |
| EU27 | -0.01 | -0.02 | -0.01 | -0.04 | -0.001 | -0.174 | -0.184 | -0.40 | -0.07 | -0.42 | -0.31 | -0.96 |
| *to or from EU27* | | | | | *0.105* | *0.804* | *0.749* | *1.96* | *0.11* | *0.80* | *0.75* | *1.96* |
| *to or from UK* | | | | | *-3.910* | *-11.533* | *-12.858* | *-33.20* | *1.38* | *-13.79* | *-10.20* | *-26.74* |
| *to or from Third Regions* | | | | | *0.531* | *0.836* | *0.749* | *2.14* | *-0.47* | *-0.04* | *-0.28* | *-0.38* |
| United States | 0.01 | 0.02 | 0.02 | 0.01 | 0.00 | 0.13 | 0.11 | 0.00 | 0.09 | 0.19 | 0.14 | 0.09 |
| China | 0.00 | 0.01 | 0.01 | 0.00 | 0.08 | -0.07 | -0.05 | 0.08 | 0.16 | 0.06 | 0.09 | 0.16 |
| Rest of the World | 0.00 | 0.02 | 0.02 | 0.00 | 0.02 | -0.05 | 0.01 | 0.02 | 0.04 | 0.19 | 0.11 | 0.04 |

| | Production in UK | | | | Exports in UK | | | | Imports in UK | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sectors** | Zero Tariff | Soft Brexit | Hard Brexit Tariffs | Hard Brexit | Zero Tariff | Soft Brexit | Hard Brexit Tariffs | Hard Brexit | Zero Tariff | Soft Brexit | Hard Brexit Tariffs | Hard Brexit |
| Agriculture | -0.36 | 0.04 | -0.45 | 0.96 | 3.74 | -31.01 | -25.62 | -59.18 | 0.53 | -9.12 | -6.87 | -16.69 |
| Other primary | 0.01 | -0.08 | 0.02 | -0.07 | -0.25 | -24.02 | 1.97 | -35.92 | 0.21 | -11.05 | -1.53 | -16.51 |
| Food | -0.84 | -0.20 | -0.36 | 0.98 | 3.33 | -26.60 | -30.96 | -52.41 | 6.06 | -19.22 | -22.50 | -41.01 |
| Textiles | -3.44 | 0.14 | -3.56 | -1.72 | 8.95 | -11.39 | -30.08 | -38.22 | 8.49 | -5.53 | -6.00 | -13.52 |
| Wood and paper | 0.16 | 1.31 | 0.77 | 2.95 | 1.47 | -1.72 | 1.05 | -3.64 | -0.13 | -6.18 | -2.48 | -13.41 |
| Chemicals | 0.26 | 0.38 | -1.95 | -1.74 | 1.19 | -1.29 | -0.74 | -13.28 | 0.64 | -5.43 | -3.81 | -12.87 |
| Metals | 0.75 | 0.45 | -1.04 | 0.04 | 2.30 | -3.19 | -3.63 | -9.27 | 1.01 | -2.66 | -2.94 | -6.76 |
| Motor vehicles | 0.71 | -3.42 | -5.55 | -7.79 | 1.95 | -12.44 | -10.79 | -33.30 | 0.63 | -9.59 | -10.30 | -25.01 |
| Other transport | 0.69 | 0.53 | 0.33 | 1.60 | 2.47 | -3.79 | -1.27 | -6.66 | 1.43 | -7.08 | -2.80 | -14.24 |
| Electronics | 0.78 | -0.85 | 0.00 | -1.76 | 2.40 | -6.49 | -1.86 | -13.88 | 0.75 | -5.08 | -2.26 | -10.99 |
| Other machinery | 0.78 | 2.70 | -0.18 | 4.44 | 2.21 | 5.71 | -2.16 | 7.54 | 0.92 | -2.86 | -3.67 | -6.26 |
| Other manufactures | 0.03 | 0.32 | -0.28 | 0.19 | 2.22 | -0.07 | -5.67 | -3.92 | 1.12 | -5.05 | -3.41 | -13.32 |
| Construction | 0.16 | -2.48 | -1.26 | -5.42 | 0.87 | 6.75 | 3.77 | 15.57 | -0.30 | -7.42 | -3.22 | -15.30 |
| Water transport | 0.40 | 1.14 | 0.59 | 2.51 | 0.41 | 1.02 | 0.61 | 2.27 | 0.03 | -1.43 | -0.23 | -2.87 |
| Air transport | 0.47 | 1.45 | 0.58 | 2.88 | 0.80 | 2.35 | 0.93 | 4.74 | -0.34 | -1.73 | -0.32 | -3.44 |
| Communications | 0.11 | 0.47 | 0.47 | 1.11 | 0.79 | -0.51 | 1.97 | -0.36 | -0.40 | -4.62 | -0.75 | -9.30 |
| Finance | 0.26 | 0.82 | 0.78 | 1.95 | 0.58 | 0.69 | 1.63 | 2.03 | -0.22 | -3.00 | -0.58 | -6.12 |
| Insurance | 0.01 | 0.39 | 0.42 | 0.99 | 0.85 | 3.28 | 2.21 | 7.63 | -0.53 | -5.19 | -0.99 | -10.37 |
| Business services | 0.18 | 0.14 | 0.39 | 0.44 | 0.68 | -0.80 | 2.12 | -0.77 | -0.35 | -5.32 | -1.09 | -10.68 |
| Personal services | 0.01 | 0.34 | 0.40 | 0.87 | 0.99 | 3.99 | 2.29 | 9.00 | -0.59 | -3.86 | -0.95 | -7.85 |
| Other services | -0.12 | -0.08 | 0.21 | -0.06 | 1.20 | 4.65 | 2.37 | 10.42 | -0.72 | -4.19 | -1.18 | -9.56 |

Source: Author's estimations

**Table 7.** Effects of migration restrictions after Brexit in total production, exports and imports in the United Kingdom by industry (percentage change)

| | Standard Elasticity of Substitution among Factors of Production | | | | | | | | | Burfisher's Elasticity of Substitution among Factors of Production | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aggregate Production | | | Aggregate Exports | | | Aggregate Imports | | | Aggregate Production | | | Aggregate Exports | | | Aggregate Imports | | |
| | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled |
| UK | -0.58 | -0.42 | -0.33 | -0.22 | -0.15 | -0.09 | -0.54 | -0.44 | -0.35 | -0.51 | -0.41 | -0.32 | -0.52 | -0.43 | -0.32 | -0.32 | -0.26 | -0.20 |
| *to or from EU* | | | | *-0.21* | *-0.14* | *-0.08* | *-0.54* | *-0.43* | *-0.34* | | | | *-0.53* | *-0.42* | *-0.32* | *-0.31* | *-0.24* | *-0.19* |
| *to or from Third Regions* | | | | *-0.25* | *-0.17* | *-0.11* | *-0.54* | *-0.44* | *-0.35* | | | | *-0.56* | *-0.44* | *-0.35* | *-0.33* | *-0.27* | *-0.21* |
| EU27 | 0.00 | 0.00 | 0.00 | -0.03 | -0.02 | -0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.01 |
| *to or from EU27* | | | | *0.01* | *0.01* | *0.01* | *0.01* | *0.01* | *0.01* | | | | *0.02* | *0.02* | *0.01* | *0.02* | *0.02* | *0.01* |
| *to or from UK* | | | | *-0.54* | *-0.43* | *-0.34* | *-0.21* | *-0.14* | *-0.08* | | | | *-0.31* | *-0.24* | *-0.19* | *-0.53* | *-0.42* | *-0.32* |
| *to or from Third Regions* | | | | *0.01* | *0.01* | *0.01* | *0.01* | *0.00* | *0.00* | | | | *0.01* | *0.01* | *0.01* | *0.01* | *0.01* | *0.01* |
| United States | 0.00 | 0.00 | 0.00 | -0.05 | -0.04 | -0.04 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | 0.00 | -0.01 | -0.01 | 0.00 |
| China | 0.00 | 0.00 | 0.00 | -0.03 | -0.03 | -0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Rest of the World | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | 0.00 |
| | | | | | | | | | | | | | | | | | | |
| **Sectors** | Production in UK | | | Exports in UK | | | Imports in UK | | | Production in UK | | | Exports in UK | | | Imports in UK | | |
| | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled | All skilled | Mix | All unskilled |
| Agriculture | -0.14 | -0.19 | -0.23 | 0.78 | 0.36 | 0.02 | -0.47 | -0.31 | -0.18 | -0.35 | -0.47 | -0.39 | -0.53 | -0.50 | -0.47 | -0.16 | -0.11 | -0.05 |
| Other primary | -0.01 | -0.01 | 0.00 | 0.50 | 0.41 | 0.34 | -0.60 | -0.49 | -0.39 | -0.30 | -0.23 | -0.16 | 0.03 | 0.05 | 0.07 | -0.52 | -0.42 | -0.34 |
| Food | -0.45 | -0.36 | -0.29 | -0.06 | -0.07 | -0.08 | -0.48 | -0.37 | -0.28 | -0.38 | -0.46 | -0.37 | -0.58 | -0.47 | -0.38 | -0.28 | -0.22 | -0.17 |
| Textiles | -0.70 | -0.56 | -0.43 | -0.58 | -0.46 | -0.36 | -0.44 | -0.35 | -0.26 | -0.81 | -0.65 | -0.51 | -0.90 | -0.72 | -0.57 | -0.31 | -0.24 | -0.19 |
| Wood and paper | -0.60 | -0.48 | -0.39 | -0.29 | -0.27 | -0.25 | -0.51 | -0.40 | -0.31 | -0.68 | -0.54 | -0.43 | -0.75 | -0.61 | -0.49 | -0.26 | -0.20 | -0.16 |
| Chemicals | -0.42 | -0.34 | -0.27 | -0.21 | -0.17 | -0.13 | -0.48 | -0.39 | -0.31 | -0.53 | -0.42 | -0.33 | -0.40 | -0.32 | -0.25 | -0.41 | -0.33 | -0.25 |
| Metals | -0.67 | -0.55 | -0.45 | -0.48 | -0.39 | -0.31 | -0.54 | -0.44 | -0.36 | -0.65 | -0.52 | -0.41 | -0.67 | -0.54 | -0.43 | -0.44 | -0.35 | -0.28 |
| Motor vehicles | -0.57 | -0.45 | -0.36 | -0.35 | -0.28 | -0.21 | -0.60 | -0.49 | -0.39 | -0.52 | -0.41 | -0.33 | -0.48 | -0.38 | -0.30 | -0.31 | -0.25 | -0.19 |
| Other transport | -0.65 | -0.52 | -0.40 | -0.50 | -0.38 | -0.28 | -0.51 | -0.42 | -0.35 | -0.79 | -0.63 | -0.50 | -0.91 | -0.72 | -0.57 | -0.21 | -0.17 | -0.14 |
| Electronics | -0.52 | -0.42 | -0.34 | -0.27 | -0.21 | -0.15 | -0.66 | -0.56 | -0.47 | -0.72 | -0.58 | -0.46 | -0.81 | -0.65 | -0.51 | -0.18 | -0.15 | -0.12 |
| Other machinery | -0.63 | -0.52 | -0.42 | -0.42 | -0.33 | -0.25 | -0.60 | -0.51 | -0.43 | -0.69 | -0.55 | -0.44 | -0.82 | -0.65 | -0.52 | -0.18 | -0.14 | -0.09 |
| Other manufactures | -0.60 | -0.49 | -0.39 | -0.24 | -0.18 | -0.14 | -0.58 | -0.47 | -0.38 | -0.58 | -0.47 | -0.37 | -0.72 | -0.58 | -0.45 | -0.22 | -0.18 | -0.14 |
| Construction | -0.75 | -0.66 | -0.58 | 0.85 | 0.27 | -0.21 | -1.20 | -0.80 | -0.47 | -0.13 | -0.11 | -0.09 | -0.44 | -0.41 | -0.38 | 0.12 | 0.11 | 0.11 |
| Water transport | -0.12 | -0.14 | -0.15 | -0.07 | -0.10 | -0.12 | -0.31 | -0.25 | -0.20 | -0.19 | -0.15 | -0.13 | -0.14 | -0.11 | -0.10 | -0.26 | -0.21 | -0.16 |
| Air transport | -0.31 | -0.29 | -0.27 | -0.07 | -0.12 | -0.17 | -0.54 | -0.41 | -0.30 | -0.45 | -0.37 | -0.30 | -0.30 | -0.25 | -0.20 | -0.46 | -0.37 | -0.29 |
| Communications | -0.44 | -0.39 | -0.35 | 0.26 | -0.03 | -0.27 | -0.65 | -0.41 | -0.21 | -0.58 | -0.47 | -0.38 | -0.44 | -0.38 | -0.34 | -0.37 | -0.28 | -0.20 |
| Finance | -0.46 | -0.31 | -0.19 | -0.22 | -0.10 | 0.00 | -0.44 | -0.36 | -0.29 | -0.56 | -0.44 | -0.34 | -0.42 | -0.32 | -0.24 | -0.38 | -0.31 | -0.24 |
| Insurance | -0.57 | -0.42 | -0.29 | -0.23 | -0.09 | 0.03 | -0.50 | -0.42 | -0.36 | -0.59 | -0.46 | -0.35 | -0.48 | -0.37 | -0.28 | -0.35 | -0.28 | -0.23 |
| Business services | -0.56 | -0.39 | -0.25 | -0.36 | -0.04 | 0.23 | -0.43 | -0.45 | -0.46 | -0.54 | -0.42 | -0.32 | -0.54 | -0.39 | -0.28 | -0.27 | -0.23 | -0.20 |
| Personal services | -0.39 | -0.45 | -0.50 | 0.56 | -0.06 | -0.57 | -0.78 | -0.46 | -0.19 | -0.58 | -0.48 | -0.40 | -0.42 | -0.41 | -0.40 | -0.38 | -0.28 | -0.19 |
| Other services | -0.60 | -0.48 | -0.38 | -0.08 | -0.10 | -0.12 | -0.56 | -0.43 | -0.32 | -0.64 | -0.49 | -0.38 | -0.49 | -0.39 | -0.32 | -0.33 | -0.26 | -0.20 |

Source: Author's estimations
Note: See note in Table 5.

**Table A1.** Mapping of ISCO-08 major groups to skill levels and Mapping of ISCO-08 skill level to ISCED-97 levels of education.

| ISCO-08 Major groups | ISCO-08 Skill Level | ISCED-97 Groups | ISCO-08 Skill Level |
|---|---|---|---|
| 1 Managers | 3+4 | 6 Second stage of tertiary education | 4 |
| 2 Professionals | 4 | 5a First stage of tertiary education | 4 |
| 3 Technicians and Associate Professionals | 3 | 5b First stage of tertiary education (short medium duration) | 3 |
| 4 Clerical Support Workers | 2 | 4 Post-secondary, non-tertiary education | 2 |
| 6 Skilled Agricultural, Forestry and Fishery Workers | 2 | 3 Upper secondary level of education | 2 |
| 7 Craft and Related Trades Workers | 2 | 2 Lower secondary level of education | 2 |
| 8 Plant and Machine Operators and Assemblers | 2 | 1 Primary level of education | 1 |
| 9 Elementary Occupations | 1 | | |
| 0 Armed Forces Occupations | 1+2+4 | | |

Source: ILO (2012)

**Table A1.2** Total population and employment by educational attainment level and citizenship

| **Citizenship** | **Total Employment (thousands)** | | | |
|---|---|---|---|---|
| | Less than primary, primary and lower secondary education (levels 0-2) | Upper secondary and post-secondary non-tertiary education (levels 3 and 4) | Tertiary education (levels 5-8) | **Total** |
| EU27 | 317 | 967 | 1076 | **2360** |
| Non-EU | 460 | 1313 | 1795 | **3569** |
| UK | 4487 | 11390 | 11891 | **27768** |
| ***Total*** | ***5265*** | ***13670*** | ***14762*** | **33697** |
| | ***Total Employment (percentages)*** | | | |
| | ***Unskilled*** | | ***Skilled*** | ***Total*** |
| EU27 | *54.42* | | *45.58* | **100** |
| Non-EU | *49.69* | | *50.31* | **100** |
| UK | *57.18* | | *42.82* | **100** |

Source: Author's estimations based on Eurostat (2017) database, ILO (2012) , Alfano et al., (2016)

**Table A2.1** Sensitivity analysis

| | | | GDP | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Zero tariffs | Soft | Hard tariffs | Hard total | Migration restrictions | | |
| | | | | | | | All skilled | Mix | All unskilled |
| *Core estimations* | | EU27 | 0.00 | -0.07 | -0.01 | -0.14 | 0.00 | 0.00 | 0.00 |
| | | GBR | 0.04 | -0.49 | -0.15 | -1.14 | -0.56 | -0.45 | -0.35 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | CHN | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| | | ROW | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | |
| **A) Elasticity of substitution between labor and capital** | Half | EU27 | 0.00 | -0.07 | -0.01 | -0.14 | 0.00 | 0.00 | 0.00 |
| | | GBR | 0.04 | -0.49 | -0.14 | -1.13 | -0.56 | -0.45 | -0.35 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | CHN | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| | | ROW | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | |
| | Double | EU27 | 0.00 | -0.07 | -0.01 | -0.14 | 0.00 | 0.00 | 0.00 |
| | | GBR | 0.04 | -0.49 | -0.16 | -1.14 | -0.56 | -0.45 | -0.35 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | CHN | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| | | ROW | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | |
| **B) Elasticity of substitution between imports and domestic production (Armington)** | Half | EU27 | -0.01 | -0.07 | -0.01 | -0.14 | 0.00 | 0.00 | 0.00 |
| | | GBR | 0.05 | -0.52 | -0.17 | -1.24 | -0.56 | -0.45 | -0.35 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | CHN | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| | | ROW | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | |
| | Double | EU27 | 0.00 | -0.07 | -0.02 | -0.14 | 0.00 | 0.00 | 0.00 |
| | | GBR | 0.03 | -0.45 | -0.14 | -1.01 | -0.56 | -0.45 | -0.35 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | CHN | 0.02 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| | | ROW | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | |
| **C) Elasticity of subtitution between regional allocation of imports** | Half | EU27 | 0.00 | -0.07 | -0.01 | -0.16 | 0.00 | 0.00 | 0.00 |
| | | GBR | 0.01 | -0.51 | -0.11 | -1.18 | -0.56 | -0.45 | -0.35 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | CHN | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| | | ROW | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | |
| | Double | EU27 | -0.01 | -0.06 | -0.02 | -0.13 | 0.00 | 0.00 | 0.00 |
| | | GBR | 0.06 | -0.46 | -0.18 | -1.11 | -0.56 | -0.45 | -0.35 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | CHN | 0.02 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| | | ROW | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |

Source: Author's estimations.

# Chapter 5. The economic impact of Brexit in the United Kingdom: A short and long – term general equilibrium analysis[1]

[1] This chapter has been presented at the conferences; (1) The International Conference on Economic Modelling – EcoMod 2018, organized by Ca' Foscari University of Venice, on 4-6 July 2018, in Venice, Italy. (2) The 21st and the 22nd Annual Conference on Global Economic Analysis, organized by the Center for Global Trade Analysis, on 13th -15th June 2018 and 19th-21st June 2019, in Cartagena, Colombia and Warsaw, Poland, respectively. (3) The 27th International Input-Output Association -IIOA Conference, organized by IIOA, on June 30 – July 05, 2019, in Glasgow, Scotland.

A paper with content related to this chapter, has been accepted for presentation in the 23rd Annual Conference on Global Economic Analysis

**Abstract**

This chapter provides a thorough assessment of the impact of Brexit through trade by means of both a static and a dynamic Computable General Equilibrium (CGE) model. To this aim we use the static Global Trade Analysis Project (GTAP) and the Recursive Dynamic GTAP RD models, both extended to consider Non-Tariff Barriers. Our analysis allows us to shed light not only on the role of trade, but also on some of the potential effects of Foreign Direct Investment (FDI).

The static model helps us to understand the role of FDI and barriers to trade in the overall impact of Brexit in the dynamic setting. Regarding barriers to trade, we study three potential scenarios: soft Brexit, Johnson's Brexit and hard Brexit. We extend our previous research including the simulation of the new agreement negotiated by Boris Johnson, which would introduce more barriers to trade than the one struck by Theresa May. To the best of our knowledge this is one of the few assessments which simulates this new agreement. With respect to FDI, we analyse several reductions in the United Kingdom's capital stock, which are consistent with the empirical evidence on potential reductions in the FDI capital stock after Brexit.

We estimate the long and short-run impact on GDP, welfare, capital remuneration, capital accumulation, skilled and unskilled wages, together with the evolution of aggregate exports and imports for the United Kingdom (UK),the European Union (EU), China, US and the Resto of the World. Additionally, we offer the results for sectoral output, exports, imports and capital demand, across the 21 sectors in which the UK has been split under both the static and the dynamic setting. We find that a static model of trade does only partially grasp the negative impact on the services sectors of the UK economy. By contrast, once a static trade shock is combined with capital stock reductions or the same trade shock is run in a dynamic setting, most of the services sectors are damaged.

## 1. Introduction

Most of the previous studies on Brexit have analysed its impact on trade. Others have included elements such as migration, uncertainty, exchange rate effects, budget savings and changes in the unemployment rate (for more details see Busch and Matthes, 2016; Fernandez-Pacheco et al., 2018; Latorre and Yonezawa, 2018; Latorre et al., 2019a). However, only a few have analysed in detail the impact of Foreign Direct Investment (FDI) and have disentangled its effects from the ones caused by other forces. Modelling FDI is much more difficult than modelling some aspects of trade (tariffs and non-tariffs barriers). Investment is volatile and to a great extent, its performance is more difficult to be grasped than trade (Fernández-Pacheco et al., 2018).

According to the World Investment Report (UNCTAD, 2018), FDI inflows to the United Kingdom (UK) declined by 92 percent in 2017. This contraction is explained by the return to prior levels of FDI inflows in the UK after the large cross-border mergers and acquisitions (M&As) that it experienced in 2016. However, this negative evolution may also be related to the uncertainty generated by Brexit.

The potential emergence of restrictions on cross-border investment due to Brexit suggests that the total cost of leaving the EU is likely to be larger than what previous estimations based only on trade and migration suggest. Therefore, this chapter provides an impact assessment of Brexit considering not only barriers to trade but also the role of FDI in the UK.

Regarding barriers to trade, we include in our estimations the impact of both, tariffs and non-tariffs barriers (NTBs). It is standard to model tariffs in CGEs. However, not all of them include the treatment of NTBs, which is crucial in the context of Brexit. The treatment of NTBs implies dealing with how rents are assigned and how inefficiencies are accounted for all sectors across countries. Unlike tariffs, NTBs do not provide revenues to governments, the wedge between the world price and the domestic one created by an NTBs reduce competition from other firms and allow inefficient firms to increase their prices. In addition,

if NTBs create red tape or other unjustified bureaucratic processes, they cause a waste of resources.

We have three main objectives: the first one is to provide a thorough analysis of Brexit, including many macroeconomic and microeconomic results in the short and long-run. To do that, we use both a static and a dynamic multi-region and multi-sector Computable General Equilibrium (CGE) model. These two models are the static Global Trade Analysis Project (GTAP) model (Corong et al., 2017) and the GTAP Recursive Dynamic model (Aguiar et al., 2019a), respectively. Both models allow integrating several economic dimensions to provide a complete description of an economy, thus providing detailed macroeconomic and sectoral results. Hence, our trade-related effects are based on a very granular approach, which contrasts with the "reduced form" approach that others have derived to proxy the dynamic effects of Brexit (e.g., Dhingra et al, 2017; Aichele et al., 2015).

Regarding sectoral results we provide results for 21 sectors. We pay particular attention to the impact of Brexit on services sectors. Traditionally the UK economy is seen as a services economy, since services sectors such as finance and other business services are considered some of the strengths of this economy. Should we, then, expect that because foreign trade is not that important for services sectors as for manufactures, Brexit will not harm the UK economy to an important extent? Our data for the UK show that business services account for 12.32 percent on UK's production and that finance and insurance account for 5.05 and 1.94 per cent, respectively. These shares tend to be larger than in other economies and could potentially dampen the impact of Brexit. However, the results of the dynamic model allow us to identify that services will probably loose with Brexit, despite their limited export orientation. We believe these results may be of great interest for the policy makers and cannot be easily identified by looking at trade impacts alone in a static setting.

The second objective is to shed light on the role of FDI in the context of Brexit. Therefore, we proceed in a step by step manner to understand the contributions of trade and FDI in the overall impact of Brexit. We present a comparison between the results obtained in the static

framework with the impacts derived in the dynamic setting. The latter reflects the simultaneous impact of trade and capital accumulation, while the former allows to disentangle the impact of trade from the one of capital accumulation. Thus, the static model helps us to decompose the dynamic results in order to understand them better. A comment by Dhingra et al. (2017, p. 679) may help to express some common difficulties involved in the analysis of the results of dynamic models: "The dynamic gains from trade are less well understood than the static gains captured by our model. More empirical work is needed to establish the relative importance of the different channels studied in the theoretical literature and to allow for the development of a workhorse quantitative trade model that incorporates dynamic technology effects. However, the existing literature suggests that dynamic effects are quantitatively important and that static models substantially underestimate the gains from trade. This implies that by using a static trade model we underestimate the costs of Brexit". We believe the interpretation of the results and the decomposition we propose can shed light for policy analysis. They can also help to understand the results not only from the dynamic model we use, but also from other dynamic models, by combining trade effects with capital stock effects in a static framework.

Our third objective is to offer an estimation of the impact of the new Brexit agreement struck by Boris Johnson in Brussels last November 2019. To the best of our knowledge, there are not many assessments of this new agreement, apart from the one of Menon (2019). Johnson's agreement would introduce more barriers to trade and FDI than the one struck by Theresa May in November 2018.

For the results in this chapter we use the latest version of the GTAP 10 dataset for 2014 (Aguiar et al., 2019b), which we disaggregate in 21 sectors, 4 factors (skilled and unskilled labour, land and capital) and 5 economies (UK, EU, USA, China, and ROW). The information for 2014 is updated to the year 2020, as will be explained below.

We offer a broad set of macroeconomic results (GDP, skilled and unskilled wages, capital remuneration and accumulation, aggregate exports and imports) for both the UK and the rest

of the EU (i.e., EU28 excluding the UK). At the sectoral level we cover the impact on production, exports and imports for 21 sectors in the UK under the static and dynamic setting.

The chapter is organized as follows. Section 2 describes the new agreement negotiated by Boris Johnson and its potential implications for the UK. Section 3 presents a review of the empirical literature related to the potential evolution of FDI inflows in the UK after Brexit and how other CGE models have implemented FDI. We also explain the differences between our CGE approach and the previous ones. Section 4 describes data and simulations used in the study. Finally, we offer a detailed analysis of the macroeconomic and sectoral results in section 5, while section 6 provides the main conclusions.

## 2. The New Brexit Agreement of Boris Johnson.

The Withdrawal Agreement (WA) negotiated by Theresa May and approved by the 27 EU leaders last 25 November 2018, intended to set the main terms of the UK's exit from the EU, e.g., the divorce bill, citizens' rights, and the problematic Northern Ireland 'backstop'.

After several failed attempts to ratify the WA and its Political Declaration (PD), Prime Minister Theresa May presented her resignation on May 24, 2019. She was eventually substituted by Boris Johnson, who was elected the new UK's PM on July 24, 2019. With Boris Johnson, a new WA proposal born. This proposal seeks to remove the 'backstop' provision from the deal.

The revised WA and its PD were considered and agreed at the European Council on 17 October 2019. The former was ratified by the Members of the European Parliament with 621 votes to 49 against, and it entered in force on 31 January 2020 at midnight CET.

According to UK Government (2019a), the new PD states that the future relationships between the UK and the EU must be based on a Free trade agreement (FTA) that ensures no tariffs, no fees, charges or quantitative restrictions across all sectors. In this agreement

disciplines on Technical Barriers to Trade, Sanitary and Phyto-sanitary control and service liberalization must be based on and go beyond the WTO agreements. Therefore, it seems that this new proposal would be between the soft (i.e., a Norway-EU type of agreement) and hard Brexit (i.e., a no deal withdrawal), although the PD is not politically binding.

Under the new Brexit agreement negotiated by Boris Johnson, if the UK and EU do not agree on a new future relationship deal at the end of the transition period, an open border between Northern Ireland and Ireland will be maintained. Northern Ireland will be part of the EU customs union, while the rest of the UK will not. However, Northern Ireland will apply many EU customs rules and there will be a customs border between the UK and the Northern Ireland in the Irish Sea. Also, trade in goods between the rest of the UK and the EU will fall back to WTO rules (Curtis et al., 2019). Do note that Northern Ireland's GDP is less than 2 percent of the overall UK's GDP in 2017 (ONS, 2019) and explains 2.63 and 1.63 percent of UK's aggregate exports and imports, respectively, in 2018 (UK Government, 2019b).

Leaving the EU without a deal would imply new checks on both sides of the border, introducing delays in supply chains, which means higher cross-border costs. In addition, the flow of exports and imports conducted by foreign affiliates would also be affected and consequently could negatively impact their further investment decisions, which could be delayed or even cancelled.

Moreover, if the UK is no longer represented by the EU in the WTO, some amendments to the current lists of concessions and schedules commitments will be required. Hence, the UK will need to record its own list of concessions and commitments. This would imply that trade partners could ask for renegotiating the conditions of those agreements that would remain in force after Brexit.

According to Molinuevo (2017) and Sacerdoti (2017), after Brexit, those Preferential Trade Agreements (PTAs) that are focused only on goods and the Generalized System of Preferences (GSP) will no longer apply to the UK. However, the applicability of those

agreements that include services, investment and intellectual property (mixed agreements) remains uncertain. This is because these agreements include provisions that go well beyond the competences of the EU and require the acceptance by the states that form part of the EU. On the other hand, WTO membership and Bilateral Investment Treaties (BITs) with third countries will remain in force.

Regarding BITs, until the 2009 Lisbon treaty, Member States in the EU made their network of Bilateral Investment Treaties and national regulation to attract FDI. This is because, before the 2009 Lisbon Treaty, the EU did not have formally competence over the negotiations of FDI agreements of its Member States. According to Meunier (2014, p.4) "by the time of the Lisbon Treaty, member states had about 1,200 extra-EU BITs with 148 countries, accounting for almost half of the investment agreements in the world". For example, UK had concluded over 100 BITs since 1975, the last one with Colombia in March 2010 (Molinuevo, 2017).

Although, the investment treaties concluded by the UK with third countries will remain valid after Brexit, some of these third countries may want to renegotiate some terms of the treaty or reject the deal, if they consider that Brexit could have a potential impact on their economic relationship with the UK or in their business with other EU member states. As Molinuevo (2017, p.16) suggests: "Third countries may consider that the original rights and obligations set out in the BITs are not proportionate to the new conditions and could wish to revise the terms of the investment treaty that links them to the UK". For example, Fernández-Pacheco et al. (2018) found in their study that the USA, France, Germany, Japan and China were the most important investment partners for the UK in 2014. Hence, companies located in the UK could consider that Brexit could limit their operations in the other EU member states and their government could ask to revise the current BITs with the UK or could seek the cancelation of the agreements.

The exit of the UK from the EU without a deal and even with a deal would imply an increase in the cross-border cost and potential retards, which would negatively affect the just-in-time delivery that most companies apply. According to Anastassia Beliakova, head of trade policy

at the British Chambers of Commerce, the uncertainty of Brexit negotiations "has forced companies to look at their supply chains". In the case of a no deal things would be more complicated than with a deal. For example; the aerospace giant Airbus S.E., based in Toulouse, France argues that delays produced by a withdrawal from EU without a trade deal "would be so costly that it could likely close its British operations" and "even a negotiated exit would likely throw grit into the gears of the sensitive supply chains built up over decades" (Wall Street Journal, 2018b).

As we noted above, the loss of the UK' appeal for the entry of FDI does not affect only the flows coming from the EU investors but also from the rest of partners that are interested in accessing to the European single market.

## 3. A review of the literature on FDI

There are several studies which have assessed the impact of regional integration in the flows or stocks of FDI. Overall, they find that regional integration affects FDI entry positively. Levy, E, Stein, E. and Daude, C. (2003) find evidence that a regional integration agreement (such as the EU membership) would increase the stock of FDI by around 27 percent. Fournier (2015) estimates that a reduction of 20 percent in regulatory differences increases FDI inflows by 15 percent and suggests that belonging to the EU single market can have an additional positive impact on FDI flows beyond the effects of traditional Free Trade Agreements (FTAs). This makes sense given the fact that the EU is the economic area which is most integrated (i.e., with the lowest regulatory barriers across different countries) in the world. Both studies use a gravity model. The former uses a dataset that covers FDI from 20 source countries, all of them from the OECD, while the latter uses a baseline country sample that includes OECD countries in which the share of FDI assets owned by Special Purpose Entities (SPEs) does not exceed 80 percent. The little or no physical presence of this type of company in the country implies that they are less likely to be affected by regulations of the country. Hence, it seems to be suitable to control for the share of this type of company in the

sample when the researcher wants to analyse the impact of a potential reduction in the inflow of FDI due to restrictions imposed by the host country.

In addition, there are other studies that focus on the impact of the EU membership on FDI flows. Clausing and Dorobantu (2005) examine the impact of EU membership on the Central and Eastern European economies. They find that key announcements around EU accession resulted in increased FDI inflows going to the applicant countries. Bajo-Rubio and Torres (2001) found that FDI going to Spain expanded due to its EU accession and played an important role in promoting productivity growth. Bajo-Rubio and Sosvilla-Rivero (1994) and Barrell and Pain (1998) found that the inward FDI in Spain and Portugal increased significantly after their accession into the EU in 1986. Similar results were found for the UK, Ireland, Spain and Sweden too (Barrell and Pain, 1998). Baldwin et al. (1996) also confirm the increase in FDI inflows for the accession of Austria, Finland and Sweden. It seems, that FDI inflows rise when a country forms part of the EU. Brouwer et al. (2008) estimate the impact of a potential enlargement of the European Monetary Union (EMU) to the ten countries that obtained EU membership in 2004. They estimate that the FDI inflow would rise around 21 percent.

On the other hand, UK Government (2016b), Clausing and Dorobantu (2005) and Bruno et al. (2016) have estimated the potential impact on FDI of leaving the EU. UK Government (2016b) estimates comprise different ranges of FDI reductions. It estimates the impact on total FDI inflows into the UK from EU and non-EU countries under different counterfactuals using a panel dataset constructed with FDI data for 40 countries over the period 2000 to 2012. According to its three alternative scenarios, the UK would face a fall in FDI flows by 10 percent under the European Economic Area (EEA) membership, between -15 and -20 percent under an FTA with the EU or a reduction between 18 and 26 percent in the “no deal” case. These results have been latter used as inputs into modelling the overall macroeconomic impact of leaving the EU. Clausing and Dorobantu (2005) calculate that the FDI stock would decrease by 34 percent. On the other hand, Bruno et al. (2016) estimate the effect of EU

membership on FDI inflows using bilateral FDI data from 34 OECD countries between 1985 and 2013. They predict a 22 percent decrease in FDI inflows in the UK after leaving the EU.

All in all, the empirical studies analysing economic integration and FDI find a positive relationship. This is common in economic integration processes, in general, but seems to be even more pronounced in the case of EU integration and is also confirmed by the studies focusing on Brexit. Most of the studies cited above focus on estimating the size of the reduction in FDI stock or flows but do not evaluate its resulting impact. This is precisely what we do in this chapter.

Among the few papers which estimate the impact of a reduction on FDI in the UK after Brexit, we can find the analysis of Dhingra et al. (2017), OECD (2016), UK Government (2016b), Latorre et al. (2019a, 2019b, 2020), Ciuriak et al. (2015) and Pain and Young (2004).

Dhingra et al. (2017) and OECD (2016) evaluate the impact of FDI flow reductions in the UK. The former uses the average of the estimations of the impact of EU membership on FDI in the UK calculated by several authors (Bruno et al., 2016; Campos and Coricelli, 2015; Straathof et al., 2008), while OECD (2016) use the estimations of Fournier (2015).

Dhingra et al. (2017) estimate that an average reduction of 26 percent fall in the inflow of FDI would lead to lower real income in the UK by 3.4 percent. In this chapter we aim at broadening the number of variables for which we offer the impact of FDI, compared to the analysis of Dhingra et al. (2017). The OECD (2016) runs a decline on FDI stock between 10 and 45 percent. Unlike, Dhingra et al. (2017), the OECD and UK Government (2016b) approaches do not show the effects of FDI reductions in the real incomes separately from the rest of channels considered in the study (e.g., migration, tariffs and non-tariff barriers on trade, uncertainty, among others). The latter is precisely one of the objectives of this chapter, by which we want to disentangle the effects of FDI from those of trade in the dynamic impact of Brexit.

To the best of our knowledge only Latorre et al. (2019a, 2019b, 2020), Ciuriak et al. (2015), Pain and Young (2004) include FDI and the operations of multinationals. Latorre et al. (2019a, 2019b, 2020) and Ciuriak et al. (2015) derive the impact of Brexit as an increase of the barriers that multinationals would face to operate in the Brexit partners. Latorre et al. (2019a, 2019b, 2020) find that one third of the overall negative impact of Brexit (e.g., 0.88 of the overall 2.64 percent GDP fall in the UK under hard Brexit scenario) is because multinationals would face costs increases. However, Latorre et al. (2019a, 2019b, 2020) only cover the impact of Brexit on service multinationals (and not on multinationals operating in manufactures and agriculture), while this chapter covers FDI throughout all sectors of the economy. On the other hand, Ciuriak et al. (2015) estimate that the impact of FDI reductions on the GDP in the UK is close to zero (-0.002 percent). This result is surprising since multinationals play a very important role in the UK, as was shown above. Finally, Pain and Young (2004) estimate a very significant effect from FDI in the UK´s GDP (2.25 percent reduction). However, the mechanisms of FDI are different from the ones in the two previous studies because lower FDI inflows result in a reduction of productive efficiency. Note that, Pain and Young (2004) and Dhingra et al. (2017), OECD (2016) and UK Government (2016b) do not provide estimates of the impact of FDI fall on sectoral production and trade across sectors, as we do in this chapter.

There have been other attempts, not necessarily in the context of Brexit, of modelling multinationals and FDI flows in CGE models. However, due to the complex specifications of the CGE dynamic models, a lot of challenges arise to estimate the impact of FDI, or even of the changes in the capital stock in isolation. In a dynamic model using GEMPACK software it is not possible to separate the impact of capital accumulation alone from the one of trade barriers. As we have just noted, Ciuriak et al. (2015, 2016, 2017) do not derive any significant impact from FDI (or multinationals) using GEMPACK software when they evaluate the impact of the TPP and Brexit, although they extend the model specifically to account for the presence of foreign affiliates. On the other hand, the study by the USITC (2019) combines econometric estimations and a CGE model formulated in GEMPACK that

includes foreign affiliate sales to derive more sizeable impacts from multinationals. Adjustments in the Investor State Dispute Settlements of the USMCA could result in a 4.8 percent reduction in FDI stocks within affected industries in Mexico.

Using GAMS software, some authors (e.g., Hosoe, 2014; Latorre and Hosoe, 2016) have derived the direct impact of FDI in isolation in different contexts. However, they evaluate the overall impact from FDI, and the effects for the operations of foreign multinationals and national firms, with a very comprehensive modelling strategy, but they seldom combine those FDI and multinationals effects with other trade effects derived from NTBs.[1] These previous studies suggest that dynamic modelling entails its difficulties. Our analysis allows to get a proxy of the impact of capital accumulation itself, which has received very little attention in CGE models.

On the other hand, few studies have looked at the dynamic effects of Brexit (Dhingra et al., 2017; Aichele et al., 2015 and PwC, 2016). To incorporate the dynamic impact of Brexit in the UK, both Dhingra et al. (2017) and Aichele et al. (2015) used a reduced form approach that "uses existing empirical estimates of the effects of EU membership to infer the impact of leaving the EU on UK income per capita" (Dhingra et al., 2017 p. 679). Dhingra et al. (2017) derive reductions in GDP per capita in the UK in a range of 6.3–9.4 percent. Aichele et al. (2015) report that GDP per capita could fall between 6 and 26 percent in the UK. However, "we must warn readers here not to take the results too seriously because they always apply the average effect of openness (determined for many countries) to the specific case of a Brexit" (Aichele et al., 2015, p. 50). Regarding PwC (2016), for a soft Brexit they predict a contraction in GDP per capita in the UK of 0.8% in 2030, while for the hard Brexit they predict a fall of 2.7%. Because population growth cannot expected to be very high in

[1] It is noteworthy the very detailed distinction between the technology of national firms and multinationals in each of the sectors in the models of Hosoe (2014) and Latorre and Hosoe (2016), which is to the best of our knowledge the most demanding in terms of data and modelling effort that we have ever seen in a CGE analysis of multinationals' effects. These papers differentiate, not only labour and capital intensity ratios between both types of firms, but also their patterns of intermediates' sourcing, as well as their export orientation.

the UK in the coming decade, these results are close to the ones we obtain with a 0.96% and 2.15% contraction of GDP in 2030 after a soft and hard Brexit, respectively.

The reduced form approach has received some criticisms. Gancía suggests that "this approach suffers from well-known identification issues. For example, since EU countries are not randomly selected, it is difficult to predict what their volume of trade would be, had they not joined the EU. Second, the elasticity of income to trade is estimated using a clever strategy exploiting the fact that air travel changed the cost of the distance between country pairs. However, this raises the question of whether this elasticity is applicable to other countries, to different time periods and whether it applies to trade policy barriers as well" (Dhingra et al., 2017 p. 691).

As noted above, to the best of our knowledge, the latter dynamic models do not deliver or, at least, the authors have not reported the impact at the sector level that Brexit would imply. In addition, the results at the macroeconomic level are confined to a few variables. In this chapter we provide a very detailed sectoral analysis of production, exports and imports after Brexit and a broader set of macroeconomic results.

## 4. The Model

Our simulations are conducted by means of two well-known CGE models, namely, the static (Corong et al., 2017) and dynamic (Aguiar et al., 2019) versions of the GTAP model, extended to include Non-Tariff Barriers.

### 4.1 The static GTAP model

We use version 7 of the GTAP model (Corong et al., 2017), which is publicly available and widely-used comparative-static general equilibrium model of the global economy. The fact that the model is static implies that after a shock, each economy's equilibrium moves from one equilibrium point to another (i.e., the impact is a before and after comparison of the

economy). The results that a static model generates are derived mostly from a reallocation of resources throughout the economy (i.e., efficiency effects) unless factor endowments are allowed to change.

As a CGE model, the static GTAP model rests on the circular flow of the income and spending in the economy. In the GTAP model, incomes from production are returned to a regional household, who allocates regional income to three sources of aggregate final demand: private expenditure, government spending and saving-investment spending. As shown in Figure 1, a top-level utility function, using a Cobb-Douglas specification governs the allocation of aggregate expenditure across these three categories. Going below, we can see that preferences for private spending are represented by a Constant Differences of Elasticities implicitly additive expenditure function (CDE) and private expenditures on the composite goods are subsequently decomposed into demand for domestic and imported goods using a CES sub-utility preference á la Armington (1969), which is shown in further detail in Figure 2. Thus, the model incorporates imperfect substitutability between domestically produced and imported goods and also among the different varieties of imported goods according to the country of origin. Therefore, the demand for imports presents CES preferences between domestic and imported goods and for imports there is, in turn, another nest of CES preferences among imports from different sourcing countries. So, goods from different countries are differentiated.

Continuing with other nests in Figure 1, a CES expenditure function determines the allocation of public expenditures and investment, with a Cobb-Douglas form for public expenditures and a Leontief form for investment expenditures. Additionally, public expenditures and investment expenditure on the composite goods are subsequently decomposed into demand for domestic and imported goods again using a CES sub-utility preference á la Armington (1969), as described in Figure 2.

The behavioural adjustments to shocks introduced in the model are derived from the efficiency-maximizing behaviour of firms and the utility-maximizing behaviour of

consumers. These microeconomic optimization decisions are then comprised in a framework representing national accounts identities, which also define the equilibrium in the economy.

Regarding firm's behaviour, the production structure in GTAP model is based on a sequence of nested Constant Elasticity of Substitution (CES) functions, which allow to re-produce the substitution possibilities across the full set of inputs. Figure 3 shows this structure of production and how the allocation of production is modelled. On the top of the Figure 3, we can see that a Constant Elasticity of Transformation (CET) function allocates production to exports or to the domestic market.

Going below the CET specification in Figure 3, we reach the level of production for which the top-level nest is composed of two aggregate composite bundles. One of the bundles describes the intermediate demand and the other one value added. The elasticity of substitution between both bundles is assumed to be zero, as is common in CGE models, resulting in a Leontief specification.

In the second levels nests of Figure 3, each of these two aggregate bundles are disaggregated into their components using additional CES nests. On the one hand, the demand for individual intermediate goods follows again an CES sub-utility preference á la Armington (1969), with firms' demand for domestically produced intermediate goods and a composite of imported intermediates, which amalgamates imports from different regions. On the other hand, the other nest depicts the CES demand for individual factors of production. All factors of production are fully mobile, with the exception of land which is partially mobile and natural resources which is sector-specific. Capital is fully mobile in the static model, which suggests a long run framework for the results derived in order to properly contrast them with the ones obtained with the dynamic model.

In the static GTAP model, unchanged aggregate endowments of population, labour, and capital are assumed so that the economy's factors of production are in fixed supply, unless they are modified as a model experiment.

Mathematically, ensuring that a model is "closed" amounts to ensuring that we have enough independent equations to explain the endogenous variables. Thus, we must make a choice as to what is to be determined within the model (the endogenous variables) and what is to be considered external to the model (the exogenous variables). This is done through the closure rules.

For the labour market, we have included the most common closure, which is that the wage rates for skilled and unskilled labour are assumed to vary to ensure full employment of both types of labour (neoclassical closure). On the other hand, changes in the capital market closure are usually used to represent different adjustment time frames. When capital is sector-specific the stock of capital in each industry is exogenous, and the price of capital in each sector is endogenous. This closure choice does not attempt to explain the allocation of capital. By contrast, when capital is fully mobile, capital moves across sectors and its price is equalized. The specific factors case is thought of as "short run" adjustment and the fully mobile as "long run". As noted above, capital is assumed to be fully mobile in this chapter.

For macroeconomic closures, there is a savings-driven closure at the national level, in which the savings rate (the percentage of income that is saved) is assumed to be exogenous, constant and based on the empirical value in the GTAP dataset. This implies that a nation's savings rate remains the same as the rate observed in the base year. If the nation's income falls, as happens with Brexit, the fixed savings' rate in the UK and the rest of the EU (REU) translate into a smaller value saved in these regions. Savings of each regional household are aggregated across all regions and given to a global investor known as the "global bank", which distributes global savings across regions according to their rates of return, till capital returns converge across regions. To be more precise, investment is allocated across regions such that percentage changes in regional expected rates of return are equalized across regions. This latter mechanism is known as the rental rates of return closure. Note that the Although, many CGE modelers consider fixed trade balance a suitable closure in the short run, Bekkers and Orlov (2020) recommend that for large trade policy experiments, the rate of return

closure would be more appropriate. Because large trade policy experiments would involve investment and savings decisions, which consequently result in macroeconomic decisions, therefore, fixed trade balance closure would imply a significant loss of the action. In addition, in a framework in which we aim at studying capital accumulation processes, this closure rule seems more appropriate.

## 4.2 The recursive dynamic GTAP model

We also apply the Recursive Dynamic GTAP model (GTAP-RD) in our analysis. The core code in GTAP-RD is derived from the static GTAP model version 7 explained in Corong et al., (2017), that we have briefly described above.

Compared to the static version of GTAP, the recursive dynamic model (Aguiar et al., 2019) updates the exogenous endowments of population and labour force, technology, preferences and policies between periods. In this type of model, growth in the capital stock is derived from endogenous capital accumulation, i.e., there is a stock-flow relation between investment and capital stock, with a 1-year gestation lag. Therefore, this model reflects a sequence of time-based comparative static equilibria, which allows to estimate the long run impacts of Brexit. In our analysis, Brexit will unfold from 2020 till 2030.

Arguably, the reductions in the capital stock could be considered the dynamic effects of trade and not necessarily the impact of FDI reductions. We understand that the frontiers between trade dynamic effects and FDI inflows may be blurred. In any case, what we try to understand is which part of the dynamic adjustment corresponds to trade barriers and which part is due to reductions in the capital stock, even if the latter are also related to the dynamic impacts of trade. In order to disentangle both effects, we use a static model which introduces them in a step-by-step manner, as will be explained below.

As in the static GTAP model in GTAP-RD we assume that the allocation of global savings to investment across different regions is driven by the expected rates of return. That means,

the global investment will be allocated across regions so as to ensure that the expected rate of return is equalized across regions. Therefore, a global investor is sensitive to changes in relative rates of return. This would imply net flows of capital to countries with an above-average rate of return. Hence, the use of rate of return closure, in both the static and dynamic framework seems to be suitable to analyse and capture the impact of large trade policy experiments, such as Brexit. In addition, Bekkers and Orlov (2020) analyse the impact of different macroeconomic closures on long run trade projections and trade policy experiments. They recommend that for large trade policy experiments, the rate of return closure would be very appropriate.

To estimate the potential impact of Brexit in the long-term, each scenario is modelled against a baseline scenario in which Brexit is not in force. The difference between the two scenarios quantifies the impact of Brexit in the UK (Aguiar et al., 2019).

The baseline projection is developed simulating the model forward from the 2014 base year of the dataset (GTAP10) to 2030, using the tools of a dynamic database. In our model, the baseline includes updates in GDP, GDP per capita, population and labour force (skilled and unskilled). Different values for these variables and parameters are assumed depending on the year and region. The Shared Socioeconomic Pathways (SSP) Database developed by The International Institute for Applied Systems Analysis (IIASA), allows researchers to choose between five possible paths of socioeconomic development:

- SSP1 implies a state of environmental sustainability and is categorized as the green path.
- SSP2 corresponds to an intermediate level of growth.
- SSP3 implies a world in which scarce investments in technological development and education slow down economic growth in high, medium and low-income regions,
- SSP4 corresponds to a path with growing inequality, assumes that government and globalization are controlled by a small privileged group and that it is inefficient for most of the population.

- SPP5 corresponds to a development path with rapid economic growth, with high levels of carbon emissions.

In our simulations, the baseline projections are constructed considering the SSP2 path, as is common in the GTAP Research Center in Purdue University. This pathway assumes an extension of the current trends in urbanization in all parts of the world, along with similar middle of the road assumptions about population growth, technological change, and economic growth. High income countries continue their practices in urban development; developing countries generally follow the historical urbanization experiences of the more developed countries. All countries follow the central urbanization pathway, with various forms and patterns depending on their current practices and their stages of urbanization (IIASA, 2018, p. 7). In the Sensitivity Analysis at the end of this chapter, we run the Shared Socioeconomic Pathways 1 and 5 and analyse whether assuming those paths instead of the SSP 2 the outcomes of the model would vary substantially, which is not the case.

In addition to the pathways, dynamic models carry more assumed parameters than static ones, such as the discount factor, the depreciation rate, and the elasticity parameter of investment allocation with respect to its rental rate of return. We assume a common value for the depreciation rate of 4% (e.g., Hosoe, 2014; Latorre and Hosoe, 2016) and the GTAP default value of 10 for the elasticity of investment allocation. This elasticity parameter for investment allocation affects the climate of investment and thus the capital accumulation process. If a region's capital stock increases by 1%, then it is expected that the net rate of return on capital will decline by the percentage given by RORFLEX, i.e. 10% or 0.1 in the default specification. A larger (smaller) absolute value for this parameter will reduce (increase) the tendency of investment flows to respond to changes in expected rates of return. Since they may affect the simulation results, we examine other values for these parameters in the sensitivity analysis. We have tried to avoid the very complex issue of comparing the timelines of the static model and the dynamic model. Because we do not report any absolute values for the results after the accumulation period, we do not necessarily need a discount rate for the conversion of the absolute values to previous periods. Instead, we report percentage changes

deviations with respect to the Business as Usual (BAU) scenario for the dynamic results and with respect to the benchmark values for the static ones.

## 5. Data and Simulations

In this chapter we have also changed the database used for our simulations, compared to the previous ones. Now, the database for micro and macroeconomic variables and the model's input-output framework come from the latest version of the GTAP 10 dataset (Aguiar et al., 2019b), released in August 2019. We disaggregate the world economy in 21 sectors, 5 economies (UK, EU, USA, China, and ROW), and 4 factors of production (skilled and unskilled labour, land, and capital). We use this new database to simulate our scenarios with the static and dynamic model. With the dynamic model, scenarios are modelled against a baseline scenario or Business as Usual (BaU) simulation in which the UK remains in the European Union. The baseline is developed by simulating the model forward from the 2014 base year of the dataset to 2020, using GTAP dynamic database tools. In this latter year we simulate the shock of Brexit and then run the dynamic model results till 2030. The projections draw on the available macroeconomic data of the Shared Socio-Economic Pathways (SSPs) projections on GDP per capita, population and employment growth developed by the International Institute for Applied Systems Analysis (IIASA). GTAP has prepared a friendly version of the SPPs which includes the UN's population projections and that can be used with the GTAP recursive dynamic model. Compared to the projections of GDP and GDP per capita from other sources such as OECD, IMF and World Bank, which usually provide short and medium term projections, the SSPs version from GTAP include more countries in order to match the UN's population dimensionality and offers annualized projections that were initially available in 5-year steps (Aguiar et al., 2019a).

Although chapter 4 offers a detailed sectoral picture of the UK economy, we consider that it is necessary to update the sectoral data again in this chapter for two reasons. First, because we now use the latest version of the GTAP 10 data set, and second because the baseline

simulations allow projecting the economic conditions of the UK till the moment in which Brexit would come into force, i.e., 2020. Therefore, Tables 1 and 2 in this chapter provide a sectoral picture of the UK economy for 2020. We also include Table 3, which provides the exact values of barriers to trade that we run in our model for every scenario.

On the one hand, Table 1 provides the industry share in total production, exports and imports (columns 1, 2 and 3), as well as the import and export share on total production by sector (columns 4 and 5).

As we can see, data in Table 1 reflect a worldwide trend, in which trade in manufacturing goods prevail on total trade. In the UK, the weight of manufacturing goods in total exports and total imports is beyond 60 percent, while services account for 36.94 and 23.86 percent, respectively. The sectors that devote an important share of their production to exports or rely heavily on imports (e.g., motor vehicles, chemicals, other primary, textiles, and metals), would be expected to experience an important transmission of trade shocks into production shocks.

The share of exports and imports in total production in services is considerably smaller than in manufactures (columns 4 and 5), except for air transport. This suggests that the bulk of production in services is sold in the domestic market and that we would expect services to be less vulnerable to trade shocks. However, as we shall see services will be harmed by the Brexit shock. As we have commented in the introduction the UK economy is a services economy. Overall manufactures account for 29.31% of its production, while services account for 69.88%.

On the other hand, Table 2 shows the bilateral trade flows of the UK with the EU, the USA, China and the ROW. As we can see, the most important destinations of UK's exports are the EU and ROW, which account for 44.58 and 36.77 percent, respectively. Regarding UK's imports, 48.13 percent come from the EU and 31.07 percent from ROW. Foreign trade is expected to be more intensively affected by Brexit in the sectors that have an important share

of the bilateral trade with the EU, particularly in exports. This is true for the majority of British sectors.

Finally, Table 3 provides the exact values of the barriers that we run in our model. Columns 1 and 2 show the NTBs for every sector in the UK and in the EU with the soft and Johnson's Brexit, while columns 3, 4, and 5 reflect the values of MFN tariffs and NTBs that the UK and the EU would face under a hard Brexit. The larger size of the NTBs compared to the tariffs suggest that they would guide the bulk of Brexit's impact on trade. NTBs are especially high in agriculture, other primary, food, and motor vehicles, and to a lesser extent, in textiles, chemicals, metals, and other transport. The sectors that would experience the emergence of the largest barriers would also be the candidates to have their trade most affected by Brexit. Note that the barriers for the soft and hard Brexit are the same as the ones in the previous chapters, but now we include the ones for Johnson's Brexit.

In principle, three important characteristics that make sectors more vulnerable to Brexit are the following ones: 1) How much of the production in each sector is related to trade (last two columns in Table 1), in particular how much of the production is devoted to exports; 2) How important is the EU as a trade partner, specially, as a destination for each sector's exports (first column in Table 2); and 3) How large are trade barriers expected to be for each particular sector (Table 3). Increases (decreases) in exports are expected to be followed by a rise (contractions) in production. If these three characteristics jointly unleash forces that push to a reduction in production after Brexit, the sector will likely decrease its production. If not all of them are pushing production downwards, then they may compensate one another, leaving production nearly unchanged or experiencing a small increase.

It is less clear, a priori, the relationship between imports and production. Imports may be of intermediates and, therefore, would move in the same direction of production (i.e., if production goes up (down), then imports of intermediates would also go up (down). By contrast, imports may be final goods which will compete with (or compensate for the fall of) domestic.

However, we cannot assume that the bulk of the adjustment in total production in these sectors would be related to the evolution of trade flows. This is because, as we will see in the next sections, all sectors will face a negative impact from the reduction in the stock of capital (that we interpret as FDI shock), too. In addition, private consumption will be negatively affected with Brexit. This will constitute an extra force leading to the contraction of production in some sectors whose output is mostly devoted to the satisfaction of private consumption.

Regarding our simulations, as shown in Table 3, we estimate the effects of three broad potential post-Brexit scenarios: a soft, the Boris Johnson's and the hard Brexit. In the soft Brexit we assume that the UK and the EU continue to enjoy a free trade agreement, which implies that tariffs between both remain at zero. In this scenario we simulate the emergence of NTBs equivalent to 25 percent of the ones estimated for Europe by Ecorys (2009) (Table 3), following the approach of Dhingra et al. (2017), Latorre et al. (2019a, 2019b, 2020) and Ortiz and Latorre (2019).

The Johnson's Brexit scenario reflects the main characteristics of its political declaration. As we have noted, he proposes that the UK applies its own regulatory and trade policy based on and going beyond the WTO agreements. It also envisages the creation of a free trade area between the UK and the EU that combines deep regulatory and customs cooperation between both parties. However, the arrangements should take account of the fact that the parties will form separate markets and distinct legal orders. This could imply customs checks, product standards, regulations, and other costs of cross-border trade. For example, in terms of Sanitary and Phytosanitary Measures (SPS), parties should treat one another as single entities, so, it could imply extra regulatory checks on borders. Hence, following the approach of Menon (2019) we assume zero tariffs as in the soft Brexit. But, in terms of NTBs, these would be slightly higher than those that the UK would face under the soft Brexit and slightly lower than the hard Brexit. We simulate an increase of NTBs, whose level is 38 percent of the ones in goods and 44 percent of the ones estimated for Europe by Ecorys (2009). This is

based on the fact that the political declaration also suggests future lower convergence in services than in goods regulations.

The hard Brexit scenario represents the "no deal" case between the UK and the EU. It involves two simultaneous shocks. First, we assume that import tariffs between the UK and the EU would increase to the Most Favoured Nation (MFN) level. This means, that the UK and the EU would trade under the World Trade Organization (WTO) conditions. Second, the no deal is also composed of a shock in which we simulate the increase of NTBs, whose level is 50 percent of the ones estimated for Europe by Ecorys (2009), again following the literature.

These three types of Brexit scenarios are simulated with the static and dynamic models. Additionally, we simulate trade restrictions considering two different techniques with the dynamic model. In one of them, we assume that all trade restrictions appear in the first year once the UK leaves the EU. In the other one, we adopt a gradual increase in barriers to trade over 4 years, i.e., we apply one-third of the total shock in the first year while the rest of NTBs emerge gradually along 3 years, finally reaching the same level for the barriers as in the previous scenario.

We also simulate potential reductions in the inflow of FDI coming to the UK, proxied by reductions in the UK's capital stock. We assume decreases in FDI stocks by 6.77, 10, 16.77, 20 and 30 percent only in the UK. This allows us to cover a broad range of impacts, which are consistent with the evidence discussed in section 3. In order to simulate the impact in the stock of FDI, we consider the share of the gross capital stock in the UK, which is controlled by multinationals. According to OECD (2018), it is 15 percent. If we apply this 15 percent to the information in the GTAP database, we obtain that multinationals control US$ 114,810.42 billion of capital stock in the UK. Then, we calculate the corresponding absolute values of 6.77, 10, 16.77, 20 and 30 percent decreases in total UK FDI stocks which correspond to 1.05, 1.55, 2.43, 3.10 and 4.64 percent reductions in the overall capital stock in this country. These contractions in the capital stock in the UK are lost and not reallocated

to the rest of regions. This is because once we split it across regions the impact on them would be negligible, as analysed in the sensitivity analysis.

## 6. Results

### 6.1 Aggregate results

Table 4 offers a rich set of macroeconomic impacts arising from the emergence of trade restrictions and the reduction in the stock of FDI in the UK. Table 4 shows two sets of columns. In the first set we present the results with the static model, while the second set displays the results using the dynamic model. Columns 1, 2 and 3 display the impact of trade restrictions considering the three scenarios of soft Brexit, Johnson's Brexit and hard Brexit. Columns 4, 5, 6, 7 and 8 provide the impact of a fall in the stock of FDI in the UK, also using the static model. Columns 9, 10 and11 show the simultaneous impact of the emergence of barriers to trade and the reduction in the stock of FDI with the static model. Finally, the last three columns display the impact in 2030 of trade barriers using the dynamic model.

The impact on GDP appears at the top of the table. The effect of Brexit seems to be confined to the two regions directly involved in it, while for the rest the impact would be again negligible. That is why we focus on the results for the rest of macroeconomic variables in the UK and in the EU in the middle and bottom parts of Table 4. For the rest of regions, the impact would be very close to zero.

As we can see, the impact of Brexit would be more harmful to the UK than to the EU. The increase of barriers to trade (columns 1-3) would imply a reduction in GDP in the UK between 0.49 and 1.11 percent, while the EU would face a fall between 0.06 and 0.14 percent. In addition, the UK would face a more intense fall in GDP than the EU, when we analyse the simultaneous impact of a reduction in the stock of FDI and the rise of barriers to trade (columns 9-11). Do note however, that for the simulations in columns 9-11, we only run the reduction in FDI stock in the UK, while for the EU we only run the trade barriers.

Regarding trade restrictions (columns 1-3), the decline in UK's GDP seems to be explained by the reduction of total production due to the fall in output of industries such as motor vehicles, other primary, textiles, food, construction, communications and other services, which would face a reduction in exports. This will be seen in the sectoral results below. Table 4 shows that barriers to trade constrain trade flows. That is why both aggregate exports and imports go down (see rows of aggregate exports and imports for the UK and the EU in columns 1-3). The contraction in production explains the fall in factors remuneration in both regions. Wages of skilled and unskilled workers go down, as capital remuneration does. Also, there would be a reduction in welfare. The fall in factors remunerations and the introduction of barriers to trade lead to a reduction in imports and competition from other firms. This would allow local firms to supply these goods at higher prices. Therefore, the variety of goods supplied in the local market would shrink and they would be more expensive than before the emergence of trade restrictions. Although the Brexit shock is contractionary for all macroeconomic variables in both the EU and the UK, the impact is very asymmetric with UK being more damaged than the EU.

In terms of FDI stock reductions (columns 4-8), we can see that losses from FDI in the UK after Brexit would not have a significant impact on the rest of regions considered in the model, whose capital stock remains unchanged. For example, the maximum reduction of 30 percent in the stock of FDI in the UK would imply a negligible effect on the GDP (-0.01 percent) in the Rest of the European Union.

Focusing on the UK (columns 4-8) we obtain that, of course, with less productive capital GDP falls. We also find that there is an increase in capital rents. This is consistent with economic theory which points out that less capital combined with the same amount of labour makes capital become more productive, thus, resulting in an increase of its remuneration. To compensate the reduction in capital some sectors increase labour demand, which pushes up (skilled and unskilled) wages.

As mentioned above, less capital involves a reduction in GDP. The reduction in the capital stock itself reduces GDP and, in addition, brings about a drop in total production. It also causes an increase in aggregate imports in order to supply the local market.

Recall that both NTBs and tariffs are run simultaneously in the joint impact of barriers to trade. If we compare the impact of these barriers to trade under the static and dynamic CGE models, i.e., columns 1-3 versus columns 12-14, respectively, we can see that the contractionary patterns for all macro variables are common with both models, but that the losses in GDP are more pronounced in the dynamic framework, as expected. Note that the impact on the UK's GDP would be almost double if we simulate the shock with the dynamic model. In the static CGE model, the GDP would drop by 0.49, 0.74, and 1.11 percent in the UK under the soft, Johnson's and hard Brexit, respectively, while it would decrease by 0,96, 1.43, and 2.15 percent in the dynamic model. This is because in a dynamic setting the capital stock is no longer pre-determined and fixed, but depends on the endogenous level of investment, which will go down after Brexit. Therefore, in this contractionary shock, the capital stock shrinks. However, as discussed in the literature review, in the complex framework of a dynamic CGE model, it is difficult to disentangle the effect of the reduction of the capital stock from other forces interacting in the model. To address this gap in the dynamic CGE model, we use the static CGE model to try to disentangle the potential impact of a reduction in the stock of FDI from the trade effects of Brexit. First, we simulate the impact of both shocks separately in the static model (in columns 1-8) and then we combine both in order to estimate the simultaneous impact of a reduction in the stock of FDI and the rise of barriers to trade also using the static model (columns 9-11). Second, we compare these latter results obtained with the static model (columns 9-11), with those from the dynamic model (Columns 12-14).

Note that the impact of a reduction in the stock of FDI by 6.77, 10 and 16.77percent, would lead to falls in the capital stock by 1.05, 1.55 and 2.43 percent, respectively (see row "capital stock" in columns 4-6). These results for the capital stock are nearly the same as those obtained with the dynamic model (row "capital stock", columns 12-14). For example: the

impact of a reduction by 6.77 percent in the stock of FDI in the UK (column 9), would imply a fall in the capital stock by 1.05 percent (row "capital stock" in column 9). This result for the capital stock of -1.05 is the same under a soft Brexit in the dynamic setting (row "capital stock" and column 12). Analogous similarities arise when we compare the impact of a decline in FDI stock by 10.00 and 16.77 percent, which yield 1.55 and 2.43 percent decreases in the capital stock, which are the same as the ones derived after the impact of Johnson's and hard Brexit in the dynamic setting (columns 13 and 14). That is why for the combination of trade and FDI results in the static model (columns 9-11), we assume that under soft Brexit, the UK would face a reduction of FDI stock by 6.77 percent, while under the Johnson's and hard Brexit this reduction would be 10.00 and 16.77 percent, respectively.

The simultaneous trade and FDI impacts in the UK derived with the static model (columns 9-11) are very close to those obtained with the dynamic model (columns 12-14), at least in terms of GDP. What is more, using the static model we can decompose the contribution of the trade barriers (columns 1-3) and FDI components (columns 4-6) to the total results (columns 9-11). Thus, under the soft Brexit, the two static shocks together, barriers to trade (column 1) and FDI reduction (column 3) (-0.49% + -0.46% = -0.95%) yield a very similar impact on GDP (column 9) than the one that combines both shocks in the dynamic setting, which yields a 0.96 percent loss in UK's GDP (column 12).

For Johnson's Brexit, the static model yields a fall in GDP by 1.42 percent which comprises the impact of -0.74 percent due to barriers to trade and a -0.68 percent loss because of the fall of 10 percent in the stock of FDI (i.e., a decline on the capital stock by 1.55 percent). This overall impact with the static model (-1.42 percent) is very close to the one with the dynamic model (a reduction of 1.43 percent on GDP).

Finally, with hard Brexit, the static model yields a 1.11 percent fall in GDP due to trade barriers and a reduction of 1.07 percent GDP after the fall of 16.77 percent in FDI (i.e., a reduction of 2.43 percent in the capital stock). Thus, the static shock yields a total impact of 2.16 percent drop in GDP, which is the similar as the 2.15 percent GDP loss in the hard

scenario of the dynamic model. Recall that we have not run any reduction in the FDI stock of the EU, and thus we cannot decompose the effects of the dynamic model for this region.

This decomposition of the impact of trade and FDI using the static model works very well to proxy the GDP results of the dynamic model in the UK. It also provides a pretty good approximation for the evolution of capital rents and wages. This can be seen by comparing the sum of the impact of FDI reductions and the static trade restrictions with the impact of the dynamic model. However, in the case of welfare, the decomposition approach offers a loose approximation for the impact derived in the dynamic setting. The differentiated impact of FDI with respect to the effects of barriers to trade, becomes clearer in the evolution of welfare. The FDI shock raises factors' remunerations and aggregate imports, contrasting with their contractionary trend after the trade barriers. Of course, welfare is less damaged in the FDI simulations because factors remunerations go up, even in the context of decreasing production, while after trade barriers factors remunerations contract. The same applies to aggregate exports and imports, for which the approximation is again rather loose. Despite the somewhat more marked differences between the static and dynamic results for these latter variables, it seems that this decomposition approach can be helpful to get an idea about the impact of FDI. We would have no clue for the role of FDI after Brexit, relying only on the results of the dynamic model alone.

Going back to the impact of FDI stock reductions with the static model, columns 7 and 8, allow us to expand the results for FDI to match some of the estimations of the literature. We can see that reductions of 20 percent and 30 percent in the FDI stock (in isolation), would bring about GDP losses of 1.37 percent and 2.06 percent, respectively. These are important losses which would have to be added to the ones derived from trade losses alone, if FDI stocks reductions end up being larger than the ones derived in the dynamic setting.

An interesting characteristic of the dynamic model, however, is that it allows us to analyse the timing of the adjustment, which would be impossible in a static setting. In order to identify this timing, we now apply two different techniques to simulate the emergence of

non-tariff barriers to trade using the dynamic model. First, we assume that all barriers to trade appear once the UK leaves the EU. In other words, we assume that the increase of NTBs and tariffs takes place in 2021, since the transition period ends on 31 December 2020[2]. With the second technique, we assume a gradual increase in barriers to trade along 4 years. In particular, we run one-third of the total shock in 2021, while the rest of the NTBs emerge gradually over the next 3 years (2022-2024), finally reaching the same barriers as in the previous technique.

Figure 4 shows the cumulative percent deviation of GDP in the UK from 2020 to 2030. Results correspond to the three scenarios considered in the model, soft, Johnson's and hard Brexit. The dotted lines reflect the evolution of GDP when we apply the whole increase of barriers to trade in the first year, while solid lines indicate a gradual shock.

As we can see, both techniques provide similar results and tend to converge along time. The differences are very small by 2030 and the Figure 4 suggests that gradual shocks are very slightly less harmful. This convergence would also support our strategy to better understand the dynamic results by using the decomposition approach based on the static model.

Let us go to deeper into this analysis by looking at the sectoral results in the next section.

### 6.2 Sectoral results

This section presents the main microeconomic results for the UK, which are obtained with the static and the dynamic models. We begin by providing one table for each of the three Brexit scenarios, which reflect how production, exports, and imports across sectors would adjust.

Table 5 displays the estimates obtained for the Boris Johnson’s scenario. We concentrate on the analysis of this scenario, because it seems to be the most likely one and provides a

[2] We have applied this technique in the dynamic simulations of Table 4.

somewhat intermediate impact between the hard and the soft Brexit. Besides, the results follow a very similar pattern for the soft and hard Brexit, mainly differing in magnitude as can be seen in Tables A1 and A2 of the appendix, which have the same structure of Table 5. Thus, all these tables display the effects of trade and FDI restrictions with the static model and with the dynamic model. As before, FDI reductions in the static model match the capital stock reductions of the dynamic model. In addition, trade restrictions are the same in both models.

The first set of columns in Table 5 shows the results with the static model, which involves the shock of barriers to trade and the reduction of FDI stock by 10 percent. As already noted, the fall of FDI stock by 10 percent implies a reduction in the capital stock of 1.55 percent (Table 4, row capital stock), which is equivalent to the drop in the capital stock obtained for the Johnson's Brexit with the dynamic model. The second set of columns in Table 5 provides the results with the dynamic model.

The results for the static model show that sectoral adjustments after trade barriers clearly contrast with the one experienced with a reduction in the stock of FDI.

Focusing on the joint effects of NTBs and tariffs (i.e., the simultaneous effects of barriers to trade), we find a negative impact on the flow of exports in *several* sectors and a contraction in imports *across* all sectors in the UK (columns 2 and 3 in Table 5).

The increase of barriers to trade will reduce exports in agriculture, other primary, food, textiles, and motor vehicles to a larger extent than exports in wood and paper, chemicals, other transport and electronics. This is because, although all these sectors have an important share of the bilateral trade with the EU (Table 2), agriculture, other primary, food, textiles, and motor vehicles are the ones that will face the largest barriers to trade once Brexit comes into force (Table 3). In particular, food, agriculture and other primary, exhibit by far the largest trade barriers among sectors and this is reflected in the most sizeable contractions of their exports. On the other hand, as we increase the barriers to trade from a scenario of soft

Brexit to Johnson's Brexit, and from this latter one to the hard Brexit. Trade contractions become larger than with smaller barriers, when we compare Table 5 with Tables A1 and A2 in the appendix.

As mentioned before, decreases in exports will tend to push down production. However, we cannot assume that this channel of adjustment applies to all sectors. Reductions in exports could explain declines in production in other primary, textiles, and motor vehicles (and in food under the soft Brexit) but not in agriculture, other transport, electronics, wood and paper, and chemicals. Regarding agriculture, wood and paper and food, they would experience a slight increase in total production. The fact that these sectors sell abroad less than 12 percent of their total production (as can be seen in Table 2) could explain why their production does not fall with the export decreases. Therefore, these sectors mainly supply the local market. Additionally, reductions in imports in these sectors would stimulate national producers to cover the local market.

Concerning other transport, electronics, and chemicals, these sectors experience rather small contractions in total exports, which are not big enough so as to contract overall production.

Construction, communications, and other services would experience reductions in total production. However, the fall in total production in these sectors responds more to the contraction of aggregate investment and private consumption in the UK. Do note that production in most services sectors seems to be unaffected by trade barriers, with the exception of Other services and communications.

On the other hand, the UK will import less products and services to satisfy the decreasing production and consumption.

We turn now to the sectoral adjustment process due to a reduction in the stock of FDI in isolation (columns 4-6) in Table 5. We can see that reductions in the capital stock bring about a fall in production across the board, with the only exception of construction. This contracting

trend in output is due to the reduction in the capital available for production in each sector. In addition, the drop in production and the rise in factor remunerations (Table 4) reduce exports, which also contract across the board. Because no barriers to trade are in play in this simulation, the fall in exports is much smaller than the one obtained in the trade barriers scenario. Contrasting with the decrease in exports, imports go up very slightly to compensate for the reduction in local production and also because, with the increases in factor remunerations, domestic varieties have become relatively more expensive than imports. Note also, that after the FDI shock the reduction in welfare and private consumption is considerably smaller than in the case of trade restrictions. Factors remuneration are going up after the FDI shock, which helps to dampen the reduction in welfare and private consumption. As a result, the contraction of imports related to the provision of goods and services for private consumption, is less strong than in the scenario of (isolated) trade restrictions we have just described above. In addition, again there are no barriers to trade in this FDI scenario, so that import flows are less harmed than when barriers are at play.

The results from the static model suggest that contractions in manufacturing goods production would be related to both the reductions in the stock of FDI and the fall in exports and imports. By contrast, in services sectors the decline in production would be explained to a higher extent by the reduction in FDI, since services sectors are not so dependent on the evolution of trade. As can be seen in Table 1, smaller shares of services production than manufacturing production are devoted to either imports or exports. These results should be relevant for the policy maker. The negative impact on production in services sectors seems very limited in the static scenarios, which focus on trade impacts (first block of columns in Table 5). Negative results arise, however in the dynamic scenarios after the trade shocks (last block of columns in Table 5). In the dynamic model disinvestments lead to a process of capital stock reduction. These cuts in capital available for production, as well as the drop in its remuneration, which in turn reduces national income, is harmful for the production and demand of services sectors, respectively. The damage for services is larger than in the context of the trade shock in static model, with no reductions in the FDI capital stock.

These negative outcomes for services in the dynamic framework are more related to the capital stock reductions (or FDI outflows), as can be seen in the second block of columns of Table 5, than to trade impact themselves. Our decomposition analysis allows us to shed light on the origin of these contractions of output in services sectors that are nearly absent in the static simulations and arise either in a dynamic setting or in a stating setting considering contractions in the capital stock as a result of Brexit[3]. As a consequence, putting both effects together (i.e., the increase of barriers to trade and the reduction of the FDI stock) in the static model, we obtain results that are similar to the ones of the dynamic model that, somehow, combines these two shocks in a dynamic setting (columns 8, 9 and 10 in Table 5).

Table 6 again provides estimates with the static and the dynamic models. For the static model we focus now on the simultaneous impact of barriers to trade and reductions in the capital stock (i.e., we do not show these results in isolation as in Table 5, but jointly). The table presents the results for capital demand, as well as for production, exports, and imports across sectors under Johnson's Brexit scenario.

Even though the percentages changes of production differ slightly in intensity in the dynamic and static setting, in general overall patterns of production are similar with both models. In particular, the sectors that tend to contract or increase production tend to be the same with both models[4]. Once more, the combination of the trade and FDI shocks allows us to better proxy dynamic outcomes, which would be harder to grasp in the static trade scenario alone.

It is interesting that in order to be able to grasp the negative impacts on services production, simulations beyond static trade shocks have to be implemented. Services are not so much affected by trade alone, due to its dependency on the local market and to the fact that they are less export oriented than manufactures. Thus, it seems necessary to implement capital

[3] If the reader goes back to the analysis of Table 5 in the previous chapter, it is clear that the static simulations were hardly capturing important contractions in services sectors.
[4] If the impact is close to zero, as happens in Finance, Chemicals and Food then the static setting may yield a positive impact while the dynamic one a negative outcome or vice versa, but in any case the impact for the sector in the two setting would be similar (i.e., close to zero).

stock reduction to be able to capture other effects that may be at play with Brexit and that will affect services more than what we could have previously expected. It is noteworthy, that some previous attempts of modelling Brexit have overlooked these sectoral impacts, because their methodologies do not offer much sectoral details if any, as happens in macroeconometric approaches and New Quantitative Trade Models.

On the other hand, Table 6 also shows that Motor vehicles would be the second most severely hurt sector in the UK after the Other Primary good sector. Note. however, that even though Other primary goods accounts for an important share in aggregate imports (since it includes oil imports), Motor vehicles is much bigger with more relevant shares in UK's imports, exports and production (Table 1). It is precisely the smaller size of the Other Primary goods sector, which helps to somehow overvalue changes when they are measured in percentage change. Production in Motor vehicles would decline more than the one of the rest of sectors in the economy. In the long-term production in motor vehicles would decrease by 4.06 percent under the Johnson's Brexit scenario, experiencing a drop in exports and imports flows by 16.40 and 7.20 percent, respectively. The fall in production in the dynamic setting is very similar to the one we derive after combining the trade and FDI effects in the static setting (4.79 percent). In addition, our decomposition approach with the static model shows that trade effects would account for the largest share with a 3.76 percent reduction while FDI effects would explain the remaining 1.09 percent, as displayed in Table 5.

Motor vehicle's trade with the EU is very intense, accounting for 43.15 and 82.97 percent of its total exports and imports, respectively (Table 2). In addition, Motor vehicles exhibits one of the highest trade barriers (Table 3). These two forces push down exports in this sector. Moreover, it is a sector whose production relies heavily on trade, i.e., its export and import shares account for 53.74 and 78.32 percent of its total production. This implies that the reduction in exports in this sector, will in turn, heavily affect its production. In fact, there are other sectors, which would experience larger contractions in exports and imports than Motor vehicles. Those sectors would have even more sizeable barriers after Brexit or their trade would be more related to the EU, than in the case of motor vehicles. However, trade

contractions are not transmitted as severely to production as in motor vehicles, since foreign trade is not so important for their production. For example, because UK's agriculture or food exhibit rather small shares of production devoted to exports in the context of manufactures, their production is not so harmed as the one of motor vehicles, despite the large contractions in exports they experience.

All in all, it seems that our static simulations give us hints to understand and proxy the different channels through which Brexit can affect the evolution of sectors in the UK. The sectoral analysis confirms that with the static model we can decompose the dynamic effects of a trade shock into a proxy for the impact of FDI and another one for the effects of trade barriers. Only when trade shocks are combined with capital stock effects, either by implementing a reduction in the capital stock in the static setting or by running a dynamic model, the full effects for services sectors unfold.

## 7. Conclusions

According to UNCTAD (2018) reductions in FDI inflows have already taken place in the UK in 2017. Despite the importance of FDI in the UK, its effects after Brexit have received little attention in the literature. Modelling FDI is a challenging issue. In this chapter we proxy its impact by implementing reductions in the UK's capital stock, that are consistent with empirical estimations on potential reductions in FDI after Brexit.

This chapter extends the scope of our previous analyses of Brexit along several lines. First, we implement a modelling strategy which allows us to shed light on some of the potential effects of Foreign Direct Investment (FDI) after Brexit. Second, we expand the scenarios by looking at the impact of Boris Johnson's Brexit proposal. Third, our analysis is made by means of two different models, a static one and a dynamic one. Fourth, we use a new database, namely, the latest version of the GTAP10 dataset.

The analysis of this chapter again confirms what we had seen in previous chapters, namely, that the impact of Brexit would be more harmful to the UK than to the EU. In our new dynamic setting we obtain that for the year 2030 UK's GDP would fall by 0.96, 1.43, and 2.15 percent, under the soft, Johnson's and hard Brexit, while the EU's GDP would face a reduction of 0.09, 0.13, and 0.21 percent, respectively, compared to the business as usual (BAU) scenario. Note that these results leave clear that Boris Johnson's Brexit proposal would not be as favourable as a soft Brexit but would be better than leaving the EU without a deal.

The dynamic model allows estimating the impact of Brexit in the long run. Several methodologies are not able to provide the effects of a reduction in the capital stock in isolation, because investment adjusts endogenously leaving no trace of its impact. Endogenous capital movements appear together with trade shock effects and previous attempts to model FDI explicitly have failed to obtain its impact, which they derive as being nearly zero in the context of Brexit (e.g., Ciuriak et al., 2015; 2017) or simply providing no effects for capital accumulation itself (Dhingra et al., 2017; Aichele et al., 2015). Therefore, in order to disentangle the effects of an increase of barriers to trade from the impact of a fall in the capital stock, we use the static model. This helps us to proxy and understand the role of FDI in Brexit and the adjustments that underlie the dynamic setting.

Our results point out that the joint impact of a fall in the stock of FDI (i.e., capital stock reductions) and barriers to trade with the static model are quite close to the results obtained with the dynamic model, for GDP. Recall that the GDP in the UK would decrease by 0.96, 1.43, and 2.15 percent by 2030, compared to the BAU scenario. We show that once we combine the impact of the resulting fall in the stock of FDI (i.e., capital stock reductions) in the dynamic setting with the ones of the barriers to trade, we can reproduce the dynamic results for GDP in our static setting. What is more, our step by step procedure with the static model allows us to disentangle the trade effects from the FDI effects underlying the dynamic results. Thus, in the static setting under the soft Brexit, trade effects would explain 0.49 percent of the GDP reduction of 0.95 percent, while FDI would explain 0.46 percent. In

Johnson's Brexit scenario, the drop in GDP by 1.42 percent involves a fall of 0.74 and 0.68 percent on barriers to trade and FDI, respectively. Finally, with hard Brexit, the fall of GDP by 2.16 percent comprises a reduction of 1.11 percent due to trade barriers and a decline of 1.07 percent because of FDI fall. These results suggest that FDI impacts turned to be as sizeable as trade impacts in a static setting. This estimation for the role of FDI is larger than one of the few previous existing ones by Latorre et al. (2019a, 2019b and 2020), who estimated they accounted for around one third of the total overall impact of Brexit including trade and FDI in a static setting. The contrasting results are understandable since Latorre et al. (2019a, 2019b and 2020) only consider services multinationals in their analysis, while here we consider FDI in all sectors of the economy.

In addition, our analysis expands the number of macroeconomic variables considered in the few studies analysing the impact of Brexit in a dynamic setting (e.g., Dhingra et al., 2017; Aichele et al., 2015). We provide results not only for GDP, but also for welfare, factors' remunerations (including skilled and unskilled wages), capital stock variations, as well as, aggregate exports and imports for the year 2030. Our dynamic results suggest that remunerations of skilled (unskilled) workers would decrease by 1.92 (1.99), 2.82 (2.90), and 4.06 (4.18) percent under soft, Johnson's, and hard Brexit, respectively. Regarding capital rents, they also would experience a fall, which would be between 1.27 and 2.49 percent. Reductions in factors' remunerations and the increase in barriers to trade would imply contractions of aggregate imports by a range of 4.29 - 9.72 percent. Competition from foreign firms would decrease, leading to less variety of goods in the local market which would be more expensive than before the emergence of trade restrictions. Therefore, the UK would face a loss of welfare between 1.47 and 3.03 percent. Aggregate exports would experience a contraction ranging between 4.82 and 11.27 percent. The final form of the deal between the UK and the EU would be crucial for the final outcomes.

We also offer estimates of the impact of FDI on the sectoral production, capital demand and trade across sectors, which are absent in the previous literature analysing the impact of FDI

(e.g., Pain and Young, 2014; OECD, 2016; UK Government, 2016b; and Dhingra et al., 2017, Aichele et al., 2015, PWC, 2016).

At the microeconomic level, our decomposition strategy allows us to shed light on the sectoral adjustments. We find that the effects of trade barriers clearly contrast with the ones from a reduction in the stock of FDI. The emergence of barriers to trade would imply a negative impact for exports in several sectors and for imports across the board. As a result, total production contracts in motor vehicles, other primary, textiles, food, construction, communications, and other services. These sectors are characterized by the simultaneous interaction of an important export orientation in their production, high barriers to trade and a marked reliance on European markets. By contrast, the decrease in the stock of FDI in our static setting would bring about a drop in production across the board, since all sectors experience a decrease in the capital available for production.

We also find that motor vehicles would be one of the most harmed sectors in the UK. In the long-term production in motor vehicles would decrease by 4.06 percent under the Johnson's Brexit scenario in 2030, experiencing a decrease in exports and imports flows by 16.40 and 7.20 percent, respectively. The contraction in production that we derive in the dynamic setting is very similar to the one we derive by combining the trade and FDI effects in the static setting. The fall in this static setting in motor vehicles would be of (4.79 percent), trade effects would explain (3.76 percent) while FDI effects would explain (1.09 percent). Across sectors again the static decomposition of trade and capital stock effects, allows us to better proxy the sectoral impact with the dynamic model.

Motor vehicle's trade with the EU is very intense, accounting for 43.15 and 82.97 percent of its total exports and imports, respectively (Table 2). In addition, Motor vehicles exhibits one of the highest trade barriers (Table 3). These two forces push down exports in this sector. Moreover, it is a sector whose production relies heavily on trade, i.e., its export and import shares account for 53.74 and 78.32 percent of its total production (Table 1). This implies that the reduction in exports in this sector, will heavily affect its production. In fact, there are

other sectors, which would experience larger contractions in exports and imports than Motor vehicles. Those sectors have even more sizeable barriers after Brexit or their trade is more related to the EU, than in the case of motor vehicles. However, trade contractions are not transmitted as severely to production as in motor vehicles, since foreign trade is not so important for their production. For example, because UK's agriculture or food exhibit rather small shares of production devoted to exports in the context of manufactures, their production is not so harmed as the one of motor vehicles, despite the large contractions in exports they experience.

Another important finding is that using the static model including only the trade shock (with no FDI shock) derives a rosy future for services sectors, in general. However, once we introduce either the trade shock in the static model combined with the FDI stock reduction or a trade shock in a dynamic model, we obtain that services sectors suffer considerably after Brexit. This is an important contribution of the sectoral analysis of this chapter, which carries important policy implications. It seems very likely that Britain's large services sector—including its vast financial, legal and accounting centres—will no longer have seamless access to EU clients after Brexit. This will have important consequences. However, some quantitative models, particularly static trade models, will miss these effects even if they consider non-tariff barriers in services sectors.

Finally, an additional important advantage of a dynamic model, compared to a static one, is that the former can be used to identify the timing in the adjustment after a shock. We make use of this feature by applying two different techniques to simulate the impact of barriers to trade: 1) Barriers to trade appear all of a sudden once Brexit comes into force; and 2) There is a gradual increase of trade barriers along 4 years. So that, in the first year (2021), we simulate one-third of the total shock, while the rest of the barriers emerge gradually along 3 years (2022-2024), finally reaching the same level for the barriers as in the previous scenario. We find both techniques provide similar results. This would also support our strategy to better understand the dynamic results by using the decomposition approach identified in this chapter

## Appendix

### A1. Sensitivity Analysis

To evaluate the robustness of our model, we employ an unconditional systematic sensitivity analysis, which makes us change different parameters in the model, while keeping the rate as they are in order to control for the impact of each of the parameters analysed in model results. First, we analyse the impact of three crucial elasticities in detail, which are: the elasticity of substitution between labour and capital, the Armington substitution between imports and domestic goods and the Armington substitution among imports by origin. As we have just noted, each elasticity has been varied, one by one, while keeping the rest fixed at their initial value. This approach follows the sensitivity analysis developed in Harrison et al. (1993), Latorre and Hosoe (2016) and Ortiz and Latorre (2019), among others.

We have also re-run the same shocks under the assumption of specific capital instead of fully mobile capital, even though the former assumption is less appropriate for a comparison with the results of a dynamic model. The results for GDP and for most of the macro variables were, however, nearly the same to the ones obtained with fully mobile capital, which have been discussed throughout this chapter. However, with fully mobile capital sectoral results in the static model (including both trade and capital stock reductions) offer a much better proxy for the dynamic model results, than when capital is sector-specific. When capital is fully mobile the evolution of its demand across sectors in the static setting is very close to the one of the dynamic setting and this helps to proxy the sectoral dynamic results in the static setting combining barriers to trade and capital stock reductions.

We have also examined the impact of influential parameters for the dynamic simulations. To be precise, we introduce in the dynamic model two different baseline scenarios, as well as two different depreciation rates and values for the elasticity parameter for investment allocation in the GTAP static and dynamic models (i.e., a parameter called RORFLEX).

The baseline projections in the dynamic model we have used in this chapter are constructed considering the Shared Socioeconomic Pathways (SSP2) route, which corresponds to an intermediate level of socio-economic development according to the International Institute for Applied Systems Analysis (IIASA). GTAP researchers encourage to use this SSP2 route. To see how the choice of projections influences the results also employ two extreme baseline scenarios: the first one is the SSP1 pathway, which implies a state of environmental sustainability and is categorized as the green path and the second one is the SSP5 scenario, which corresponds to a development pathway with rapid economic growth and high levels of carbon emissions.

In our model the default values of the depreciation rate and the RORFLEX parameters are 4 and 10 percent, respectively. In this sensitivity analysis the depreciation rate is also run with values of 1 and 2 percent and RORFLEX with values of 8 and 12 percent.

We perform the sensitivity analysis of the results obtained across our six simulations under the static model (i.e., soft, Johnson's, and hard Brexit, and FDI stock reductions of 6.77, 10 and 16.77 percent) and across our three simulation under the dynamic setting (i.e., soft, Johnson's and hard Brexit). To simplify, this analysis focuses on the effects for GDP. The results are displayed in Table 7 and Table 7 (Cont.).

Note that in those scenarios, in which we assume the increase of barriers to trade under the static framework, results are robust to changes in the value of the elasticity of substitution between factors. On the other hand, larger values in the Armington substitution between imported varieties and domestic goods, and in the Armington substitution among imports by origin, lead to slightly lower GDP losses in the UK than with smaller values of these elasticities. This is because, if consumers and producers can more flexibly substitute goods, the GDP losses due to barriers to trade would be lower. Larger values of these elasticities imply that the UK can more easily substitute the trade lost with the EU with imports from other regions or with domestic production. These reductions in losses when there is more flexibility becomes more marked in the dynamic setting. Overall, the results suggest that our

previous results are robust to different elasticities' specifications, even though in the long run slight deviations from the short run are accumulated and the trend becomes somewhat more intense. We also find that, in those scenarios in which we only assume FDI reductions, results are quite robust to the different values of the three elasticities.

Table 7 (Cont.) shows that, as is common in dynamic models, results are sensitive to the variations of the parameter RORFLEX. This elasticity parameter for investment allocation affects the climate of investment and thus the capital accumulation process. If a region's capital stock increases by 1%, then it is expected that the net rate of return on capital will decline by the percentage given by RORFLEX, i.e. 10% or 0.1 in the default specification. A larger (smaller) absolute value for this parameter will reduce (increase) the tendency of investment flows to respond to changes in expected rates of return. Thus, when we increase (decrease) its value to 12 (8), the capital stock reductions in the UK become less intensive (stronger) than in the core simulations, which results in more limited (more sizeable) contractions in UK's GDP, respectively. Results in Table 7 (Cont.) also show that results are virtually unaffected by the choice of baseline scenarios. The same applies with respect to changes inthe depreciation rates. Lower depreciations rates dampen very slightly the negative outcomes for the UK.

The assumption that the capital stock reductions in the UK in the static model are not allocated to other regions in the model is also revised. We have run the strongest capital reduction considered across all our scenarios, i.e., the 30% reduction in UK's capital FDI stock, which implies a 4.64 percent reduction in the overall capital stock in this country. Recall, however, that even after a hard Brexit, the contraction of the capital stock that the UK experiences is about half of this 30% reduction in UK's capital. As mentioned above, the capital lost in the UK should be reallocated across the US, the EU, China and the ROW. We have taken the EU, as an example. EU affiliates in the UK's capital stock is of only 15% according to the OECD (2019), but still we have allocated the entire capital reduction in the UK into the EU. The impact on EU's GDP is of a 0.24% increase. If we multiply 0.24*0.15, this yields a 0.036% GDP change in the EU, which is close to null. If we cut it by half, which

is the impact of the hard Brexit on the UK capital stock, then the impact on EU's GDP would be of 0.018%. That is why we have not considered the impact of FDI reallocation to the EU in our simulations, although we have carefully run the simulations we have just described.

## Tables

**Table 1.** Initial data: Industry share in total production, exports and imports (percentage shares reference year, 2020).

| Sector | Industry share in: | | | Import share in total production | Export share in total production |
|---|---|---|---|---|---|
| | Total production | Total exports | Total imports | | |
| Agriculture | 0.81 | 0.80 | 2.07 | 39.92 | 10.38 |
| Other primary | 0.80 | 2.21 | 5.31 | 104.45 | 29.21 |
| Food | 2.99 | 4.06 | 6.31 | 33.16 | 14.36 |
| Textiles | 0.51 | 1.54 | 6.30 | 192.34 | 31.52 |
| Wood and Paper | 1.25 | 1.38 | 2.55 | 31.95 | 11.68 |
| Chemicals | 4.51 | 14.57 | 13.43 | 46.75 | 34.12 |
| Metals | 2.82 | 11.18 | 7.01 | 39.03 | 41.86 |
| Motor vehicles | 1.91 | 9.71 | 9.52 | 78.32 | 53.74 |
| Other transport | 0.86 | 4.17 | 2.15 | 39.00 | 50.97 |
| Electronics | 1.02 | 4.10 | 7.78 | 119.38 | 42.31 |
| Other machinery | 2.14 | 6.61 | 8.81 | 64.50 | 32.54 |
| Other manufactures | 1.60 | 2.37 | 4.55 | 44.48 | 15.58 |
| Construction | 8.90 | 0.36 | 0.34 | 0.59 | 0.43 |
| Water transport | 0.81 | 0.65 | 0.57 | 11.11 | 8.51 |
| Air transport | 0.80 | 2.32 | 2.37 | 46.31 | 30.47 |
| Communications | 6.33 | 3.36 | 2.14 | 5.29 | 5.61 |
| Finance | 5.05 | 8.07 | 2.94 | 9.13 | 16.86 |
| Insurance | 1.94 | 2.23 | 0.39 | 3.19 | 12.16 |
| Business services | 12.32 | 12.87 | 6.60 | 8.41 | 11.03 |
| Personal services | 3.10 | 1.74 | 1.57 | 7.95 | 5.92 |
| Other services | 39.53 | 5.69 | 7.27 | 2.89 | 1.52 |
| **Agriculture** | **0.81** | **0.80** | **2.07** | **39.92** | **10.38** |
| **Manufatures** | **29.31** | **62.26** | **74.07** | **39.64** | **22.42** |
| **Services** | **69.88** | **36.94** | **23.86** | **5.36** | **5.58** |
| **Total** | **99.19** | **99.20** | **97.93** | | |

Source: based on GTAP 10 baseline.

**Table 2.** Initial data: Bilateral trade by sector (2020).

| Sector | UK Exports to | | | | | UK Imports from | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EU27 | US | China | ROW | TOTAL | EU27 | US | China | ROW | TOTAL |
| Agriculture | 64.73 | 4.63 | 9.48 | 21.17 | 100.00 | 53.87 | 4.16 | 1.91 | 40.06 | 100.00 |
| Other primary | 86.95 | 1.18 | 2.83 | 9.05 | 100.00 | 8.49 | 2.39 | 0.08 | 89.05 | 100.00 |
| Food | 58.66 | 9.31 | 1.77 | 30.26 | 100.00 | 74.21 | 2.76 | 2.06 | 20.97 | 100.00 |
| Textiles | 70.44 | 4.02 | 3.06 | 22.48 | 100.00 | 26.99 | 1.04 | 39.02 | 32.94 | 100.00 |
| Wood and Paper | 56.41 | 5.73 | 8.66 | 29.20 | 100.00 | 61.86 | 9.43 | 15.20 | 13.51 | 100.00 |
| Chemicals | 55.81 | 13.29 | 3.92 | 26.98 | 100.00 | 62.14 | 8.34 | 5.81 | 23.71 | 100.00 |
| Metals | 20.42 | 4.40 | 10.84 | 64.34 | 100.00 | 37.08 | 10.61 | 9.16 | 43.14 | 100.00 |
| Motor vehicles | 43.15 | 11.25 | 19.98 | 25.62 | 100.00 | 82.97 | 1.62 | 1.93 | 13.48 | 100.00 |
| Other transport | 29.69 | 19.93 | 4.86 | 45.53 | 100.00 | 49.70 | 9.73 | 6.28 | 34.29 | 100.00 |
| Electronics | 53.89 | 9.27 | 8.10 | 28.74 | 100.00 | 33.87 | 6.98 | 41.06 | 18.09 | 100.00 |
| Other machinery | 42.65 | 12.00 | 5.42 | 39.92 | 100.00 | 49.58 | 7.62 | 24.48 | 18.32 | 100.00 |
| Other manufactures | 43.46 | 13.26 | 2.81 | 40.47 | 100.00 | 42.25 | 9.95 | 26.53 | 21.27 | 100.00 |
| Construction | 37.55 | 2.06 | 6.85 | 53.55 | 100.00 | 40.38 | 3.99 | 13.75 | 41.87 | 100.00 |
| Water transport | 39.67 | 5.33 | 3.03 | 51.97 | 100.00 | 45.27 | 2.10 | 1.46 | 51.18 | 100.00 |
| Air transport | 29.50 | 20.87 | 4.80 | 44.83 | 100.00 | 43.63 | 13.32 | 1.62 | 41.43 | 100.00 |
| Communications | 52.65 | 10.68 | 5.59 | 31.08 | 100.00 | 46.48 | 13.38 | 3.15 | 36.99 | 100.00 |
| Finance | 48.73 | 20.19 | 2.48 | 28.60 | 100.00 | 35.25 | 29.61 | 0.81 | 34.32 | 100.00 |
| Insurance | 20.43 | 31.57 | 9.51 | 38.49 | 100.00 | 48.45 | 17.73 | 3.29 | 30.53 | 100.00 |
| Business services | 47.46 | 6.06 | 6.03 | 40.45 | 100.00 | 40.33 | 12.23 | 4.96 | 42.49 | 100.00 |
| Personal services | 39.77 | 8.46 | 5.23 | 46.55 | 100.00 | 39.46 | 23.86 | 5.17 | 31.51 | 100.00 |
| Other services | 33.81 | 16.74 | 7.89 | 41.56 | 100.00 | 39.10 | 16.78 | 4.77 | 39.34 | 100.00 |
| **Agriculture** | **64.73** | **4.63** | **9.48** | **21.17** | 100.00 | **53.87** | **4.16** | **1.91** | **40.06** | 100.00 |
| **Manufacturing** | **45.34** | **10.28** | **8.03** | **36.35** | 100.00 | **50.49** | **6.12** | **15.23** | **28.16** | 100.00 |
| **Services** | **42.85** | **13.78** | **5.54** | **37.82** | 100.00 | **40.40** | **16.59** | **3.80** | **39.21** | 100.00 |
| **Total** | **44.58** | **11.52** | **7.13** | **36.77** | 100.00 | **48.13** | **8.60** | **12.20** | **31.07** | 100.00 |

Source: Authors' estimations based on GTAP 10 baseline.

**Table 3.** Non-tariff barriers and MFN tariffs under Brexit.

| Sectors | Soft Brexit | Boris Johnson's Brexit | Hard Brexit | | | | |
|---|---|---|---|---|---|---|---|
| | NTBs to trade | NTBs to trade | NTBs to trade | MFN tariffs | | Total | |
| | In EU and UK | In EU and UK | In EU and UK | In EU | In UK | In EU | In UK |
| Agriculture | 14.20 | 21.30 | 28.40 | 10.20 | 10.80 | 38.60 | 39.20 |
| Other primary | 14.20 | 21.30 | 28.40 | 0.00 | 0.10 | 28.40 | 28.50 |
| Food | 14.20 | 21.30 | 28.40 | 19.80 | 22.00 | 48.20 | 50.40 |
| Textiles | 4.80 | 7.20 | 9.60 | 10.00 | 9.50 | 19.60 | 19.10 |
| Wood and Paper | 2.80 | 4.20 | 5.70 | 0.50 | 1.00 | 6.20 | 6.70 |
| Chemicals | 3.40 | 5.10 | 6.80 | 2.80 | 2.70 | 9.60 | 9.50 |
| Metals | 3.00 | 4.50 | 6.00 | 1.90 | 2.00 | 7.90 | 8.00 |
| Motor vehicles | 6.40 | 9.60 | 12.80 | 8.00 | 8.80 | 20.80 | 21.60 |
| Other transport | 4.70 | 7.05 | 9.40 | 1.70 | 1.60 | 11.10 | 11.00 |
| Electronics | 3.20 | 4.80 | 6.40 | 0.90 | 1.50 | 7.30 | 7.90 |
| Other machinery | 0.00 | 0.00 | 0.00 | 1.70 | 1.80 | 1.70 | 1.80 |
| Other manufactures | 2.80 | 4.20 | 5.70 | 2.60 | 2.20 | 8.30 | 7.90 |
| Construction | 1.20 | 1.80 | 2.30 | | | 2.30 | 2.30 |
| Water transport | 2.00 | 3.50 | 4.00 | | | 4.00 | 4.00 |
| Air transport | 0.50 | 0.88 | 1.00 | | | 1.00 | 1.00 |
| Communications | 2.90 | 5.08 | 5.90 | | | 5.90 | 5.90 |
| Finance | 2.80 | 4.90 | 5.70 | | | 5.70 | 5.70 |
| Insurance | 2.70 | 4.73 | 5.40 | | | 5.40 | 5.40 |
| Business services | 3.70 | 6.48 | 7.50 | | | 7.50 | 7.50 |
| Personal services | 1.10 | 1.93 | 2.20 | | | 2.20 | 2.20 |
| Other services | 1.10 | 1.93 | 2.20 | | | 2.20 | 2.20 |

Source: Ecorys (2009) and Latorre et al. (2019a, 2019b).

**Table 4.** Macroeconomic results.

| | Static CGE | | | | | | | | | | | Recursive Dynamic CGE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Bariers to Trade | | |
| | Barriers to Trade | | | Reduction in FDI stock | | | | | Soft Brexit + FDI 6.77% | Johnson's Brexit + FDI 10% | Hard Brexit + FDI 16.77% | Difference with respect to the BAU in 2030 | | |
| | Soft Brexit | Johnson's Brexit | Hard Brexit | 6.77% | 10.00% | 16.77% | 20.00% | 30.00% | | | | Soft Brexit | Johnson's Brexit | Hard Brexit |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| **GDP** | | | | | | | | | | | | | | |
| United Kingdom | -0.48 | -0.72 | -1.11 | -0.46 | -0.68 | -1.03 | -1.33 | -2.06 | -0.93 | -1.43 | -2.16 | -0.96 | -1.44 | -2.15 |
| Rest of the European Union | -0.06 | -0.09 | -0.14 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.06 | -0.10 | -0.14 | -0.09 | -0.13 | -0.21 |
| United States | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.04 |
| China | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | 0.00 | 0.01 | 0.01 | 0.03 | 0.04 | 0.07 |
| Rest of the World | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.08 | 0.12 |
| **United Kingdom** | | | | | | | | | | | | | | |
| **Wages** | | | | | | | | | | | | | | |
| Skilled | -2.18 | -3.2 | -4.71 | 0.03 | 0.04 | 0.07 | 0.09 | 0.13 | -2.15 | -3.15 | -4.61 | -1.92 | -2.82 | -4.06 |
| Unskilled | -2.37 | -3.47 | -5.12 | 0.10 | 0.15 | 0.24 | 0.31 | 0.46 | -2.27 | -3.31 | -4.85 | -1.99 | -2.90 | -4.18 |
| **Capital Rents** | -2.35 | -3.33 | -4.92 | 0.77 | 1.14 | 1.80 | 2.31 | 3.51 | -1.59 | -2.20 | -3.13 | -1.27 | -1.85 | -2.49 |
| **Capital Stock** | | | | -1.05 | -1.55 | -2.43 | -3.10 | -4.64 | -1.05 | -1.55 | -2.43 | -1.05 | -1.56 | -2.43 |
| **Welfare** | -0.89 | -1.30 | -1.86 | -0.23 | -0.34 | -0.53 | -0.68 | -1.03 | -1.11 | -1.64 | -2.37 | -1.47 | -2.16 | -3.03 |
| **Aggregate exports** | -1.91 | -2.66 | -3.29 | -1.36 | -2.01 | -3.14 | -4.00 | -5.96 | -1.28 | -1.68 | -2.45 | -1.82 | -2.74 | -3.27 |
| **Aggregate imports** | -5.25 | -7.50 | -12.12 | 0.05 | 0.07 | 0.11 | 0.14 | 0.21 | -5.18 | -7.38 | -11.89 | -5.29 | -7.11 | -9.72 |
| **Rest of the European Union** | | | | | | | | | | | | | | |
| **Wages** | | | | | | | | | | | | | | |
| Skilled | -0.13 | -0.23 | -0.59 | -0.01 | -0.02 | -0.03 | -0.04 | -0.06 | -0.20 | -0.39 | -0.84 | -0.23 | -0.38 | -0.89 |
| Unskilled | -0.20 | -0.38 | -0.95 | -0.02 | -0.03 | -0.04 | -0.06 | -0.09 | -0.22 | -0.42 | -0.89 | -0.24 | -0.36 | -0.85 |
| **Capital Rents** | -0.19 | -0.28 | -0.54 | -0.01 | -0.02 | -0.03 | -0.04 | -0.07 | -0.21 | -0.40 | -0.84 | -0.13 | -0.27 | -0.49 |
| **Capital Stock** | | | | | | | | | | | | -0.05 | -0.09 | -0.16 |
| **Welfare** | -0.06 | -0.10 | -0.17 | -0.01 | -0.01 | -0.01 | -0.02 | -0.03 | -0.07 | -0.11 | -0.18 | -0.12 | -0.18 | -0.31 |
| **Aggregate exports** | -0.16 | -0.23 | -0.37 | 0.02 | 0.02 | 0.04 | 0.05 | 0.07 | -0.14 | -0.21 | -0.33 | -0.27 | -0.39 | -0.72 |
| **Aggregate imports** | -0.23 | -0.33 | -0.69 | -0.03 | -0.04 | -0.06 | -0.08 | -0.11 | -0.25 | -0.37 | -0.65 | -0.28 | -0.43 | -0.76 |

Source: Authors' estimations.

**Table 5.** Impact on production, exports and imports in the UK under the Johnson's Brexit scenario (percentage change).

| Sector | Static CGE | | | | | | Recursive Dynamic CGE | | |
|---|---|---|---|---|---|---|---|---|---|
| | Barriers to Trade | | | Reduction in FDI stock (6.77%) | | | Barriers to Trade | | |
| | Production | Exports | Imports | Production | Exports | Imports | Difference with respect to the BAU in 2030 | | |
| | Production | Exports | Imports | Production | Exports | Imports | Production | Exports | Imports |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| **Agriculture** | 1.20 | -28.94 | -11.46 | -0.49 | -0.78 | -0.01 | 1.66 | -25.65 | -7.90 |
| **Other Primary** | -4.60 | -53.58 | -9.14 | -1.72 | -2.48 | -0.40 | -6.82 | -49.74 | -8.91 |
| **Food** | 0.04 | -26.19 | -18.08 | -0.59 | -1.17 | 0.13 | 0.32 | -26.54 | -13.19 |
| **Textiles** | -0.41 | -10.90 | -4.84 | -1.16 | -1.67 | 0.09 | -1.10 | -14.27 | -2.69 |
| **Wood and Paper** | 1.78 | -1.02 | -6.76 | -0.77 | -1.64 | 0.19 | 1.15 | -2.67 | -4.54 |
| **Chemicals** | 1.15 | -2.89 | -5.65 | -1.01 | -1.84 | -0.14 | 0.37 | -4.03 | -4.13 |
| **Metals** | 3.29 | 2.81 | -2.88 | -1.04 | -1.20 | -0.51 | 2.26 | 2.01 | -1.81 |
| **Motor Vehicles** | -2.82 | -10.45 | -8.74 | -0.74 | -0.94 | -0.01 | -3.04 | -11.61 | -4.97 |
| **Other Transport** | 1.44 | -0.65 | -9.99 | -0.95 | -1.50 | 0.51 | 1.19 | -2.38 | -6.09 |
| **Electronics** | 1.73 | -3.64 | -3.98 | -1.28 | -1.52 | -0.15 | 1.37 | -4.71 | -1.77 |
| **Other Machinery** | 3.73 | 8.12 | -3.21 | -1.04 | -1.62 | 0.26 | 2.76 | 7.44 | -2.72 |
| **Other Manufactures** | 1.34 | 1.11 | -6.29 | -0.74 | -1.82 | 0.39 | 0.61 | -1.24 | -3.91 |
| **Construction** | -2.85 | 6.92 | -7.85 | 0.22 | -1.93 | 1.25 | -1.63 | 3.29 | -4.44 |
| **Water Transport** | 1.27 | 1.66 | -3.70 | -0.43 | -0.41 | 0.04 | 0.75 | 1.08 | -2.76 |
| **Air Transport** | 0.86 | 2.66 | -2.18 | -0.62 | -0.88 | 0.00 | 0.08 | 1.46 | -1.86 |
| **Communications** | -0.27 | 2.38 | -6.35 | -0.89 | -1.68 | 0.54 | -0.66 | 0.01 | -4.42 |
| **Finance** | 0.79 | 2.49 | -4.93 | -0.67 | -1.27 | 0.18 | 0.05 | 1.00 | -3.81 |
| **Insurance** | 0.57 | 4.92 | -5.78 | -0.67 | -1.79 | 0.45 | -0.15 | 2.97 | -4.20 |
| **Businness Services** | 0.25 | 1.51 | -6.05 | -0.55 | -1.49 | 0.34 | -0.31 | -0.26 | -4.26 |
| **Personal Services** | 0.26 | 5.91 | -4.37 | -0.53 | -1.76 | 0.45 | -0.33 | 3.63 | -3.33 |
| **Other Services** | -0.21 | 5.50 | -4.25 | -0.40 | -1.43 | 0.31 | -0.67 | 3.19 | -3.22 |

Source: Authors' estimations.

**Table 6.** Impact on demand of capital, production, exports and imports in the UK under Boris Johnson's Brexit scenario (percentage change).

| Sector | Static CGE | | | | | | Recursive Dynamic CGE | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Barriers to Trade | | |
| | Barriers to Trade | | | Reduction in FDI stock (10%) | | | Difference with respect to the BAU in 2030 | | |
| | Production | Exports | Imports | Production | Exports | Imports | Production | Exports | Imports |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| **Agriculture** | 2.02 | -38.79 | -15.64 | -0.73 | -1.15 | -0.02 | 2.72 | -34.10 | -10.71 |
| **Other Primary** | -4.96 | -64.93 | -11.27 | -2.53 | -3.65 | -0.59 | -7.94 | -59.72 | -10.99 |
| **Food** | 0.52 | -34.68 | -25.10 | -0.86 | -1.72 | 0.19 | 0.87 | -34.97 | -18.42 |
| **Textiles** | -0.48 | -15.56 | -6.97 | -1.71 | -2.47 | 0.13 | -1.47 | -20.18 | -3.88 |
| **Wood and Paper** | 2.62 | -1.59 | -9.82 | -1.13 | -2.42 | 0.28 | 1.66 | -4.03 | -6.58 |
| **Chemicals** | 1.54 | -4.59 | -8.05 | -1.49 | -1.97 | -0.21 | 0.34 | -6.31 | -5.94 |
| **Metals** | 4.82 | 4.01 | -3.38 | -1.54 | -1.77 | -0.75 | 3.22 | 2.74 | -2.55 |
| **Motor Vehicles** | -3.76 | -14.83 | -12.68 | -1.09 | -1.39 | -0.01 | -4.06 | -16.40 | -7.20 |
| **Other Transport** | 2.33 | -0.46 | -14.22 | -1.41 | -2.20 | 0.75 | 1.85 | -2.99 | -8.71 |
| **Electronics** | 2.66 | -5.18 | -5.78 | -1.89 | -2.23 | -0.22 | 2.06 | -6.74 | -2.58 |
| **Other Machinery** | 5.56 | 12.06 | -4.59 | -1.54 | -2.38 | 0.38 | 4.06 | 10.96 | -3.93 |
| **Other Manufactures** | 1.93 | 1.51 | -9.07 | -1.09 | -2.67 | 0.58 | 0.83 | -2.02 | -5.62 |
| **Construction** | -3.44 | 9.81 | -10.80 | 0.32 | -2.84 | 1.85 | -2.42 | 4.87 | -6.56 |
| **Water Transport** | 1.84 | 2.34 | -5.67 | -0.63 | -0.60 | 0.06 | 1.08 | 1.48 | -4.12 |
| **Air Transport** | 1.21 | 3.73 | -3.26 | -0.92 | -1.30 | 0.01 | 0.03 | 1.92 | -2.73 |
| **Communications** | -0.48 | 2.29 | -9.82 | -0.58 | -2.48 | 0.80 | -1.05 | -1.23 | -6.75 |
| **Finance** | 1.01 | 2.72 | -7.62 | -0.98 | -1.87 | 0.27 | -0.07 | 0.44 | -5.74 |
| **Insurance** | 0.79 | 6.86 | -9.00 | -0.98 | -2.63 | 0.67 | -0.28 | 3.90 | -6.43 |
| **Businness Services** | 0.25 | 0.93 | -9.42 | -0.81 | -2.20 | 0.50 | -0.56 | -1.68 | -6.51 |
| **Personal Services** | 0.36 | 8.37 | -6.56 | -0.78 | -2.59 | 0.66 | -0.52 | 4.93 | -4.95 |
| **Other Services** | -0.32 | 7.83 | -6.39 | -0.59 | -2.11 | 0.45 | -0.98 | 4.38 | -4.79 |

Source: Authors' estimations.

**Table 7.** Sensitivity Analysis (section 1)

| | | | GDP | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Static Model | | | | | | Dynamic Model | | |
| | | | Soft Brexit | Johnson's Brexit | Hard Brexit | FDI 6.77% | FDI 10% | FDI 16.77% | Soft Brexit | Johnson's Brexit | Hard Brexit |
| *Core estimations* | | EU27 | -0.06 | -0.10 | -0.14 | 0.00 | 0.00 | 0.00 | -0.09 | -0.13 | -0.21 |
| | | UK | -0.49 | -0.73 | -1.09 | -0.46 | -0.68 | -1.07 | -0.96 | -1.43 | -2.15 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.04 |
| | | CHN | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.03 | 0.04 | 0.07 |
| | | ROW | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.08 | 0.12 |
| A) Elasticity of substitution between labor and capital | Double | EU27 | -0.06 | -0.09 | -0.14 | 0.00 | 0.00 | 0.00 | -0.10 | -0.15 | -0.24 |
| | | UK | -0.49 | -0.74 | -1.10 | -0.47 | -0.70 | -1.09 | -1.01 | -1.49 | -2.27 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.05 |
| | | CHN | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.03 | 0.05 | 0.08 |
| | | ROW | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.06 | 0.08 | 0.13 |
| | Half | EU27 | -0.06 | -0.09 | -0.14 | 0.00 | 0.00 | 0.00 | -0.07 | -0.11 | -0.17 |
| | | UK | -0.50 | -0.74 | -1.11 | -0.44 | -0.66 | -1.03 | -0.85 | -1.26 | -1.88 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.03 |
| | | CHN | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | -0.01 | 0.02 | 0.03 | 0.05 |
| | | ROW | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.05 | 0.07 | 0.10 |
| B) Elasticity of substitution between imports and domestic production (Armington) | Double | EU27 | -0.06 | -0.09 | -0.13 | 0.00 | 0.00 | 0.00 | -0.10 | -0.15 | -0.23 |
| | | UK | -0.46 | -0.69 | -1.03 | -0.47 | -0.69 | -1.08 | -0.79 | -1.16 | -1.74 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.03 |
| | | CHN | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.05 |
| | | ROW | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.04 | 0.05 | 0.08 |
| | Half | EU27 | -0.06 | -0.09 | -0.14 | 0.00 | 0.00 | 0.00 | -0.07 | -0.11 | -0.18 |
| | | UK | -0.52 | -0.79 | -1.19 | -0.46 | -0.68 | -1.06 | -1.15 | -1.70 | -2.58 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.04 | 0.06 |
| | | CHN | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.04 | 0.05 | 0.09 |
| | | ROW | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.07 | 0.10 | 0.15 |
| C) Elasticity of subtitution between regional allocation of imports | Double | EU27 | -0.06 | -0.10 | -0.13 | 0.00 | 0.00 | 0.00 | -0.08 | -0.11 | -0.17 |
| | | UK | -0.39 | -0.57 | -1.03 | -0.47 | -0.69 | -1.09 | -0.86 | -1.24 | -1.79 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.04 |
| | | CHN | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.03 | 0.04 | 0.06 |
| | | ROW | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.05 | 0.07 | 0.10 |
| | Half | EU27 | -0.07 | -0.11 | -0.16 | 0.00 | 0.00 | 0.00 | -0.10 | -0.16 | -0.27 |
| | | UK | -0.53 | -0.81 | -1.22 | -0.45 | -0.66 | -1.04 | -0.93 | -1.40 | -2.10 |
| | | USA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.04 |
| | | CHN | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | -0.01 | 0.03 | 0.04 | 0.07 |
| | | ROW | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.05 | 0.08 | 0.12 |

Source: Authors' estimations.
Notes: EU27 stand for the Rest of the European Union.

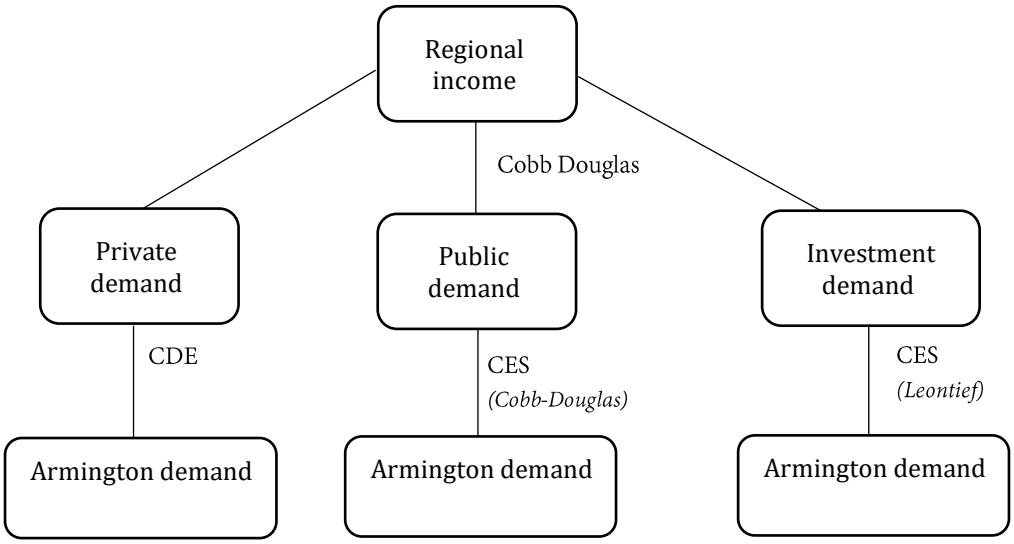
**Table 7 (Cont.).** Sensitivity Analysis (section 2)

| | | Dynamic Model | | |
|---|---|---|---|---|
| | | Soft Brexit | Johnson's Brexit | Hard Brexit |
| *Core estimations* | EU27 | -0.09 | -0.13 | -0.21 |
| | UK | -0.96 | -1.43 | -2.15 |
| | USA | 0.02 | 0.03 | 0.04 |
| | CHN | 0.03 | 0.04 | 0.07 |
| | ROW | 0.01 | 0.08 | 0.12 |
| A) SSP1 | EU27 | -0.09 | -0.13 | -0.21 |
| | UK | -0.96 | -1.43 | -2.15 |
| | USA | 0.02 | 0.03 | 0.04 |
| | CHN | 0.03 | 0.04 | 0.07 |
| | ROW | 0.05 | 0.08 | 0.12 |
| B) SSP5 | EU27 | -0.09 | -0.13 | -0.21 |
| | UK | -0.93 | -1.38 | -2.08 |
| | USA | 0.02 | 0.03 | 0.04 |
| | CHN | 0.03 | 0.04 | 0.07 |
| | ROW | 0.05 | 0.08 | 0.12 |
| C) RORFLEX Value : 8 | EU27 | -0.09 | -0.14 | -0.22 |
| | UK | -1.07 | -1.59 | -2.40 |
| | USA | 0.02 | 0.03 | 0.05 |
| | CHN | 0.03 | 0.05 | 0.08 |
| | ROW | 0.07 | 0.09 | 0.15 |
| C) RORFLEX Value : 12 | EU27 | -0.08 | -0.13 | -0.20 |
| | UK | -0.88 | -1.31 | -1.97 |
| | USA | 0.02 | 0.02 | 0.04 |
| | CHN | 0.02 | 0.04 | 0.06 |
| | ROW | 0.05 | 0.07 | 0.10 |
| E) Depreciation rate 1% | EU27 | -0.09 | -0.14 | -0.21 |
| | UK | -0.91 | -1.35 | -2.04 |
| | USA | 0.02 | 0.02 | 0.04 |
| | CHN | 0.02 | 0.03 | 0.05 |
| | ROW | 0.04 | 0.05 | 0.08 |
| F) Depreciation rate 2% | EU27 | -0.09 | -0.14 | -0.21 |
| | UK | -0.91 | -1.36 | -2.05 |
| | USA | 0.02 | 0.02 | 0.04 |
| | CHN | 0.02 | 0.03 | 0.06 |
| | ROW | 0.04 | 0.06 | 0.08 |

Source: Authors' estimations.

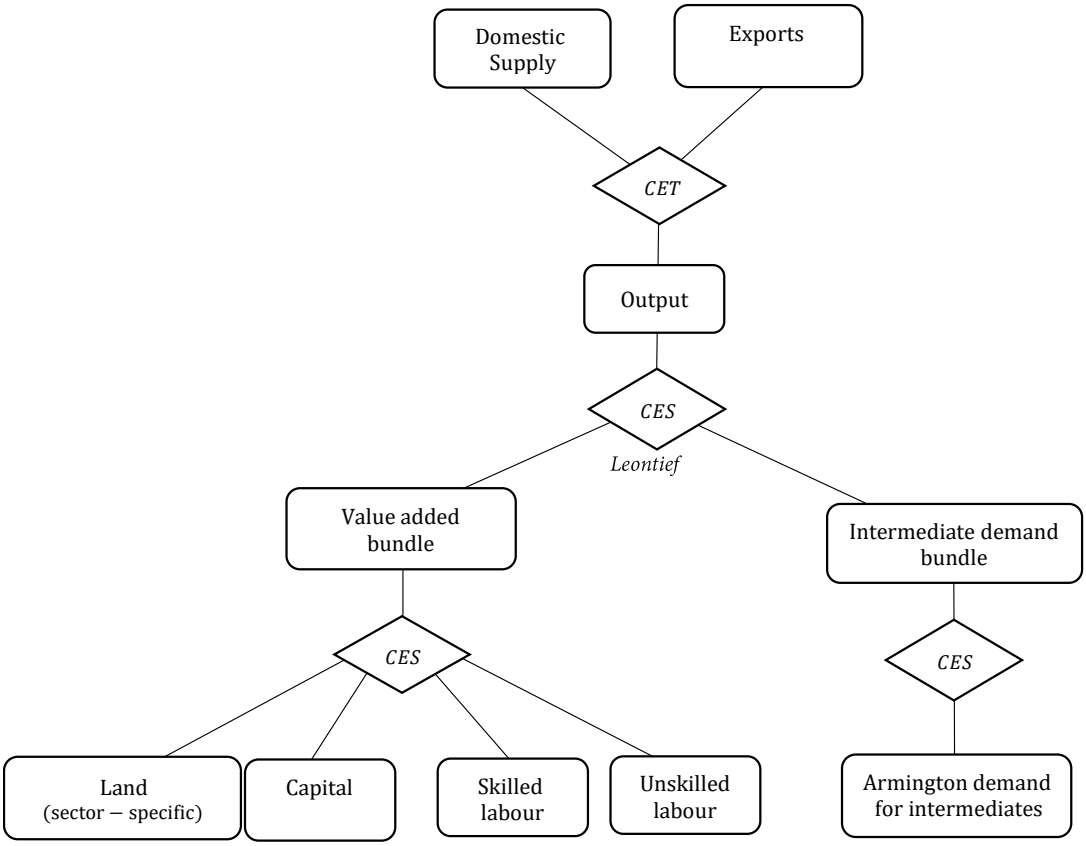
Notes: EU27 stand for the Rest of the European Union.

**Figure 1.** Final aggregate demand



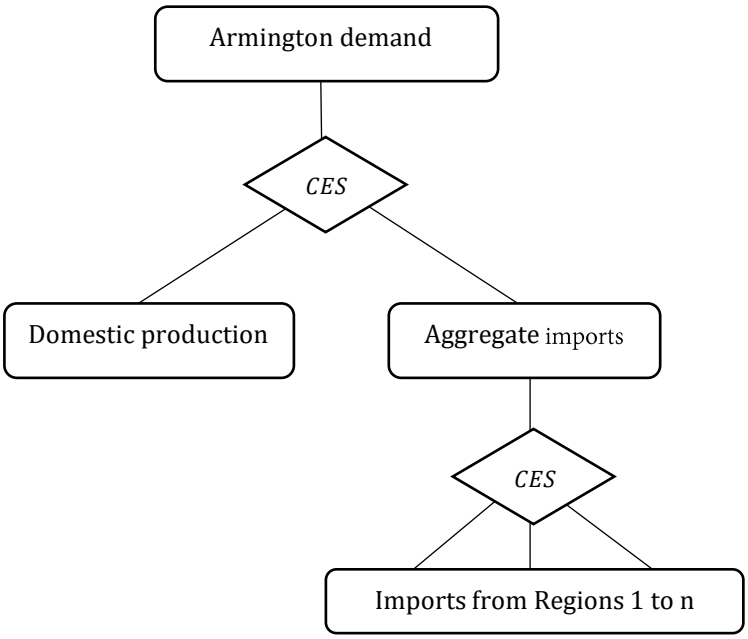

Source: Authors' elaboration.

**Figure 2.** Production structure for each good or service



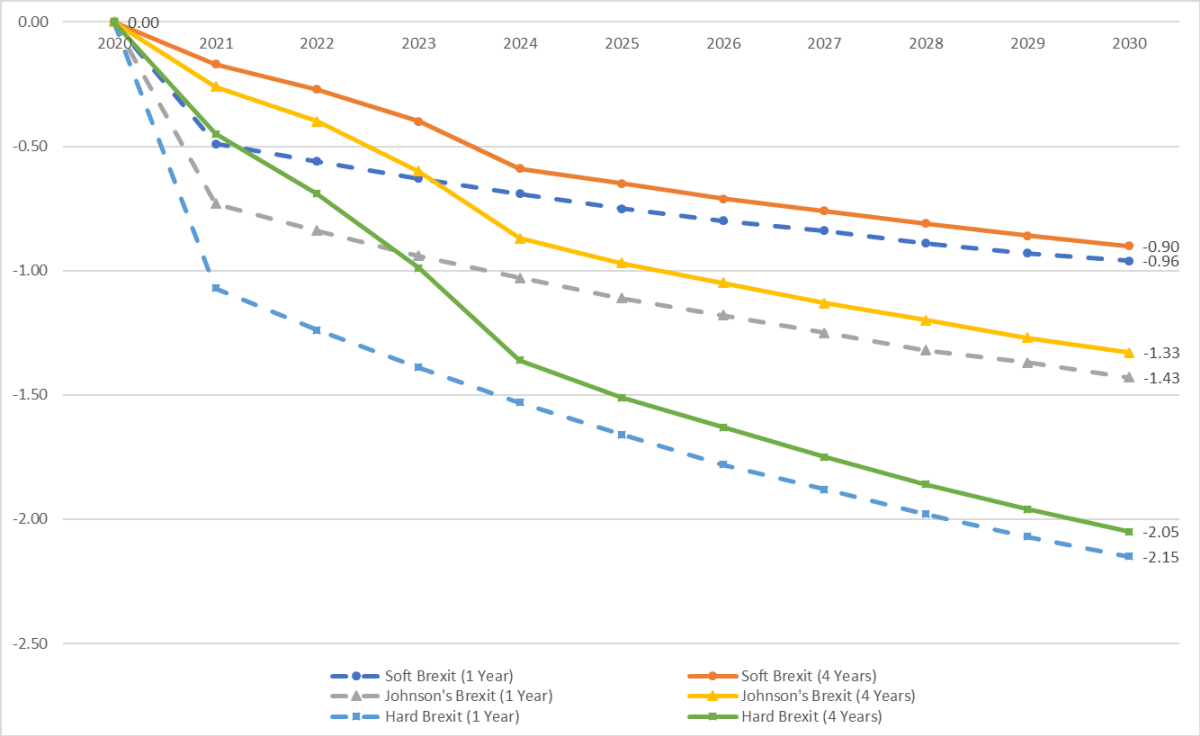

Source: Adapted from Corong et al. (2017).

**Figure 3.** Armington (1969) preferences for each good or service




Source: Authors' elaboration.

**Figure 4.** The UK's GDP cumulative percent deviation (2020-2030)




Source: Authors' estimations.

# Appendix

**Table A1.** Impact on production, exports and imports in the UK under a soft Brexit scenario (percentage change).

| Sector | Static CGE | | | | | | Recursive Dynamic CGE | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Barriers to Trade | | |
| | Barriers to Trade | | | Reduction in FDI stock (16.77%) | | | Difference with respect to the BAU in 2030 | | |
| | Production | Exports | Imports | Production | Exports | Imports | Production | Exports | Imports |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| **Agriculture** | 3.65 | -53.88 | -21.52 | -1.15 | -1.81 | -0.02 | 4.65 | -47.53 | -15.10 |
| **Other Primary** | -4.32 | -68.45 | -13.47 | -3.95 | -5.69 | -0.93 | -8.46 | -63.12 | -13.43 |
| **Food** | 2.27 | -51.26 | -39.29 | -1.36 | -2.70 | 0.30 | 2.62 | -51.73 | -30.14 |
| **Textiles** | -4.68 | -38.89 | -11.96 | -2.67 | -3.86 | 0.21 | -5.70 | -45.42 | -5.81 |
| **Wood and Paper** | 3.79 | -2.58 | -14.54 | -1.78 | -3.78 | 0.44 | 1.86 | -7.91 | -9.39 |
| **Chemicals** | 0.64 | -11.72 | -13.38 | -2.33 | -3.09 | -0.33 | -1.43 | -14.80 | -10.16 |
| **Metals** | 5.87 | 3.94 | -6.21 | -2.41 | -2.77 | -1.18 | 3.07 | 1.38 | -4.87 |
| **Motor Vehicles** | -7.30 | -29.39 | -23.10 | -1.71 | -2.18 | -0.02 | -7.64 | -31.55 | -14.45 |
| **Other Transport** | 3.03 | -0.68 | -20.24 | -2.21 | -3.45 | 1.17 | 2.02 | -4.91 | -12.41 |
| **Electronics** | 3.84 | -7.78 | -8.79 | -2.96 | -3.49 | -0.35 | 1.70 | -12.07 | -3.97 |
| **Other Machinery** | 6.31 | 11.06 | -9.16 | -2.41 | -3.72 | 0.59 | 3.68 | 7.17 | -6.58 |
| **Other Manufactures** | 2.00 | -2.88 | -14.04 | -1.71 | -4.17 | 0.90 | 0.54 | -8.12 | -8.47 |
| **Construction** | -5.30 | 15.57 | -15.13 | 0.49 | -4.42 | 2.90 | -3.70 | 6.59 | -8.99 |
| **Water Transport** | 2.85 | 3.72 | -7.18 | -1.00 | -0.94 | 0.10 | 1.54 | 2.22 | -5.19 |
| **Air Transport** | 1.65 | 5.27 | -4.30 | -1.45 | -2.04 | 0.01 | -0.38 | 1.98 | -3.48 |
| **Communications** | -0.58 | 5.77 | -12.78 | -0.92 | -3.88 | 1.26 | -1.52 | 0.08 | -8.80 |
| **Finance** | 1.81 | 5.91 | -9.99 | -1.54 | -2.92 | 0.42 | 0.05 | 2.18 | -7.61 |
| **Insurance** | 1.38 | 10.98 | -11.41 | -1.54 | -4.11 | 1.05 | -0.28 | 6.16 | -8.16 |
| **Businness Services** | 0.57 | 3.95 | -12.09 | -1.27 | -3.44 | 0.79 | -0.78 | -0.38 | -8.47 |
| **Personal Services** | 0.68 | 13.10 | -8.82 | -1.22 | -4.05 | 1.04 | -0.67 | 7.47 | -6.56 |
| **Other Services** | -0.39 | 12.02 | -8.57 | -0.92 | -3.30 | 0.71 | -1.39 | 6.36 | -6.33 |

Source: Authors' estimations.

**Table A2.** Impact on production, exports and imports in the UK under a hard Brexit scenario (percentage change).

| Sector | Capital Demand | | Static CGE (Barriers to trade + FDI fall) | | | Recursive Dynamic CGE | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Barriers to Trade | | |
| | | | | | | Difference with respect to the BAU in 2030 | | |
| | Static CGE | Dynamic CGE | Production | Exports | Imports | Production | Exports | Imports |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Agriculture | -1.55 | 2.78 | 1.32 | -39.56 | -15.58 | 2.72 | -34.10 | -10.71 |
| Other Primary | -1.55 | -8.87 | -7.28 | -66.50 | -11.59 | -7.94 | -59.72 | -10.99 |
| Food | -1.55 | 0.09 | -0.28 | -35.88 | -24.89 | 0.87 | -34.97 | -18.42 |
| Textiles | -1.55 | -2.23 | -2.16 | -17.75 | -6.80 | -1.47 | -20.18 | -3.88 |
| Wood and Paper | -1.55 | 0.86 | 1.47 | -4.05 | -9.50 | 1.66 | -4.03 | -6.58 |
| Chemicals | -1.55 | -0.25 | -0.01 | -6.57 | -8.20 | 0.34 | -6.31 | -5.94 |
| Metals | -1.55 | 2.18 | 3.16 | 2.09 | -4.11 | 3.22 | 2.74 | -2.55 |
| Motor Vehicles | -1.55 | -5.01 | -4.79 | -16.07 | -12.64 | -4.96 | -16.40 | -7.20 |
| Other Transport | -1.55 | 0.76 | 0.90 | -2.75 | -13.46 | 1.85 | -2.99 | -8.71 |
| Electronics | -1.55 | 1.14 | 0.69 | -7.40 | -5.93 | 2.06 | -6.74 | -2.58 |
| Other Machinery | -1.55 | 3.16 | 3.90 | 9.33 | -4.17 | 4.06 | 10.96 | -3.93 |
| Other Manufactures | -1.55 | 0.04 | 0.83 | -1.30 | -8.47 | 0.83 | -2.02 | -5.62 |
| Construction | -1.55 | -3.12 | -3.04 | 6.58 | -9.02 | -2.42 | 4.37 | -6.56 |
| Water Transport | -1.55 | -0.19 | 1.18 | 1.71 | -5.59 | 1.08 | 1.48 | -4.12 |
| Air Transport | -1.55 | -0.87 | 0.25 | 2.34 | -3.24 | 0.03 | 1.92 | -2.73 |
| Communications | -1.55 | -1.65 | -1.05 | -0.31 | -9.05 | -1.05 | -1.23 | -6.75 |
| Finance | -1.55 | -0.77 | 0.01 | 0.76 | -7.35 | -0.07 | 0.44 | -5.74 |
| Insurance | -1.55 | -0.67 | -0.22 | 4.02 | -8.37 | -0.28 | 3.90 | -6.43 |
| Businness Services | -1.55 | -1.20 | -0.56 | -1.34 | -8.93 | -0.56 | -1.68 | -6.51 |
| Personal Services | -1.55 | -1.10 | -0.43 | 5.52 | -5.92 | -0.52 | 4.93 | -4.95 |
| Other Services | -1.55 | -1.76 | -0.90 | 5.30 | -5.94 | -0.98 | 4.38 | -4.79 |

Source: Authors' estimations.

# Chapter 6. Conclusions

## 1. Main results

In this PhD dissertation we analyse the impact of the Trans-Pacific Partnership (TPP) in Mexico and the effects of Brexit in the United Kingdom (UK) by means of CGE techniques. The first is an example of an economic integration process and the latter is an economic disintegration event. Using this methodology, we have been able to offer a rich set of micro and macro results that provide several original quantitative estimations of this phenomena, as we will try to explain in these conclusions.

To analyse the impact of TPP in Mexico we apply the static Global Trade Analysis Project (GTAP) model. We extend the previous research on this topic, which does not include estimates of the impact of non-tariffs barriers (NTBs). Our analysis provides the results of the impact of the reductions of tariffs and the decline in NTBs in isolation. Therefore, we can identify the contribution of each element in the total effect of the TPP. We also address another gap in the literature, which focuses its research on the impact in the United States of America (USA), because our analysis concentrates on the impact of TPP on Mexico (an upper-middle economy), while also providing the results for the USA.

We find that Mexico and the USA would benefit slightly from the agreement. In addition, the TPP without the presence of the United States, would still be beneficial to Mexico, since this latter economy would gain from further integration with the rest of the members of the TPP. When we run a reduction of tariffs, we find that the USA and Mexico become more integrated with the rest of the TPP members with whom they face larger tariff reductions. This implies that a trade-diversion effect prevails for Mexico after the decrease in tariffs, because with NAFTA tariffs between Mexico and the USA are already very low. By contrast, a reduction in NTBs would lead to higher integration of Mexico with the USA, thereby increasing Mexico's welfare and GDP by 0.14 and 0.19 percent, respectively. This is possible because NAFTA does not cover NTBs, but NTBs would go down with TPP.

Our results suggest that the simultaneous reduction of tariffs and NTBs would lead to an increase in GDP of 0.16 and 0.77 percent in Mexico and the United States, respectively. The TPP, as an economic integration process, would provide favourable trade conditions that would benefit Mexico to access new markets, thus pushing up its GDP, welfare, and wages. The small rate of growth of GDP for Mexico is related to the already existing preferential trade agreements which Mexico has signed with several TPP members. Another reason for the reduced impact obtained from reductions in tariffs and NTBs is that we estimated only the short-run effects. This means that we do not model the impact of a full implementation of NTB reductions, as other studies have done. In that sense, our results are consistent with the estimates of Petri and Plummer (2016) and Lee and Itakura (2015).

At the microeconomic level, tariffs and NTBs reductions lead to a production increase of durable manufactured goods, trade transport, utilities, and construction in Mexico. The sector of durable manufactured goods is highly dependent on the world market (i.e., 59.00 percent of its output is devoted to exports). It would experience cost savings due to the TPP. Therefore, reductions of trade barriers would push up exports to the rest of the members of the agreement, leading to an increase in total production.

We study the effect of Brexit in the UK by means of both, the static and the recursive dynamic GTAP model. We analyse the impact of restrictions on migration, the increase of barriers to trade, a UK unilateral tariff elimination and the reduction in the stock of FDI in the UK. The latter are proxied by contractions in the capital stock consistent with the empirical evidence on potential FDI stock reductions.

First, our empirical evidence suggests that the UK's exit from the European Union should be under the lowest possible trade barriers and immigration restrictions in order to face the lowest economic implications. We find that the more restrictive the migration policy is, the greater the loss in terms of GDP, GDP per capita and welfare. Decreases in the number of workers would reduce the UK's production capacity, and therefore, its GDP, GDP per capita and national income. For example, in the unlikely scenario in which all the EU migrants

living in the UK come back to the EU, the UK would experience a GDP, GDP per capita and welfare loss of 4.71, 1.06 and 4.63 percent, respectively. On the other hand, if all the EU migrants living in the UK come back to the EU, and the latter retaliates (i.e., all UK migrants living in the EU come back to the UK), the UK would face a GDP, GDP per capita and welfare loss of 2.50, 0.68 and 2.45 percent, respectively. By contrast, our milder scenarios suggest that a reduction of the inflow of EU immigrants between 0.13 and 0.27 percent of the total number of workers (i.e. between 42,000 and 87,000) would lead to foregone increases of 0.08 and 0.17 percent of GDP in the UK, per year. This impact should be considered cumulative across years in which the net inflows are reduced, so that the total number of years in which the net inflows of migrants are constrained should multiply those GDP reductions to obtain the overall impact (See Chapter 3 and Chapter 4).

Restrictions to immigration flows would increase wages in the UK. However, although the remaining workers earn more, what prevails is that a significant number of workers have left the UK, leading to reductions in welfare.

As mentioned above, in chapter 4 we estimate the impact of barriers to trade and migration restrictions in the UK. Regarding migration restrictions, we extend our previous analysis about migration policies after Brexit by including their impact on skilled and unskilled workers.

In this chapter, we follow one of the most likely OECD (2016) scenarios, which assumes that the UK would experience an annual reduction of 116,000 persons per year. Since controls on migration would remain for some time, we accumulate this reduction in the inflow of workers throughout 5 years. This means, the UK would experience an overall fall in the inflow of workers of 1.45 percent. In our central scenario (mix scenario), we disaggregate the shock between both skilled and unskilled workers. Therefore, it implies a reduction of 0.66 percent of skilled and 0.79 percent of unskilled workers. We find that a potential decline of 1.45 percent of EU migrants would imply a GDP and welfare loss of 0.45 and 0.44 percent, respectively.

With respect to barriers to trade we also find that under the soft Brexit, the UK would face a reduction in GDP by 0.49 percent, while under the hard Brexit this fall would be around 1.14 percent in the short run. According to our results, the elimination of all tariffs by the UK to the rest of its trading partners, would be not a sufficient policy to compensate the losses by Brexit. Running this latter scenario in isolation, the GDP in the UK remains nearly unaffected. In other words, Tariffs' elimination in the UK would lead to a tiny increase of its GDP by 0.04 percent. However, the UK would face small reductions in welfare and factors' remuneration. Concerning the welfare loss, after the increase of imported goods coming from third countries the UK reduces its trade with the EU. Because the EU is a very efficient partner this is a trade diversion effect which reduces welfare in the UK. The EU´s factors of production would also lose slightly after the UK´s tariffs elimination. These results are in line with the ones derived by Dhingra et al. (2016) and contrast with the one of Minford et al. (2015) who derived a very positive impact for Brexit arising after such a policy. This latter analysis supported the Brexit campaign with Minford being one of the few academics in favour of Brexit. (See Chapter 4).

On the other hand, in Chapter 5 we find that although Boris Johnson's proposal is not as favourable as a soft Brexit, his Brexit agreement would be better for the UK than leaving the EU without a deal. Clearly, Brexit as an economic disintegration process will be harmful for the UK and to a lesser extent for the EU. Restrictions to trade, FDI, and migration will imply the loss of access to a wide variety of resources and goods and services at convenient costs. Therefore, the UK could lose its attractiveness to attract new investors and trade partners, leading to a drop in its GDP, welfare, and factor remunerations.

Brexit does not only imply the emergence of barriers to trade and immigration restrictions but also the potential reduction in the inflow of FDI in the UK. In chapter 5, we apply both static and dynamic CGE model to analyse the impact of Brexit in the UK through the emergence of barriers to trade. Although the dynamic model allows us to estimate the impact of Brexit in the long term, it remains silent about how much of the effect of Brexit corresponds to a reduction in the stock of FDI. Therefore, we use the static model to

disentangle the potential effect of a decline in the stock of FDI from the impact of barriers to trade. This modelling strategy allows us to shed light on some of the potential effects of FDI after Brexit and help us to understand the role of FDI and barriers to trade in the overall impact of Brexit in the dynamic setting.

We find that the joint impact of a fall in the stock of FDI (i.e., capital stock reductions) and barriers to trade with the static model are quite close to the results obtained with the dynamic model. Once we combine the impact of the resulting fall in the stock of FDI (i.e., capital stock reductions) in the dynamic setting with the ones of the barriers to trade, we can reproduce the dynamic results for GDP in our static setting. Recall that, GDP in the UK would decrease by 0.96, 1.43 and 2.15 percent by 2030, compared to the BAU scenario. In the static setting under the soft Brexit, trade effects would explain 0.49 percent of the GDP reduction of 0.95 percent, while FDI would explain 0.46 percent. In Johnson's Brexit scenario, the drop in GDP by 1.41 percent involves a fall of 0.73 and 0.68 percent on barriers to trade and FDI, respectively. Finally, with hard Brexit, the fall of GDP by 2.15 percent comprises a reduction of 1.09 percent due to trade barriers and a decline of 1.07 percent because of FDI fall. Note that these results suggest that FDI impacts turned to be as sizeable as trade impacts in a static setting. Thus, the static model allows us to disentangle the contribution of trade and FDI to the total impact of Brexit in the dynamic model.

In addition, our estimations for the role of FDI is larger than ones of the few previous existing ones, such as the ones by Latorre et al. (2019a, 2019b and 2020), who estimated that FDI accounted for around one third of the total overall impact of Brexit including trade and FDI in a static setting. The contrasting results are understandable since Latorre et al. (2019a, 2019b and 2020) only consider services multinationals in their analysis, while here we consider FDI in all sectors of the economy.

We also expand the results offered by previous dynamic analysis of Brexit (e.g., Dhingra et al., 2017; Aichele et al., 2015). We find that wages of skilled (unskilled) workers would fall by 1.92 (1.99), 2.82 (2.90), and 4.06 (4.18) percent under soft, Johnson's and hard Brexit,

respectively. Capital rents would also face a decrease between 1.47 and 3.03 percent. Reductions in factors' remunerations and the increase in barriers to trade would imply contractions of aggregate imports by a range of 4.29 - 9.72 percent. Aggregate exports would also decrease between 4.82 and 11.27 percent. Lower aggregate imports imply less competition from foreign firms, therefore the variety of goods in the local market would be more expensive than before the emergence of barriers to trade. Hence, the UK would experience a welfare loss between 1.47 and 3.03 percent. All these results are, of course, compared to the BAU scenario (See Chapter 5).

In addition, Brexit also has economic implications at the microeconomic level. Policy makers should consider in their economic policy formulation the impact of Brexit on particular UK's sectors, such as motor vehicles.

In Chapter 4, we find that at the microeconomic level, migration restrictions lead to a decline in the number of workers, which brings about a fall in production across most sectors in the economy. Also, the increase of tariffs and NTBs push up export and import costs between the UK and the European Union, particularly affecting exports of manufacturing sectors (e.g., motor vehicles, chemicals, textiles, and other primary products) in the UK.

With our extension in Chapter 5, we derive that the effects of trade clearly contrast with the ones from a reduction in the stock of FDI. One important finding is that the impact for services sectors are very different depending on whether capital stock reductions (a proxy for FDI reductions) are included in the modelling exercise or not. In the dynamic model disinvestments lead to a process of capital stock reduction. These cuts in capital available for production, as well as the drop in its remuneration, which in turn reduces national income, is harmful for the production and demand of services sectors, respectively. The damage for services is larger than in the context of the trade shock in static model, with no reductions in the FDI capital stock. Using the static model including only the trade shock (with no FDI shock) derives a rather rosy future for services sectors, in general. However, once we introduce either the trade shock in the static model combined with the FDI stock reduction

or a trade shock in a dynamic model, we obtain that services sectors suffer considerably after Brexit. This is an important contribution of the sectoral analysis of this chapter, which carries important policy implications. It seems very likely that Britain's large services sector—including its vast financial, legal and accounting centres—will no longer have seamless access to EU clients after Brexit. This will have important consequences. However, some quantitative models, particularly static trade models, will miss these effects even if they consider non-tariff barriers in services sectors, as we have done in our static analysis.

In addition, Motor vehicles would be one of the most hurt sectors in the UK, compared to the BAU scenario. Production in motor vehicles would decline by 4.06 percent under the Johnson's Brexit scenario in 2030. It would experience a decrease in exports and imports flows by 16.40 and 7.20 percent, respectively. As we noted, this contraction in production under the dynamic model is very similar to the one derived in the static setting (in the simultaneous shock of trade and FDI).

Motor vehicle's trade with the EU is very intense, accounting for 43.15 and 82.97 percent of its total exports and imports, respectively. In addition, Motor vehicles exhibits one of the highest trade barriers (Table 3). These two forces push down exports in this sector. Moreover, it is a sector whose production relies heavily on trade, i.e., its export and import shares account for 53.74 and 78.32 percent of its total production. This implies that the reduction in exports in this sector, will heavily affect its production. In fact, there are other sectors, which would experience larger contractions in exports and imports than Motor vehicles. Those sectors have even more sizeable barriers after Brexit or their trade is more related to the EU, than in the case of motor vehicles. However, trade contractions are not transmitted as severely to production as in motor vehicles, since foreign trade is not so important for their production. For example, because UK's agriculture or food exhibit rather small shares of production devoted to exports in the context of manufactures, their production is not so harmed as the one of motor vehicles, despite the large contractions in exports they experience.

We also use the dynamic model to analyse the timing of the adjustment due to the emergence of barriers to trade. To this aim, we apply two different techniques to simulate the impact of barriers to trade: 1) All barriers to trade takes place in 2021 once Brexit comes into force; and 2) There is a gradual increase of trade barriers along 4 years. In the first year (2021) one-third of the barriers appear, while the rest of the shock emerges gradually along 3 years (2022-2024), finally reaching the same level for the barriers as in the previous scenario. We find that both techniques provide similar results. Therefore, it also supports our strategy to better understand the dynamic results by using the decomposition approach identified in this chapter.

Beyond the analysis of the economic implications of TPP and Brexit, our research provides several contributions to the literature from the perspective of policy implications and methodological considerations.

Regarding the policy implications the present analysis provides clear-cut impacts for the phenomena they analyse. CGEs derive the exact percentage changes for a rich set of macroeconomic and sectoral variables, for different regions in a consistent framework. There are other methodologies, such as New Quantitative Trade Models (Dhingra et al., 2017; Aichele et al., 2015) or Macroeconometric models (UK Government, 2016a, 2016b), which also provide quantitative estimations. However, the latter methodologies do not provide sectoral results. Regarding the macroeconomic variables, while the macroeconometric models provide an important set of results, in the case of NQTMs the scope is more limited. Most of the analyses using NQTMs and macroeconometric models, as well as other previous CGEs have concentrated on the impact for the UK alone. In this Thesis we offer the results for the Rest of the EU, China, the US and the rest of the world, always. In some cases, we even provide sectoral results for the EU as well. This helps to check the consistency of the results and provide a broader panorama than in other studies.

We believe an important distinction on how the analysis of Brexit haven been undertaking in the NQTMs and macroeconometric models and ours is that we clearly show how much of the impact corresponds to trade effects (tariffs and NTBs), migration restrictions and FDI,

not only at the aggregate level but also at the sectoral level. This may be helpful for the policy maker to try to negotiate future barriers for the different chapters of the negotiation, as well as for the sectors according to his needs. In fact, to better understand the role and contributions of the different components of the overall shock we proceed in a step-by-step manner throughout this Thesis. We first study migration and the disaggregate by type of workers, we first study the static effects and then decompose the dynamic results we find, by using some static results.

With respect to the contributions related to methodological considerations, throughout the chapters we have compared CGE modelling impacts, with the ones derived with other methodologies. Regarding static trade effects after Brexit, we derive even larger impacts than the ones of the influential study by Dhingra et al. (2017). For a hard Brexit, our reduction is of 1.94 percent, while they obtain 2.66 percent. However, in their more detailed welfare decomposition, shown in Table 4 (Dhingra et al., 2017. p.671)[1], we see that the most important contribution to their overall total welfare impact (-2.66 percent) is the absence of future EU integration (-1.61 percent)[2]. The latter surpasses the joint contribution of NTBs and tariffs for the hard Brexit (-1.31 and -0.13 percent, respectively), which as we say is smaller than the -1.94% contraction that we derive for NTBs and tariffs jointly.

Our welfare reduction for the UK after the soft Brexit (-0.91 percent) is also larger than the impact of the increase in NTBs they obtain (-0.53 percent). Our model and the one of Dhingra et al. (2017) have an important array of features in common. Both use similar non-tariff barriers to trade and a static general equilibrium model with a comprehensive input-output structure in a perfectly competitive setting. However, our CGE methodology yields deeper impacts than their NQTM approach. We can hypothesize, in line with the findings of Balistreri and Tarr (2017) and Costinot and Rodríguez-Clare (2014), that the more structure

[1] The detailed decomposition of Table 4 was not available in its working paper version, namely, Ottaviano et al. (2014).

[2] Although implementing a shock of further future EU integration consists in reducing NTBs among EU countries and could be done in our CGE model if we disaggregate the EU region, we are not convinced that achieving an even deeper level of integration among EU countries is a very likely scenario.

we add to the model, the larger the impact obtained compared to a more stylized model. In this sense, our CGE model includes more detailed modelling features than NQTMs. Latorre et al. (2019b) and Bekkers and Rojas-Romagosa (2019) explain that NQTMs estimate trade impacts using a small group of structural-type variables, such as national income, geographical distance, technology and trade obstacles like tariffs and NTBs.

In addition, our study provides a technique to better understand dynamic results. Understanding dynamic impacts is not an easy task as can be inferred in the following comment by Dhingra et al. (2017, p. 679): "The dynamic gains from trade are less well understood than the static gains captured by our model. More empirical work is needed to establish the relative importance of the different channels studied in the theoretical literature and to allow for the development of a workhorse quantitative trade model that incorporates dynamic technology effects. However, the existing literature suggests that dynamic effects are quantitatively important and that static models substantially underestimate the gains from trade. This implies that by using a static trade model we underestimate the costs of Brexit". In this Thesis, we disentangle the potential impact of a reduction in the stock of capital from the impact of barriers to trade, when modelers employ the recursive dynamic GTAP model. This modelling strategy, developed in Chapter 5, allows us to shed light on some of the potential effects of FDI after Brexit and help us to understand the role of FDI and barriers to trade in the overall impact of Brexit in the dynamic setting. In addition, it identifies that the services sectors are much more damaged in the dynamic setting than in the static one.

Overall, our analysis also confirms that economic integration understood as the reduction or elimination of the economic barriers between countries clearly improves the overall commercial and economic conditions of the countries involved. Fewer barriers to trade imply cost savings, which push up the flow of exports and imports in most sectors. More exports push up production increasing demand for labour and capital. Factor remunerations would increase, leading to an increase in private consumption, which, in turn, pushes up aggregate production. Additionally, more imports increase competition in the local market. Hence, there will be a greater variety of intermediate and final goods at more competitive prices than

before economic integration. As a result, countries would experience welfare improvements. Not all sectors, however, benefit from economic integration and not all sectors loose with disintegration, but our methodology provides the policy maker with estimations that will enable him to try to negotiation better conditions for some sensitive sectors.

Although the UK will look for a favourable trade agreement with the EU, this agreement will not provide the benefits that the UK already had as an EU member. Brexit implies the increase of trade, migration and FDI restrictions which will diminish trade, workers and investment flows between both regions, leading to a fall in GDP, welfare, aggregate exports and imports, and factors remunerations, as we have quantified in our analysis. What is more, our current estimations may be underestimating the overall negative impact of Brexit.

## 2. Proposal for future research

The negative impact of Brexit in the United Kingdom (UK) could be accompanied by the negative effect of the recent pandemic (i.e., Covid19), which has not been considered in the analysis and is not related to the disintegration process.

According to the Office for National Statistics (ONS, 2020), the UK has experienced a significant shock since the coronavirus pandemic started. For example, the GDP has fallen by 20.4 percent between March and April 2020. Regarding the services sector production, 40 of 50 services industries fall by 10 percent or more, 27 by more than 20 percent and 8 more than 50 percent. In goods sectors, the most harmed industries are motor vehicles, furniture, leather, and related products, wearing apparel and wood, with falls between 51 and 90.3 percent, in the same period.

The bulk of the impact in services sectors would be explained by the social distancing measures, while the lockdown restrictions could explain the fall in goods sectors. Therefore, to the extent that these restrictions remain in force and their relaxation depends on the

evolution of the pandemic in the different regions of the world, it will not be possible to accurately estimate the final effect of Covid19 on the GDP in the UK and in other regions of the world. Therefore, to analyse the impact of Covid19 in the UK economy and identify how much of the decrease in GDP would be explained by the pandemic, we should wait for more accurate information and data.

We are aware of some limitations that are present in our current analysis. Regarding the impact of TPP, we focus our analysis on Mexico and provide estimates for the short term. Hence, it would be interesting to extend the study of TPP and its impact in the long term, not only for Mexico but also for the rest of the members of the agreement. It would be worth it to analyse the potential impact of TPP on the flow of FDI among members and its effects at the macroeconomic and sectoral levels.

With respect to the analysis of Brexit, although we provide estimates for the short and the long run in terms of trade barriers and FDI, we do not provide estimates for the impact of migration in the long run. Therefore, a future extension of our analysis would be to combine the analysis of the four freedoms of the EU in a dynamic setting.

Melitz and Redding (2014, 2015) indicate there is a potential channel (i.e., the endogenous changes in domestic productivity á la Melitz, 2003) which increases the welfare gains from trade. Therefore, they suggest that the share of expenditure on domestic goods and the trade elasticity are not enough to predict welfare gains from trade, as suggested by Arkolakis et al. (2012). According to Melitz and Redding (2014, 2015), all the models (e.g., Ottaviano et al., 2014; Dhingra et al., 2017) that do not incorporate heterogeneous firms, including ours, would provide lower bound estimates for the trade impact of Brexit on welfare.

However, in our analysis we find that the welfare effects we derive are very similar to the ones for trade derived by Latorre et al. (2019a, 2019b, 2020), whose model includes a Melitz

structure on several manufacturing sectors[3]. We also find that our estimations for GDP are only slightly smaller than the ones estimated by Latorre et al. (2019a, 2019b, 2020). In addition, Jafari and Britz (2018) obtain in a Melitz framework an impact on GDP from NTBs and tariffs of -1.08 and -0.29 percent, respectively. This would be only slightly larger than our joint -1.14 percent impact on GDP (composed of -0.15 percent reduction due to tariffs and the rest being explained by NTBs -0.99 percent). Overall, it seems that we are not missing much, at least at the aggregate level, by not including a heterogenous firm approach in our model, once the comparison with other models is made carefully in a component by component basis. An explanation for this may be that modelling Melitz effects is still in its infancy in a framework like CGE models and New Quantitative Trade Models, which are already quite complex without the Melitz structure.

In the Introduction we have discussed other modelling efforts that have been presented in the latest GTAP conference of 2020. We believe all of them constitute promising lines of research, which will be considered in our next steps: 1) Going deeper into the analysis of the impact of different closure rules baselines in recursive dynamic models (Bekkers and Orlov, 2020); 2) Working on proper ways of accounting for firm heterogeneity, as we have just discussed in line with the work of Akgul and Saad (2020) and Latorre et al., (2020); 3) Digging deeper in the sectoral approach in order to be able to introduce important products at the HS-6 digit level in CGE models, in the line of Pelikan et al., (2020); 4) Extend our work on the modelling of multinationals affiliates sales and Foreign Direct Investment modelling, including the very comprehensive dynamic modelling strategy of Hosoe (2020); 5) Extend our analysis of migration to pay close attention to the impact of economic (dis)integration on workers, following the analyses of Tsigas and Bernard (2020).

[3] We have previously commented the comparison between the impact of multinationals of Latorre et al. (2019a, 2019b, 2020) and the one we obtain with FDI. Now we focus on the comparison of our results for tariffs and for the total of trade impacts (including NTBs), with the ones from Latorre et al. (2019a, 2019b, 2020).

In this Thesis we have proceeded in a step by step manner to better understand the different components of the impact of economic (dis)integration. Now we are in the position to be able to incorporate and disentangle the impact of the next steps ahead.

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