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Global production networks and foreign direct investment in China: a computable general equilibrium analysis of their effects on East Asia, the US and the rest of the world
Redes de producción global e inversión extranjera directa en China : un análisis de equilibrio general computable de sus efectos en Asia oriental, EEUU y el resto del mundo

MEMORIA PARA OPTAR AL GRADO DE DOCTOR

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PhD Dissertation

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Resumen

1. Introducción

Hoy día es fácil encontrar la etiqueta ´Made in China´ en muchos productos. Parece que China es una fábrica enorme que produce casi todo. El gigante asiático tiene un gran superávit por cuenta corriente frente a los EE.UU. y frente a otras economías occidentales. ¿Pero es verdad que China ingresa realmente tanto como su superávit en cuenta corriente sugiere? La respuesta es No.

De hecho, algunos de los productos tienen etiquetas como 'diseño en los EE.UU., componentes procedentes de Japón, Corea y Taiwán, montaje en China'. Esto revela una división y colaboración en la cadena de suministro a nivel mundial. Fenómeno que se ha designado en la literatura como "Redes de Producción Global", comercio de intermedios y fragmentación.

Xing y Detert (2010) concluyen que los trabajadores chinos agregan sólo 6,50 dólares al coste total ($179) de fabricación de un iPhone, mientras que el resto del valor es una transferencia de componentes procedentes de Alemania, Japón, Corea, los EE.UU. y otros países. La cadena de montaje de China depende en gran medida de los intermedios importados. Después del tsunami y la fuga nuclear de Fukushima, Foxconn, la empresa de Taipei a la que iPhone subcontrata importantes tareas en sus sedes de China, cerró un par de líneas de producción debido a la escasez de componentes. Los consumidores se encontraron con una escasez de suministro de iPhones durante ese período. Por contraste, los trabajadores de Foxconn, habitualmente hacen horas extras en sus líneas de montaje para satisfacer una demanda que se expande rápidamente. El caso del iPhone nos ha

llamado la atención como ejemplo de interacción entre la inversión extranjera directa (IED), el comercio de intermedios y las Redes de Producción Global. ¿Qué relación hay entre las importaciones de intermedios y el comercio de bienes finales? ¿Cómo influye la demanda final en el comercio? ¿Qué efectos tienen la IED en el patrón del comercio entre las diferentes regiones a través de las redes de producción asiáticas? ¿Qué papel desempeña cada región en el mercado mundial? ¿Cuál es el impacto en las principales variables micro y macroeconómicas de las diferentes regiones que participan en el proceso? Estas son las preguntas que esta tesis doctoral trata de responder.

La entrada de IED en China, realizada por empresas multinacionales (EMNs), ha contribuido sustancialmente a la tasa de inversión de este país. Los flujos (el stock) de IED se elevaron de 2,8% (1,07%) en 1991 a 8,1% (3,48%) en 2011 (UNCTAD, varios años). Desde 2008 China ostenta la segunda posición como país de máxima atracción de flujos de IED del mundo, tras los EE.UU (UNCTAD, varios años). Las economías de Asia Oriental han proporcionado el 63% de la IED acumulada en China desde 1985 hasta 2008 (Xing, 2010). A través de la IED y el comercio, China se ha integrado en las Redes de Producción Global. El surgimiento de China ha intensificado la segmentación internacional de los procesos de producción dentro de Asia, pero no ha creado un motor autónomo para el comercio de la región, ya que Asia sigue dependiendo de otros mercados para sus exportaciones de bienes finales (Athukorala and Yamashita, 2006; Gaulier et al., 2007a).

Las EMNs han utilizado China como base de producción y exportación. La producción de bienes intensivos en mano de obra se ha trasladado a China. Los países asiáticos desarrollados han perdido su cuota de exportación en los mercados de bienes finales, pero

han acelerado sus exportaciones de bienes intermedios sofisticados a China (Gaulier et al., 2007b).

Las exportaciones e importaciones entre China y Asia oriental casi se han cuadruplicado entre 2000 y 2009 (OCDE, varios años). Por otra parte, el 70% del comercio intrarregional en Asia oriental es de partes y componentes que serán montados y exportados a otras regiones (ADB, 2007).

Koopman et al. (2011) y Wang et al. (2011) han investigado el comercio de valor añadido basándose en un análisis de tablas Input-Output (IO). Sus resultados muestran que existe un alto contenido de bienes intermedios importados de Asia Oriental en las exportaciones chinas y una alta dependencia del mercado occidental en las exportaciones chinas. Este país realiza principalmente tareas de montaje de piezas, quedando en la parte baja de la cadena de valor (Koopman et al, 2011; Baldwin y López-González, 2013).

Sin embargo, la producción en realidad no es una combinación fija de intermedios y factores como la metodología el análisis IO asume. Otra de las limitaciones de los análisis basados en la metodología IO es la dificultad de realizar comparaciones entre países precisamente porque las matrices I-O se calculan con poca regularidad.

Dada la complejidad del proceso de globalización de China, se desconoce aún gran parte de cómo la IED afecta al patrón de comercio a través de las redes de producción global, y el impacto sobre variables como el PIB, la renta nacional, la demanda interna y el comercio entre las diferentes regiones involucradas.

Los análisis con Modelos de Equilibrio General Aplicado (MEGAs o CGE Computable General Equilibrium models en inglés) son aún escasos. Una de las pocas excepciones es

Kawai y Zhai (2009), que ilustran a través de un MEGA cómo la reducción de la demanda de bienes filiales por parte de los países occidentales, debida a la crisis, reduce la demanda en China de importaciones intermedias procedentes de las economías asiáticas.

Los MEGAs permiten analizar la tecnología de producción que utiliza cada sector en cada una de las regiones, así como, sus respectivos papeles por el lado de la demanda. Todo ello junto con la evolución de los flujos de comercio distinguiendo si los bienes finales son para el consumo privado, el consumo público, la formación de capital o productos intermedios. Esto permite analizar la presencia y el impacto de las redes de producción globales. A esto se añade la consideración de flujos de IED, que han sido poco tratados con esta metodología (Latorre, 2009).

Este trabajo aporta a la literatura de IED y de redes de producción global los resultados de un MEGA de, al menos cuatro regiones (China, Asia Oriental, EE.UU. y el Resto del Mundo) y 15 sectores de producción.

2. Objetivos y resultados

Tras un Capítulo 1 inicial introductorio los principales objetivos y resultados de la tesis se desarrollan en los Capítulo 2, 3 y 4.

Capítulo 2: Objetivos

Atraídos por los casos de iPod e iPhone, hemos querido analizar cómo los flujos de IED de las EMNs en China afectan a lo que se ha llamado el "Patrón de comercio triangular" ("Triangular trade pattern") del sector de la Electrónica. La literatura utiliza esta expresión para describir un proceso por el que Asia Oriental importa intermedios de alto valor añadido de EE.UU, que son reexportados a China. China, a su vez, monta los intermedios y exporta los bienes finales a EE.UU (Amiti y Freund, 2010; Xing, 2011). Este capítulo analiza el papel de los flujos de IED en este proceso.

La literatura, sin embargo, no ha prestado mucha atención al papel de la IED desempeñado en las redes de producción, menos aún la que utiliza la metodología de los MEGAs. La abundante oferta de obra barata, las políticas de promoción de la IED y exportaciones, el crecimiento económico elevado y el tamaño del mercado de China han sido importantes factores para la atracción de enormes flujos de IED.

Según la base de datos GTAP 8 (Narayanan et al., 2012), Asia Oriental provee el 60,4% de las importaciones chinas y casi el 80% de las importaciones chinas son de productos intermedios. Asia es, por tanto, el principal proveedor de componentes para la producción de China. Estos datos coinciden con otras fuentes de evidencia empírica. China tiene un muy bajo consumo privado en Electrónica. El 55% de su producción se exporta y el 71% de sus exportaciones van a los EE.UU. y el resto del mundo (RM), regiones que, a su vez, dedican un alto porcentaje de las importaciones al consumo privado.

Los EE.UU. y el RM son el mayor destino de las exportaciones chinas y China es también una fuente importante de importaciones de estas dos regiones. El "Comercio triangular" se

desarrolla cuando las filiales de EMNs en China importan intermedios de sus empresas matrices y exportan bienes finales a los mercados Occidentales. Tengamos en cuenta que más del 80% de la producción y el 70% de las exportaciones de Electrónica está en manos de las EMNs. Por lo tanto, parece que hay una fuerte relación entre la IED, las Redes de Producción Global y el comercio.

Basado en la última base de datos de GTAP 8 (Narayanan et al., 2010), el modelo consta de 15 sectores, 4 regiones y 2 factores de producción. La Electrónica es el sector más orientado a la exportación en China y, como acabamos de señalar, la mayor parte de su producción está en manos de EMNs. El capítulo examina los patrones de comercio entre China, Asia oriental, los EE.UU. y el RM tras la llegada de flujos de IED al sector de Electrónica en China. Replicamos el aumento real del stock de IED en Electrónica, que casi se ha duplicado entre 2004 y 2011.

Capítulo 2: Resultados

Los resultados de la simulación indican que China se ha beneficiado de las entradas de IED en términos de aumento del PIB (1%) y bienestar (el 3,8%, aproximado por el aumento de la renta nacional).

En cuanto al comercio, el papel fundamental de China en la red de producción de la Electrónica se ha fortalecido mediante la intensificación de sus exportaciones a todos los socios comerciales. Sus vínculos de exportaciones e importaciones permanecen sin cambios, es decir, continúa con la estructura geográfica de comercio de la que partía.

El aumento en la producción de la Electrónica en China es más importante para el aumento de las exportaciones de Electrónica de Asia oriental a China que para el aumento de las exportaciones de EE.UU. y RM a China. Esto es debido a las redes de producción que existen entre China y Asia oriental. China colabora con Asia oriental en la producción de bienes de Electrónica, pero compite con esa región en los mercados de EE.UU. y el RM. Tras la entrada de IED, Asia oriental aumenta las exportaciones a China, pero reduce las exportaciones al resto de las regiones y, además, las exportaciones de componentes electrónicos dentro de Asia Oriental también son desplazadas por China. A pesar de que el Este de Asia exporta más a China, pierde terreno en el mercado mundial. Esta última fuerza se impone y, en general, las exportaciones de Asia Oriental se reducen.

La estructura geográfica de importación del resto de las regiones cambia considerablemente. El gran aumento de las exportaciones chinas, tras una gran caída en sus precios de exportación, desplaza a otros competidores en todo el mundo. China también atrae más exportaciones del resto de las regiones (principalmente debido a los productos intermedios importados necesarios para su producción en Electrónica). Sin embargo, la estructura de exportación del resto de regiones varía menos que la estructura de importación. Esto implica que China desempeña un papel más importante como proveedor de productos electrónicos para RM que como mercado de bienes finales para ellos.

China se ha fortalecido aún más en su papel como base de producción y exportación. Asia Oriental se integra más con China (a través de más exportaciones e importaciones), pero pierde competitividad y terreno en los mercados de EE.UU., el RM y en su propio mercado interno. La IED desempeña un papel vital en la formación de redes de producción regionales en Asia.

Este capítulo se ha aceptado en "Economic Modelling" tras una primera revisión que ha sido reenviado en Abril. También ha sido presentado en "16th Annual Conference on Global Economic Analysis, GTAP", Shanghai en 2013 y en "XVI Jornadas de Economía Aplicada" celebradas en Granada en 2013.

Capítulo 3: Objetivos

En el capítulo 2, hemos profundizado en el análisis del "Patrón de comercio triangular" del sector de la Electrónica. En este nos planteamos si la IED tendría un impacto similar en los sectores de Textiles y Maquinaria, que también están muy orientados a las exportaciones como Electrónica. ¿Podemos esperar en China, Asia Oriental, EE.UU. y el RM efectos similares a nivel micro y macroeconómico? Este capítulo explora en detalle los papeles que cada región desempeña como proveedor de intermedios o como un mercado final para productos de 3 sectores diferentes: Electrónica, Textil y Maquinaria.

Aunque conservamos las 4 regiones y los 15 sectores del capítulo previo, en este diferenciamos entre mano de obra cualificada y no cualificada que junto con el capital constituyen los 3 factores utilizados.

Los sectores de Electrónica, Maquinaria y Textiles suponen el 55,4% y el 40% de las exportaciones e importaciones totales chinas, respectivamente, y el 13,6% de su PIB. Tres características del comercio chino destacan:

1. Alrededor del 80% de las exportaciones chinas en estos sectores se dirigen a los EE.UU. y el RM. Esta última región es el destino más importante explicando entre el 50% y 60% de

las exportaciones totales chinas, mientras que las dirigidas a EE.UU., suponen entre el 25% y 30%. Por lo tanto, sólo alrededor del 20% de las exportaciones chinas van a Asia Oriental. A su vez la mayoría de las importaciones de Asia Oriental son de productos intermedios, considerando el muy reducido porcentaje de las importaciones que se destinan al consumo privado, especialmente en Maquinaria. Esto implica que la mayor parte de las exportaciones chinas de bienes finales se dirigen a los EE.UU. y al RM. Por lo tanto, estos últimos constituyen sus principales mercados finales.

2. La mayoría de las importaciones chinas son intermedios, concretamente el 68% (en Maquinaria) y alrededor del 85% (en Electrónica y Textiles). Es difícil encontrar estadísticas de comercio que incluyan información simultánea sobre el tipo de bienes comercializados (es decir, si son bienes intermedios o destinados al consumo privado o público, o a la inversión) y el país de origen. La información puede existir en algunos países aislados, pero es poco común para grupos de países. La información de la base de datos de GTAP utilizada en este capítulo informa, por una parte, del tipo de bienes importandos y, por otra, del país de origen, sin cruzar ambos tipos de información. Sin embargo, nos da pistas importantes de la existencia de redes y de mercados finales en este sentido, como se verá en la tercera característica.

3. Alrededor del 60% de las importaciones totales de China provienen de Asia Oriental. Como se señaló anteriormente, nuestros datos no permiten conocer al mismo tiempo el país de origen (si se trata de Asia Oriental o no) y el tipo de uso del bien de ese país de origen. Pero con un 80% las importaciones intermedias y 60% siendo proporcionada por Asia Oriental, parece razonable suponer que Asia Oriental está muy integrada en las redes de producción de China, proporcionando una importante cantidad de productos intermedios.

¿Cuál es el impacto de la IED en las redes de producción asiáticas y en los mercados finales a los que China envía la mayor parte de sus exportaciones?

Capítulo 3: Resultados

Los resultados revelan que China se ha beneficiado de la entrada de IED con un aumento del PIB (2,1%) y del bienestar (9,6%). Aumenta el salario de la mano de obra cualificada, pero disminuye el de la no cualificada y también la remuneración de capital. Las reducciones de precios y los aumentos de producción en los sectores en los que entra la IED es proporcional a la magnitud de flujos de IED recibidos. Debido a que el sector de la Electrónica es el principal receptor de flujos de IED, es el que experimenta la más intensa caída de precios y el más pronunciado aumento de la producción.

Los patrones de comercio de China y los del resto de regiones difieren en los tres sectores considerados. Después de las entradas de IED, las exportaciones chinas de Electrónica y Maquinaria aumentan, mientras que las exportaciones del Textil bajan. Los EE.UU. y el RM absorben la mayor parte del aumento de las exportaciones chinas. El patrón del sector Textil difiere de Electrónica y Maquinaria debido a la importancia del Textil en el consumo privado chino. Con las entradas de IED, la renta de los hogares y la demanda nacional aumentan en China. Crece la demanda de Textil en el interior del país y se exportan menos.

Por otra parte, después del aumento de las exportaciones de Electrónica y de Maquinaria, la producción y las exportaciones de estos bienes en el resto de las regiones se ven perjudicadas. La caída en los precios de exportación hace las exportaciones chinas muy competitivas. Además encontramos que China importa más bienes de Electrónica pero

reduce las importaciones de Maquinaria después de shock. Este contraste se debe al hecho de que las importaciones de Electrónica son clave porque la producción de Electrónica que se expande después de las entradas de IED, depende en gran medida de bienes intermedios importados. El sector de la Maquinaria utiliza con menor intensidad en su producción, que también se expande después de que los flujos de IED, los intermedios importados. Por último, la caída de las exportaciones chinas de Textiles provoca un aumento de las exportaciones del resto de regiones. Sin embargo, las exportaciones de Textiles son más pequeñas en el total de los flujos de comercio mundial que las de Maquinaria y Electrónica. Por lo tanto, el aumento de las exportaciones Textiles no es capaz de compensar la reducción de las exportaciones de Maquinaria y Electrónica que experimentan todas las regiones salvo China.

Este análisis, utilizando una perspectiva de equilibrio general, confirma y amplía los principales resultados de la literatura empírica. Existen redes de producción importantes entre China y Asia Oriental en Maquinaria y en Textil, y no sólo en Electrónica. Aunque la integración de Asia Oriental y China es más intensa en el sector de la Electrónica. Además, analizamos el papel de EE.UU. y el RM como principales mercados de bienes finales para China. Tener en cuenta estos patrones geográficos, junto con las tecnologías de producción particulares de cada sector (por ejemplo, la intensidad de la utilización de bienes intermedios importados o domésticos) y la orientación de la demanda (por ejemplo, la orientación al consumo privado del Textil) ayuda a estimar el impacto de la IED en las Redes de Producción Global, flujos de comercio y mercados finales.

Este capítulo, que ha enviado en diciembre 2013 a la revista en “Global Economic Review: Perspectives on East Asian Economies and Industries”, está en revisión en abril 2014

todavía. Se ha presentado en las "Las X Jornadas de Integración Económica" celebradas en Castellón de la Plana en diciembre de 2013, siendo organizadas por el grupo INTECO. Está disponible como documento de trabajo en "Munich RePEc Personal Archive". También se ha enviado.

Capítulo 4: Objetivos

En el capítulo 3, se analiza cómo la IED afecta a la evolución del comercio y otras variables a través de la interacción con las redes de producción y los mercados de demanda final. En las redes de producción de Asia Oriental la región provee la mayoría de los bienes intermedios de China y China, a su vez, es el principal proveedor de intermedios de Asia Oriental. EE.UU. y el RM son los principales mercados para las exportaciones chinas. Sin embargo, desde la perspectiva de la producción mundial, el RM es un mercado muy grande. Un siguiente paso lógico es separar la Europa de RM y otra gran economía, a saber, Japón de Asia oriental.

En la estructura de producción de los sectores de Electrónica, Maquinaria y Textil, los intermedios procedentes del sector de la Química son importantes. Además, el sector Químico también está muy orientado a la exportación y cuenta con una importante dependencia de intermedios importados. Por ello, extendemos nuestro análisis del impacto de la IED al sector Químico.

Además, en los dos últimos capítulos, nos hemos centrado en el impacto de la IED en las variables microeconómicas, como las redes de producción y el patrón de comercio en los

sectores a los que la IED llega. En este capítulo, se da una explicación en profundidad de los impactos de la IED en los resultados macroeconómicos en seis regiones.

Con un MEGA de 2 factores, 15 sectores y 6 regiones, analizamos cómo la IED que llega a los sectores Textil, Química, Electrónica y Maquinaria en China, afecta a las redes de producción (entre China, Japón y Asia Oriental), y a los mercados finales (Estados Unidos, Europa y el RM).

Capítulo 4: Resultados

En el año 2007 China representaba una parte relativamente pequeña del PIB (6,3%), las exportaciones (8,3%) y las importaciones (6,4%) del mundo. Porcentajes muy reducidos frente a los de Europa (31%, 39.7% y 40.8%, respectivamente) o los de EE.UU. (25.2%, 9.2% y 14.5%, respectivamente). No obstante, la llegada de IED a la fabricación china parece haber producido efectos negativos en muchas regiones del mundo. Cuando las exportaciones chinas aumentan, debido a la IED, las exportaciones y la producción se reducen en los sectores que compiten con ellas en el resto de regiones. Esas reducciones en la producción total hacen bajar los salarios y la renta de capital, disminuyendo también la renta nacional y el PIB en las regiones que compiten con China.

Simulamos los incrementos reales de IED que ha acudido a los sectores de Electrónica, Maquinaria, Química y Textil en China. Estos cuatro sectores conjuntamente representan el

64,5% y el 53,5% de las exportaciones e importaciones totales chinas, y el 38,1%[1] de las exportaciones (o importaciones) mundiales totales.

China se beneficia de los flujos de IED, debido al aumento de los salarios (0,42%), el PIB (2,68%) y la renta nacional (11,54%). La competitividad de las exportaciones aumenta con fuerza en Electrónica, Maquinaria y Química. Asia Oriental es la región que resulta más negativamente afectada, a pesar de que comparte redes de producción con China. Asia Oriental exporta más en aquellos sectores en los que China compite menos después del aumento de la IED. Además, en general, va a suministrar intermedios en aquellos sectores en los que China aumenta la producción, va a ser desplazada por China en el resto de mercados. Los principales resultados negativos para Asia Oriental surgen de la disminución de la producción en los sectores en los que China es más agresiva (Electrónica, Maquinaria y Química). Estos tres sectores suponen el 13,3% del PIB en el Este de Asia, la proporción más alta entre todas las regiones consideradas. Como consecuencia, la caída del PIB es la más grande de todas las regiones (-0,4%, aproximadamente).

En Japón y Europa, el peso de los sectores de Electrónica, Maquinaria y Química en el PIB es de 8,6% y 9,1%, respectivamente. Sus sectores Químicos son el único ejemplo de supervivencia a la competencia china en los sectores que han recibido la IED. De hecho, excepto en esto caso, China desplaza a las exportaciones de todas las regiones tras las entradas de IED. A pesar de esta virtuosa evolución del sector Químico, la producción total todavía se reduce en Japón y Europa, disminuyendo su PIB alrededor del 0,26% en ambas regiones. En los EE.UU., el peso en el PIB de los tres sectores, en los que la competencia china aumenta con fuerza, es inferior al de las tres regiones anteriores. Esto, junto con su

[1] Este 38,1% es el porcentaje que el total de comercio en estos 4 sectores (del que China explica una parte importante supone en el total de comercio mundial en todos los sectores. Véase Tablas 2 y 3 del capítulo 4).

menor apertura al comercio y la gran importancia en su economía de los servicios (de los que China exporta menos tras el shock), reduce considerablemente sus resultados negativos en el PIB (-0,10%).

El RM es la única región de las que hemos analizado que se beneficia de la IED en China. El RM está protegido de la competencia de China debido a que en la estructura de su PIB los sectores como Minería y Agricultura son muy importantes. De hecho, después de la entrada de IED, las exportaciones de estos sectores de RM se dirigen principalmente a satisfacer la demanda creciente de China de productos agrícolas y de recursos mineros.

A la luz de la literatura sobre la especialización vertical, este trabajo concluye que la participación en las redes de producción con China no garantiza resultados rentables. Adicionalmente, nuestro análisis del equilibrio general permite analizar con detalle el papel de las regiones como mercados finales. Podríamos esperar "a priori" que los consumidores se beneficiarían de las más baratas importaciones chinas. Este no parece ser el caso, tampoco. Como hemos visto Europa, EE.UU. y el RM son los principales destinos de las exportaciones chinas. Éstas se abaratan, pero el problema es que Europa, EE.UU. y el RM también son productores importantes en el mundo.

Nuestro análisis revela que las fuerzas del lado de la producción de la economía son más importantes que las del lado del consumo. Como hemos dicho, RM sale beneficiado pero Europa y EE.UU. se ven dañadas aunque en una magnitud diferente.

En conjunto, nuestro trabajo sugiere que las mejores políticas industriales fuera de China deben tratar de fortalecer la ventaja comparativa en aquellos sectores en los que China compite menos.

En la tesis el Capítulo 5 ofrece las principales conclusiones. A continuación, presentamos un resumen de las mismas y propuestas de investigación futura.

3. Principales contribuciones y conclusiones

Con el modelo GTAPinGAMS, analizamos la interacción entre la IED y las redes de producción global. Este es uno de los pocos estudios que aplican el análisis de MEGAs considerado al impacto de la IED. Proporcionamos un análisis en profundidad, basado en una amplia serie de resultados micro y macroeconómicos, con el fin de capturar las fuerzas impulsoras detrás de los ajustes después de shock de la IED. Este trabajo amplía la literatura existente mediante la combinación de las Redes de Producción Global y IED en un análisis empírico.

Encontramos un impacto diferencial de la IED según los sectores a los que se dirige. La IED puede provocar una mayor demanda de intermedios domésticos (como en Maquinaria) o de intermedios importados (como en Electrónica). Por otra parte, el aumento de la renta nacional y el PIB, después de las entradas de IED, eleva la demanda interna en China y afecta al patrón de comercio de los sectores relacionados con el consumo privado, como en el caso del Textil. Adicionalmente, identificamos un importante papel de la IED como instrumento de política económica porque la magnitud de los flujos de IED afecta proporcionalmente a los ajustes de las variables como las exportaciones, la producción o los precios, de los sectores a los que se dirige.

La entrada de IED eleva la producción y reduce los precios. En los casos de Electrónica, Maquinaria y Química las exportaciones chinas se elevan considerablemente desplazando las de otras regiones en el mercado mundial. El resto de las regiones exportarán más al gigante asiático pero perderán exportaciones en el resto de regiones.

Las importaciones de Electrónica, Química y Textil suben mientras que las importaciones de Maquinaria disminuyen. La demanda de productos intermedios importados explica en gran medida el aumento de las importaciones de Electrónica y Química, que depende en gran medida de intermedios importado en su producción y tienen fuertes redes de producción con los proveedores de Asia Oriental. La tecnología de producción de Maquinaria es más dependiente de los intermedios domésticos que la de Electrónica y Química. Por lo tanto, reduce sus importaciones de Maquinaria comprando los intermedios domésticos más baratos, tras el shock de IED, en China.

Asia oriental, como proveedor más importante de importaciones chinas, experimente los cambios más importantes en el comercio. Cuando China aumenta las importaciones de Electrónica, Química y Textil, el aumento proviene principalmente de Asia Oriental. Del mismo modo, cuando China reduce las importaciones de Maquinaria, Asia Oriental experimenta la mayor reducción de exportaciones. EE.UU., Europa y el RM siguen siendo los mayores mercados para las exportaciones chinas, absorbiendo los que en mayor medida el aumento de las exportaciones chinas después del shock.

Nuestro análisis confirma la existencia de redes de producción en Asia Oriental. China depende en gran medida del suministro de intermedios de Asia Oriental mientras Asia Oriental también es muy dependiente de las importaciones procedentes de China. Hay un

patrón de comercio triangular entre China, Asia Oriental y las economías desarrolladas, especialmente en Electrónica y Química. El sector de Maquinaria en China también muestra una fuerte red de producción con la de Asia Oriental, pero de menor intensidad que la de los otros dos sectores, debido a que su producción utiliza en mayor medida intermedios domésticos. El Textil en China también tiene una estrecha relación comercial con Asia Oriental, pero esta red es más débil debido a que su producción depende principalmente de intermedios domésticos y es un sector muy orientado al consumo privado.

Para el resto de regiones, nuestros resultados revelan que el RM, que depende en gran medida de las exportaciones de Minería, gana tras las entradas de IED en China. El resto de regiones, especialmente Asia Oriental experimentan impactos negativos en su PIB y bienestar. La esencia de este contraste es la estructura sectorial del PIB, las importaciones y las exportaciones en las regiones. Después del shock, el RM incrementa intensamente sus exportaciones de servicios y de Minería, sectores en los que China no compite tan ferozmente como en los sectores que reciben la IED. Por el contrario, la estructura del PIB de Asia Oriental es similar a la de China. Inevitablemente compiten en esas exportaciones en las que China pasa a tener mayor ventaja en precios. Es por eso que se ve más afectado a pesar de que proporciona intermedios importantes a China. Por lo tanto, la estrategia para el resto de las regiones es fomentar sus ventajas en los sectores en los que China compita menos.

Esta tesis doctoral desarrolla una visión holística del impacto de la interacción de la IED en China y las redes de producción global para distintas economías del mundo. El carácter de equilibrio general del estudio permite estudiar un variado elenco de sus efectos a nivel micro y macroeconómico.

Summary

1. Introduction

Nowadays products with a ‘Made in China’ label can be easily found everywhere. It seems that China is an enormous factory that produces nearly everything. The Asiatic giant has a big current account surplus against the U.S. and other Western economies. But does China really earn so much as its current account surplus suggests? The answer is No.

In fact, some of the products have labels like ‘design in US, components from Japan, Korea and Taiwan, assembly in China’. This reveals a worldwide division and collaboration in Global Production Networks (GPNs). The phenomenon has drawn scholars’ close attention to issues like supply chains, trade in intermediates, value chains or fragmentation. Xing and Detert (2010) propose that Chinese workers add a merely $6.50 to the entire US$179 manufacturing cost of an iPhone, while the rest of the value is a transfer of components from Germany, Japan, Korea, the US, and other countries. Chinese assembly line depends heavily on the imported intermediate inputs. After the tsunami and Fukushima nuclear leak, Foxconn, a Taipei firm subcontracted by iPhone and investing in mainland China, shut down a few production lines due to the lack of components. Consumers faced a shortage of iPhone supply during that period. By contrast, the workers in Foxconn usually overwork in the assembly line to satisfy the fast expanding market. The iPhone case has greatly intrigued us. We wanted to analyze the impact of FDI, trade in intermediates and GPNs, especially in the most export-oriented sectors of that economy, namely, Electronics, Textiles, Machinery and Chemicals. How does the intermediate trade facilitate the final good trade? How does the final demand affect the intermediate inputs and trade? What is

the impact of FDI on the trade pattern among different regions through Asian production networks? Which role does each region play in the world market? What are the impacts on the main micro and macroeconomic variables of the different regions involved in the process? These are the sort of questions this PhD dissertation tries to answer.

FDI inflows in China, led by Multinational Enterprises (MNEs), have substantially contributed to its capital accumulation process. Its share of the world inward FDI flows (stocks) rose from 2.8% (1.07%) in 1991 to 8.1% (3.48%) in 2011 (UNCTAD, several years). East Asian economies have provided 63% of cumulative FDI in China from 1985 to 2008 (Xing, 2010). Through FDI and trade, China has become integrated in the GPNs. The emergence of China has intensified the international segmentation of production processes within Asia, but has not created an autonomous engine for the region's trade, as Asia still depends on outside markets for its final goods exports (Gaulier et al., 2007a).

Multinational firms (MNEs) rely on China as a production and export base. Production of labor-intensive goods has moved to China. Developed Asian countries have lost their export share on the final good markets but have accelerated their exports of sophisticated intermediate goods to China (Athukorala and Yamashita, 2006; Gaulier et al., 2007b).

The exports and imports between China and East Asia have nearly quadrupled between 2000 and 2009 (OECD, several years). Furthermore, 70% of intraregional trade in East Asia is in parts and components that will be further assembled and exported to other regions (ADB, 2007).

Some researchers (Koopman et al., 2011; Wang et al., 2011) have studied value added trade based on Input-Output (I-O) tables. The results show that there is a high foreign content of

imported intermediates from East Asia in Chinese exports and a high reliance on Western markets for exports. China is mainly involved in processing trade (i.e., mere assembly operations) and remains at the low end of supply chains (Koopman et al., 2012; Baldwin and Lopez-Gonzalez, 2013). However, in the real world production is not a fixed combination of intermediates and factor inputs as the fixed coefficient from the I-O analysis assumes. Another limitation of the I-O based analysis is the difficulty to make accurate cross-country comparisons since I-O matrices are computed sparsely in time and across countries.

Given the complexity of the process of Chinese globalization, much is still unknown about how FDI impacts on trade patterns through GPNs, and how FDI affects GDP, national income, domestic demand and trade of the different regions involved in the process.

Computable General Equilibrium (CGE) analyses on this production networks are still scarce. One of the few exceptions is Kawai and Zhai (2009), who illustrate the transmission of the global financial crisis through the fall in final demand in Western economies, which further impacts on the reduction in Chinese demand for intermediate imports from Asian economies.

In order to capture the production technology each sector uses and to consider the role that each region plays from both the demand and supply side, a CGE model is sound for our analysis to study FDI. Further, the CGE analyses that include FDI are rather scarce (Latorre, 2009). This work will contribute to the literature on FDI and GPNs with a multi-regional CGE analysis, considering at least four different, namely China, East Asia, the U.S. and ROW, 15 sectors of production.

2. Objectives and results

The first chapter of the Dessertation offers an introduction, while the main objectives and results are offered in Chapter 2, 3 and 4.

Chapter 2: Objectives

Attracted by the case study of iPod and iPhone, we want to analyze how FDI flows of MNEs in China impact on the "Triangular trade pattern" of Electronics. The literature uses the expression "Triangular trade pattern" to describe the process by which East Asia imports from the U.S. high-tech parts, which are converted into key intermediates and latter exported to China. China, in turn, processes and exports the finished goods to the U.S. (e.g., Amiti and Freund, 2008; Xing, 2011). This chapter aims at finding out the how FDI affects this triangular trade pattern.

The literature has not paid much attention to the role of FDI in GPNs, even less in the papers using a CGE framework. Chinese abundant cheap labor supply, FDI and export promotion policies, stable and high economic growth and market size have been important for attracting huge FDI inflows.

According to GTAP 8 Data Base (Narayanan et al., 2010), in Electronics East Asia[1] provides 60.4% of Chinese imports and nearly 80% of Chinese imports are of intermediates. Thus, East Asia is the main supplier of components for Chinese production. This is also

[1] East Asia includes Japan, Korea, Hong Kong China, Taipei China and Singapore.

consistent with other empirical evidence. Very low shares of production and imports of Electronics in China are devoted to private consumption. 55% of its output is exported and 71% of its exports go to the U.S. and ROW, which devote a high percent of imports to private consumption. The U.S. and ROW are the biggest destinations in the Chinese geographical structure of exports meanwhile China is also an important source for these two regions' imports. The triangular trade then develops when the branches of multinationals in China import intermediates from their parent firms and export it to the Western markets. Note that more than 80% of Electronics production in China is in the hands of MNEs. Thus, there seems to be a strong relationship between FDI, GPNs and trade.

Using the latest GTAP 8 Data Base, we build a 15-sector, 4-region and 2-factor data version. Electronics is the most export oriented sector in China and, as already noted, most of its output is in the hands of MNEs. We, thus, focus on FDI and trade in this sector. This chapter has studied the trade patterns among China, East Asia, the U.S. and ROW after the FDI inflows, while examining the impact on other micro and macroeconomic variables as well. We replicate the real increase in FDI stock experienced in Electronics in China, which has nearly doubled from 2004 to 2011.

Chapter 2: Results

The simulation results indicate that China has benefited from the FDI inflows in terms of GDP increase (1%) and welfare gains (3.8%, proxied by national income). Regarding the bilateral trade, the pivotal role of China in the production network of Electronics has been

strengthened by intensifying its exports to all the trade partners. Its geographical export and import destination or origin remain unchanged (i.e., its product division persists) according to its original geographical trade structure.

The increase in the production of Electronics in China is more important for the increase of exports of Electronics from East Asia to China than for that from the U.S. and ROW to China, due to the production networks that exist between China and East Asia. China collaborates with East Asia in the production of Electronics but competes with that region in the U.S. and ROW markets. After the shock, East Asia increases exports to China but reduces exports to the rest of regions and, further, exports of Electronics within East Asia are also crowded out by China. Even though East Asia exports more to China, it loses ground in the world market. This latter result prevails and, on the whole, East Asian exports of Electronics are reduced.

By contrast, the geographical import structure of the rest of regions changes considerably. The large increase of Chinese exports, following a big fall in their export prices, crowds out other competitors across the world. China also attracts more exports from the rest of regions (mainly due to the imported intermediates needed in its Electronics production). However, the export structure of the rest of regions varies less than the import structure. This implies that China plays a more important role as a provider of Electronics goods for ROW compared to its role as a final good market for them.

To sum up, the FDI inflows in Chinese Electronics has further strengthened the role of China as a production base and export center. East Asia becomes more integrated with China (through more exports and imports) but loses competitiveness and shares in the U.S.,

ROW and in its own internal market. In line with previous findings (e.g. Kawai and Urata, 2004), we conclude that FDI plays a vital role in shaping Asian regional Electronics production networks.

This chapter has been presented in the "XVI Applied Economics" Conference in Granada of Spain and in the "16th Annual conference at Global Economic Analysis" in Shanghai of China. It has been revised and resubmitted to "Economic Modelling" in April. Now it is accepted and forthcoming.

Chapter 3: Objectives

In chapter 2, we delve into the nature of the triangular trade pattern of Electronics. Now we wonder whether FDI inflows would have a similar impact on the trade pattern of Textiles and Machinery among China, East Asia, the U.S. and ROW. Note that production in the latter sectors is also very much export oriented, as happens in Electronics. Would these sectors have similar effects on variables at the micro and macroeconomic level? This chapter aims at answering these questions and exploring the roles that each regions plays as an intermediates' supplier or as a market for these goods.

We use a 3-factor, 4-region, 15-sector CGE model to capture the demand and production changes, arising from the production networks and final demand roles of the different geographical areas. Labor is split into skilled and unskilled. That is why there are 3 factors of production now.

Though we focus only on Electronics, Machinery and Textiles, we are, in fact, analyzing 55.4% and 40% of overall Chinese exports and imports, respectively, and 13.6% of Chinese GDP. Three characteristics of Chinese trade data stand out:

1. Around 80% of Chinese exports are directed to the U.S. and ROW. ROW is the most important destination accounting for 50% to 60% of total Chinese exports while the U.S. weighs around 25% to 30%. Thus, only around 20% of Chinese exports go to East Asia. Note that Chinese imports from East Asia are mostly intermediates with a rather low weight of imports to be used for private consumption, particularly in Machinery goods. This implies that most of the Chinese exports of final goods are directed to the U.S. and ROW. Therefore, the latter constitute the main final markets of Chinese exports.

2. Chinese imports are mostly intermediates ranging from 68% (in Machinery) to around 85% (in Electronics and Textiles). One of the main challenges of trade statistics nowadays is to combine the dimension of type of good traded with that of country of origin. While that information might exist for some isolated countries, it is rather uncommon and unavailable across groups of countries. The information from the GTAP database used in this chapter, however, provides us with important clues in this regard, as will be seen in the third characteristic.

3. Around 60% of total Chinese imports come from East Asia. As noted above, our data do not allow knowing simultaneously the country of origin (whether it is East Asia or not) and the use of good[2] from that country of origin. But with 80% intermediate imports and 60% being provided by East Asia, it seems reasonable to assume that East Asia is heavily

[2] Whether it is an intermediate or a final good and in this latter case, whether it is used for private or public consumption or investment.

integrated in the Chinese production networks, providing an important amount of intermediates.

What is the impact of FDI on the East Asian networks of China and on the final markets to which China sells most of its finished goods?

Chapter 3: Results

We find that China has benefited from the FDI inflows according to the rise of GDP (2.1%) and welfare (9.6%). The scope of the reductions in wages of unskilled labor and capital remunerations, as well as, the subsequent reductions in prices and increases in output follow the magnitude of FDI inflows each sector has received. Because Electronics is the main recipient of FDI inflows, it experiences the most intense fall in prices and increase in production. Next in importance come the adjustments in prices and production in Machinery. Finally, Textiles exhibits the most moderate price decreases and output expansion. The wage of skilled workers increases in contrast with the fall of unskilled ones.

The Chinese trade patterns and the trade patterns in the rest of regions differ in the three sectors considered. After FDI inflows, Chinese exports of Electronics and Machinery increase, while exports of Textiles go down. The U.S. and ROW absorb the majority of the increase in Chinese exports. The contrasting pattern in Textiles seems related to its importance in Chinese private consumption. With FDI inflows, household income and national demand in China increase. More Textiles will be demanded domestically and less will be exported.

On the other hand, after the increase in exports of Electronics and Machinery, production and exports from the rest of regions are crowded out. The important fall in export prices makes Chinese exports very competitive. However, note that China will import more Electronics and less Machinery from the rest of regions after the shock. This contrast arises from the fact that Electronics imports are heavily used for Electronics production which goes up after FDI inflows. While imported intermediates are used less intensively in production of Machinery, which also expands after the FDI inflows. Finally, the fall of Chinese exports of Textiles results in an increase of Textiles exports across the rest of regions. However, exports of Textiles are smaller in world trade flows than the ones from Machinery and Electronics. Therefore, the increase in Textiles exports falls short to compensate the reduction in exports of Machinery and Electronics that the rest of regions experience.

This analysis, using a general equilibrium perspective, confirms and expands the main outcomes from the empirical literature. Important production networks exist between China and East Asia, while the U.S. and ROW are their main final markets. Taking those geographical patterns into account together with the particular production technologies (e.g., the intensity of the use of imported intermediate in production) and the demand orientation (e.g., the private consumption orientation of Textiles) helps to trace the impact of FDI on trade.

This chapter has been presented in the conference "X Jornadas de Integración Económica" on 28-29 November 2014 in Castellón de la Plana, organized by the INTECO. It is available as a working paper on "Munich Personal RePEc Archive". It has also been sent to

the journal "Global Economic Review: Perspectives on East Asian Economies and Industries". The current status is under review.

Chapter 4: Objectives

In Chapter 3, we have analyzed how FDI affects the evolution of trade and other variables through the interplay of production networks and final demand markets. East Asia is still a close supplier for Chinese trade as China does for East Asian trade. The U.S. and ROW are the biggest markets for Chinese exports. However, from the world production perspective, ROW is a very big market. A logical next step is to separate Europe from ROW and another big economy, namely, Japan from East Asia.

Then, looking at the production structure of Electronics, Machinery and Textiles, we find that intermediates of Chemicals are important for their production. In addition, the Chemicals sector is also export oriented and import dependent. Thus, we extend our analysis of FDI to the Chemicals' sector, as well.

Further, in the two previous chapters, we focus on the impacts of FDI on microeconomic variables like production networks and trade patterns in the sectors to which FDI accrues. In the third chapter, we give an in-depth explanation of the effects of FDI on the macroeconomic results across six different regions. We use a 2-factor, 15-sector and 6-region CGE model of FDI inflows in Chinese Textiles, Chemicals, Electronics and Machinery sectors. We analyze in more detail the existing production networks (between China, Japan and East Asia) and the role of the final markets (the U.S., Europe, and ROW).

Chapter 4: Results

In 2007, China accounted for a relatively small share in World GDP (6.3%), exports (8.3%) and imports (6.4%). This was far from the weights of regions like Europe (31%, 39.7% and 40.8%, respectively) or the U.S. (25.2%, 9.2% and 14.5%, respectively). However, the arrival of FDI inflows to Chinese manufacturing seems to have produced negative effects in many regions of the world. When Chinese exports increase, due to FDI, exports and production shrink in the sectors that compete with them across the rest of regions. The latter experience an overall reduction in production which drives down wages and the capital rent, thus, reducing their national income and GDP.

We simulate the real FDI increases that have taken place in Chinese Electronics, Machinery, Chemicals and Textiles. These four sectors account for 64.5% and 53.5% of Chinese overall exports and imports, respectively, while their weight is of 38.1%[3] in total world exports (or imports).

China benefits from the FDI inflows, since there is a rise in wages (0.42%), GDP (2.68%) and national income (11.54%). Chinese export competitiveness increases very heavily in Electronics, Machinery and Chemicals. East Asia is the region that is most negatively affected, even though it is heavily involved in production networks with China. It will export more in those sectors in which China compete less after the FDI increase. Further, it will, generally, supply important intermediates for the sectors in which China increases production, but it will be displaced by China in the rest of markets. The main negative outcomes for East Asia arise from its decrease in production in the sectors in which China

[3] This weight is of total trade in these sectors (of which Chinese accounts for important shares) in total world trade flows across sectors. See Tables 2 and 3 of Chapter 4.

is more aggressive (Electronics, Machinery and Chemicals). These three sectors explain 13.3% of GDP in East Asia, the highest share among all the regions considered. As a consequence, its fall in GDP is the largest across all regions (-0.4%, approximately).

In Japan and Europe, the weight in GDP of Electronics, Machinery and Chemicals is 8.6% and 9.1%, respectively. Their Chemicals sectors are the only case of survival to Chinese competition in sectors that have received the FDI. Indeed, except in these latter cases, China crowds out exports across all regions when it becomes more competitive due to FDI. Despite this virtuous evolution of Chemicals, overall production still shrinks in Japan and Europe, driving their GDP down by 0.26% in both areas. In the U.S., the weight in GDP of the three sectors, in which Chinese competition rises strongly, is lower than in the three previous regions. This, together with its smaller openness to trade and big importance in services (in which China export less), considerably reduces its negative outcomes in GDP (-0.10%).

ROW is the only region that we have analyzed that is positively affected by the Chinese booming economy. ROW is protected from Chinese competition because in its GDP structure sectors like Mining and Agriculture account for the biggest shares. In fact, ROW's exports from these sectors are primarily going to satisfy Chinese rising demand for Agricultural products and Mining resources.

In the light of the literature on vertical specialization, this paper finds that engaging in production networks with China does not guarantee profitable outcomes. Our general equilibrium analysis allows to further analyze the role of regions as final markets. We could a priori expect that consumers would benefit from cheaper Chinese imports. This does not

seem to be the case, either. Europe, the U.S. and ROW are the main destinations of Chinese exports. These may become cheaper, but the point is that Europe, the U.S. and ROW are also important producers in the world.

Our analysis reveals that the forces from the production side of the economy are more important than the ones from the consumption side. As we have said, this benefits ROW but will harm Europe and the U.S. in a different magnitude.

All in all, our analysis suggests that the best industrial policies outside China should further strengthen the comparative advantage in the sectors in which China competes less.

Chapter 5 in the Dissertation gives the main results. Then, it discusses proposals for future research.

3. Main conclusions and contributions

Using the GTAPinGAMS model, we analyze the impact of FDI on the evolution of trade and other micro and macroeconomic variables in several regions through Asian production networks and final markets. This is one of the few studies that applies CGE analysis to the impact of FDI and GPNs. We provide an in-depth analysis, based on a wide set of micro and macroeconomic results, in order to capture the driving forces behind the adjustments after the FDI shock.

The impact of FDI across sectors differs largely, as reflected for example on whether the expansion of the sectors brings about a higher demand for domestic intermediates (like

Machinery) or for imported ones (like Electronics). Rising income and GDP, following FDI inflows, will lift up the domestic demand and affect the trade pattern of private consumption related sectors, such as in the case of Textiles. Furthermore, we find an important role for FDI in policy intervention since the magnitude of FDI inflows proportionally affects the relevant changes in sectoral variables (such as exports, production, prices, and etc.)

The arrival of FDI will increase the output of the sectors analyzed expands making their prices fall down. Chinese supply of Electronics, Machinery and Chemicals crowd out exports from the other regions in the world market. The rest of regions strengthen the trade ties with China and loosen the ties with others.

The imports of Electronics, Chemicals and Textiles go up while those of Machinery imports decrease. The demand for imported intermediates largely explains the rising imports of Electronics and Chemicals, which are very intensively used as intermediates and have a strong production networks with East Asian suppliers. Rising national income largely explains the rising imports and decreasing exports of Textiles. The production technology in Machinery relies more heavily on domestic intermediates than on imported one. Therefore, with cheaper Machinery goods in China after the FDI inflows, it will reduce its imports.

East Asia, as the biggest supplier for Chinese imports, undergoes the most substantial changes in trade. When China enlarges the imports of Electronics, Chemicals and Textiles, the increase mainly comes from East Asia. Similarly, when China reduces the Machinery imports, East Asia experiences the biggest reduction of Chinese imports. The U.S., Europe

and ROW are still the biggest markets for Chinese exports. So they absorb the most of the increase of Chinese exports after the shock.

Our analysis confirms the existence of production networks in East Asia. China relies heavily on East Asian intermediate supply meanwhile East Asia is also highly dependent on the imports coming from China. There is a triangular trade pattern among China, East Asia and developed economies, especially in Electronics and Chemicals. Machinery also has strong production networks with East Asia but less intensively than the other two sectors, because its production uses most intensively domestic intermediates. Textiles also has a close trade relation with East Asia but this network is weaker than the others because its production mainly relies on its domestic intermediate inputs and it is a more private consumption oriented sector.

For the rest of regions, our results reveal that ROW, which relies heavily on exports of Mining, gains from FDI inflows in China. The rest of regions, especially East Asia, receive negative impacts on their GDP and welfare. The essence for this contrast is the GDP, import and export structure across regions. After the shock, ROW enlarges heavily its exports of Services and Mining, in which China does not compete as fiercely as in the sectors that receive the FDI shock. By contrast, the GDP structure of East Asia is close to that of China. It is inevitably crowd out in those exports in which China has a cost edge. That is why it is affected most although it provides substantial intermediates to China. This PhD dissertation provides a holistic view of the impact of interaction between FDI in China and global production networks on the different world economies. Its general equilibrium nature provides an in-depth analysis of its effects for a rich set of variables at the micro and

macroeconomic level. Thus, the best industrial policies outside China should further strengthen the comparative advantage in the sectors in which China compete less.

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Chapter 1. Introduction

1. Introduction

Nowadays, products with a 'Made in China' label can be easily found everywhere. The emergence of China on the world stage poses important questions about its economic consequences for that and other regions of the world and demands powerful methodologies able to quantify its challenges and opportunities.

Somehow, Chinese geographical frontiers have become "blurred" in this process. On the one hand, China has been escalating positions as a favorable Foreign Direct Investment (FDI) destination. It has ranked 2nd among top hosts of FDI inflows in the world since 2008 (UNCTAD, several years). This implies that FDI must play an important role in Chinese GDP growth (e.g., Kim et al., 2003) and foreign trade (e.g., Dean et al., 2009). Some authors have pointed out that in the absence of FDI flows, the Chinese high rates of GDP growth and exports would be in danger (Whalley and Xin, 2010; Zhang, 2013).On the other hand, a significant part of what is produced in (and later exported from) China relies heavily on foreign imported intermediates. What does, then, the "made in China" really mean?

Imported intermediate inputs embodied in exports have raised close attention to what the literature calls: global production networks (GPN). There are various terminologies that describe this phenomenon like production unbundling (Baldwin, 2006), vertical specialization (Hummels et al., 2001), global supply chain trade (Baldwin and Lopez-Gonzalez, 2013), production networks (Henderson et al., 2002; Ernst and Kim, 2002; Sturgeon, 2002), slicing up the value chain (Krugman, 1995), international production sharing (Ng and Yeats, 2001), fragmentation (Deardorff, 1998; Jones and Kierzkowski, 2001)...

East Asian economies have provided 65.4% of cumulative FDI in China from 1994 to 2012 (Figure 1). It is also the main supplier of Chinese imports. The exports and imports between China and East Asia have nearly quadrupled during year 2000 to year 2009 (OECD, various years). Between 1988 and 2008, the share Chinese processing imports originating from its most important trading partners—East Asia has risen from 59.6% to 75.1%, while

the share of processing imports originating from non-Asian OECD countries has decreased from 37.7% to 18.7% over the same period (Ma and van Assche, 2010). The case study of iphone (Xing and Detert 2010) is another example of a global production networks (GPNs). Chinese workers only account for $6.5 to the entire $179 manufacturing cost of an iPhone, while the rest of the value is mainly transferred from Germany, Japan, Korea and the US.

It seems clear that East Asian economies are highly integrated through GPNs. However, due to their low private consumption, they heavily depend on the Western markets for their output. In fact, more than 70% of intraregional trade in East Asia (except the one from Japan) is in parts and components (ADB, 2007), around 50.2% to 78.7% of which will be re-exported (OECD, several years). The production networks seem therefore to be really global, since they end up in several different Western markets. This is an aspect that the literature has not emphasized very much.

One of the main challenges of trade statistics nowadays is to combine the dimension of type of good traded (i.e., whether it is an intermediate for further processing or a final good) with that of country of origin. While that information might exist for some isolated countries, it is rather uncommon and unavailable across groups of countries. The information from the GTAP8 Data base used in this Dissertation, however, provides a good starting point in this regard. It will allow to identify (quantifying the importance of) the different roles played by regions across the production division, while the computable general equilibrium methodology will derive the consequences.

Given the complexity of the process of Chinese globalization, much is still unknown about how FDI impacts on trade pattern through production networks, and how FDI affects GDP, national income, domestic demand and trade of the different regions involved in the process.

2. The methodology

Input-Output (IO) analysis has been the dominant methodology to analyze GPNs. The salient work of Hummels et al. (2001) has quantified the import content embodied in a

country's exports and the vertical specialization index of a sector. A caveat of this analysis is, however, that often the so called "proportionality assumption" is used, i.e., when data are not available they assume that proportions in other type of trade relationship also hold in the one for which they have no data. For example, if the amount of imported intermediates coming from East Asia to China is unknown and only total imports from East Asia are known, the same proportion would be used for East Asia's weight in Chinese imported intermediates.

Koopman et al. (2014), and Johnson and Noguera (2012) have improved the work of Hummels et al. (2001). Johnson and Noguera (2012) estimate the domestic contents of re-imports, thus, calculating the amount of value added generated in the country that exports the goods (ratio of value added to gross exports). They get a significant conclusion. The Chinese trade surplus with the US is 30–40% smaller when measured in value added in 2004. Focusing on Chinese processing trade (i.e., trade after mere assembly operations in China with very little value added), Koopman et al. (2008) point out that only 40-50% of Chinese processing exports value is produced in China, while the rest consists of the value of imported inputs. Japan, Korea, Taiwan, Hong Kong and the U.S. are the primary contributors to Chinese products[1]. They find a triangular production sharing pattern among China (processing), Japan and Korea (intermediates) and the US (destination). Dean et al. (2011), following Koopman et al. (2008) methodology to split the Chinese IO tables, show strong evidence of vertical specialization in Chinese trade, particularly in Electric Computers and Telecommunications Equipment exports. Their results point out that there is a significant Asian-supplier network, with Japan and the Four Tigers (Hong Kong, Taiwan, Singapore and Korea) accounting for more than half of China's imported inputs in 1997 and 2002. This network is even more significant for processing trade. Baldwin and Lopez-Gonzalez (2013), based on two different data sets (the World IO Database and the Trade in Value Added Database), suggest that supply-chain trade has shifted heavily towards "Factory Asia" and away from "Factory North America" and "Factory Europe".

All these studies show important evidence on the presence on East Asian production networks. Besides, they quantify their magnitude. However, this Dissertation does not use

[1] They also derive that in the case of Electronics the share of value added in China goes down to 18.1%.

an IO methodology for 3 main reasons: 1) In the real world production is not a fixed combination of intermediates and factor inputs as the fixed coefficient from the I-O analysis assumes. 2) Another limitation of the I-O based analysis is the difficulty to make accurate cross-country comparisons since I-O matrices are computed sparsely in time and across countries. 3) Beyond the IO methodology, one step further can be given in order to analyze what the *effects* of these production networks are. This is what we aim to do in this PhD Dissertation, focusing on the interplay of FDI with GPNs. To this aim we use a CGE.

A CGE model incorporates real data of the economies into a rigorous theoretical framework. It offers a comprehensive representation of the economy in which the interactions among different economic agents are presented as a system of equations derived from microeconomic optimization theory. The model also rests in the usual progression of the circular flow of the economy: production, income distribution and domestic and foreign demand (Latorre, 2010). In a CGE, production sectors across borders are linked through intermediates and final goods trade, while domestic production sectors are related to one another through intermediate inputs and through competition in attracting labor or capital (Francois et al., 2013). Therefore, this technique seems suitable to derive a deep analysis of the interaction between FDI and GPNs and its effects.

Our model is the GAMS (General Algebraic Modeling System) version (Rutherford, 2005) of a well-known CGE, namely, the Global Trade Analysis (GTAP) model (Hertel, 1997). The model grasps whether production and trade of the sector (and the rest of goods in the economy) are devoted to intermediate demand or to any of the forms of final demand (i.e., private consumption, public consumption, exports and investment). We want to study the role that the regions play in the different stages of the production chain (e.g., as providers of intermediates or as final consumption markets).

The core GTAP model is a static CGE model of the world, which makes viable evaluating the medium term impacts of different shocks. One of the nice features of this model is its specification of the production nest. On the first layer, production is carried out by combining the composite intermediate and value added under a Leontief technology. On the second layer, value added is a constant elasticity substitution (CES) composite of sluggish capital and mobile labor. So far, the approach is rather standard. However, GTAP

includes a CES composite of intermediate inputs by which different combinations of domestic and import intermediates are possible. This is a rather non-standard characteristic in CGE models, and it will allow us to better exploit the treatment of the different sectors' intermediates. The modeling of imported goods is standard but carries an allocation to its demand use (i.e., whether imports are used for intermediate inputs, private consumption, public consumption or investment). We will also exploit this feature in the present analysis.

3. Structure of the Dissertation

Chapter 2

We are interested in how FDI flows of MNEs in China interact with GPNs and affect trade patterns. In this chapter we analyze one of the GPNs for which there exists evidence in the empirical literature, namely, the "Triangular trade pattern" of the Electronics sector.

The expression "Triangular trade pattern" describes the process by which East Asia imports from the U.S. high-tech parts, which are converted into key intermediates and latter exported to China. China, in turn, processes and exports the finished goods to the U.S. (e.g., Amiti and Freund, 2010; Xing, 2011). So this chapter aims at finding out how FDI affects this triangular trade pattern, because not much attention has been paid to the role of FDI in this GPNs, even less in the papers using a CGE framework.

According to GTAP 8 Data Base (Narayanan et al., 2012) Electronics is the most export oriented sector of China contributing to 22% and 20% of its overall exports and imports, respectively. East Asia provides 60.4% of Chinese imports and nearly 80% of Chinese imports are of intermediates. Thus, East Asia is the main supplier of components for Chinese production. This is also consistent with other empirical evidence, such as the one quoted above. Very low shares of production and imports of Electronics in China are devoted to private consumption. 55% of its output is exported and 71% of its exports go to the U.S. and ROW, which devote a high percent of imports to private consumption. The U.S. and ROW are the biggest destinations in the Chinese geographical structure of exports

meanwhile China is also an important source for these two regions' imports. The triangular trade then develops when the branches of multinationals in China import intermediates from their parent firms and export it to the Western markets. Note that more than 80% of Electronics production and 70% of its exports in China is in the hands of MNEs. Thus, there seems to be a strong relationship between FDI, GPNs and trade.

Using the latest GTAP 8 Data Base, we build a 15-sector, 4-region and 2-factor data version. We replicate the real increase in FDI stock experienced in Electronics in China, which has nearly doubled from 2004 to 2011, and examine the impact on the trade patterns among China, East Asia, the U.S. and ROW, as well as, the effects for other micro and macroeconomic variables.

Chapter 3

In chapter 2, we delve into the nature of the triangular trade pattern of Electronics. In this chapter we analyze whether FDI inflows would have a similar impact on the trade pattern of Textiles and Machinery among China, East Asia and the U.S. and ROW. Note that production in the latter sectors is also very much export oriented, as happens in Electronics. Would these sectors have similar effects on variables at the micro and macroeconomic level? This chapter aims at answering this question and exploring the roles that each regions plays as an intermediates' supplier or as a market for these goods.

The chapter presents a comprehensive appendix where model equations, variables and parameters are described. Besides, it also offers Figures with the nests of production, private and public consumption, foreign trade etc., to facilitate the analysis of the mathematical functional forms of the model.

We use a 3-factor, 4-region, 15-sector CGE model to capture the demand and production changes, arising from the production networks and final demand roles of the different geographical areas. In this version of the model, contrasting with the previous chapter, labor is split into skilled and unskilled.

Though we focus only on Electronics, Machinery and Textiles, we are, in fact, analyzing 55.4% and 40% of overall Chinese exports and imports, respectively, and 13.6% of Chinese GDP. Two characteristics of Chinese trade data stand out:

1. Around 80% of Chinese exports are directed to the U.S. and ROW. ROW is the most important destination accounting for 50% to 60% of total Chinese exports while the U.S. weighs around 25% to 30%. Thus, only around 20% of Chinese exports go to East Asia. Note that East Asian imports from China are mostly intermediates with a rather low weight of imports to be used for private consumption, particularly in Machinery goods. This implies that most of the Chinese exports of final goods are directed to the U.S. and ROW. Therefore, the latter constitute the main final markets of Chinese exports.

2. Chinese imports are mostly intermediates ranging from 68% (in Machinery) to around 85% (in Electronics and Textiles). Around 60% of total Chinese imports come from East Asia. As noted above, it is not easy to find data displaying simultaneously the country of origin (whether it is East Asia or not) and the use type of good (i.e., intermediates of final goods) from that country of origin. But with 80% intermediate imports and 60% being provided by East Asia, it seems reasonable to assume that East Asia is heavily integrated in the Chinese production networks, providing an important amount of intermediates. What is the impact of FDI on the East Asian networks and on the final markets to which China sells most of its finished goods?

Chapter 4

In Chapter 3, we go deeper in the analysis of how FDI affects the evolution of trade and other variables through the interplay of production networks and final demand markets. Electronics is more integrated in the production networks than other sectors, according to the intensity of the imported components used in its output. ROW and East Asia are very big markets. A logical next step is to separate Europe from ROW and another big economy, namely, Japan from East Asia.

Then, looking at the production structure of Electronics, Machinery and Textiles, we find that intermediates of Chemicals are important for their production. In addition, the Chemicals sector is also export oriented and import dependent. Thus, we extend our analysis of FDI to the Chemicals' sector, as well.

Further, in the two previous chapters, we focus on the impacts of FDI on microeconomic variables like production networks and trade patterns in the sectors to which FDI accrues. In the third chapter, we give an in-depth explanation of the effects of FDI on the macroeconomic results across the six different regions. The emphasis of the analysis turns from the sectoral to the aggregate variables in this chapter. We use the model with 2 factors, 15 sectors and 6 regions. But now FDI inflows go to Chinese Textiles, Machinery, Electronics *and* Chemicals sectors. We examine in more detail the existing production networks (between China, Japan and East Asia) and the role of the final markets (the U.S., Europe, and ROW).

Chapter 5: Conclusions

Chapters 2-4 are written as papers to be sent to scientific journals, therefore, they exhibit the standard structure of those types of papers. A final chapter on conclusions, as well as, a summary in English and Spanish, wrap up their main results and contributions at the end of the Dissertation.

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Chapter 2

How FDI influences the triangular trade pattern among China, East Asia and the U.S.?
A CGE analysis of the sector of Electronics in China[*]

[*] This paper has been presented at "XVI Applied Economics" Conference in Granada, Spain on 6-7 June 2013 and at GTAP "16th Annual Conference at Global Economic Analysis" in Shanghai, China on 12-14 June 2013. The revised version of this chapter is forthcoming in Economic Modelling.

Abstract

This paper uses a computable general equilibrium (CGE) model to simulate the FDI inflows in the Electronics sector in China. Our aim is to capture how the causation chain works through production networks and the triangular trade pattern. China is a production base and export center for Electronics, with a heavy dependence on East Asian Electronics supply. Meanwhile, the U.S. and Rest of the world (ROW) are important markets for Electronics exports. China collaborates with East Asia in the production networks but competes with East Asia for the exports to the U.S. and ROW. The shock of FDI reinforces the pivotal role of China and intensifies its exports without any remarkable change on the pattern of the geographical destination or origin of its Electronics exports and imports. The Chinese trade links and production division remain unchanged. However, China takes up more of the world market crowding out its competitors. In this sense, after the shock, the shares in imports of Electronics of rest of regions change noticeably, showing a remarkable increase in the weight of China. East Asia will increase its exports to China, providing more intermediates for further processing. However, it will be displaced by China in the rest of markets, thus, reducing its overall exports.

Key words: Production Networks; computable general equilibrium, intermediates.

JEL Classification: C68, F14, F15, F17, F21.

1. Introduction

The impact of triangular trade among China, East Asia and the U.S. has raised much interest. Particular attention has been devoted to the pattern of collaboration (Haddad, 2007) or competition (Gaulier et al., 2007) through FDI (foreign direct investment) or trade. Some authors have focused on free trade agreements and trade policy to explain the regional integration. One important conclusion is that trade liberalization policy has accelerated the transition of East Asia (Kitwiwattanachai et al., 2010; Kawai et al., 2010).

Other studies have paid attention to production networks, as well as processing trade, vertical specialization, domestic export content, triangular trade and production networks among China, East Asia itself and the U.S. (Koopman et al., 2011; Ma and van Assche, 2010; Wang et al., 2011; Xing and Detert, 2010). Indeed, there is considerable evidence that East Asia imports from the U.S. high-tech parts, which are converted into key intermediates and latter exported to China, while China processes and finally exports the finished goods to the U.S. The U.S., in fact, is the main export market for Asian finished goods and has been playing a significant role in this network (Amiti and Freund, 2008; Xing, 2011).

In the literature, however, not much attention has been paid to the role of FDI in these processes, particularly using a CGE framework. We try to bridge this gap by analyzing the impact on the triangular trade pattern of the FDI accruing to China. China, as an emerging and transition economy, is abundant in cheap labor supply and unique in its FDI and export encouraging policies, continuous high economic growth and potential market size. These factors together have been important for attracting huge FDI from the rest of the world. Especially, the neighboring East Asian economies, due to the geographic proximity and cultural links, have provided 63% of cumulative FDI in China from 1985 to 2008 (Xing, 2010). An important part of the triangular trade, then, develops when the multinationals from advanced Asian economies set up fragmentation production branches and import intermediates from their parent firms. Thus, there seems to be a strong relationship between FDI, networks and trade.

This Chapter is organized as follows. Section 2 describes the model that we use. The data and simulation scenario are discussed in section 3. The results from the simulation are analyzed both at the aggregate and sectoral level in section 4. Section 5 concludes.

2. The model

We think the present model is suitable for a deep analysis of the production, demand and foreign trade of the Electronics sector. Indeed, we analyze several dimensions of those three sides of the economy across several regions of the world. The model grasps whether production and trade of Electronics (and the rest of goods in the economy) are devoted to intermediate demand or to any of the forms of final demand (i.e., private consumption, public consumption, exports and investment). We want to study the role that the regions play in the different stages of the production chain (e.g., as providers of intermediates or as final consumption markets). This analysis is greatly facilitated when a computable general equilibrium (CGE) model is used. A CGE allows the combination of the supply and demand sides of the economies, as well as, their interplay with foreign trade.

Our model is the GAMS (General Algebraic Modeling System) version (Rutherford, 2005) of a well-known CGE, namely, the Global Trade Analysis Project (GTAP) model (Hertel, 1997). The GTAPinGAMs is a traditional static Arrow–Debreu general equilibrium model in which the equilibrium is defined by zero profit and market clearance conditions. Most of the model specifications are the same as in Hertel (1997), which uses GEMPACK software package instead of GAMS, with only two differences. First, the GEMPACK version is based on a constant difference elasticity demand system, while the GAMS model uses Cobb–Douglas preferences. Second, in GEMPACK global capital is treated as a portfolio investment and, thus, endogenously allocated by regional rates of return. By contrast, for simplicity, the GTAPinGAMS exogenously fixes the global capital flows at base year levels.

The core GTAP model is a static CGE model of the world, which makes viable evaluating the medium term impacts of different shocks. Mathematically it is a system derived from a series of non-linear equations determined by each agent's optimization, as well as, national account identities. In the model there are four economic agents: producers, private consumers, government and trading partners, all of them maximizing their own profit or welfare.

One of the nice features of this model is its specification of the production nest. On the first layer, production is carried out by combining the composite intermediate and value added under a Leontief technology. On the second layer, value added is a constant elasticity substitution (CES) composite of sluggish capital and mobile labor. So far, the approach is rather standard. However, GTAP includes a (CES) composite of intermediate inputs by which different combinations of domestic and import intermediates are possible. This is a rather non-standard characteristic in CGE models, and it will allow us to better exploit the treatment of Electronics' intermediates.

We adopt a framework of perfect competition, therefore, the marginal cost of production equals the price. There are authors that suggest the use of imperfect competition in some sectors of the economy (e.g., Rutherford and Tarr, 2008). However, others obtain that the impact of FDI would not vary much depending on the climate of competition (e.g., Verikios and Zhang, 2001, and Dee et al., 2003).

Production is distributed to private consumption, government consumption, investment, exports and international transportation. The modeling of imported goods is standard but carries an allocation to its demand use (i.e., whether imports are used for intermediate inputs, private consumption, public consumption or investment). We will also exploit this feature in the present analysis.

Hertel (1997) offers a complete explanation of the model. The equations appear in a "linearized" form, as is standard in GEMPACK. Rutherford (2005) explains the whole set of equations, parameters and variables in a more friendly algebraic format, while Latorre (2010, Chapter 3) provides a particularly detailed explanation of the model[1]. In the current

[1] The full set of data and GAMS code needed to replicate the results in this paper is available by request,.

aggregation of the model, we use a 4-region, 2-factor and 15-sector version. Let us turn to the data that underlie it.

3. Data and simulations

As mentioned before, there are two factors of production (labor and capital), four regions (China; East Asia[2]; the U.S. and Rest of World) and fifteen sectors. The Manufacturing sector is disaggregated into thirteen sub-sectors. The other two sectors are Agriculture and Services. We model capital as sector-specific and labor as fully mobile within but not across regions. This implies that our results grasp the medium term impact of the shock analyzed.

Table 1, offers the whole sectoral picture of the Chinese economy. In the first two columns, it presents the complete sectoral names, as well as, the shorter name after aggregation that will be used, henceforth. The percentage calculations of the table are based on the latest GTAP8 database (Narayanan et al., 2012), which is the one used in our model. The information refers to the Year 2007. The exports of Electronics account for 22% of total Chinese exports while the imports of Electronics take up 20% of all the imports in China. By contrast, sectoral output and value added of Electronics only account for 5% and 3% of total production and aggregate GDP, respectively. Similarly, the amount of labor and capital used in Electronics is for both only 2.5% of the total amount of factors available in China. This rather small sector has a high dependence on the world market, as 56.33% of its production goes to exports and 48.17% of the domestic demand for Electronics relies on the imports.

Apart from Electronics, Textiles and Machinery also show a high dependence on the export markets, contributing to 16.7% and 16.9% of total Chinese exports. As happened with

[2] After the close observation of the FDI sources and main trade partners of China, we finally aggregate Japan and new industrialized economies (Republic of Korea, Taiwan China, Hong Kong China and Singapore) as East Asia.

Electronics, the two sectors are smaller in terms of value added, production, use of capital and labor. However, their foreign trade links are very important in Chinese total trade. Table 1 also shows that other sectors are more oriented to private consumption. This is the case of Agriculture, Food and Beverages, as well as, the Services sectors, which account for 12.5%, 17.5% and 45.5% of total private consumption in China. We will see that the export or private consumption orientation of the sectors will be important for their outcomes of production and labor demand after the shock.

China, out of its abundant labor and market potential, has attracted huge FDI flows in its most export-oriented sector— Electronics. MNEs account for 80% of total Electronics production and contribute to more than 70% of Electronics exports[3]. We are interested in how the evolution of FDI reshapes the East Asian economy and how the effects are magnified through production networks and trade linkages of Electronics. Thus, our simulation consists of a realistic shock about the evolution of the capital stock of Electronics in China. According to the National Bureau of Statistics of China (various years), the accumulated FDI inflow in Electronics has more than doubled during the period of 2004- 2011[4]. Thus, we simulate a 100% increase of capital stock in Electronics in China, meanwhile the capital stock in rest sectors and regions remains fixed.

4. Empirical Results

4.1. Aggregate results

Table 2 presents the macroeconomic impacts across regions of the FDI shock in Electronics in China. It provides the percentage change in real terms with respect to the benchmark

[3] 中国工业经济统计年鉴 2008 (China Industry Economy Statistical Yearbook 2008) .

[4] The exact source is the 'Investment in Fixed Assets in Urban Area By Sector, Jurisdiction of Management and Registration Status' from National Bureau of China Statistics (various years). Due to the lack of detailed FDI stock data and FDI flows across sectors, we take the "fixed assets investment funded by foreign capitals" as a proxy for the foreign fixed assets. The latter takes into account the capital invested in China by all foreign firms across the world, including firms from Hong Kong, Taiwan, and Macao.

value of aggregate variables: the wage, the capital rent, GDP from the income side, national income[5], the CPI and the overall increase of capital stock.

Since the capital input of the Electronics sector only accounts for 2.48% of total capital stock in China (Table 2), the 100% increase of capital stock in it results in a 2.48% increase of total capital stock. The rest of the regions keep their capital stock stable. Capital accumulation leads to a fall in the rental rate of capital. The abundant labor supply and the flexible substitution between labor and capital in manufacturing ensure that the wage in China rises by 0.22%. The fall in the rental rate of capital and the increase in wages, following an increase in the capital stock, have been generally obtained in previous CGEs (e.g., Latorre et al., 2009; Latorre, 2013), as well as in broader reviews of the literature using other methodologies (e.g., Rama, 2003). It is also the expected outcome in a capital specific setting, as the theory of trade models with specific capital shows (e.g., Jones, 2000; 2002). Higher wages and, more importantly, a bigger capital stock lead to a 3.82% and 0.99% increase in national income and GDP, respectively. The impact on macroeconomic variables across the rest of regions is very small.

The CPI[6] in China has risen up around 2%. The higher domestic prices of Services, Agriculture, as well as Food and Beverage have mainly lead to the higher CPI. This upward pressure is only partially offset by the fall in Electronic prices, due to the small weight (1.9%) of this sector in total private consumption. Across the rest of regions variations in the CPI are small.

[5] Due to the fact that private consumption is calculated using a Cobb-Douglas form, percentage variations in private consumption coincide with changes in households' income. According to Hertel (1997, Chapter 1), the change of households' consumption or income can be considered as a welfare change when investment and public consumption are fixed in real terms (as in GTAPinGAMS).

[6] As a CGE model describes only relative prices, we take the standard approach of choosing CPI as the model's numeraire. CPI is the weighted sum of initial consumer prices, where the weights are each good's base budget share in the consumption bundle. GTAP6inGAMS by default takes a different variable as the numeraire. That is the dispensable budget for private consumption in ROW (RA_{row}). The CPI outcomes are then expressed in terms of the (RA_{row}), since RA_{row} only experiences a change of 0.09%, the CPI itself can be regarded as the real evolution of prices in each region.

4.2. Sectoral results

4.2.1. Production, output prices and labor demand

In China, the evolution of exports and private consumption are the key to the changes in output across sectors. Those sectors that are more export oriented—devoting a large part of its production to exports, as shown in Table 1, will diminish their production (Table 3). The reason for this is that the increase in the Chinese prices (as reflected in the higher CPI) are bigger than in the rest of regions, so China loses competitiveness (except in Electronics). Production falls because these sectors export less. The sectors experiencing increases in output are the ones whose production is more devoted to private consumption. Private consumption increases due to the higher national income in China, pushing up the production of the sectors more responsive to its tendency.

The biggest changes in output take place in the Electronic sectors itself. Following the arrival of new capital, output increases strongly in this sector in China. The important increase of Chinese exports to the rest of regions will crowd out the output of electronics in East Asia, the U.S. and ROW (Table 3). In East Asia production has contracted by 3.76%. Reductions are more sizeable in the U.S. (-6.89%) and ROW (-4.61%). This is due to the role of East Asia as a provider of intermediates of Electronics to China. This will be analyzed more deeply when dealing with exports.

Labor demand follows the evolution of production. In this capital specific setting, sectors that increase production do so by employing more labor. The only exception is Electronics. Since its capital rent in China is nearly half of the former price after the shock meanwhile the labor price goes up slightly, this sector replaces labor with capital.

4.2.2. Intermediate input of the Electronics sector

Table 4 shows the demand for total, imported and domestic intermediates to be used in the Electronics sector across regions. The final three columns show the change in total intermediates. We find they exactly follow the production change in Electronics production (shown in Table 3). This is due to the Leontief function of the upper nest in the production tree of GTAP6inGAMS. The interesting point, however, is that the combination of

imported or domestic varieties (first six columns of Table 3), which underlies the total demand for intermediates, differs.

Except for Electronics intermediates themselves, the Electronics sectors in East Asia, the U.S. and ROW rely more on domestic intermediates than on imported ones (i.e., the fall in imported intermediates is more sizeable than the fall in domestic intermediates). In China the tendency is reversed (i.e., the increase in the demand for imported intermediates is larger than the increase experienced for domestic ones). This difference arises from the fact that domestic intermediate prices are cheaper than imported ones in East Asia, the U.S. and ROW, but are more expensive than imported ones in China (see Part 2 of table 4). These tendencies are following the evolution of the CPI presented in Table 2. The CPI increases in China, it also increases slightly (and less than in China) in ROW, but decreases in East Asia and the U.S.

Let us focus now on the demand in Electronics for Electronics intermediates themselves. East Asia, the U.S. and ROW reduce more the demand for domestic inputs than imported ones when they cut down their output, as the imported inputs are cheaper than domestic ones. Imported goods are cheaper because the output price of Electronics goods in China falls heavily, pushing import prices for East Asia, the U.S. and ROW down[7]. This sector in China, however, uses 47.55% more of domestic intermediates and 20% more of imported ones. As a result, the production of domestic intermediates to be used in Electronics increases much more than does that of imported intermediates.

4.2.3. Bilateral exports of Electronics

4.2.3.1. Benchmark allocation structure of production and imports of Electronics

Table 5 shows the different roles that the four regions considered play in Electronics in the benchmark, i.e., before the shock. Let us look first at the use of imports in this sector. The left side of Part 1 of the table displays the allocation of each region's total imports of Electronics according to their use (i.e., the share used for private consumption, government consumption, gross capital formation or intermediates). China and East Asia stand out in

[7] More detail on these results on prices is provided in Table 6 below and will be further analyzed later on.

the weight of imports that are intermediate goods, i.e., goods that will be further processed, with a weight of around 80% and 66%, respectively. By contrast, in the U.S. and ROW the weight of intermediates of Electronics falls to around the half of imports. This reflects the idea that China and East Asia have an important role as "factories of Electronics" in the world, also considering that among the imported intermediates of Electronics, 74% (79%) go to the Electronics' sector itself and not to other sectors in China (in East Asia).

The right side of Part 1 of Table 5 shows a complementary picture. It displays the destination of the production of Electronics in each of the four regions. In particular, it shows the percentage of Electronics' production that is allocated to private and government consumption, gross capital formation, intermediates and exports. This information further confirms the role of China as a factory of Electronics in the world. 55% of its production is exported and 36% is used as intermediates. It also plays an important role as an export center. In China only 2.5% of production goes to private consumption and only 6% is for gross capital formation, while government consumption is negligible. In East Asia about 75% of the output is devoted to either exports (49%) or intermediates production (26%). However, the weight of private consumption and gross capital formation is higher than in China (10.5% and 13.3%, respectively). East Asia is a region which includes developed Asian economies, therefore, it devotes a higher share than China to the consumption of finished Electronics goods. It also reveals that East Asia plays a role as an export center for Electronics as China does, though less intensively, according to their export ratio of production. Thus, there are some similarities in the weight of export and intermediate ratio relative to production in China and East Asia.

The left side of Part 2 of Table 5 displays the geographical share of total imports of Electronics across the world, by demand component (i.e., classified as intermediate inputs, private consumption, public demand and investment demand). It unfolds the truth that the U.S. and ROW are the biggest markets for Electronics goods, according to their joint weight in imports for private consumption (82%), public demand (99%) and investment demand (78%). By contract, China and East Asia account for rather small share in private consumption (18%), public demand (0.17%) and investment demand (21%). China and East Asia account for 38% of world imports of Electronics intermediates.

The right side of Part 2 of Table 5 shows us the geographical shares of total world production of Electronics by demand component. Looking at the geographical shares world production of intermediates, 44% of them are concentrated in China and East Asia (with 21.6% and 23%, respectively). The table does not exhibit any absolute numbers. However, taking into account absolute numbers behind the imports of intermediates of China and East Asia (21.4% and 16.7% at the left of the table) together with absolute numbers of production of intermediates taking place in them, the whole East Asia overtakes ROW as the center of intermediates processing. This enables us to interpret China and East Asia as the main factory of Electronics in the world. This is further confirmed by looking at their share in total domestic supply of Electronics in the world (right side of Part 2 of Table 5). China and East Asia together account for more than 46% of total world production of Electronics.

These data suggest that the regions considered play a different role in the "triangular trade pattern". China stands out as a factory, East Asia follows that same trend although less intensively. The U.S. and ROW are the biggest markets for the Electronics finished goods of the world.

4.2.3.2. Evolution of bilateral trade in Electronics.

The main outcomes for the evolution of trade appear in Table 6. Part 1 of that Table presents the benchmark real values of exports of Electronics, as well as, the values after the simulation and their corresponding percentage changes. Note that the values of imports can be inferred from the exports values.

Let us begin by looking at the first group of columns in Part 1 of Table 6, which refer to Chinese exports. After the arrival of FDI to China its exports increase heavily and by a rather similar percentage (around 34%[8]) to the rest of regions. This implies that China strongly intensifies its exports without any marked change on the pattern of the geographical destination of those exports. The trade links and the export division remain unchanged. The absolute values show that for Chinese exports, the U.S and ROW are the most important markets. This is also confirmed by the percentage weight in total Chinese

[8] Note that the increase experienced in the production of Electronics after the shock is of 34% (Table 3).

exports reported in the second part of Table 6. It can be seen that the U.S. and ROW account for 32.4% and 48.7% of Chinese exports in the benchmark. Note the contrast with the pattern of the East Asia region. For East Asia China alone accounts for 32.04% of East Asian exports, while the U.S. and ROW account for 13.44% and 34.57% of East Asian exports, respectively. The East Asian region is also a rather important market for itself, bigger than the U.S., since it takes up nearly 20% of exports from East Asia.

As a result of the shock, all the rest of regions intensify their exports to China, while diminishing exports to other destinations (percentage changes in Part 1 of Table 6). We have seen that most of the exports accruing to China are of intermediates (Table 5 Part 1). More imports of intermediates are necessary given that Chinese production is increasing very heavily. The ROW region exhibits the biggest increase of exports to China (10.9%). However, in absolute values the increase is smaller than the exports of East Asia to China. The percentage is bigger just because the level of ROW's initial exports is much smaller than the one from East-Asia to China. Indeed, East-Asia provides much more exports to China (in absolute terms, before and after the shock). This means that there are important production networks between East Asia and China. East Asia is more a partner in the production networks for China than a market like the U.S. or ROW.

Indeed, Table 6 confirms that the nature of the ties of Electronics' trade between China and East Asia is different from the ones between China, the U.S. and ROW. Part 3 of that Table shows the geographical import structure. Nearly two thirds of Electronics imports of China come from East Asia while two thirds of the imports of East Asia come from itself and China. The adjustment after the shock is more intense when we look at its import side. Note that China does not change much its import structure in Electronics (again the product division remains unchanged). This means that the regional import shares in China remain nearly unaffected. However, due to the lower Chinese prices in Electronics it crowds out other providers of Electronics. In other words, imports coming from China increase in all regions, while the ones coming from the rest of regions go down. The adjustments in the import structure in other regions than China are more intense than in the case of the exports structure.

The last row of Table 6 shows import prices and domestic output prices of Electronics goods. Imports coming from China exhibit the biggest fall in prices in East Asia (-5.85%), the U.S. (-5.90%) and ROW (-6.00%). Clearly the price competitiveness of China has become very challenging. Particularly when we compared the import prices with the domestic output prices in Electronics. This explains why China gains in the import share of all regions: from 27.38% to 35.16% of total imports of Electronics in East Asia; from 38.01% to 46.54% in the U.S. and from 21.50% to 28.08% in ROW. By contrast, the shares of the imports provided by East Asia, U.S. and ROW are always reduced in the bilateral transactions among them.

4.3. Sensitivity analysis

In order to examine the robustness of the results, we change the values of two crucial elasticities in the model: 1) the elasticity of substitution between imports and domestic production (i.e. the Armington elasticity) and 2) the elasticity of substitution between labor and capital. We perform a Conditional Systematic Sensitivity Analysis (CSSA) following Harrison et al. (1993). We halve and double of each the two types of elasticities in all of the fifteen sectors while keeping the rest of elasticities at their benchmark value. Then we rerun the model and obtain the results for the aggregate and sectoral variables which have been analyzed above.

Table 7 shows the results of the aggregate variables, in a structure analogous to that of Table 2. The columns of "double" and "half" show the results obtained from the sensitivity analysis in which each of the elasticities are multiplied or divided by two. Changes in elasticities do not lead to significant variance in the aggregate variables. Only factor prices are slightly more affected under the different values of the elasticity of substitution between labor and capital. It is reasonable that the more flexible the substitution the smaller the impacts on wage and capital rents. Apart from that, the general outcomes analyzed before are preserved.

Now we turn to Table 8, analogous to the output results displayed in Table 3. Again the differences are negligible for the substitution elasticity between domestic goods and

imports. Only for the output of Electronics increases are more sizeable with the larger value of the Armington elasticity. The reason is that with higher values for this elasticity the sector tends to replace the imported goods with domestic ones whose prices are cheaper. Regarding the change of substitution elasticity between labor and capital, the output of Electronics increases less when the elasticity is higher. The more abundant capital in this sector replaces labor inputs more easily with a higher elasticity but faces a decreasing marginal product revenue of capital and also has less labor to produce. On the contrary, the inelastic substitution between factors leads to the higher demand for labor inputs which complement the capital inputs in the production of Electronics and lead to higher production levels.

Lastly we turn to Table 9 to analyze the trade pattern. There are no remarkable changes in the trade pattern for East Asia, the U.S. and Rest of World. Therefore, we concentrate on the effects for China. The overall trade pattern persists as before. East Asia is still the main supplier for Chinese imports of Electronics, and the U.S. and ROW are the biggest markets for Chinese exports. Although the changes are small, the lower the values of the elasticity of substitution between labor and capital, the larger the exports from China to Rest of World. Production in Electronics is larger in the more inelastic case, leading to a higher expansion on exports. Changes in the elasticity of substitution between imported and domestic goods are small.

All in all, the changes we have analyzed in the elasticities could vary the magnitude of the process described above but they would not change their causation chain since no outcomes straddle the origin.

5. Conclusions

This Chapter has examined the trade patterns of Electronics among China, East Asia, the U.S. and ROW. In particular, it has analyzed how the evolution of production and sourcing of intermediate inputs, as well as, the supply of final goods affect foreign trade. In line with

previous findings (e.g. Kawai, 2004), we obtain that FDI plays a vital role in shaping Asian regional Electronics production networks.

We replicate the real increase in FDI stock experienced in Electronics in China, which has doubled in the period 2004-2011. The simulations from our CGE model indicate that China has benefited from the FDI inflow. Its GDP increases by 1% while welfare rises by 3.8%. Besides, the pivotal role of China in the production network of Electronics has been strengthened by intensifying its exports to all the trade partners. However, the increase in Electronics exports occurs without any remarkable change in the pattern of its previous geographical destinies neither of its importing sources. In other words, Chinese export and import links remain unchanged (i.e., its product division persists).

By contrast, the geographical import structure of the rest of regions considered in the model changes considerably. The large increase of Chinese exports, following a big fall in their export prices, crowds out other competitors across the world. China also attracts more exports from the rest of regions (mainly due to the imported intermediates needed in its Electronics production). However, interestingly, the export structure of the rest of regions varies less than the import structure. This implies that China plays a more important role as a provider of Electronics goods for the rest of the world compared to its role as a final good market for them.

China plays, indeed, a central role as a production base and export center for Electronics in the world. Its main export markets are the U.S. and ROW. East Asia is the main input provider of Chinese Electronics. The increase in the production of Electronics in China is more important for the larger exports of electronics from East Asia than for the U.S. and ROW, due to the production networks that exist between China and East Asia. China collaborates with East Asia in the production of electronics but competes with that region in the U.S and ROW markets. After the shock, East Asia increases exports to China but reduces exports to the rest of regions and, further, some East Asian providers of Electronics within the region itself are also crowded out by China. Even though East Asia will export more to China it loses ground in the world market. This latter result prevails and, on the whole, East Asian exports of Electronics are reduced.

All in all, the FDI shock in Electronics sector in China has further strengthened its role of China as a production base and export center. East Asia becomes more integrated with China (through more exports and imports) but loses competitiveness and shares in the U.S., ROW, and in its own internal market.

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Table 1: Definition of sectors, commodity shares, import reliance, export tendency and production structure of China (year 2007)

Sector/Goods Definition (based on GATPAgg)		Commodity % in:			Import % of domestic consumption	Export % of domestic production	Production side (%)			
		Domestic Demand	Trade				% of Production Value	V.A. % in GDP	% of capital input	% of Labor input
		Private consumption	Imports	Exports						
Agriculture	01~14 Agriculture, hunting and fishing	12.49	2.97	0.91	5.05	1.85	6.40	11.04	10.33	15.05
Mining	15~18 Mining and quarrying	0.20	15.04	0.53	34.93	2.39	2.89	3.95	5.74	2.97
Food and Beverage	19~26 Food, beverages and tobacco	17.56	1.91	1.95	4.69	5.15	4.92	3.21	2.58	2.80
Textiles	27~29 Textiles, wearing apparel, leather, footwear	5.99	2.7	16.7	6.83	35.81	6.06	4.07	2.84	4.18
Woods and Paper	30~31 wood without furniture, paper, publishing, media	0.62	1.98	4.08	7.37	17.05	3.11	2.06	1.95	2.33
Petroleum	32 Petroleum	2.58	2.36	1.72	9.46	7.85	2.84	0.60	0.49	0.45
Chemicals	33~34 Chemicals, rubber and plastic products	2.51	12.81	7.15	22.82	12.88	7.21	5.67	4.75	3.86
Metals	34~37 Mineral products nec, Ferrous metals, metals nec, metal products	0.63	8.27	9.51	7.25	9.88	12.49	7.41	8.23	7.30
Motor Vehicles	38~39 Motor vehicles and parts, transport equipment nec	2.36	4.07	3.24	13.35	11.42	3.69	2.46	1.63	2.44
Electronics	40 Electronic equipment	1.89	19.44	21.84	48.17	56.33	5.03	2.95	2.48	2.47
Machinery	41 Machinery and equipment nec	2.07	17.85	16.93	23.78	24.85	8.85	6.45	5.34	5.56
Other Manufacturing	42 Manufactures nec	1.42	0.42	6.01	3.9	38.97	2.00	2.48	3.99	1.24
Electricity, Gas and Water	43~45 Electricity; Gas manufacture and distribution; Water	3.28	0.08	0.12	0.31	0.56	2.84	3.36	4.53	2.48
Construction	46 Construction	0.85	0.34	0.42	0.48	0.67	8.18	6.34	4.39	8.26
Services	47~57 Services	45.55	9.76	8.89	4.44	4.92	23.50	37.94	40.73	38.62
Total		100	100	100	11.53	12.99	100	100	100	100

Source: Authors' calculations based on GTAP 8 Data Base (Narayanan et al., 2012).

Table 2: Impact on aggregate variables (% change)

Macro indices	CHN	EAS	U.S.	ROW
Wage	0.22	-0.14	-0.03	-0.08
Capital rental	-0.71	-0.17	0.02	0.02
National income	3.82	-0.16	0.02	-0.09
GDP	0.99	-0.12	-0.02	-0.03
CPI	2.06	-0.08	-0.01	0.09
Capital stock	2.48	0.00	0.00	0.00

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al., 2012).

Note: CHN represents China, EAS stands for East Asia, and ROW for Rest of the world.

Table 3: Impact on sectoral output and labor input (% change)

% change	Output				Labor input			
	CHN	EAS	U.S.	ROW	CHN	EAS	U.S.	ROW
Agriculture	0.38	0.09	0.09	0.06	0.64	0.21	0.25	0.11
Mining	-0.22	0.13	0.06	0.03	-0.65	0.44	0.25	0.2
Food & Beverage	0.94	-0.02	0.03	0.01	1.82	-0.05	0.05	0.03
Textiles	-2.72	1.41	1.04	0.87	-4.55	2.05	1.3	1.43
Woods and Paper	-1.19	0.30	0.19	0.22	-2.18	0.49	0.26	0.36
Petroleum	0.61	0.11	-0.13	-0.06	1.29	0.32	-0.25	-0.21
Chemicals	-0.68	0.6	0.3	0.23	-1.52	1.19	0.5	0.46
Metals	-0.54	0.55	0.22	0.25	-1.15	0.97	0.28	0.45
Motor Vehicles	-0.97	0.53	0.23	0.01	-1.62	0.80	0.28	0.02
Electronics	34.18	-3.76	-6.89	-4.61	-13.68	-7.05	-9.56	-9.10
Machinery	-1.55	0.76	0.42	0.25	-3.03	1.23	0.53	0.37
Other manufacturing	-0.94	0.45	0.65	0.19	-3.94	0.70	0.77	0.31
Electricity, Gas and Water	0.6	-0.01	-0.02	0	1.7	-0.06	-0.04	0
Construction	0.03	0.02	-0.02	0	0.04	0.03	-0.03	0
Services	1.00	0.04	-0.02	-0.01	2.07	0.07	-0.02	-0.01

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al., 2012).

Note: See note on Table 2.

Table 4: Impact on intermediate demands and prices of the Electronics sector (% change)

Part 1: Intermediate demand of the Electronics sector												
	domestic intermediate demand				Imported intermediate demand				total intermediate demand			
	CHN	EAS	U.S.	ROW	CHN	EAS	U.S.	ROW	CHN	EAS	U.S.	ROW
Agriculture	26.08	-3.67	-6.95	-4.57	34.18	-4.63	-6.86	-4.73	34.18	-3.76	-6.89	-4.61
Mining	33.89	-4.05	-6.81	-4.67	35.15	-3.73	-6.94	-4.50	34.19	-3.77	-6.89	-4.61
Food and Beverage	33.95	-3.76	-6.89	-4.59	42.23	-4.81	-7.28	-4.70	34.18	-3.76	-6.89	-4.61
Textiles	33.8	-3.39	-6.76	-4.26	39.93	-5.94	-8.76	-5.25	34.18	-3.76	-6.89	-4.61
Woods and Paper	33.6	-3.70	-6.85	-4.56	39.81	-4.82	-8.00	-4.82	34.18	-3.76	-6.89	-4.61
Petroleum	34.07	-3.76	-6.89	-4.61	35.28	-3.79	-6.87	-4.60	34.18	-3.76	-6.89	-4.61
Chemicals	32.94	-3.66	-6.79	-4.54	38.43	-4.04	-7.36	-4.68	34.18	-3.76	-6.89	-4.61
Metals	33.68	-3.56	-6.72	-4.51	39.32	-4.26	-7.68	-4.75	34.18	-3.76	-6.89	-4.61
Motor Vehicles	33.47	-3.59	-6.82	-4.60	38.75	-4.14	-7.04	-4.62	34.18	-3.76	-6.89	-4.61
Electronics	47.55	-6.72	-10.09	-7.21	19.76	-0.46	0.34	-3.28	34.34	-3.75	-6.86	-4.6
Machinery	33.1	-3.41	-6.60	-4.49	37.76	-4.11	-7.41	-4.72	34.18	-3.76	-6.89	-4.61
Other manufacturing	34.05	-3.19	-6.52	-4.48	37.38	-4.34	-7.70	-4.89	34.18	-3.76	-6.89	-4.61
Electricity, Gas and Water	34.16	-3.76	-6.89	-4.61	41.55	-4.77	-7.24	-4.66	34.18	-3.76	-6.89	-4.61
Construction	34.16	-3.76	-6.89	-4.60	38.33	-4.12	-7.15	-4.70	34.18	-3.76	-6.89	-4.61
Services	33.82	-3.70	-6.88	-4.60	40.18	-4.33	-7.07	-4.65	34.18	-3.76	-6.89	-4.61
Part 2: Intermediate input prices												
	domestic intermediate input price				import intermediate input price				composite intermediate input price			
	CHN	EAS	U.S.	ROW	CHN	EAS	US	ROW	CHN	EAS	U.S.	ROW
Agriculture	0.83	0.28	0.33	0.13	-1.79	0.71	0.29	0.2	-1.79	0.32	0.3	0.15
Mining	-1.26	0.77	0.63	0.58	-1.42	0.71	0.65	0.55	-1.29	0.71	0.64	0.57
Food and Beverage	0.5	0.12	0.09	0.03	-1.91	0.56	0.26	0.07	0.43	0.12	0.09	0.03
Textiles	-0.56	0.38	0.18	0.24	-1.73	1.09	0.76	0.52	-0.64	0.48	0.22	0.34
Woods and Paper	-0.48	0.09	0.06	0.05	-1.92	0.47	0.46	0.13	-0.62	0.11	0.08	0.06
Petroleum	-1.08	0.63	0.57	0.46	-1.5	0.65	0.55	0.46	-1.12	0.63	0.56	0.46
Chemicals	-0.6	0.32	0.15	0.12	-1.81	0.44	0.33	0.16	-0.88	0.35	0.18	0.14
Metals	-0.65	0.26	0.07	0.11	-1.84	0.48	0.37	0.18	-0.75	0.32	0.12	0.14
Motor Vehicles	-0.78	0.04	-0.01	-0.03	-2	0.22	0.07	-0.02	-0.95	0.09	0.02	-0.03
Electronics	-7.93	-1.33	-0.99	-1.8	-3.46	-2.77	-3.43	-2.72	-5.92	-2.03	-1.77	-2.42
Machinery	-1.14	0.11	-0.01	-0.03	-1.98	0.30	0.20	0.03	-1.34	0.21	0.06	0
Other manufacturing	-1.29	0.09	0.03	0.05	-1.94	0.41	0.38	0.17	-1.32	0.25	0.14	0.09
Electricity, Gas and Water	0.01	0.15	0.06	0.08	-1.89	0.53	0.20	0.10	0.01	0.15	0.07	0.08
Construction	-0.39	0.02	0	-0.01	-1.98	0.22	0.15	0.05	-0.40	0.02	0	-0.01
Services	0.37	-0.05	-0.03	-0.05	-2.06	0.29	0.08	-0.02	0.23	-0.02	-0.02	-0.05

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al., 2012).

Note: See note on Table 2.

Table 5: Benchmark allocation of production and imports of Electronics (% shares, year 2007)

Part 1	Total Electronics' imports of each region by demand type (%)					Demand use of production in Electronics in each region (%)					
	Private Consumption	Public Demand	Investment Demand	Intermediates	Total	Private Consumption	Public Demand	Investment Demand	Export	Intermediates	Total
CHN	6.05	0.00	14.56	79.38	100	2.45	0.00	5.89	55.16	36.51	100
EAS	11.71	0.01	22.36	65.93	100	10.57	0.01	13.34	49.32	26.76	100
U.S.	21.14	0.00	26.10	52.75	100	5.92	0.00	23.88	18.38	51.81	100
ROW	16.17	0.89	31.31	51.62	100	9.46	0.33	12.46	55.96	21.80	100
Part 2	Geographical share of world Electronics imports by demand type (%)					Geographical share of world production of Electronics by demand type (%)					
	Private Consumption	Public Demand	Investment Demand	Intermediates	Total	Private Consumption	Public Demand	Investment Demand	Export	Intermediates	Total
CHN	6.44	0.00	8.71	21.47	15.78	5.91	0.00	8.10	22.13	21.65	18.78
EAS	11.73	0.17	12.60	16.80	14.87	37.19	1.78	26.70	28.80	23.09	27.33
U.S.	26.47	0.01	18.38	16.79	18.57	14.60	0.01	33.51	7.53	31.35	19.16
ROW	55.37	99.82	60.30	44.94	50.78	42.29	98.21	31.69	41.54	23.91	34.74
World	100	100	100	100	100	100	100	100	100	100	100

Source: Authors' calculations based on GTAP 8 Data Base (Narayanan et al., 2012).

Note: See note on Table 2.

Table 6: Impact on bilateral trade in Electronics (absolute values and % change)

Part 1. Export Quantity (benchmark values, simulations values and percentage change)																		
Exports	Exports from China to:				Exports from East Asia to:					Exports from the U.S. to:				Exports from ROW to:				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	50.48	86.53	130.08	267.09	114.87	71.64	47.99	123.43	357.94	10.70	20.26	61.97	92.94	64.26	46.50	97.47	306.77	515.00
Simulation	68.43	114.61	176.92	359.96	124.01	64.20	42.05	111.01	341.26	11.14	17.51	53.78	82.43	71.29	42.79	87.68	283.70	485.46
% change	35.58	32.45	36.00	34.77	7.95	-10.39	-12.38	-10.07	-4.66	4.13	-13.58	-13.22	-11.30	10.94	-7.97	-10.04	-7.52	-5.74
Part 2. Regions' shares in exports at FOB price in the benchmark, in the simulation and the difference in % points																		
Regions' shares in Exports	Exports from China to:				Exports from East Asia to:					Exports from the U.S. to:				Exports from ROW to:				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	18.86	32.42	48.71	100	32.04	19.96	13.44	34.57	100	11.51	21.81	66.68	100	12.48	9.05	19.05	59.42	100
Simulation	18.97	31.87	49.16	100	36.28	18.76	12.35	32.61	100	13.51	21.25	65.24	100	14.69	8.84	18.18	58.29	100
Difference	0.11	-0.56	0.45	0	4.24	-1.20	-1.09	-1.96	0	2.00	-0.56	-1.44	0	2.21	-0.21	-0.87	-1.13	0
Part 3. Regions' shares in imports at CIF price in the benchmark, in the simulation and the difference in % points																		
Regions' shares in Imports	Imports of China by source				Imports of East Asia by source					Imports of the U.S. by source				Imports of ROW by source				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	60.43	5.67	33.91	100	27.38	37.45	10.69	24.48	100	38.01	20.38	41.61	100	21.50	19.72	9.93	48.85	100
Simulation	60.04	5.45	34.51	100	35.16	33.33	9.21	22.30	100	46.54	17.30	36.16	100	28.08	17.86	8.71	45.34	100
Difference	-0.39	-0.22	0.60	0	7.78	-4.12	-1.48	-2.18	0	8.53	-3.08	-5.45	0	6.59	-1.86	-1.22	-3.51	0
Part 4. % change of bilateral import price (PM) and output price of Electronics (PY)																		
Prices	bilateral PM of China, from			PY_ CHN	bilateral PM of East Asia, from				PY_ EAS	bilateral PM of the U.S., from			PY_ U.S.	bilateral PM of ROW, from				PY_ ROW
	EAS	U.S.	ROW		CHN	EAS	U.S.	ROW		CHN	EAS	ROW		CHN	EAS	U.S.	ROW	
% change	-3.38	-2.98	-3.68	-7.93	-5.85	-1.31	-0.90	-1.61	-1.33	-5.90	-1.38	-1.67	-0.99	-6.00	-1.47	-1.07	-1.78	-1.80

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al., 2012).

Note: The export quantity is in billions of dollars, it does not include any subsidy on the exports neither the transport margin. See note on Table 2.

Table 7: Sensitivity analysis—effects on aggregate variables of changes in elasticities (% change from benchmark)

	A) Elasticity of substitution between imports and domestic production								B) Elasticity of substitution between labor and capital							
	Half				Double				Half				Double			
	CHN	EAS	U.S.	ROW	CHN	EAS	U.S.	ROW	CHN	EAS	USA	ROW	CHN	EAS	U.S.	ROW
Wage	0.18	-0.14	-0.04	-0.08	0.29	-0.14	-0.03	-0.07	0.75	-0.15	-0.03	-0.08	0.02	-0.12	-0.04	-0.07
Capital Rent	-0.68	-0.17	0.02	0.02	-0.75	-0.18	0.03	0.03	-1.36	-0.19	0.03	0.02	-0.40	-0.14	0.02	0.03
National income	3.81	-0.16	0.02	-0.10	3.84	-0.17	0.02	-0.08	3.98	-0.18	0.03	-0.12	3.67	-0.14	0.01	-0.06
GDP	0.95	-0.13	-0.02	-0.03	1.05	-0.13	-0.01	-0.02	0.91	-0.14	-0.02	-0.03	1.06	-0.10	-0.02	-0.02
CPI	2.26	-0.07	0.01	0.10	1.77	-0.11	-0.03	0.08	2.98	-0.06	0.02	0.12	1.35	-0.10	-0.03	0.06
Imports	2.02	-0.02	0.04	-0.10	2.73	-0.11	0.05	-0.11	2.43	-0.11	0.04	-0.15	2.21	0.00	0.05	-0.06
Exports	-0.56	0.03	0.04	0.11	0.12	-0.06	0.04	0.07	-0.81	-0.05	0.04	0.11	0.22	0.04	0.05	0.08

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al., 2012).
Note: See note on Table 2.

Table 8: Sensitivity analysis—Effects on sectoral variables of changes (% change from benchmark)

Effects on Sectoral Output	A) Elasticity of substitution between imports and domestic production								B) Elasticity of substitution between labor and capital							
	Half				Double				Half				Double			
	CHN	EAS	U.S.	ROW	CHN	EAS	U.S.	ROW	CHN	EAS	U.S.	Row	CHN	EAS	U.S.	ROW
Agriculture	0.48	0.09	0.08	0.04	0.24	0.09	0.12	0.07	0.08	0.11	0.11	0.07	0.78	0.07	0.07	0.05
Mining	-0.22	0.13	0.06	0.03	-0.21	0.13	0.06	0.03	-0.23	0.13	0.06	0.03	-0.15	0.13	0.06	0.03
Food &Beverage	1.01	-0.02	0.03	0.01	0.82	-0.02	0.03	0.02	0.57	-0.01	0.04	0.01	1.30	-0.02	0.02	0.01
Textiles	-2.90	1.32	1.10	0.94	-2.49	1.58	0.95	0.76	-3.21	1.62	1.21	1.00	-1.93	1.12	0.81	0.67
Woods and Paper	-1.20	0.28	0.19	0.22	-1.19	0.34	0.19	0.21	-1.64	0.36	0.23	0.26	-0.65	0.24	0.15	0.16
Petroleum	0.67	0.08	-0.13	-0.06	0.50	0.15	-0.12	-0.05	0.45	0.16	-0.11	-0.04	0.75	0.06	-0.14	-0.07
Chemicals	-0.47	0.51	0.29	0.23	-0.95	0.73	0.31	0.23	-1.05	0.73	0.36	0.29	-0.21	0.46	0.23	0.17
Metals	-0.52	0.49	0.23	0.26	-0.59	0.66	0.21	0.25	-0.81	0.69	0.27	0.34	-0.27	0.41	0.17	0.17
Motor Vehicles	-0.80	0.49	0.21	0.01	-1.25	0.60	0.25	0.02	-1.46	0.62	0.29	0.03	-0.48	0.42	0.18	0.00
Electronics	31.81	-3.28	-6.73	-4.40	38.23	-4.60	-7.16	-4.97	42.41	-4.68	-8.46	-5.67	26.13	-2.86	-5.31	-3.55
Machinery	-1.50	0.69	0.43	0.27	-1.61	0.87	0.40	0.22	-1.91	0.86	0.50	0.30	-1.05	0.61	0.33	0.18
Other manufacturing	-1.02	0.45	0.67	0.21	-0.83	0.47	0.62	0.17	-0.87	0.46	0.66	0.16	-0.86	0.41	0.60	0.20
Electricity, Gas and Water	0.62	-0.02	-0.02	-0.00	0.56	-0.01	-0.01	0.00	0.42	-0.00	-0.01	0.01	0.78	-0.02	-0.02	-0.01
Construction	0.03	0.02	-0.02	0.00	0.02	0.03	-0.02	0.00	0.00	0.03	-0.03	0.00	0.04	0.02	-0.02	0.00
Services	1.04	0.03	-0.02	-0.01	0.91	0.06	-0.01	-0.00	0.72	0.06	-0.02	-0.01	1.16	0.03	-0.01	-0.00

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al., 2012).

Note: See note on Table 2.

Table 9: Sensitivity analysis—Trade Patterns for China

	A) Elasticity of substitution between imports and domestic production								B) Elasticity of substitution between labor and capital							
	Half				Double				Half				Double			
Part 1. Export Quantity (benchmark values, simulations values and percentage change)																
Exports	Exports from China to:				Exports from China to:				Exports from China. to:				Exports from China to:			
	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total
Benchmark	50.48	86.53	130.08	267.09	50.48	86.53	130.08	267.09	50.48	86.53	130.08	267.09	50.48	86.53	130.08	267.09
Simulation	69.58	115.78	179.20	364.56	66.34	112.43	172.70	351.47	72.70	121.15	188.05	381.90	64.23	108.11	165.94	338.27
% change	37.85	33.80	37.76	36.49	31.43	29.93	32.76	31.59	44.02	40.02	44.56	42.99	27.24	24.94	27.56	26.65
Part 2. Regions' shares in exports at FOB price in the benchmark, in the simulation and the difference in % points																
Regions' shares in exports	Exports from China to:				Exports from China to:				Exports from China to:				Exports from China to:			
	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total
Benchmark	18.86	32.42	48.71	100	18.86	32.42	48.71	100	18.86	32.42	48.71	100	18.86	32.42	48.71	100
Simulation	19.05	31.79	49.16	100	18.84	32.02	49.15	100	19.00	31.75	49.25	100	18.95	31.99	49.06	100
Difference	0.19	-0.64	0.45	0	-0.03	-0.41	0.43	0	0.13	-0.67	0.54	0	0.09	-0.44	0.35	0
Part 3. Regions' shares in imports at CIF price in the benchmark, in the simulation and the difference in % points																
Regions' shares in improts	Imports of China by source				Imports of China by source				Imports of China by source				Imports of China by source			
	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total
Benchmark	60.43	5.67	33.91	100	60.43	5.67	33.91	100	60.43	5.67	33.91	100	60.43	5.67	33.91	100
Simulation	59.91	5.49	34.60	100	60.26	5.39	34.35	100	59.93	5.40	34.67	100	60.14	5.50	34.36	100
Difference	-0.51	-0.18	0.69	0.00	-0.16	-0.28	0.44	0.00	-0.50	-0.26	0.76	0.00	-0.29	-0.16	0.45	0.00
4. % change of Real bilateral import price (PM) and real output price of Electronics (PY)																
Prices	bilateral PM of China, from			PY_CHN	bilateral PM of China, from			PY_CHN	bilateral PM of China, from			PY_CHN	bilateral PM of China, from			PY_CHN
	EAS	U.S.	ROW		EAS	U.S.	ROW		EAS	U.S.	ROW		EAS	U.S.	ROW	
% change	-3.45	-3.16	-3.81	-8.22	-3.32	-2.74	-3.52	-7.47	-4.54	-4.06	-4.91	-9.96	-2.40	-2.10	-2.63	-6.02

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al., 2012).

Note: See note on Table 6

Chapter 3

The impact of FDI on the production networks between China and East Asia and the role of the U.S. and ROW as final markets[*]

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Abstract

This Chapter uses a 3 factor – 4 region – 15 sector computable general equilibrium model to study the impact of FDI accruing to China. We focus on the sectors of Electronics, Machinery and Textiles which account for 55.4% and 40% of Chinese overall exports and imports, respectively. Our data confirm the existing empirical knowledge on the production networks between China and East Asia, and the role that the U.S. and ROW play as final markets for Chinese exports. The magnitude of FDI inflows brings about proportional impacts on the increase in production and the fall in prices across the three sectors considered. However, the subsequent adjustment in bilateral trade differs. On the one hand, FDI leads to an increase of Chinese exports of Electronics and Machinery, crowding out production and exports in the rest of regions. On the other hand, the increase in FDI in Textiles still brings about increase in production which does not result in higher exports. The private consumption orientation of Textiles explains its contrasting trade pattern with respect to Electronics and Machinery. The fall in Chinese exports of Textiles in China underlies the increase on exports of Textiles across the rest of regions. However, world trade flows in Textiles are of smaller volume than the one in Electronics and Machinery. Therefore, the increase in Textiles of exports of the rest of regions does not compensate their big losses of exports in Machinery and Electronics.

Key words: Computable general equilibrium; Intermediates; Multinationals; Triangular trade pattern; Production fragmentation.

JEL classification: C68, F14, F15, F17, F21.

1. Introduction

Through Foreign Direct Investment (FDI) and trade, China has become increasingly integrated into the global production Chain. It is the largest recipient of FDI among all developing economies. Its share of the world inward FDI flows rose from 2.8% in 1991 to 8.1% in 2011 (UNCTAD, various years). FDI inflows have substantially contributed to its capital formation process.

East Asian economies, out of the geographic proximity and cultural links, provide 63% of cumulative FDI in China from 1985 to 2008 (Xing, 2010). As empirically tested by Fukao et al. (2003) with data from the electrical machinery industry, FDI plays a significant role in the rapid increase in vertical intra-industry trade in East Asia in recent years.

The exports and imports between China and East Asia have nearly quadrupled from 2000 to 2009 (OECD, various years). In fact, more than 70% of intraregional trade in East Asia is in parts and components that will be further assembled and exported to other region (ADB, 2007). Trade of intermediate goods has largely driven the rapid growth of intra-Asian trade (Athukorala, 2008; Brooks and Hua, 2009). Dean et al. (2008), using two Chinese benchmark input-output tables and a detailed trade dataset which distinguishes processing trade from other forms of trade, shows strong evidence of an Asian network of intermediate supplies to China. Xing (2011) points out that most of the processing imports from East Asian economies are used as intermediate inputs for finished products targeting third markets and that China has primarily functioned as a big assembling factory for MNEs from East Asian economies. The U.S. is the largest single market for processing exports of China, based on panel data of 51 trading partners of China from 1993–2008.

The emergence of China has intensified the production fragmentation within Asia (Gaulier et al., 2007a) and led to a triangular trade pattern among China (the export base), advanced Asian economies (component suppliers), the U.S. and Europe (markets) (Gaulier et al., 2007b). Triangular trade through China is thought to form the principal mechanism of shock transmission in the Asia-Pacific region under the Crisis based on international Input-Output analysis (Inomata and Uchida, 2009).

The close ties among Asian economies can be explained by the increased production fragmentation and the rise in intra-industry trade. Production fragmentation (Deardorff, 1998) is a production process during which final product is split into two or more steps and each production step is undertaken in different locations across national boundaries. Various terms have been used to describe this phenomenon including production networks (Henderson et al., 2002; Ernst and Kim, 2002; Sturgeon, 2002), slicing the value chain (Krugman, 2005), vertical specialization (Hummels et al., 2001), international production sharing (Ng and Yeats, 1999) and outsourcing (Feenstra and Hanson, 1999). Xing and Detert (2010) give iphone as an example of the global production networks and highly specialized production processes in which China is mainly devoted to the assembly phase.

Koopman et al. (2008) develop a general formula for computing domestic and foreign contents, and reveal that the share of foreign content in exports from Chinese electronic devices is particularly high (about 80%). Wang et al. (2009), using an international input-output table, disclose the heterogeneity in the value chain across sectors: the Electronics industry has the most integrated global production network, with value shares becoming more evenly distributed among East Asian economies from 1990 to 2000. In contrast, Wearing apparel is more concentrated in Asian developing countries, with a shift in value-added away from industrialized Asian countries and the rest of the world. Decomposing Chinese real export growth of over 500 percent since 1992, China's export structure changed dramatically, with growing export shares in Electronics and Machinery and a decline in Agriculture and Apparel. These results match the evidence derived in this Chapter. The strongest overall export growth has been in Machinery, and within this broad category, particularly in Telecoms, Electrical Machinery (Amiti and Freund, 2008).

Specialization allows the production to be distributed efficiently across the regions, based on their comparative advantage, like wage differentials. Multinational enterprises (MNEs) in advanced Asian economies specialize in production of intermediate goods and they further export intermediates to their affiliates in China for assembly and re-export (Haltmaier et al., 2007). Production networks centered on China have contributed significantly to growth in East Asia (Haddad, 2007).

In summary, the empirical literature points to the existence of different geographical roles in the production process worldwide. In particular, it suggests that the emergence of China has intensified integration in Asia through production networks. China works closely with other Asian economies through processing trade and its growth further reinforces the production networks within the region. China plays an important role as a production center and export base, relying heavily on the intermediates from more advanced Asian economies (Japan, Korea, Taiwan, Hong Kong, Singapore). FDI inflows in China, as well as, trade have largely induced the development of this production network, which in turn, has consequences for the trade patterns within and outside the region. The U.S. and ROW, by contrast, are the main final markets for East Asian exports.

However, the above refereed literature, often lacks a general equilibrium perspective which would allow analyzing the micro and macroeconomic impact, as well as, the demand and supply sides of this phenomenon, in a manner consistent with trade patterns. Further, the CGE analyses that include FDI are rather scarce (Latorre, 2009). This is the gap that we aim to cover with this study of the impact of inward FDI in Electronics, Machinery and Textiles sectors of the Chinese economy. We focus on the effects on the Chinese trade pattern in these sectors which constitute 55.4% and 40% of its overall exports and imports, respectively. We pay particular attention to the role that the different geographical areas play in their associated production networks and in their final demand. In particular, we analyze the evolution of East Asian production networks and its final markets – the U.S. and the Rest of the World (ROW).

This Chapter is organized as follows. The benchmark data and simulation scenario are discussed in section 2. Section 3 describes the model that we use. The results are analyzed both at the aggregate and sectoral level, as well as, from the demand and supply side in section 4. Section 5 concludes.

2. Data

In our model there are three factors of production (capital, unskilled and skilled labor), four regions (China, East Asia[1], the U.S. and ROW) and fifteen sectors. The Manufacturing sector is disaggregated into thirteen sub-sectors which are presented in Table 1. The other two sectors are Agriculture and Services. We model capital and skilled labor as sector-specific, while unskilled labor is fully mobile within but not across regions. This assumption allows us to capture the medium term impact of the simulated FDI shock.

Table 1 displays the whole structure of the Chinese economy. In the first two columns, it presents the names of the sectors and their correspondences with the original GTAP sectors. The percentage calculations of the table are based on the latest GTAP8 database (Narayanan et al., 2012), which is the one used in our model. The information refers to the year 2007.

2.1. Comparing the three sectors' importance in Chinese economy

As shown in column 3 of Table 1, Electronics, Textiles and Machinery are the most export oriented sectors in the Chinese economy: 56% of Electronics production, 36% of Textiles and 25% of Machinery are exported. Combining their exports together, they account for 55.5% of Chinese overall exports (column 5). According to their weights in the production and value added (GDP), Machinery is a bit larger, followed by Textiles and Electronics (columns 8 and 9). Moreover, MNEs are highly involved in the production of these sectors, since they contribute to more than 80% of Electronics output, 24% and 27% in Textiles and Machinery, respectively[2].

[1] After the close observation of the FDI sources and main trade partners of China, we finally aggregate Japan and new industrialized economies (Republic of Korea, Taiwan China, Hong Kong China and Singapore) as East Asia.

[2] 中国工业经济统计年鉴 2008 (China Industry Economy Statistical Yearbook 2008).

On the other hand, the three sectors vary largely in the aspects mentioned below. As shown in column 4, imports play a much smaller role for domestic consumption of Textiles (6.8%), contrasting with 48.2% of Electronics and 23.8% Machinery. Column 7 shows that Textiles outweighs the sum of Electronics and Machinery in Private consumption. From the production side, Textiles is unskilled labor intensive compared with Electronics and Machinery (column 11). The Machinery sector is logically most capital intensive (column 12).

2.2. Comparing the role of the four regions in the world commodity market

2.2.1 Role in Electronics

Table 2 shows the different roles that the four regions play in Electronics. The left side of Part 1 of this table displays the demand structure (private consumption, government consumption, gross capital formation and intermediate inputs) of imported Electronics in each region. China and East Asia lie ahead of the U.S. and ROW with respect to their high weight of intermediate inputs in imports. The U.S., ROW and, to a lesser extent, East Asia distinguish themselves from China due to their high private consumption weight (20%, 14% and 11.5%, respectively) and high capital formation weight (26.2%, 31.5% and 22.2%, respectively). These tendencies underlie the geographical shares of world Electronics imports by demand (left side of Part 2 of Table 2). Note first, that the U.S. and ROW together account for 69.4% (18.8% + 50.5%) in world Electronics imports[3]. However, their weights are higher in world private consumption (81.6% = 28.3% + 53.3%), public consumption (99.8%) and capital formation (80.5% = 19.1% + 61.4%), exhibiting a smaller importance in intermediates (61.7% = 16.8% + 44.9%). East Asia and China together, play a more important role in intermediate imports of Electronics (38.3%= 21.5% + 16.8%) than in the rest of components of demand. Imports for private demand in China are the lowest in the world.

[3] Imports include the value of physical imports, transport margins and import tariffs.

Now let us analyze the roles played by the different regions in production. The right side of Part 1 reflects the allocation of domestic Electronics goods (production[4]). China, East Asia and ROW share similarities in devoting most of their output to exports and intermediates, while the U.S. devotes domestic goods intensively to capital formation and intermediates, with a rather small share going to private consumption. China exhibits the lowest of production devoted to private consumption across regions. The low private consumption weight in production and imports of the Chinese economy will soon become familiar to us. These patterns in production also have a reflection in world patterns. This can be seen in the right side of Part 2, which shows us the geographical shares of world production of Electronics, further specifying the shares in each demand component. Nearly half of world production of Electronics (46.4% = 18.9% + 27.5%) is concentrated in China and East Asia, which also contribute to 51% (22.1% + 28.8%) of world exports and employ 35.7% (23.9% + 11.8%) of world domestic intermediates. Private consumption, public consumption and Investment in the U.S. and ROW contribute to 81.7%, 99.4% and 77.2 % of world levels, respectively.

To sum up, in relative terms, imports and production of Electronics are more related to intermediates and exports in China and East Asia. Most of Chinese imports are of intermediates, mainly from East Asia due to the existing production networks[5] between the two regions. They together serve as the biggest world production and export base for Electronics. By contrast, in the U.S. and ROW, Electronics seem more related to final domestic demand (i.e., private consumption, public consumption and investment). This underlies a triangular trade pattern among these regions that has been pointed out by some authors (Gaulier et al., 2007b; Inomata and Uchida, 2009), by which East-Asia provides intermediates to be further processed in China, while the latter exports them to the U.S.

[4] The right side of Tables 2, 3 and 4 display the demand allocation of "domestic goods". Strictly speaking, domestic goods (commodities) in a social accounting matrix (SAM) table are the sum of production (output) and total export tariffs. Production takes up 96.1%, 98.4% and 99.2% of domestic goods in Textiles, Electronics, and Machinery, respectively. Therefore, we will use the terms production or output to refer to domestic commodities, hereafter.

[5] In Part 1 of Table 2 we see that 84.5% of Chinese imports are of intermediates. We will see later (in Part 3 of Table 7) that 60% of total Chinese imports of Electronics come from East Asia. It seems logical to assume that most of the Chinese imports are intermediates from East Asia. The literature review from the introduction also points clearly in this direction.

which is the main (single-country) final market. A pattern which is consistent with the literature review presented in the Introduction.

2.2.2 Role in Machinery

Table 3 shows the different roles that the four regions play in Machinery in a manner analogous to Table 2. Therefore, the left side of Part 1 of this table exhibits the allocation structure of imported goods in each region. The imports are largely used for intermediates but this tendency is more intense in China and East Asia. As befits the nature of the Machinery sector, an important part of imports is also devoted to investment. Imports for private consumption are more important in the U.S. and ROW. China exhibits the lowest import tendency for private consumption and the highest for intermediates. The left side of Part 2 shows the geographical shares of world Machinery imports by demand. Following the above explained patterns, East Asia and China account for 22% (11.4% + 10.6%) of world intermediate inputs and 18.5% (8.8% + 9.7%) of world capital formation but their shares are very low in world private consumption. The U.S. and ROW take up 90% (23.2% + 66.4%) of world private consumption of imported goods.

The right side of Part 1 displays how each region allocates their domestic output. Private consumption of Machinery goods is pretty low across regions, though more important in the U.S. and ROW. Production for investment is important across all regions. China devotes most of its production (49.3%) to intermediates, followed by exports (24.7%). By contrast, East Asia and ROW, devote nearly half of their outputs for exports, next in importance come intermediates. The resulting world output patterns are in the right side of Part 2, which displays the geographical share of each demand component of world Machinery production. Domestic intermediate input in China ranks high in the world. East Asia shows a large share in the world exports, though ROW, as a combination of rest of the regions has a much higher weight. China and East Asia provide 30.4% (16.5% + 13.9%) of world production of Machinery and 28.3% (10.5% + 17.8%) of world exports. The U.S. and ROW contribute 87.5% to the world private consumption, and around two thirds to the world capital formation and intermediates.

These patterns suggest that, in relative terms, China and East Asia play more the role of producers than the role of final markets, the latter being more important in the U.S. and ROW. To put it simpler, from a world perspective the U.S. and ROW play a more important role as final markets, while China and East Asia are more specialized in producing intermediate goods and export goods. Thus, we again find a similar pattern to the one described above for Electronics, especially in the flows of Chinese intermediate imports coming from East Asia (Part 1 of Table 3 and Part 3 of table 8 below). But because the Machinery production depends less on imported intermediates (and more on domestic ones) than Electronics does (Figure 6), the production networks between China and East Asia is not as strong as in Electronics. In addition, the higher importance of Machinery in investment across all geographical areas, makes its pattern somewhat different to the one of Electronics.

2.2.3 Role in Textiles

Table 4 repeats the structure of Tables 2 and 3, now including information for Textiles. The left side of Part 1 reveals how each region allocates the imported Textile goods. According to the nature of the product, Textiles is quite different from Electronics and Machinery in its small importance for capital formation. In China 86.3% of the imports are intermediates. As happened in Electronics and Machinery, China exhibits the smallest share of imports used for private consumption across all regions. However, it is important to note that in the case of textiles 13.7% of all Chinese imports go to private consumption, while in Electronics and Machinery the shares were much lower (4.5% and 2.7%, respectively). In East Asia, the U.S. and ROW, by contrast, more than 59% of imports are for private consumption, especially high is the case of the U.S., with 72.7% of imports going to private consumption. The rest of imports are mainly used for intermediates in these regions. The left side of Part 2 shows the geographical shares of world Textiles imports by demand type. In contrast with Electronics and Machinery, Textiles imports from China and East Asia account for a much reduced share (12.7% = 3.7%+9%) of world imports. These two regions hold similar weights (around 8% each) in world intermediates imports but differ in final demand due to China's extremely low private consumption (less than 1%) and negligible investment in the world. Private households from the U.S. explain 22.7% of world imports.

ROW, being a region comprised of a mixture of many countries, shows a pretty high weight in the world imports of Textiles in every component of final and intermediate demand.

The right side of Part 1 shows how each region allocates its domestic output. As happened in Machinery, Textiles output in China is largely used as intermediates (54.5%) and exports (34.4%), while again only small quantities are devoted to private consumption. With a high share of private demand (46.4%) and very low exports (7.5%), the U.S. pattern contrasts with the Chinese one. East Asia devotes a higher share than usual to private consumption (32.9%), but devotes more to intermediates (35.9%). ROW exhibits a rather similar pattern to the one of East Asia but the latter is slightly more specialized in intermediates' production and ROW in production for private consumption. The right side of Part 2 reflects the geographical shares of world production of Textiles. China takes up 10% of world production for private consumption, while the U.S. accounts for 17.6%. China again shows nearly zero world production devoted to investment, while the U.S. and ROW lie ahead, taking up 37.1% and 40.1%, respectively. In terms of the weights of exports and intermediates in the world, China exhibits the highest importance if we do not consider ROW. Looking at Part 2 as a whole, China takes up only 3.7% of world textile imports but 27.9% of world output as shown in the last column of this part. This means that domestic demand for textiles in China is mostly satisfied by national production (93.2%)[6]. The imported goods mainly serve as intermediates in China in contrast to their use as private consumption in the rest of regions considered.

Overall, China accounts for 28% of world output and 30.7% of world exports in Textiles. These percentages are higher than the ones exhibited in Electronics and Machinery. As in the two former sectors, China still relies on the imported intermediates coming mainly from East Asia (again we find evidence for production networks), while the U.S. and ROW are its main export markets (Part 3 of Table 9).

[6] This can also be seen in the column of "Import percentage of domestic consumption" in Table 1, with 6.8% in Textiles.

3. The model and simulation

Mathiesen (1985) has expressed an Arrow-Debreu general equilibrium model in a compact and efficient way. Equilibrium is defined by three types of equations: market clearance (i.e., supply equals demand for all goods and factors), income balance (i.e., net income equals net expenditure) and zero profits (i.e., cost of inputs equals the value of outputs). Rutherford (2005) uses Mathiesen's approach for the setup of the GTAPinGAMS model. It is the version in the software GAMS of the well-known GTAP model created by Hertel (1997). The GTAP model is able to reflect the world economy using input-output information, detailed foreign trade data, as well as, a rich set of data from national accounts of the different regions. All data are homogenized in the GTAP database (Narayanan et al., 2012). Latorre (2010, Chapter 3) offers a very detailed explanation of the GAMS version, while a more succinct one is available in Latorre et al. (2009).

In the mathematical form, Rutherford's model is derived from maximizing a series of nonlinear equations using a dual approach (Dixit and Norman, 1980). Thus, microeconomic optimization reflects the adjustments to the shocks introduced in the model. The adjustment is also consistent with the macroeconomic framework embedded in the national accounts identities present in the model. The whole set of equations of the model appear in appendix 1, which includes illustrative figures of the trees with their mathematical functional forms.

The shock we run consists of a simultaneous increase in the capital stock of the Chinese sectors of Electronics, Machinery and Textiles. According to the National Bureau of Statistics of China (various years), the accumulated FDI inflow in Electronics has more than doubled during the period of 2004—2011[7], the increase was of 50% in Machinery and of 30% in Textiles. Thus, we simulate a shock of the corresponding capital stock increases in the three sectors simultaneously, meanwhile the capital stock in rest sectors and regions

[7] The exact source is the 'Investment in Fixed Assets in Urban Area By Sector, Jurisdiction of Management and Registration Status' from National Bureau of China Statistics (various years). Due to the lack of detailed FDI stock data and FDI flows across sectors, we take the "fixed assets investment funded by foreign capitals" as a proxy for the foreign fixed assets. The latter takes into account the capital invested in China by all foreign firms across the world, including firms from Hong Kong, Taiwan, and Macao.

remains fixed. We are interested in how the accumulation of FDI reshapes the trade divisions within East Asia, as well as, the impacts for the U.S. and ROW.

After the shock, factor remunerations will be changed. Then the sectors will readjust their factor inputs, intermediate inputs, prices and production. This further has an impact on the regional income, domestic consumption and exports in the host country. Through the trade links and production networks, this shock is transmitted to rest of regions. As a result, they will change the production, imports, and exports. According to the above analyzed contrasting characteristics of these three sectors, we expect that their subsequent adjustments will differ.

4. Results

4.1. Aggregate results

As shown in Table 5, after the simulation China has benefited from the FDI inflows according to the rise of GDP (2.1%) and national income and welfare (9.6%)[8], which are mainly related to the increase of the capital stock. The aggregate skilled wages are pushed up by 1.9%. By contrast, the unskilled wages and capital rents are pulled down in China, 0.7% and 1.6%, respectively, resulting from the shrink of labor input and the large decrease of capital rent in the sectors receiving FDI. Note that these evolutions of factors remunerations are intuitive since one would expect a higher complementarity between foreign capital and skilled labor so that the entry of capital raises skilled labor remuneration. On the other hand, the fall in the wage of unskilled labor would match its smaller complementarity with capital. Further, capital accumulation pushes down its rent and this is also consistent with an increase in the competition climate brought about by the increase in FDI.

[8] Note that in GTAPinGAMS the increase in national income is equal to the increase in real private consumption, which, in turn, can be used as a proxy for the variation of the country's welfare. For more details on this see Hertel (1997, chapter 1) or Latorre (2010, chapter 3).

The impact of this shock, initially involving only three sectors, is negligible in the rest of regions at this aggregate level. However, East Asia seems slightly more affected, experiencing a very small contraction.

4.2. Sectoral output, prices and specific factor prices

FDI inflows in China will result in a decrease of capital and skilled labor remunerations in the sectors directly involved in the shock, which, in turn, will push down their prices and increase their production (Table 6). The scope of the reductions in skilled labor and capital remunerations, as well as, the subsequent reductions in prices and output increases follow the relative importance of the amount of FDI inflows received. Recall that FDI inflows are much higher in Electronics (100%) than in Machinery (50%), followed by Textiles (30%). Besides, there is a substitution effect between new foreign capital and unskilled labor, so that capital crowds out unskilled labor in Textiles, Machinery and Electronics. Unskilled labor is then reallocated throughout the rest of sectors in the economy. Those sectors (not receiving FDI) that increase production do so because they employ more unskilled labor, since capital and skilled labor are sector specific. When more unskilled labor is accumulated, skilled labor and capital become relatively less abundant in the sectors (not receiving FDI) that produce more, thus increasing their productivity and remuneration.

The outputs of Electronics and Machinery in the rest of regions are crowded out by their large expansion in China and the much cheaper Chinese prices. As a result, output has contracted noticeably for Electronics (ranging from 2.8% fall in East Asia to a 5.3% decrease in the U.S.) and moderately in Machinery (with around 1% to 1.5% reductions). By contrast, the output of Textiles remains unchanged since the shock on Textiles in China is weak to affect the rest of regions. Further, Textiles is much more oriented to private consumption than Electronics or Machinery. Therefore, following a drastic increase in national income and demand of 9.6% (Table 5), Textiles production will tend to satisfy this prevailing force. Returns on capital and skilled wages are affected negatively in Electronics and Machinery for East Asia, the U.S and ROW, while they go up in the case of Textiles.

This seems to be the result from the reduction (increase) of output in the first two sectors (Textiles) which carries a reduction of (an increase in) the demand for factor inputs.

4.3. Comparing the evolution of trade patterns

Tables 7, 8 and 9 offer a broad panorama about the main geographical partners in bilateral trade of each of the four regions in the sectors of Electronics, Machinery and Textiles, respectively. In particular, they present detailed information on bilateral exports (in Parts 1 and 2), imports (Part 3), as well as, import prices (Part 4). This is a valuable complement to the Tables 2, 3 and 4, which provide information on each region's production and imports putting them in relationship with macroeconomic variables from the demand side of the economy (private and public consumption, Investment, intermediates and exports.).

4.3.1. Chinese exports

Chinese exports of Electronics have increased by 29.4% after the FDI inflow (Part 1 of Table 7). This figure is very close to the expansion rate of output (30.2%). Given that Electronics is very export oriented, the increase in output will be primarily allocated to exports. The difference of exports between the simulation and the benchmark (labeled as "difference" in Part 1 of Table 7), shows that the U.S. and ROW absorb the majority of the increase in Chinese exports. Indeed they are the main markets of China (Part 2 of Table 7), accounting for 81% (32.4% + 48.7%) of its exports in the benchmark. Chinese exports crowd out other suppliers and gain substantially in the world export market as a big source of Electronics. As reflected in Part 3 of Table 7, it raises the share in its trade partners' import structures and crowds out other suppliers' shares. An important force contributing to the heavy increase in exports is the large fall in the price of Chinese Electronics goods (Part 4 of Table 7).

After the shock, the Machinery sector in China expands its overall exports by 19.6% (Part 1 of Table 8), exceeding by far the expansion rate (9.6%) of output. Machinery allocates more output to exports than Electronics because the Machinery intermediates are extensively used across sectors rather than intensively for its own production as Electronics

does (Figure 6)[9]. As a consequence, the extra intermediate demand caused by the increase in its own output is smaller in Machinery than in Electronics, so more production is exported in Machinery. As happened in Electronics, the U.S. and ROW are the biggest markets of China (together they explain 79.6% (23.8% + 55.8%) of overall exports in the benchmark. That is why they absorb the majority of the increased exports of China after the shock (see the "difference" in absolute value terms). And again, similarly to the Electronics case, though less intensively, output and exports in the rest of regions are crowded out (Part 3 of Table 8). Machinery goods also experience an important fall in prices in China, thus enhancing its competitiveness, even though the fall is less pronounced than in Electronics (Part 4 of Table 8).

Textiles is distinct from the two other sectors because it is more private-consumption oriented. Because FDI inflows increase national income and demand in China, Textiles exports go down by 1.2% (Part 1, Table 9) despite of its production expansion (2.4%). Part 3 also reflects the fall in the weight of China in the import structure of the rest of regions. On the other hand, the fall in the output price of Chinese Textiles is milder than in the case of Electronics or Machinery (Part 4, Table 9).

Looking at the export structure of China across Part 2 of Tables 7, 8 and 9, we find that it basically remains stable, especially in Textiles. China expands the exports to all the partners relative to their weight in its exports, largely revealing the underlying collaboration and division in production and demand among them. In short, in Electronics and Machinery exports are enlarged while Textiles exports are reduced when the three sectors receive FDI flows and expand their output.

4.3.2. Chinese imports

We reorganize the same information on exports that appears Tables 7, 8, and 9 in a different manner with the purpose of making easier the analysis of imports. Table 10 displays imports values in the benchmark and simulation, as well as, the percentage and value (in billions of dollars) change after the shock. This calculation is based on the

[9] Figure 6 presents the input-output structure of Machinery, Electronics and Textiles in China.

absolute numbers shown in Part 1 of Tables 7, 8 and 9. Therefore, the overall Electronics imports of China are the sum of the Electronics exports from the rest of regions to China.

Chinese overall imports of Electronics increase by 9.9% (Table 10). As a destination of Electronics exports from other regions, China becomes more important, since its domestic consumption of Electronics —private consumption, capital formation and intermediates, relies heavily (48.2% in Table 1) on imports. In particular, the intermediate demand for Electronics imports has largely pushed up the overall import demand. Indeed, intermediates account for 84.5% of overall imports and they are very intensively used in Electronics production, which expands after the FDI inflow[10]. The biggest increase of Chinese imports comes from East Asia. This region, which is highly integrated with China in the Electronics production networks, provides 60% of Chinese overall imports (Part 3, Table 7). Thus, after the shock East Asia strengthens its export ties with China as an important intermediate supplier. One interesting phenomenon is that even though domestic output price is cheaper than imported ones (Part 4 of Table 7), China still enlarges the imports from other regions.

Unlike the increase of Electronics imports, overall imports of Machinery shrink by 4% (Table 10). The overall import demand is mainly pulled down by the decreasing investment demand. As mentioned above, Machinery relies less on its own imported intermediates in its production process than Electronics does (Figure 6). Therefore, the increase in production in Machinery does result in a relatively smaller increase in demand for imported Machinery intermediates compared to the case of Electronics. Further, domestic output price is much cheaper than the imported one (Part 4 of Table 8) and all the sectors substitute imports with domestic production. East Asia suffers the biggest decrease of Chinese imports, in absolute value, because it supplies 59.2% for Chinese imports and serves as an import intermediate supplier. Nevertheless, comparing the import structure of China before and after shock, East Asian weight grows up a bit due to the overall reduction of Chinese Machinery imports.

[10] The intense use of imported intermediates in the production of Electronics, which is higher than their use in Machinery or Textiles, can be well related to the more important presence of multinationals in the former sector. This finding is common to other previous studies (e.g., Latorre, 2012; Latorre, 2013).

More surprisingly, China enlarges its overall Textiles imports by 4.4% from the rest of regions (Table 10). This is twice the increase experienced in the production of Textiles after the FDI shock. This means that the big increase of national income (9.6%) further pushes up private consumption of Textiles which, in turn, increases the demand for their imports. East Asia, as the biggest supplier (60.4%) of Chinese imports, experiences the biggest increase of exports to China, in absolute value; while ROW, due to a smaller benchmark value, undergoes the biggest percent increase of exports to China.

Looking at the import structures of China (Part 3 of Table 7, 8, and 9), as happened with the Chinese export structure, they basically do not change. The main collaboration and division trends with the rest of regions remain. East Asia is the main provider of Chinese imports before and after the shock. It accounts for around 60-65% of them.

4.3.3. Exports of the rest of regions

Let us analyze the differences between the benchmark value of exports and their simulation values (Part 1, Tables 7, 8 and 9). If we want to compare the impact on exports across regions, we should compare the evolution of the difference between the simulation and benchmark values (not the percentages changes). In this sense, East Asia loses, decreasing its exports of Electronics (-11.6 billion of dollars, Part 1 of Table 7) and Machinery (-5.7 billion, Part 1 of Table 8). Even though East Asia exports a bit more of Textiles, the impact is very small, compared to the falls experienced in Machinery and Electronics. The U.S. loses more in its Electronics exports (-7.8 billion of dollars compared to -5.5 billion in Machinery). For both East Asia and the U.S. the most important cause of losses is the fall in exports to ROW. However, their losses are more important in Electronics than in Machinery because Chinese exports are more competitive in the former sector. In the case of ROW, by contrast, the largest falls in exports arise in the Machinery sector. ROW exports more volume of Machinery than Electronics and the associated losses are larger.

Even though all the rest of regions, apart from China, increase their exports of Textiles, the values involved are so small that they do not make up for the above commented losses that all of them experience in Electronics or Machinery.

4.3.4. Imports of the rest of regions

In Electronics, total imports of all regions increase after the shock, as reflected in Table 10. China and East Asia become more integrated since the Electronics imports from China (probably more of the intermediates) increase. Imports of the U.S. and ROW also increase. In the latter case, probably the exports are mainly final goods[11].

A similar pattern arises in Machinery. The U.S. and ROW increase their imports. East Asia also increases its imports although less intensively. Note that the U.S., both in Electronics and Machinery, increase its overall imports more intensively than ROW. This may come as a surprise given that ROW is by far a more important trade partner for both China and East Asia. It seems that even through China increases its exports more heavily to ROW (Part 1 in Table 7 and 8, Table 10), there is a substitution effect in the interregional trade flows in the regions of ROW, so that previous imports among ROW regions are now displaced by Chinese exports, resulting in a reduction of imports within the ROW region. Total trade within that region is reduced. These results would therefore support the triangular trade pattern between China, East Asia and the U.S. (Gaulier et al., 2007a; Inomata and Uchida, 2009).

Again the Textiles pattern differs drastically from the two previous ones. Due to the reduction of Chinese exports after the shock, the rest of regions increase their exports, we now also see that they reduce their imports. Only China, which experiences an important increase in private consumption, increases its imports demand for Textiles.

[11] Part 3 of Tables 7, 8 and 9 reflect that for the U.S. and ROW, China is not the main provider of imports. Indeed, it is ROW the region that weights more as an import source both for the U.S. and ROW. This contrasts with the importance of the U.S. and ROW as markets for the Chinese economy (Part 2 of Tables 7, 8 and 9). The two former regions account for around 80% of total Chinese exports in the 3 sectors considered. China is, however, more integrated with East Asia if we look at the data from the point of view of East Asia. China, indeed, exhibits a much higher weight in East Asian geographical structure than it does in the ones from the U.S. and ROW.

5. Sensitivity analysis

To examine the robustness of the results, we change the values of two crucial elasticities in the model: 1) the elasticity of substitution between imports and domestic production (i.e. the Armington elasticity); 2) the elasticity of substitution between labor and capital. We carry out an Unconditional Systematic Sensitivity Analysis (Harrison et al. 1993), in which we halve and double each one of the two types of elasticities in all of the fifteen sectors in China, while keeping the rest of elasticities at their benchmark value. Then we compare the results for the aggregate and sectoral variables which have been analyzed above.

Table 11 shows the results of the aggregate variables, in a structure analogous to that of Table 5. The columns of "double" and "half" list the results obtained when each of the elasticities are multiplied or divided by two, respectively. There are not significant differences in the aggregate variables compared to our previous results. Slightly bigger differences occur in the percent change of capital rent and skilled wage in China in the case of changing the elasticity of substitution between labor and capital. A bigger elasticity of substitution among factors conveys a more flexible production technology. This implies that the adjustments in factors remunerations are milder (more intense) with higher (lower) elasticities of substitution among factors. In general, the more elastic the substitution, the bigger the increase of GDP, since factors and goods can be more easily reallocated across sectors which helps the economy to become more efficient.

Table 12 shows us the Chinese trade patterns in the simulation previously run and those obtained with the new values of the elasticities. We omit the trade patterns for the rest of regions, due to the very small changes found after the sensitivity test. The overall trade pattern in China remains unchanged. East Asia is still the main supplier of Chinese imports while the U.S. and ROW are the biggest markets for Chinese exports. The different values of the elasticities have a small impact on Chinese exports. The less elastic the substitution elasticities, the higher the Chinese exports. In the case of lower elasticity of substitution among factors of production, the less flexible technology results in a larger amount of unskilled labor being employed in the sectors receiving the FDI shock. As a consequence,

their production will be larger and their prices lower. Therefore, Chinese exports become more competitive and expand more in the world market. In the case of lower substitution between imported and domestic goods, there is higher rigidity in the domestic demand for final consumption even though the domestic price is relatively cheaper. Thus, more domestic goods will be exported after the output expansion.

All in all, we find that our results are robust, since the causation chain found remains unchanged.

6. Conclusions

This Chapter analyzes how FDI accruing to Electronics, Machinery and Textiles in China affects the bilateral trade patterns among China itself, East Asia, the U.S. and ROW. We use a (3-factor 4-region 15-sector) CGE model that allows us to capture the demand and production side, as well as, the production networks and final demand roles of the different geographical areas.

Though we focus only on Electronics, Machinery and Textiles, we are, in fact, analyzing 55.4% and 40% of overall Chinese exports and imports, respectively, and 13.6% of Chinese GDP. We find that China has benefited from the FDI inflow according to the rise of GDP (2.1%) and welfare (9.6%, proxied by national income). The scope of the reductions in skilled labor and capital remunerations, as well as, the subsequent reductions in prices and output increases follow the magnitude of FDI inflows each sector has received. Because Electronics is the main recipient of FDI inflows it experiences the most intense fall in prices and increase in production. Next in importance come the adjustments in prices and production in Machinery. Finally, Textiles exhibits the most moderate price decreases and output expansion.

There are 3 characteristics of Chinese trade that stand out from the data. We summarize them as follows:

1. Around 80% of Chinese exports are directed to the U.S. and ROW. ROW is the more important destination accounting for 50% to 60% of total Chinese exports while the U.S. weights around 25% to 30%. Thus, only around 20% of Chinese exports go to East Asia. Note that imports of East Asia from China are mostly intermediates with a rather low weight of private consumption, particularly in Machinery goods. This implies that most of the Chinese exports of final goods are directed to the U.S. and ROW. Therefore, the latter constitute the main final markets of Chinese exports.

2. Chinese imports are mostly intermediates ranging from 68% (in Machinery) to around 85% (in Electronics and Textiles). One of the main challenges of trade statistics nowadays is to combine the dimension of type of good traded and country of origin. While that information might exist for some isolated countries, they are rather uncommon and not available across groups of countries. The information from the GTAP database used in this Chapter, however, provides us with important clues in this regard, as will be seen in the third characteristic.

3. Around 60% of total Chinese imports come from East Asia. As noted above, our data (to the best of our knowledge, no existing data) do not allow knowing simultaneously the country of origin (whether it is East Asia or not) and the type of good from that country of origin (whether it is an intermediate or a final good). But with 80% intermediate imports and 60% being provided by East Asia, it seems reasonable to assume that East Asia is heavily integrated in the Chinese production networks, providing an important amount of intermediates.

The Chinese trade patterns brought about by more FDI and the trade patterns in the rest of regions differ in the three sectors considered. Figure 7 shows a diagram summarizing our main findings. Let us point out here the essence behind them.

After FDI inflows, Chinese exports of Electronics and Machinery increase, while exports of Textiles go down. The U.S. and ROW absorb the majority of the increase in Chinese exports. The contrasting pattern in Textiles seems related to its importance in Chinese

private consumption. With higher FDI inflows, household income and national demand in China increase. More Textiles will be demanded domestically and less will be exported.

On the other hand, after the increase in exports of Electronics and Machinery, production and exports from the rest of regions are crowded out. The important fall in export prices makes Chinese exports very competitive. However, note that China will import more Electronics and less Machinery from the rest of regions after the shock. This contrast arises from the fact that Electronics imports are heavily used for Electronics production which goes up after FDI inflows. In Machinery, though, imported intermediates are used less intensively in production which also expands after the FDI inflows. Finally, the fall in Chinese exports of Textiles results in an increase of Textiles exports across the rest of regions. However, exports of Textiles are smaller in world trade flows than the ones from Machinery and Electronics. Therefore, the increase in Textiles exports falls short to compensate the reduction in exports of Machinery and Electronics that the rest of regions experience.

This analysis confirms and expands the main outcomes from the empirical literature summarized in the introduction using a general equilibrium perspective. There are tight production networks between China and East Asia, while the U.S. and ROW are their main final markets. Taking those geographical patterns into account together with the particular production technologies (e.g., the intensity of the use of imported intermediate in production) and the demand orientation (e.g., the private consumption orientation of Textiles) helps to trace the impact of FDI on trade.

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Appendix

Apart from some new parameters, we basically keep the GTAP's notation. Sets *i* and *j* define sectors and commodities; *r* and *s* refer to regions; and *f* denotes factors of production, i.e., unskilled labor, skilled labor and capital. The new parameters are *h* (host economy), which belongs to *r*; *l* (sectors receiving the FDI shock), which is a subset of *i*; and FDI(f, j, r), which is the new overall capital stock index.

Model equations:

Production

$$cf_{jr} = \left(\sum_{f} \theta_{fjr} \left(\overline{p}_{jr}^{f} \right)^{\left(1-\sigma_j^{Lsf}\right)} \right)^{1/\left(1-\sigma_j^{Lsf}\right)} \tag{1}$$

$$ci_{ijr} = \left[\left(\theta_{dijr} \left(\overline{p}_{ijr}^{d} \right)^{\left(1-\sigma_i^{A}\right)} \right) + \left(\left(1-\theta_{dijr}\right) \left(\overline{p}_{ijr}^{m} \right)^{\left(1-\sigma_i^{A}\right)} \right) \right]^{1/\left(1-\sigma_i^{A}\right)} \tag{2}$$

$$c_{jr}^{y} = \left(\sum_{i} \theta_{ijr} ci_{ijr} \right) + \left(\theta_{jr}^{f} cf_{jr} \right) \tag{3}$$

$$c_{jr}^{y} = p_{jr}^{y} (1-t_{jr}^{y}) \tag{4}$$

$$ddfm_{ijr} = vdfm_{ijr}\, Y_{jr} \left(ci_{ijr} \Big/ \overline{p}_{ijr}^{d} \right)^{\sigma_i^{A}} \tag{5}$$

$$difm_{ijr} = vifm_{ijr}\, Y_{jr} \left(ci_{ijr} \Big/ \overline{p}_{ijr}^{m} \right)^{\sigma_i^{A}} \tag{6}$$

$$dfm_{fjr} = vfm_{fjr}\, Y_{jr} \left(cf_{jr} \Big/ \overline{p}_{jr}^{f} \right)^{\sigma_i^{LK}} \tag{7}$$

Remuneration of capital and skilled labor as specific factors

$$p_r^{sf} = \left(\sum_{j} \theta_{jr}^{sf} \left(p_{jr}^{sf} \right)^{(1+\eta)} \right)^{1/(1+\eta)} \tag{8}$$

Public consumption

$$p_{ir}^{g} = \left[\left(\theta_{ir}^{dg} \left(\overline{p}_{ir}^{dg} \right)^{\left(1-\sigma_i^{A}\right)} \right) + \left(\left(1-\theta_{ir}^{dg}\right) \left(\overline{p}_{ir}^{mg} \right)^{\left(1-\sigma_i^{A}\right)} \right) \right]^{1/\left(1-\sigma_i^{A}\right)} \tag{9}$$

$$\sum_{i} \left(\theta_{ir}^{g}\ p_{ir}^{g} \right) = p_r^{G} \tag{10}$$

$$ddgm_{ir} = vdgm_{ir}\ G_r\left(p^g_{ir} \Big/ \overline{p}^{dg}_{ir}\right)^{\sigma^A_i} \tag{11}$$

$$digm_{ir} = vigm_{ir}\ G_r\left(p^g_{ir} \Big/ \overline{p}^{mg}_{ir}\right)^{\sigma^A_i} \tag{12}$$

Private consumption

$$p^c_{ir} = \left[\left(\theta^{dc}_{ir}\left(\overline{p}^{dc}_{ir}\right)^{\left(1-\sigma^A_i\right)}\right) + \left(\left(1-\theta^{dc}_{ir}\right)\left(\overline{p}^{mc}_{ir}\right)^{\left(1-\sigma^A_i\right)}\right)\right]^{1/\left(1-\sigma^A_i\right)} \tag{13}$$

$$\prod_i \left(p^c_{ir}\right)^{\theta^p_{ir}} = p^C_r \tag{14}$$

$$ddpm_{ir} = vdpm_{ir}\ C_r\left(p^c_{ir} \Big/ \overline{p}^{dc}_{ir}\right)^{\sigma^A_i}\left(p^C \Big/ p^c_{ir}\right) \tag{15}$$

$$dipm_{ir} = vipm_{ir}\ C_r\left(p^c_{ir} \Big/ \overline{p}^{mc}_{ir}\right)^{\sigma^A_i}\left(p^C \Big/ p^c_{ir}\right) \tag{16}$$

Imports

$$pm_{isr} = \theta^{ym}_{isr} . \overline{py}^m_{isr} + \sum_j \theta^{tm}_{jisr}\, \overline{pt}^m_{jisr} \tag{17}$$

$$p^M_{ir} = \left(\sum_s \theta^M_{isr}\, pm_{isr}^{\left(1-\sigma^M_i\right)}\right)^{1/\left(1-\sigma^M_i\right)} \tag{18}$$

$$dxmd_{isr} = vxmd_{isr} \times M_{ir} \tag{19}$$

$$dtwr_{jisr} = vtwr_{jisr} \times M_{ir} \tag{20}$$

Transport services

$$\prod_r \left(p^Y_{ir}\right)^{\theta^t_{ir}} = p^T_i$$

$$dst_{jr} = vst_{jr} \times yt_j \times \left(pt_j \Big/ py_{jr}\right) \tag{21}$$

Income balance condition

$$\begin{aligned} raInc_r = vb_r - \left(p^G_r\ \overline{vgm}_r\right) - \sum_i \left(p^Y_{ir}\ \overline{I}_{ir}\right) + \sum_f \left(p^f_r\ evom_{fr}\right) + revt^y_r + revt^L_r + revt^K_r \\ + revt^{fd}_r + revt^{fm}_r + revt^{pd}_r + revt^{pm}_r + revt^{gd}_r + revt^{gm}_r + revt^{xs}_r + revt^{ms}_r \end{aligned} \tag{22}$$

Market clearance equations

$$raInc_r = C_r\ vpm_r\ p^C_r \tag{23}$$

$$G_r = 1 \tag{24}$$

$$Y_{ir}\ vom_{ir} = \sum_j ddfm_{ijr} + ddpm_{ir} + ddgm_{ir} + dxmd_{irs} + dst_{ir} + \bar{I}_{ir} \tag{25}$$

$$M_{ir}\ vim_{ir} = \sum_j difm_{ijr} + dipm_{ir} + digm_{ir} \tag{26}$$

$$YT_j\ vtw_j = \sum_i \sum_s \sum_r dtwr_{jisr} \tag{27}$$

$$evom_{Lr} = \sum_i dfm_{Lir} \tag{28}$$

$$NEWevom_{Kr} = evom_{Kr}\ FT_{Kr} \tag{29*}$$

$$vfm_{Kjr}\ FDI_{Kjr}\left(p^K_{jr} \Big/ p^K_r\right)^{\eta} = dfm_{Kjr} \tag{30*}$$

Endogenous variables:

Production

$difm_{ijr}$	Total demand for the imported intermediate *i* in sector *j* in region *r*
$ddfm_{ijr}$	Total demand for domestic purchases of intermediate *i* in sector *j* in region *r*
dfm_{fir}	Total demand for primary factor *f* in sector *i* in region *r*
$NEWevom_{Kr}$	Value of the capital stock after FDI inflows in region *r*
FT_{Kr}	One plus the percentage change in the capital stock in region *r*
$\bar{p}^f_{jr}$	Tax-inclusive price of factor *f* used in sector *j* in region *r*
$\bar{p}^L_r$	Tax-inclusive wage in region *r*
$\bar{p}^K_{jr}$	Tax-inclusive price of capital in sector *j* in region *r*
$\bar{p}^d_{ijr}$	Tax-inclusive price of the domestically purchased intermediate *i* to be used in sector *j* in region *r*
$\bar{p}^m_{ijr}$	Tax-inclusive price of the imported intermediate *i* to be used in sector *j* in region *r*
p^K_{jr}	Price of capital in sector *j* in region *r*

p_r^K Price of capital, excluding taxes or subsidies, in region *r*

p_{jr}^Y Price of good *j* before taxes

Y_{jr} One plus the percentage change in total gross output in sector *j* in region *r*

Public consumption

$ddgm_{ir}$ Demand for domestic purchases of good *i* for public consumption in region *r*

$digm_{ir}$ Demand for imports of good *i* for public consumption in region *r*

G_r One plus the percentage change in national public consumption in region *r*

$\overline{p}_{ir}^{dg}$ Tax-inclusive price of public consumption of the domestic good *i* in region *r*

$\overline{p}_{ir}^{mg}$ Tax-inclusive price of public consumption of the imported good *i* in region *r*

p_{ir}^g Tax-inclusive price of good *i* for public consumption in region *r*

p_r^G Aggregate price of public consumption in region *r*

Private consumption

$ddpm_{ir}$ Demand for domestic good *i* for private consumption in region *r*

$dipm_{ir}$ Demand for imports of good *i* for private consumption in region *r*

$raInc_r$ Budget available for private consumption of the representative household in region *r*

C_r One plus the percentage change in national private consumption in region *r*

$\overline{p}_{ir}^{dc}$ Tax-inclusive price of private consumption of domestic good *i* in region *r*

$\overline{p}_{ir}^{mc}$ Tax-inclusive price of private consumption of imported good *i* in region *r*

p_{ir}^c Tax-inclusive price of good *i* for private consumption in region *r*

p_r^C Aggregate price of private consumption in region *r*

Imports and transport services

$dxmd_{isr}$ Demand for physical units of imports of good *i* in region *r* coming from region *s*

$dtwr_{jisr}$ Demand for the transport service *j* needed for transport of good *i* from region *s* to region *r*

dst_{ir} Production of good *i* used as a transport service in region *r*

M_{ir} One plus the percentage increase in imports of good *i* in region *r*

pm_{isr} Bilateral import price of region *r* for good *i* from *s*, including transport-service cost

p_{ir}^{M} Price of imports of good *i*, including transport services, in region *r*

$\overline{py}_{isr}^{m}$ Import price in region *r* of physical good *i* coming from region *s*, including export subsidy of region *s*, import tariff of region *r*

$\overline{pt}_{jisr}^{m}$ Price of the transport service *j* for moving good *i* from *s* to *r*, including import tariffs of region *r*

p_{i}^{T} Price of the transportation service *i*

YT_{j} One plus the percentage change in the world production of the international transport service *j*

Taxes and subsidies

$revt_{r}^{y}$ Total payments of subsidies on output in region *r*

$revt_{r}^{f}$ Total income from taxes on primary factors in region *r*

$revt_{r}^{fd}$ Total income from taxes on domestic intermediates in region *r*

$revt_{r}^{fm}$ Total income from taxes on imported intermediates in region *r*

$revt_{r}^{pd}$ Total income from taxes on private consumption of domestic goods in region *r*

$revt_{r}^{pm}$ Total income from taxes on private consumption of imported goods in region *r*

$revt_{r}^{gd}$ Total income from taxes on public consumption of domestic goods in region *r*

$revt_{r}^{gm}$ Total income from taxes on public consumption of imported goods in region *r*

$revt_{r}^{xs}$ Total payments of subsidies on exports in region *r*

$revt_{r}^{ms}$ Total income from tariffs on imports in region *r*

Exogenous variables and parameters:

Production

$evom_{fr}$ Total endowment of factor *f* in region *r*

θ_{fjr} Share of the factor *f* in value in sector *j* in region *r*

θ_{dijr} Share of the domestic intermediate input *i* in its total use in sector *j* in region *r*

θ_{ijr} Share of the intermediate input *i* (domestic plus imported) in gross production in sector *j*

θ_{jr}^{f} Share of value added in gross production in sector *j* in region *r*

θ_{jr}^{sf} Share of specific factor *sf* (skilled labor; capital) employed in sector *j* in region *r*

$vdfm_{ijr}$ Benchmark value of the domestic purchases of intermediate *i*, used in sector *j* in region *r*

vfm_{fir} Benchmark value of the demand for the primary factor *f* in sector *j* in region *r*

$vifm_{ijr}$ Benchmark value of the demand for the imported intermediate *i* to be used in sector *j* in region *r*

vom_{ir} Benchmark value of the sectoral gross production in region *r*

Demand

$\bar{I}_{ir}$ Fixed investment expenditure in sector *i* in region *r*

Public consumption

θ_{ir}^{dg} Share of the domestic good *i* in public consumption in region *r*

θ_{ir}^{g} Share of the good *i* in total public consumption in region *r*

$vdgm_{ir}$ Benchmark value of the domestic purchases of good *i* for public consumption in region *r*

$vigm_{ir}$ Benchmark value of the imports of good *i* for public consumption in region *r*

$\overline{vgm}_{r}$ Benchmark value of total (imported plus domestic) national public consumption in region *r*

Private consumption

θ_{ir}^{dc} Share of the domestic good *i* in private consumption in region *r*

θ_{ir}^{p} Share of the good *i* in total private consumption in region *r*

$vdpm_{ir}$ Benchmark value of the domestic purchases of good *i* for private consumption in region *r*

$vipm_{ir}$ Benchmark value of the imports of good *i* for private consumption in region *r*

vpm_{r} Benchmark value of total national private consumption in region *r*

Foreign sector

vb_{r} Current account balance of region *r* in the benchmark

vim_{ir} Benchmark physical volume of imports in sector *i* in region *r*

θ_{isr}^{m} Bilateral import value share (the weight of region *s* in total imported good *i* of region *r*)

Transport services

θ_{isr}^{ym} Share of the amount of physical units of goods (excluding transport services) in imports of region *r*

θ_{jisr}^{tm} Share of the amount of transport service *j* used in imports of good *i* in region *r*

θ_{ir}^{t} Share of the part of production of good *i* devoted to transport services in region *r* in the part of world production of good *i* devoted to transport services

$vxmd_{isr}$ Benchmark amount of physical units of imports of the good *i* in region *r* coming from region *s*

$vtwr_{jisr}$ Benchmark amount of the transport service *j* needed for transport of good *i* from region *s* to region *r*

vst_{jr} Benchmark production of good *j* used as a transport service in region *r*

vtw_{j} Benchmark aggregate of international transport services in sector *j* in the world

Taxes

t_{ijr}^{fd} Tax rate of the domestic intermediates from sector *i* to be used in sector *j* in region *r*

t_{ijr}^{fm} Tax rate of the imported intermediates from sector *i* to be used in sector *j* in region *r*

t_{jr}^{f} Tax rate on the factor *f* used in sector *j* in region *r*

t_{jr}^{y} Output subsidy rate in sector *j* in region *r*

t_{ir}^{gd} Tax rate on the domestic public good *i* purchased domestically in region *r*

t_{ir}^{gm} Tax rate on the imported public good *i* in region *r*

t_{ir}^{pd} Tax rate on the domestic private good *i* purchased domestically in region *r*

t_{ir}^{pm} Tax rate on the imported private good *i* in region *r*

t_{isr}^{ms} Import tariff rate on the good *i* exported from *s* to *r*

t_{isr}^{xs} Export subsidy rate on the good *i* exported from *s* to *r*

Elasticities

σ_i^A Elasticity of substitution between imports and domestic production in sector *i* (Armington elasticity)

σ_i^M Intra-import elasticity of substitution

σ_i^{Lsf} Elasticity of substitution between labor and specific factors in sector *i*

η_{sf} Elasticity of transformation of specific factors across sectors

Simulation parameters

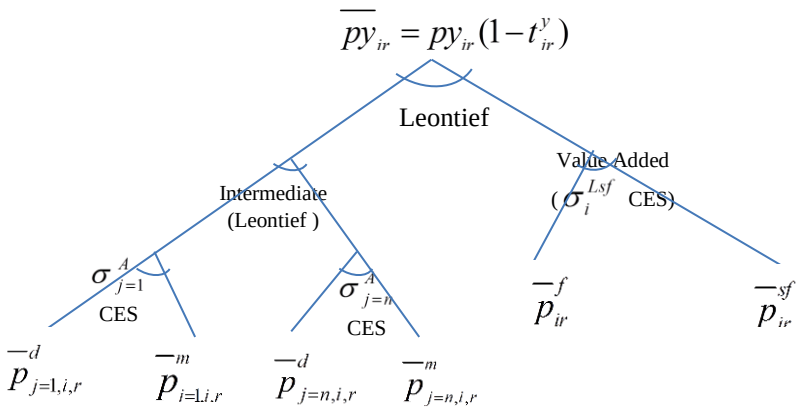
FDI_{Kjr} One plus the percentage increase in the total stock of capital of sector *j* in region *r*

Figures

1. Production

As shown in Figure 1, on the top layer, the production is carried out under a Leontief technology combining a composite of intermediate goods and a composite of primary factors. On the second layer, the composite of intermediate inputs is a Leontief combination of n inputs. In turn, each of these n inputs are a constant elasticity substitution (CES) bundle of domestic and import intermediates. The composite of primary factors is also a CES nesting of sluggish capital, sluggish skilled labor and mobile unskilled labor.

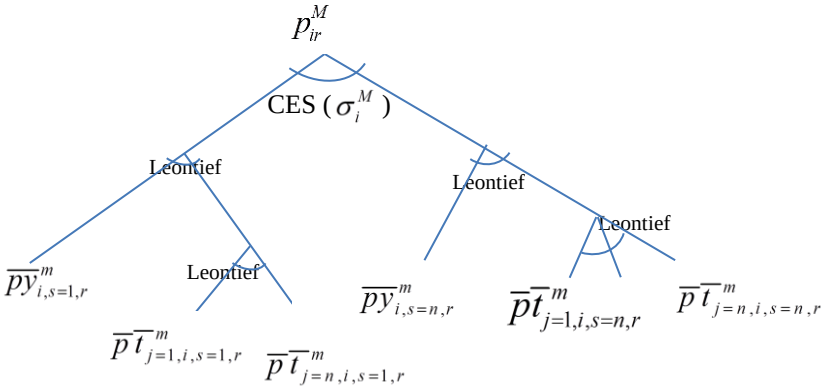
Figure 1 Production function: $Y_{ir} = F_{ir}(ddfm, difm, dfm)$



2. Imports

As can be seen at the top of Figure 2, imports of a particular good *i* are the nested CES aggregation of bundles of imported goods and associated transportation services coming from different regions. At the second layer, transportation services and imports for each regions are combined proportionally (i.e., using a Leontief technology). Trade flows embody export subsidies, paid by government in the exporting region, and import tariffs, collected by government in the importing region.

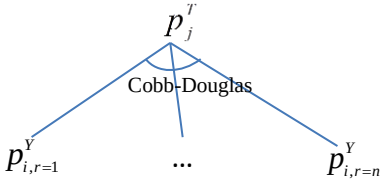
Figure 2 Armington aggregation of imports: $A_{ir}(dxmd, dtwr) = M_{ir}$



3. International transportation services

International transportation is a Cobb-Douglas combination of transport services across the different regions in the world, as shown in figure 3.

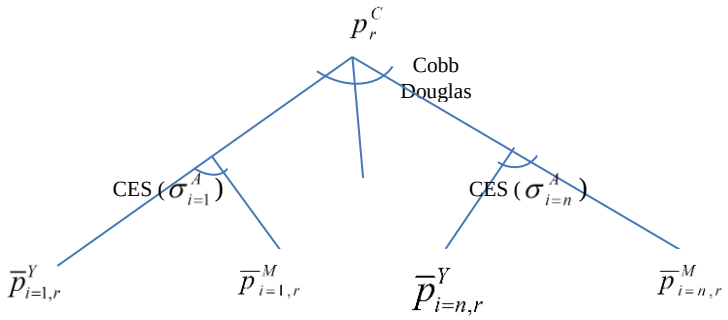
Figure 3: International Transportation Services: $YT_j = T_j(dst)$



4. Private consumption

Private consumption is a Cobb-Douglas function of *i* (*i* =1, …, n) composite goods . Each of those goods are, in turn, Armington composites of its domestic and imported varieties. As shown in figure 4 below.

Figure 4: private consumption $H_r(ddpm, dipm) = C_{ir}$



5. Public consumption

Public consumption is a Leontief combination of *i* (*i* =1, …, n) composite goods, where each composite is an Armington composites of its domestic and imported varieties.

Figure 5: Public consumption $G_r = G_r\left(ddgm_{ir}, digm_{ir}\right)$

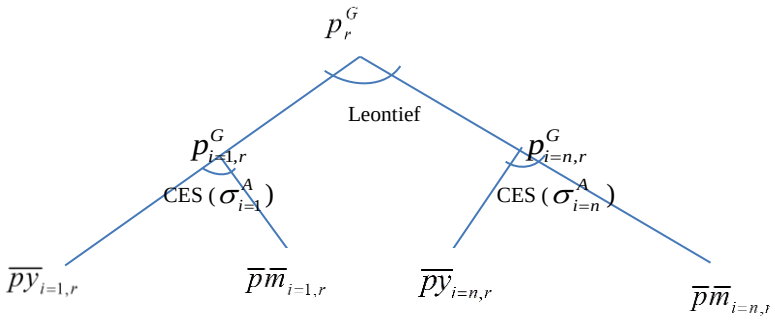


Table 1: Definition of sectors and their relative importance in China

Sector/Goods Definition		Exports % in domestic production	Imports % in domestic consumption	Commodity % in:			Production side (%)				
				Trade		Domestic Demand	% of Production	V.A. % in GDP	% of skilled Labor	% of unskilled Labor	% of Capital
				Exports	Imports	Private consumption					
Agriculture	01~14 Agriculture, hunting and fishing	1.9	5.1	0.9	3.0	12.5	6.4	11.0	0.5	19.7	10.3
Mining	15~18 Mining and quarrying	2.4	34.9	0.5	15.0	0.2	2.9	4.0	1.5	3.4	5.7
Food and Beverage	19~26 Food, beverages and tobacco	5.2	4.7	2.0	1.9	17.6	4.9	3.2	1.8	3.1	2.6
Textiles	**27~29 Textiles, wearing apparel, leather, footwear**	**35.8**	**6.8**	**16.7**	**2.7**	**6.0**	**6.1**	**4.1**	**2.3**	**4.8**	**2.8**
Woods and Paper	30~31 wood without furniture, paper, publishing, media	17.1	7.4	4.1	2.0	0.6	3.1	2.1	1.3	2.7	2.0
Petroleum	32 Petroleum	7.9	9.5	1.7	2.4	2.6	2.8	0.6	0.3	0.5	0.5
Chemicals	33 Chemicals, rubber and plastic products	12.9	22.8	7.2	12.8	2.5	7.2	5.7	2.7	4.3	4.8
Metals	34~37 Mineral products nec, Ferrous metals, metals nec, metal products	9.9	7.3	9.5	8.3	0.6	12.5	7.4	4.5	8.2	8.2
Motor Vehicles	38~39 Motor vehicles and parts, transport equipment nec	11.4	13.4	3.2	4.1	2.4	3.7	2.5	1.5	2.7	1.6
Electronics	**40 Electronic equipment**	**56.3**	**48.2**	**21.8**	**19.4**	**1.9**	**5.0**	**3.0**	**1.7**	**2.7**	**2.5**
Machinery	**41 Machinery and equipment nec**	**24.9**	**23.8**	**16.9**	**17.9**	**2.1**	**8.9**	**6.5**	**3.9**	**6.1**	**5.3**
Other Manufacturing	42 Manufactures nec	39.0	3.9	6.0	0.4	1.4	2.0	2.5	0.6	1.5	4.0
Electricity, Gas and Water	43~45 Electricity; Gas manufacture and distribution; Water	0.6	0.3	0.1	0.1	3.3	2.8	3.4	3.5	2.1	4.5
Construction	46 Construction	0.7	0.5	0.4	0.3	0.9	8.2	6.3	5.2	9.2	4.4
Services	47~57 Services	4.9	4.4	8.9	9.8	45.6	23.5	37.9	68.7	29.0	40.7
Total		13.0	11.5	100	100	100	100	100	100	100	100

Source: Authors' calculations based on GTAP 8 Data Base (Narayanan et al. 2012).

Table 2: Benchmark allocation of production and imports of Electronics (% shares)

Part 1	Total Electronics' imports of each region by demand type (%)					Demand use of production in Electronics in each region (%)					
	Private Consumption	Public Consumption	Investment	Inter-mediate	Total	Private Consumption	Public Consumption	Investment	Inter-mediate	Export	Total
CHN	4.5	0.0	11.0	84.5	100.0	2.3	0.0	5.6	36.7	55.4	100.0
EAS	11.5	0.0	22.2	66.3	100.0	10.2	0.0	13.3	26.9	49.6	100.0
U.S.	20.0	0.0	26.2	53.7	100.0	5.5	0.0	23.8	52.2	18.5	100.0
ROW	14.0	0.9	31.5	53.6	100.0	8.1	0.3	12.2	22.3	57.1	100.0
Part 2	Geographical share of world Electronics imports by demand type (%)					Geographical share of world production of Electronics by demand type (%)					
	Private Consumption	Public Consumption	Investment	Inter-mediate	World Imports	Private Consumption	Public Consumption	Investment	Inter-mediate	Export	World output
CHN	5.2	0.0	6.5	21.5	15.3	6.1	0.0	7.8	23.9	22.1	18.9
EAS	13.2	0.2	13.1	16.8	15.3	39.6	1.8	27.1	11.8	28.8	27.5
U.S.	28.3	0.0	19.1	16.8	18.8	15.0	0.0	34.0	20.6	7.5	19.2
ROW	53.3	99.8	61.4	44.9	50.6	39.3	98.2	31.0	43.7	41.5	34.4
World	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors' calculations based on GTAP 8 Data Base (Narayanan et al. 2012).

Note: CHN represents China; EAS stands for East Asia; ROW is Rest of the world. Due to very low public consumption, we ignore the analysis for it.

Table 3: Benchmark allocation of production and imports of Machinery (% shares)

Part 1	Total Machinery' imports of each region by demand type (%)					Demand use of production in Machinery in each region (%)					
	Private Consumption	Public Consumption	Investment Demand	Inter-mediate	Total	Private Consumption	Public Consumption	Investment Demand	Inter-mediate	Export	Total
CHN	2.7	0.0	29.3	68.0	100.0	2.2	0.0	23.9	49.3	24.7	100.0
EAS	7.4	0.0	35.1	57.5	100.0	2.1	0.0	19.6	28.8	49.5	100.0
U.S.	15.0	0.0	40.3	44.8	100.0	9.3	0.0	31.8	36.5	22.4	100.0
ROW	9.0	0.4	39.1	51.5	100.0	5.5	0.1	18.6	29.4	46.4	100.0
Part 2	Geographical share of world Machinery imports by demand type (%)					Geographical share of world production of Machinery by demand type (%)					
	Private Consumption	Public Consumption	Investment Demand	Inter-mediate	World Imports	Private Consumption	Public Consumption	Investment Demand	Inter-mediate	Export	World output
CHN	2.6	0.0	6.8	11.4	8.8	6.9	0.0	17.8	23.9	10.5	16.5
EAS	7.9	0.0	8.9	10.6	9.7	5.5	0.7	12.3	11.8	17.8	13.9
U.S.	23.2	0.0	14.9	12.0	14.1	34.3	0.0	27.6	20.6	11.1	19.2
ROW	66.4	100.0	69.3	66.0	67.4	53.2	99.3	42.4	43.7	60.6	50.4
World	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors' calculations based on GTAP 8 Data Base (Narayanan et al. 2012).

Table 4: Benchmark allocation of production and imports of Textiles (% shares)

Part 1	Total Textiles' imports of each region by demand type (%)					Demand use of production in Textiles in each region (%)					
	Private Consumption	Public Consumption	Investment Demand	Inter-mediate	Total	Private Consumption	Public Consumption	Investment Demand	Inter-mediate	Export	Total
CHN	13.7	0.0	0.0	86.3	100.0	11.1	0.0	0.0	54.5	34.4	100.0
EAS	60.2	0.0	0.9	38.9	100.0	32.9	0.0	1.6	35.9	29.7	100.0
U.S.	72.7	0.0	0.5	26.8	100.0	46.4	0.0	1.6	44.5	7.5	100.0
ROW	59.0	0.2	0.3	40.5	100.0	36.0	0.2	0.4	28.4	35.0	100.0
Part 2	Geographical share of world Textiles imports by demand type (%)					Geographical share of world production of Textiles by demand type (%)					
	Private Consumption	Public Consumption	Investment Demand	Inter-mediate	World Imports	Private Consumption	Public Consumption	Investment Demand	Inter-mediate	Export	World output
CHN	0.8	0.0	0.0	8.1	3.7	10.4	0.0	0.0	40.0	30.7	27.9
EAS	9.0	0.0	21.2	8.9	9.0	7.9	0.6	22.8	6.8	6.9	7.2
U.S.	22.7	0.0	25.9	12.7	18.7	17.6	0.0	37.1	13.3	2.7	11.4
ROW	67.5	100.0	53.0	70.3	68.6	64.1	99.4	40.1	39.8	59.7	53.4
World	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors' calculations based on GTAP 8 Data Base (Narayanan et al. 2012).

Table 5: Impact on aggregate variables (% change)

Macro indices	China	East Asia	U.S.	Rest of the World
Wage of skilled workers	1.89	-0.43	-0.17	-0.29
Wage of unskilled workers	-0.72	-0.43	-0.13	-0.28
Capital rent	-1.65	-0.41	0.04	0.13
National income (Welfare)	9.62	-0.45	-0.00	-0.19
Capital stock	6.00	0.00	0.00	0.00
GDP	2.07	-0.34	-0.08	-0.06

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al. 2012).

Table 6: Impact on output, prices and specific factors' remunerations (% change)

% change	Output				Price				Sectoral skilled labor price				Sectoral capital remuneration			
	CHN	EAS	U.S.	ROW	CHN	EAS	U.S.	ROW	CHN	EAS	USA	ROW	CHN	EAS	USA	ROW
Agriculture	0.8	0.2	0.2	0.2	3.7	0.7	0.9	0.4	17.5	1.6	2.6	1.3	17.5	1.6	2.6	1.3
Mining	0.0	0.2	0.1	0.1	-2.5	2.1	1.8	1.8	1.5	5.3	3.7	3.4	1.5	5.3	3.7	3.4
Food and Beverage	1.8	-0.1	0.0	0.1	2.3	0.3	0.2	0.1	10.3	-0.7	-0.0	0.1	10.3	-0.7	-0.0	0.1
Textiles	**2.4**	**0.5**	**0.2**	**0.1**	**-4.3**	**0.2**	**0.1**	**-0.0**	**-7.2**	**0.0**	**0.0**	**-0.1**	**-24.7**	**0.0**	**0.0**	**-0.1**
Woods & Paper	-2.9	0.6	0.4	0.5	-0.9	0.4	0.2	0.2	0.6	0.6	0.5	0.8	0.6	0.6	0.5	0.8
Petroleum	1.7	0.1	-0.4	-0.2	-2.1	1.7	1.6	1.4	8.6	-0.3	-1.2	-1.0	8.6	-0.3	-1.2	-1.0
Chemicals	-1.9	0.9	0.4	0.5	-1.5	0.9	0.5	0.4	1.4	1.6	1.0	1.0	1.4	1.6	1.0	1.0
Metals	0.1	1.0	0.6	0.6	-1.0	0.8	0.2	0.4	5.5	1.4	0.8	1.0	5.5	1.4	0.8	1.0
Motor Vehicles	-1.3	0.6	0.3	0.2	-2.2	0.1	-0.0	-0.1	3.3	0.5	0.4	0.2	3.3	0.5	0.4	0.2
Electronics	**30.2**	**-2.8**	**-5.3**	**-3.6**	**-10.5**	**-2.0**	**-2.0**	**-2.6**	**-14.6**	**-6.9**	**-11.2**	**-8.3**	**-50.7**	**-6.9**	**-11.2**	**-8.3**
Machinery	**9.6**	**-1.4**	**-1.0**	**-1.5**	**-7.8**	**-0.8**	**-0.7**	**-0.8**	**-16.0**	**-3.3**	**-2.0**	**-2.9**	**-39.1**	**-3.3**	**-2.0**	**-2.9**
Other manufacturing	-2.0	0.9	1.2	0.6	-2.6	0.4	0.3	0.2	-0.8	0.9	1.4	0.8	-0.8	0.9	1.4	0.8
Electricity, Gas and Water	2.1	-0.0	-0.0	-0.0	0.2	0.3	0.2	0.2	13.1	-0.9	-0.2	-0.2	13.1	-0.9	-0.2	-0.2
Construction	0.1	0.0	-0.0	0.0	-0.7	0.0	-0.0	-0.0	4.8	-0.4	-0.1	-0.1	4.8	-0.4	-0.1	-0.1
Services	2.4	0.1	0.0	0.0	0.3	-0.1	-0.1	-0.1	10.4	-0.3	-0.0	-0.0	10.4	-0.3	-0.0	-0.0

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al. 2012).

Table 7: Impact on bilateral trade in Electronics (absolute values and % change)

Part 1. Export Quantity (benchmark values, simulations values, difference between simulation and benchmark values and % change)																		
Exports	Exports from China to:				Exports from East Asia to:					Exports from the U.S. to:				Exports from ROW to:				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	50.5	86.5	130.1	267.1	114.9	71.6	48.0	123.4	357.9	10.7	20.3	62.0	92.9	64.3	46.5	97.5	306.8	515.0
Simulation	65.8	110.3	169.6	345.6	125.3	65.4	42.9	112.7	346.3	11.4	18.1	55.5	85.1	71.8	43.5	89.1	287.4	491.9
Difference	15.3	23.7	39.5	78.5	10.4	-6.2	-5.1	-10.7	-11.6	0.7	-2.1	-6.4	-7.8	7.6	-3.0	-8.4	-19.3	-23.1
% change	30.3	27.4	30.3	29.4	9.1	-8.7	-10.7	-8.7	-3.2	7.0	-10.5	-10.4	-8.4	11.8	-6.5	-8.6	-6.3	-4.5
Part 2. Regions' shares in exports at FOB price in the benchmark, in the simulation and the difference in % points																		
Regions' shares in Exports	Exports from China to:				Exports from East Asia to:					Exports from the U.S. to:				Exports from ROW to:				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	18.9	32.4	48.7	100.0	32.0	20.0	13.4	34.6	100.0	11.5	21.8	66.7	100.0	12.5	9.1	19.1	59.4	100.0
Simulation	19.0	31.9	49.1	100.0	36.1	18.8	12.4	32.6	100.0	13.4	21.3	65.2	100.0	14.6	8.9	18.2	58.3	100.0
Difference	0.1	-0.5	0.4	0.0	4.1	-1.1	-1.0	-1.9	0.0	1.9	-0.5	-1.4	0.0	2.1	-0.2	-0.8	-1.1	0.0
Part 3. Regions' shares in imports at CIF price in the benchmark, in the simulation and the difference in % points																		
Regions' shares in Imports	Imports of China by source				Imports of East Asia by source					Imports of the U.S. by source				Imports of ROW by source				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	60.4	5.7	33.9	100.0	27.4	37.5	10.7	24.5	100.0	38.0	20.4	41.6	100.0	21.5	19.7	9.9	48.8	100.0
Simulation	60.0	5.5	34.4	100.0	34.0	33.9	9.5	22.6	100.0	45.3	17.7	37.0	100.0	27.0	18.1	9.0	45.9	100.0
Difference	-0.4	-0.1	0.5	0.0	6.6	-3.6	-1.2	-1.9	-0.0	7.3	-2.6	-4.7	0.0	5.6	-1.6	-1.0	-3.0	0.0
Part 4. % change of bilateral import price (PM) and output price of Electronics (PY)																		
Prices	bilateral PM of China, from			PY_	bilateral PM of East Asia, from				PY_	bilateral PM of U.S., from			PY_	bilateral PM of ROW, from				PY_
	EAS	U.S.	ROW	CHN	CHN	EAS	U.S.	ROW	EAS	CHN	EAS	ROW	U.S.	CHN	EAS	U.S.	ROW	ROW
% change	-5.9	-6.0	-6.1	-10.5	-6.7	-2.0	-2.1	-2.3	-2.0	-6.5	-1.8	-2.1	-2.0	-6.9	-2.3	-2.4	-2.5	-2.6

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al. 2012).

Note: The export quantity is in billions of dollars. It does not include any subsidy on the exports neither the transport margin.

Table 8: Impact on bilateral trade in Machinery (absolute values and % change)

Part 1. Export Quantity (benchmark values, simulations values, difference between simulation and benchmark values and % change)																		
Exports	Exports from China to:				Exports from East Asia to:					Exports from the U.S. to:				Exports from ROW to:				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	42.2	49.0	115.0	206.2	101.6	52.6	59.9	146.6	360.7	15.8	35.8	173.5	225.0	53.8	64.1	178.0	931.0	1227.0
Simulation	49.4	58.5	138.7	246.5	98.3	50.9	59.2	146.6	355.0	15.0	34.1	170.5	219.5	51.0	60.8	172.7	912.8	1197.3
Difference	7.2	9.5	23.7	40.3	-3.3	-1.7	-0.6	-0.1	-5.7	-0.8	-1.7	-3.0	-5.5	-2.8	-3.3	-5.4	-18.2	-29.7
% change	17.0	19.4	20.6	19.6	-3.3	-3.2	-1.0	-0.0	-1.6	-5.0	-4.9	-1.7	-2.4	-5.2	-5.2	-3.0	-2.0	-2.4
Part 2. Regions' shares in exports at FOB price in the benchmark, in the simulation and the difference in % points																		
Regions' shares in Exports	Exports from China to:				Exports from East Asia to:					Exports from the U.S. to:				Exports from ROW to:				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	20.3	23.8	55.8	100.0	28.1	14.6	16.6	40.7	100.0	7.0	15.9	77.1	100.0	4.4	5.3	14.6	75.7	100.0
Simulation	19.9	23.8	56.3	100.0	27.6	14.3	16.7	41.4	100.0	6.8	15.5	77.6	100.0	4.3	5.1	14.6	76.0	100.0
Difference	-0.4	-0.0	0.5	0.0	-0.5	-0.2	0.1	0.6	0.0	-0.2	-0.4	0.6	0.0	-0.1	-0.1	-0.1	0.4	0.0
Part 3. Regions' shares in imports at CIF price in the benchmark, in the simulation and the difference in % points																		
Regions' shares in Imports	Imports of China by source				Imports of East Asia by source					Imports of the U.S. by source				Imports of ROW by source				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	59.2	9.2	31.5	100.0	22.3	26.7	18.2	32.7	100.0	17.7	20.6	61.6	100.0	8.8	10.8	12.7	67.7	100.0
Simulation	59.6	9.2	31.2	100.0	25.6	25.9	17.4	31.1	100.0	20.4	20.2	59.3	100.0	10.4	10.7	12.5	66.4	100.0
Difference	0.4	-0.1	-0.3	0.0	3.2	-0.8	-0.8	-1.6	0.0	2.7	-0.4	-2.3	0.0	1.6	-0.0	-0.2	-1.3	0
Part 4. % change of bilateral import price (PM) and output price of Machinery (PY)																		
Prices	bilateral PM of China, from			PY_	bilateral PM of East Asia, from				PY_	bilateral PM of the U.S., from			PY_	bilateral PM of ROW, from				PY_
	EAS	U.S.	ROW	CHN	CHN	EAS	U.S.	ROW	EAS	CHN	EAS	ROW	U.S.	CHN	EAS	U.S.	ROW	ROW
% change	-5.5	-5.3	-5.2	-7.8	-3.0	-0.7	-0.5	-0.5	-0.8	-3.2	-0.9	-0.6	-0.7	-3.3	-1.0	-0.8	-0.8	-0.8

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al. 2012).
Note: The export quantity is in billions of dollars. It does not include any subsidy on the exports neither the transport margin.

Table 9: Impact on bilateral trade in Textiles (absolute values and % change)

Part 1. Export Quantity (benchmark values, simulations values, difference between simulation and benchmark values and % change)																		
Exports	Exports from China to:				Exports from East Asia to:					Exports from the U.S. to:				Exports from ROW to:				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	37.7	36.8	111.9	186.4	16.3	4.4	6.5	19.7	46.9	1.2	1.5	16.0	18.7	7.6	16.1	68.4	315.8	408.0
Simulation	37.3	36.4	110.5	184.2	17.1	4.5	6.5	19.8	47.8	1.2	1.5	16.0	18.8	8.0	16.2	68.6	316.4	409.2
Difference	-0.4	-0.4	-1.4	-2.2	0.7	0.0	0.0	0.0	0.8	0.0	0.0	0.1	0.1	0.3	0.1	0.2	0.6	1.2
% change	-1.1	-1.1	-1.3	-1.2	4.5	0.4	0.4	0.3	1.8	4.6	0.5	0.3	0.6	4.4	0.3	0.3	0.2	0.3
Part 2. Regions' shares in exports at FOB price in the benchmark, in the simulation and the difference in % points																		
Regions' shares in Exports	Exports from China to:				Exports from East Asia to:					Exports from the U.S. to:				Exports from ROW to:				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	18.6	23.6	57.8	100.0	34.6	9.4	13.7	42.2	100.0	6.3	7.9	85.9	100.0	1.9	4.0	16.9	77.2	100.0
Simulation	18.6	23.6	57.8	100.0	35.6	9.3	13.5	41.6	100.0	6.5	7.9	85.6	100.0	2.0	4.0	16.9	77.1	100.0
Difference	0.0	0.0	-0.0	0.0	0.9	-0.1	-0.2	-0.6	0.0	0.2	-0.0	-0.2	0.0	0.1	0.0	0.0	-0.1	0.0
Part 3. Regions' shares in imports at CIF price in the benchmark, in the simulation and the difference in % points																		
Regions' shares in Imports	Imports of China by source				Imports of East Asia by source					Imports of the U.S. by source				Imports of ROW by source				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	64.9	4.6	30.5	100.0	64.0	7.3	2.4	26.3	100.0	40.0	5.2	54.8	100.0	26.0	4.3	3.4	66.3	100.0
Simulation	64.9	4.6	30.4	100.0	63.7	7.3	2.4	26.5	100.0	39.7	5.2	55.1	100.0	25.8	4.3	3.4	66.5	100.0
Difference	0.0	0.0	-0.0	0.0	-0.3	0.1	0.0	0.2	0.0	-0.3	0.0	0.3	0.0	-0.2	0.0	0.0	0.2	0.0
Part 4. % change of bilateral import price (PM) and output price of Textiles (PY)																		
Prices	bilateral PM of China, from			PY_	bilateral PM of East Asia, from				PY_	bilateral PM of the U.S., from			PY_	bilateral PM of ROW, from				PY_
	EAS	U.S.	ROW	CHN	CHN	EAS	U.S.	ROW	EAS	CHN	EAS	ROW	U.S.	CHN	EAS	U.S.	ROW	ROW
% change	-4.5	-4.5	-4.5	-4.3	0.5	0.3	0.2	0.3	0.2	0.3	0.1	0.1	0.1	0.2	-0.0	-0.0	-0.0	-0.0

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al. 2012).
Note: The export quantity is in billions of dollars. It does not include any subsidy on the exports neither the transport margin.

Table 10: Impact on bilateral imports in Electronics, Machinery and Textiles (absolute values and % change)

Electronics	Imports of China from:				Imports of East Asia from:					Imports of the U.S. from:				Imports of ROW from				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	114.9	10.7	64.3	189.8	50.5	71.6	20.3	46.5	188.9	86.5	71.6	97.5	255.6	130.1	123.4	62.0	306.8	622.3
Simulation	125.3	11.4	71.8	208.6	65.8	65.4	18.1	43.5	192.7	110.3	65.4	89.1	264.8	169.6	112.7	55.5	287.4	625.3
Difference	10.4	0.7	7.6	18.8	15.3	-6.2	-2.1	-3.0	3.9	23.7	-6.2	-8.4	9.1	39.5	-10.7	-6.4	-19.3	3.0
% change	9.1	7.0	11.8	9.9	30.3	-8.7	-10.5	-6.5	2.0	27.4	-8.7	-8.6	3.6	30.3	-8.7	-10.4	-6.3	0.5
Machinery	Imports of China from:				Imports of East Asia from:					Imports of the U.S. from:				Imports of ROW from				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	101.6	15.8	53.8	171.2	42.2	52.6	35.8	64.1	194.7	49.0	52.6	178.0	279.6	115.0	146.6	173.5	931.0	1366.1
Simulation	98.3	15.0	51.0	164.3	49.4	50.9	34.1	60.8	195.2	58.5	50.9	172.7	282.0	138.7	146.6	170.5	912.8	1368.5
Difference	-3.3	-0.8	-2.8	-6.9	7.2	-1.7	-1.7	-3.3	0.4	9.5	-1.7	-5.4	2.4	23.7	-0.1	-3.0	-18.2	2.4
% change	-3.3	-5.0	-5.2	-4.0	17.0	-3.2	-4.9	-5.2	0.2	19.4	-3.2	-3.0	0.9	20.6	-0.0	-1.7	-2.0	0.2
Textiles	Imports of China from:				Imports of East Asia from:					Imports of the U.S. from:				Imports of ROW from				
	EAS	U.S.	ROW	Total	CHN	EAS	U.S.	ROW	Total	CHN	EAS	ROW	Total	CHN	EAS	U.S.	ROW	Total
Benchmark	16.3	1.2	7.6	25.1	37.7	4.4	1.5	16.1	59.8	36.8	4.4	68.4	109.6	111.9	19.7	16.0	315.8	463.4
Simulation	17.1	1.2	8.0	26.2	37.3	4.5	1.5	16.2	59.5	36.4	4.5	68.6	109.4	110.5	19.8	16.0	316.4	462.7
Difference	0.7	0.1	0.3	1.1	-0.4	0.0	0.0	0.1	-0.3	-0.4	0.0	0.2	-0.2	-1.4	0.0	0.1	0.6	-0.7
% change	4.5	4.6	4.4	4.4	-1.1	0.4	0.5	0.3	-0.5	-1.1	0.4	0.3	-0.2	-1.3	0.3	0.3	0.2	-0.2

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al. 2012).
Note: The import quantity is derived from the bilateral export quantity, that means one country's physical export good is exactly the physical import good of its trade partner. It is in billions of dollars, without any export subsidy neither the transport margin nor the import tax.

Table 11: Sensitivity analysis—effects on aggregate variables of changes in elasticities (% change)

	A) Elasticity of substitution between imports and domestic production								B) Elasticity of substitution between labor and capital							
	Half				Double				Half				Double			
	CHN	EAS	USA	ROW	CHN	EAS	USA	ROW	CHN	EAS	USA	ROW	CHN	EAS	USA	ROW
Wage (skilled)	1.9	-0.4	-0.2	-0.3	1.9	-0.4	-0.2	-0.3	3.6	-0.5	-0.2	-0.3	0.8	-0.4	-0.1	-0.2
Wage (unskilled)	-0.9	-0.4	-0.1	-0.3	-0.4	-0.5	-0.1	-0.3	-0.3	-0.5	-0.1	-0.3	-0.6	-0.4	-0.1	-0.2
Capital Rent	-1.6	-0.4	0.0	0.1	-1.7	-0.4	0.1	0.2	-2.8	-0.4	0.1	0.1	-1.0	-0.3	0.0	0.1
National income	9.8	-0.4	-0.0	-0.2	9.4	-0.5	0.0	-0.1	10.2	-0.5	0.0	-0.3	9.0	-0.4	-0.0	-0.1
GDP	2.0	-0.3	-0.1	-0.1	2.2	-0.4	-0.1	-0.1	1.8	-0.4	-0.1	-0.1	2.3	-0.3	-0.1	-0.0

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al. 2012).

Table 12: Sensitivity analysis –Trade Patterns for China (absolute values and percentages)

Electronics	Electronics X from CHN to:				CHN Export structure, by destination %				CHN Import structure, by source %			
	EAS	U.S.	ROW	Total	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total
Bench	50.5	86.5	130.1	267.1	18.9	32.4	48.7	100	60.4	5.7	33.9	100
Simulation	65.8	110.3	169.6	345.6	19.0	31.9	49.1	100	60.0	5.5	34.4	100
Sensitivity 1	67.2	112.0	172.8	352.0	19.1	31.8	49.1	100	59.9	5.6	34.5	100
Sensitivity 2	63.5	107.6	164.6	335.7	18.9	32.1	49.0	100	60.3	5.5	34.2	100
Sensitivity 3	69.0	115.3	178.1	362.4	19.0	31.8	49.1	100	59.9	5.5	34.5	100
Sensitivity 4	62.3	104.9	160.6	327.8	19.0	32.0	49.0	100	60.1	5.6	34.3	100
Machinery	Machinery X from CHN to:				CHN Export structure, by destination				CHN Import structure, by source			
	EAS	U.S.	ROW	Total	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total
Bench	42.2	49.0	115.0	206.2	20.5	23.8	55.8	100	59.2	9.2	31.5	100
Simulation	49.4	58.5	138.7	246.5	20.0	23.7	56.3	100	59.6	9.2	31.2	100
Sensitivity 1	50.4	59.6	141.4	251.4	20.1	23.7	56.2	100	59.5	9.2	31.3	100
Sensitivity 2	48.4	57.5	136.2	242.0	20.0	23.7	56.3	100	59.9	9.1	31.0	100
Sensitivity 3	52.9	63.0	150.1	266.0	19.9	23.7	56.4	100	59.7	9.1	31.1	100
Sensitivity 4	46.6	54.9	129.6	231.1	20.2	23.7	56.1	100	59.5	9.2	31.3	100
Textiles	Textiles X from CHN to:				CHN Export structure, by destination				CHN Import structure, by source			
	EAS	U.S.	ROW	Total	EAS	U.S.	ROW	total	EAS	U.S.	ROW	total
Bench	37.7	36.8	111.9	186.4	20.2	19.7	60.0	100	64.9	4.6	30.5	100
Simulation	37.3	36.4	110.5	184.2	20.3	19.8	60.0	100	64.9	4.6	30.4	100
Sensitivity 1	37.6	36.7	111.6	185.9	20.2	19.8	60.0	100	64.9	4.7	30.5	100
Sensitivity 2	37.6	36.7	111.6	185.9	20.2	19.8	60.0	100	65.0	4.6	30.4	100
Sensitivity 3	39.0	38.7	117.9	195.6	20.0	19.8	60.3	100	64.9	4.6	30.5	100
Sensitivity 4	36.3	35.0	106.2	177.5	20.5	19.7	59.8	100	64.9	4.6	30.4	100

Source: Authors' simulations based on GTAP 8 Data Base (Narayanan et al. 2012).
Note: See note on Table 7.

Simulation: results after FDI shock and before sensitivity test
Sensitivity 1: results after FDI shock and **halving** the elasticity of substitution **between imports and domestic production**
Sensitivity 2: results after FDI shock and **doubling** the elasticity of substitution between **imports and domestic production**
Sensitivity 3: results after FDI shock, and **halving** the elasticity of substitution between **labor and capital**
Sensitivity 4: results after FDI shock, and **doubling** the elasticity of substitution between **labor and capital**

Figure 6: Input-Output structure of Machinery, Electronics and Textiles in China (2007)

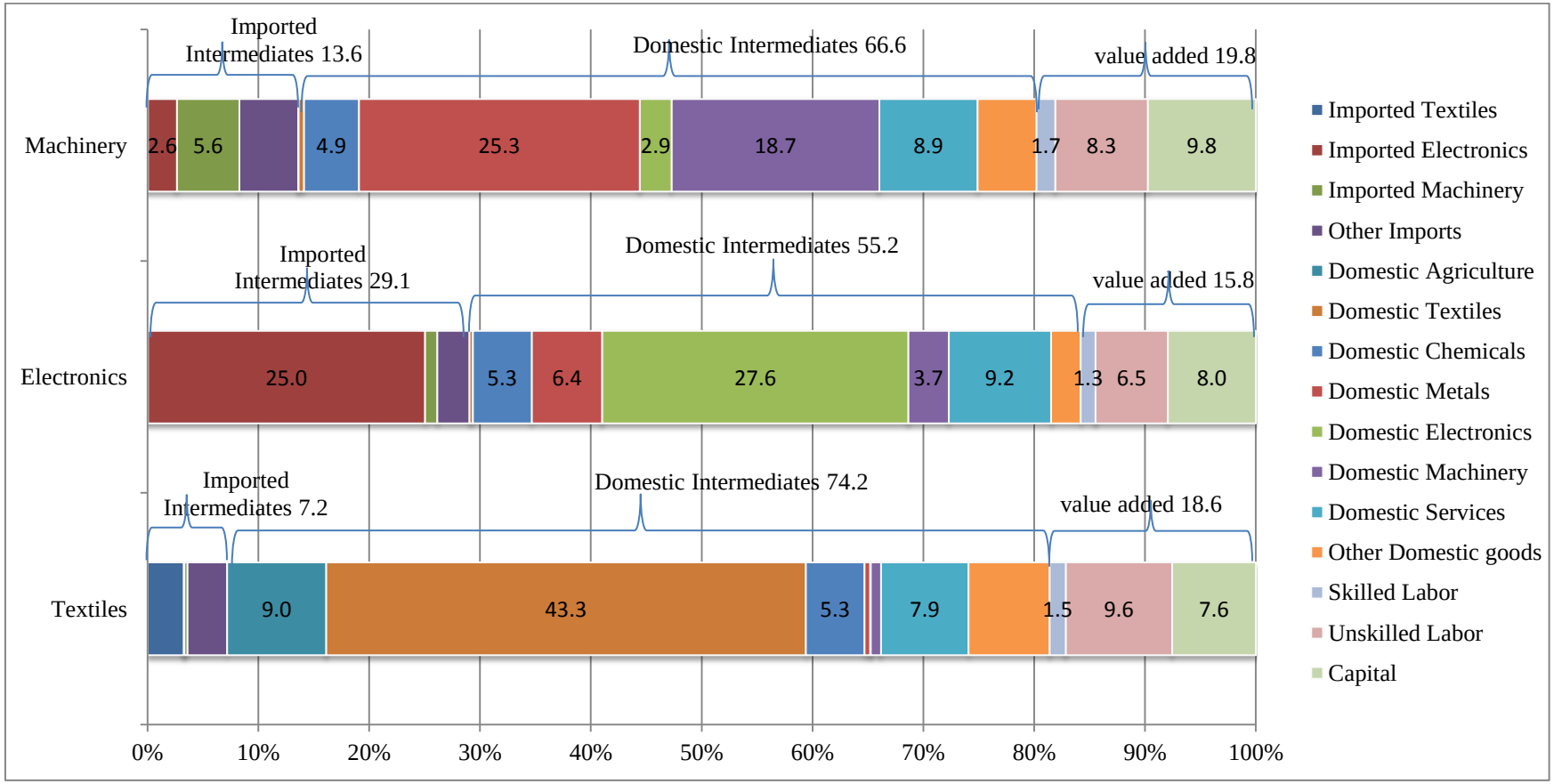
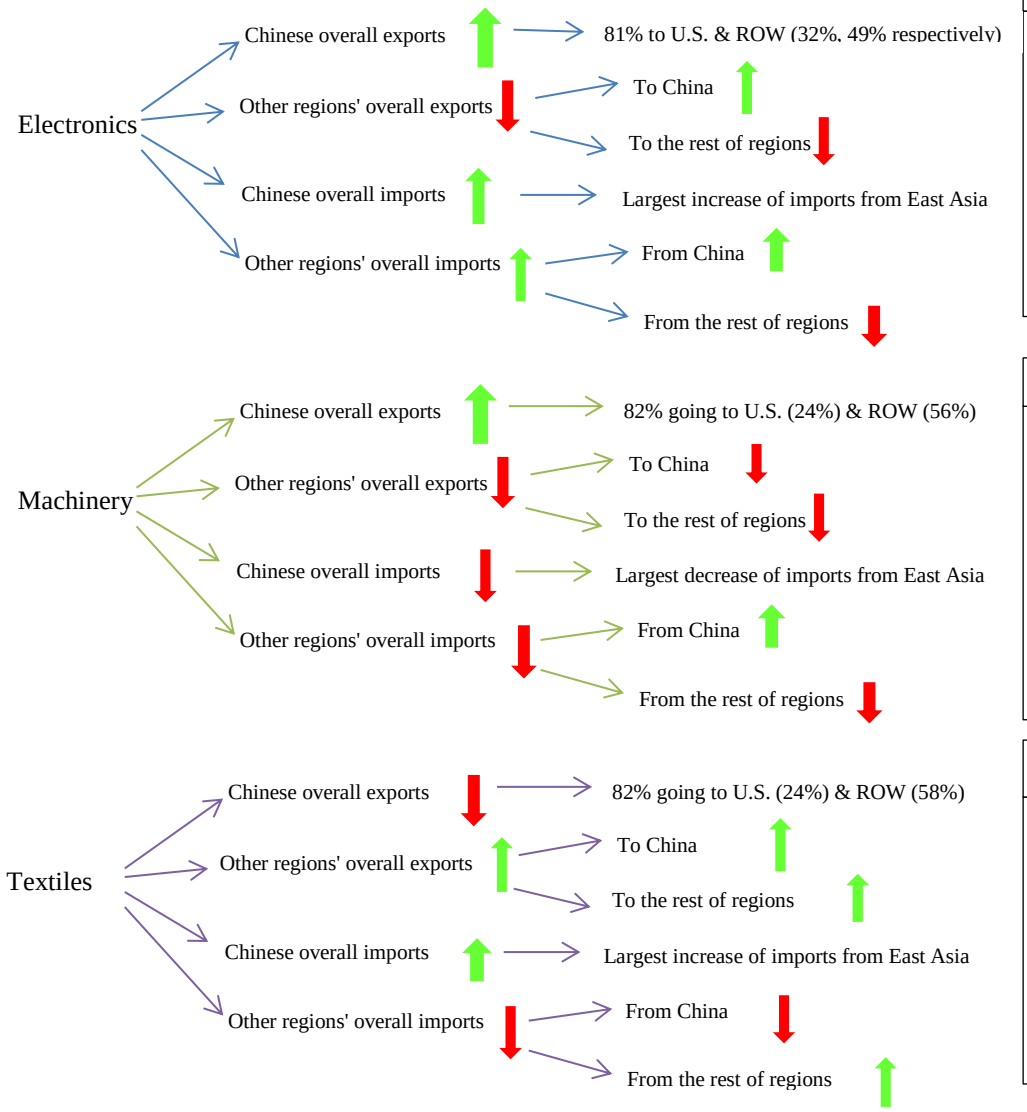


Figure 7: Diagrammatic illustration of the evolution of bilateral trade patterns after the FDI shock



Explanation

- ❖ 85% of Chinese imports are intermediates
- ❖ 60% of Chinese imports are from East Asia
- ❖ Electronics production relies heavily on imported Electronic intermediates
- ❖ Big fall in output price of Chinese Electronics

Explanation

- 68% of Chinese imports are intermediates
- 59% of Chinese imports are from East Asia
- Imported intermediates are not so intensively used in Machinery production (compared to Electronics)
- Machinery production in China relies more on domestic Machinery intermediates
- Substitution effects due to cheaper domestic prices than imported ones

Explanation

- ➢ 86% of Chinese imports are intermediates
- ➢ 65% of Chinese imports are from East Asia
- ➢ Textiles production in China relies heavily on domestic Textile intermediates
- ➢ Large increase of private consumption in China
- ➢ Exports lack price competitiveness in comparison with Electronics and Machinery

The small increase in Textiles exports that all regions except China achieve cannot compensate the big fall in exports in Electronics and Machinery.

Chapter 4

A multilevel analysis of FDI impacts: The role of big world players (China, East Asia, EU28, Japan, U.S.) in production networks and final markets*

*This paper is presented at the "77th International Atlantic Economic Conference" on 2-5 April 2014, in Madrid, Spain and to be presented at the "22nd International Input-Output Conference & 4th Edition of the International School of I-O Analysis" on 14-18 July 2014 in Lisbon, Portugal. This paper has won a travel grant to be presented in the conference.

Abstract

This Chapter analyzes the interplay of Chinese FDI inflows with the presence of Asian production networks by means of a Computable General Equilibrium (CGE) model. Despite the fact that East Asia is by far the main supplier of Chinese imported intermediates, the former experiences the largest GDP fall across all the regions considered. East Asia GDP structure relies heavily on the sectors in which China receives more FDI and the losses of East Asian exports, due to the fierce Chinese competition, result in production and GDP reductions. The rest of regions Japan, EU28 and the U.S., undergo similar crowding out effects in exports and GDP reductions, but because they are less specialized than East Asian in the sectors in which China becomes most competitive, they are less harmed. Only ROW gains because it is protected from Chinese competition and specialized in sectors in which China demands more.

Key words: Vertical specialization; Fragmentation; Intermediate; Computable general equilibrium

JEL classification: C68, F14, F15, F17, F21.

1. Introduction

The emergence of China on the world stage poses important questions about its economic consequences for that and other regions of the world and demands powerful methodologies able to quantify its challenges and opportunities.

Somehow, Chinese geographical frontiers become "blurred" in this process. On the one hand, China has been escalating positions as a favorable Foreign Direct Investment (FDI) destination, ranking now 2nd among top hosts of FDI inflows in the world (UNCTAD, 2013). This implies that FDI must play an important role in Chinese GDP growth (e.g., Kym et al., 2003) and foreign trade (e.g., Dean et al., 2009). Some authors have pointed out that in the absence of FDI flows, the Chinese high rates of GDP growth and exports would be in danger (Whalley and Xin, 2010; Zhang, 2013).On the other hand, a significant part of what is produced in (and later exported from) China relies heavily on foreign imported intermediates. What does, then, the "made in China" really mean?

Imported intermediate inputs embodied in exports have raised close attention to what the literature calls: vertical specialization, global production sharing, networks, supply-chain trade or value-added trade. Input-Output (IO) analysis is a dominant methodology in this research. Koopman et al. (2008) disentangle the imported intermediate inputs from domestic ones in Chinese exports. They obtain that only 40-50% of the value added is created in China, the rest being imported mainly from Japan, Korea, Taiwan, Hong Kong and the U.S. Dean et al. (2011), following Koopman et al. (2008) methodology to split the Chinese IO tables, find that there is a significant Asian-supplier network, with Japan and the Four Tigers accounting for more than half of Chinese imported inputs in 1997 and 2002. Baldwin and Lopez-Gonzalez (2013), based on two data sets (the World IO Database and the Trade in Value Added Database), suggest that supply-chain trade has shifted heavily towards "Factory Asia" and away from "Factory North America" and "Factory Europe".

In this Chapter, we study the interplay of FDI accruing to China with the presence of Asian networks. The regions considered are China, East Asia, Japan, EU28, the U.S. and the rest of the world (ROW) and, the Chinese sectors receiving FDI, Electronics, Machinery,

Chemicals and Textiles. We pay particular attention to the role of these sectors along several levels of analysis, such as their weight in GDP, imports and exports in the world, in China and in the rest of regions. Our approach incorporates the real numbers of costs, export orientation and import reliance of production in the different sectors across all regions, which underlie the results at the macroeconomic levels (such as GDP growth, wages, aggregate foreign trade and welfare). We use a Computable General Equilibrium (CGE) model. This methodology allows capturing the complex geographical and sectoral relationships of domestic and imported intermediates. Further, CGEs rely on a well-grounded theoretical framework in order to derive the consistent micro and macroeconomic results. They also combine both the demand and supply side of the economy, as well as, product and labor markets across regions (Markusen, 2002).

The model, thus, captures the presence of Asian networks and production chains, together with the main destinations of final and intermediate goods produced by China. However, we go beyond the data describing the presence of networks and markets and try to quantify the consequences of the particular linkages of each region with the Chinese economy. In theory, FDI inflows may have multiple effects. They affect factors remunerations, investment, GDP growth, technological transfers and productivity, the climate of competition among firms, foreign trade, and so on (see Lipsey, 2002, Barba Navaretti and Venables, 2004 or Latorre, 2010, for theoretical reviews of the literature). A small handful of big multinationals may transform the production landscape of entire countries. However, comprehensive studies of their impact, such as CGE analyses of FDI, are rather scarce (Latorre, 2009), with notable exceptions, such as, Lakatos and Fukui (2013), Jensen and Tarr (2012) and Latorre and Hosoe (2014). We, thus, aim at applying this methodology to the consequences of the complex globalization of China.

The rest of the Chapter is organized as follows. Section 2 fully describes the weight of sectors in the world and across regions. Section 3 describes the model and simulations. The aggregate and sectoral results are analyzed in section 4. Section 5 concludes.

2. Data section

Table 1 offers the definition of sectors and their relative importance in each region's GDP, exports and imports. The GDP structure reflects the level of development of the different regions. Agriculture and Mining are very important in China and ROW. Services are less important by contrast in these two regions compared with the rest. The four sectors, to which FDI accrues (Textiles, Chemicals, Electronics and Machinery) appear in bold. They account for 9.2% of Chinese GDP. In East Asia[1], whose GDP structure in manufacturing is very similar to that of China, their weight is 13.3% of GDP. The shares in Japan and Europe are similar and around 10%. The areas in which they are less relevant are the U.S. (7.5%) and ROW (6.4%).

The four sectors receiving the shock are vital for the exports of China (64%), East Asia (54.6%) and Japan (53.4%), while being less important in the other regions. There is a strong network between China and East Asia, in which Japan also participates although it is less integrated than the previous two areas. We summarize this in Figure 1. There we can see that East Asia provides the vast majority of total Chinese imports ranging from 70.4% in Electronics to 46.8% in Chemicals, with the smallest share in Machinery of 36.5%. The next most important supplier for China is Japan, which accounts for around 15% of Chinese imports, with the exception of Machinery where it provides 36.5%.Taking into account that 86.3%, 96.9%, 84.5% and 68% of total Chinese imports are of intermediates in Textiles, Chemicals, Electronics and Machinery, respectively, this must be a strong network by which East Asia and, to a lesser extent Japan, provide intermediates to be further processed in China.

Figure 1 also shows that Chinese export structure contrasts drastically with that of the imports. To the U.S., EU and ROW go between 70% and 76% of total Chinese exports. Imports from EAS, which is Chinese next important destination (after the U.S., EU and ROW) are mostly intermediates. This suggests that most of the Chinese final goods go to

[1] In the dataset of this Chapter, East Asia is constituted by Republic of Korea, Taipei China, Hong Kong China, and ASEAN countries (Singapore, Cambodia, Indonesia, Republic Lao, Malaysia, Philippine, Thailand and Vietnam).

the U.S., EU and ROW, although there may be also intermediates in those Chinese exports to be further processed in those areas of the world[2].

In the U.S. services account for the bigger share in exports (Table 1). Exports of Motor vehicles are very important for Japan, while ROW depends heavily on its Mining exports. Textiles exports are very important in China and less important in the rest of regions.

The fours sectors experiencing FDI increases account for 53.5% of overall Chinese imports and 43.2% in East Asia exhibits a closer import pattern while their weight in imports from the rest of regions is smaller.

Table 2 gives an outline (GDP, exports and imports) of the values and regions' shares in the world[3]. Europe is the largest economy (31% of world GDP), ranking first also in world trade (about 40%). The U.S. and ROW come next in their GDP shares (both around 25%) but they are very different in their trade openness. The US is a quite close economy, so is Japan, although less intensively. China and East Asia, by contrast, are more open since their weight in world trade surpasses their 6.3% and 5.2% shares in GDP, respectively.

Table 3 presents each region's weight in world GDP, exports and imports focusing on the sectors where the FDI shock takes place in China. The brackets of the columns labeled "World" further offer the importance of the sector in the world GDP, exports and imports. Even though China has a small weight in total world GDP (6.3 %), it generates important shares of global value added in these four sectors, particularly, in Textiles (16.7%) and Electronics (14.3%). Further, its contribution to world exports in these two latter sectors is of remarkable importance, 30.7% and 22.1%, respectively. China, Japan and East Asia nearly account for half of world exports of Electronics and Textiles. The three regions share a trade pattern by which their role in exports tends to surpass by far their role in imports (i.e., they constitute the "trade surplus" areas). The contrary applies to the U.S., and to a

[2] In Zhou and Latorre (2013a; 2013b) we analyze more deeply the amount of imports and their use (i.e., whether they are for Private or Public consumption, Gross capital formation, Intermediates). We do it, however, for Textiles, Electronics and Machinery and for four regions.

[3] The values for GDP and their shares in the world resemble well the ones from the World Bank "World Development Indicators" in current $ of 2007, which is the source used by GTAP for macroeconomic variables (Hussein and Aguiar, 2012). For trade data issues like re-exports are dealt carefully by the GTAP team, which use as a base United Nations COMTRADE for their calculations (Gehlhar, Wang and Yao, 2010).

lesser extent, ROW and Europe (i.e., the "trade deficit" areas). Europe is the main single region in the creation of world value added, exports and imports in the four sectors considered. It stands out, however, in its importance in value added in Chemicals and Machinery and, even more, in exports from these two sectors. ROW is relatively important in the production and trade of Textiles but clearly less important in exports from the other three sectors. Note that Textiles, in turn, accounts for a very small share in world GDP (1.5%) and in world exports which, necessary coincide with world imports (both accounting for 4.6% in the total)[4]. Machinery is the most important sector in terms of world trade (13.7%), followed by Chemicals with 11.3% and Electronics with 8.4% shares.

To sum up, in 2007 China accounts for rather reduced shares in world GDP, exports and imports. In the sectors receiving the FDI shock, however, China is considerably more important than on average in the world. The U.S., EU and ROW are not important supplier of intermediates but play more the role of markets for China. The EU is by far the region with highest weights in GDP, exports and imports in the world. Our data point to a strong integration of China with East Asia and to less intensively with Japan. Both areas do supply most of the intermediates that are further processed in China.

3. The model and simulation

We use a multilevel model that combines the technology of production of firms (their cost structures and output levels) together with the demand side of the economies (how much production of each sector is demanded internally or exported), and the presence of factor markets (labor and capital demanded for production and their corresponding remunerations). This methodology which is technically called a CGE model, tries to grasp how shocks (e.g., the arrival of new multinationals to a particular sector) occurring in one part of the economy are spread to the rest. It seeks to offer results at the microeconomic level (production, exports, imports…) in different sectors and also at the macroeconomic level

[4] Both the exports and the imports are calculated at FOB value. We have also compared the exports and imports at CIF value with the ones at FOB value. The differences are very small and do not affect our results.

(GDP, welfare, aggregate trade flows, wages…) for all the regions considered within the same model. It quantifies those shocks occurring at the different levels. Our model is the GAMS (General Algebraic Modeling System) version (Rutherford, 2005) of the Global Trade Analysis Project (GTAP) model (Hertel, 1997). It is explained technically in Zhou and Latorre (2013b). Note, however, that in the present version we use a multilevel analysis with different factors, regions and sectors compared to our previous studies.

Since we want to explore the role of FDI, we simulate the shock of capital stock changes brought about by FDI inflows. It consists of a simultaneous increase in the capital stock of the Chinese sectors of Textiles, Chemicals, Electronics and Machinery. Based on the data from NBSC (various years), the accumulated FDI inflow, proxied by fixed asset investment funded by foreign capital, in Electronics has nearly doubled during the period of 2004—2011, the increase was around 50% in Machinery, and 30% in Chemicals and 27% in Textiles. Thus, we simulate a shock corresponding to those sectoral capital stock increases simultaneously, keeping the capital stock in rest sectors and regions fixed.

Capital is assumed to be firm-type and sector specific, i.e., the capital used in, say, chemicals will be different to the one used in other sectors. This assumption of specific capital also implies that capital is fixed and cannot move across sectors. As a consequence, our results should be interpreted as the short run outcome, i.e., the impact after two or three years. The assumption of specific capital also involves that its remuneration will differ across sectors. Labor, by contrast, is fully mobile within regions and its endowments are fixed. Therefore the wage will be the same within each of the regions considered in the model.

The macroeconomic outcomes, arise from the aggregation of all sectoral results. Additionally, the resulting aggregates have to fulfill equations reflecting the national accounts identities. These latter equations reproduce the circular flow of the economy: production, income distribution, and (domestic and foreign) demand. After the simulation, factor remunerations in the sectors receiving a shock will be changed (i.e., the rental rate of capital and the overall wage will vary). As a consequence, those sectors will readjust their factor demands, intermediate inputs, prices, production, exports and imports. The rest of sectors respond to the shock as well, changing their inputs, production and price. Due to the

change of capital stock and the overall wage, national income changes. Domestic demand for private consumption and intermediates adjust to national income and output changes, respectively.

However, the export orientation, domestic/imported intermediate intensity, private consumption orientation and trade relationship vary largely in the four sectors studied. Given the division and collaboration through production networks and other trade patterns, the rest of regions respond to the changes of Chinese trade. As a result, they will also adjust production, imports, and exports.

4. Results

4.1. Sectoral results

Table 4 presents the percentage change in output and the differences with respect to the benchmark of the value of exports and imports across all regions and sectors.

Chinese production in the sectors receiving FDI will expand heavily. The larger the FDI increase, the higher the output goes up. Therefore, the biggest increase takes place in Electronics (30.3%) and the smallest in Textiles (1.2%). The arrival of FDI will decrease the price of goods, enhancing the competitiveness in exports with the only exception of Textiles[5]. Chinese exports increase dramatically, crowding out exports from the rest of regions in Electronics, Machinery and Chemicals, which explains their respective reductions in production in those sectors. This will bring about a mild fall in overall production across regions, which contrasts with the Chinese output expansion (see row "Total" at the bottom of Table 4).

Chinese exports in the sectors receiving FDI crowd out all exports across *all* the rest of regions. Only one exception to this general trend arises in Chemicals, in which Europe and

[5] The causation chain of more FDI producing more exports is analyzed in detail in Zhou and Latorre (2013a; 2013b).

Japan escape from the reductions in exports. The world predominance of Europe in foreign trade of Chemicals is clear in Table 3 above. Besides, Europe is a very important provider of Chemicals for ROW and will not be displaced by Chinese exports in this area. Japan accounts for higher Chinese import shares in this sector and will benefit from the increase in Chinese production sufficiently enough so as to compensate the exports lost in the rest of regions[6].

China will export less in several sectors, especially in Metals and Services, which will turn out to be supplied by the rest of regions excluding ROW. In the case of Metals, the overall increase in Chinese production brings about a higher demand for this product in order to be used as an intermediate. Regarding Services, the expansion of national income, stemming from FDI inflows, explains the rising demand for this private consumption oriented sector. The increase in Chinese output and lower exports in Food and Beverages is also related to higher national income. Exports from Textiles do not follow the general pattern of sectors receiving FDI, because they will be more demanded with higher private consumption. Therefore, the amount of Textiles exports from China will shrink.

Chinese aggregate exports increase and so do those of the other regions with the exception of ROW. Aggregate imports accruing to China go up as well. This is because more intermediates are needed for higher levels of production and for the rising Chinese private consumption. By contrast, overall imports in other regions will be reduced. As we shall see shortly, national income decreases (so does production) in them (again with the exception of ROW).

Looking at the absolute values of exports and imports, we find that the largest adjustments (in real value) occur in Electronics, Chemicals, Metals and Services. Interestingly, the exports of Services and Metals counteract to some extent the evolution of foreign trade in the sectors where the shock in FDI takes place in China. Chinese competitiveness does crowd out exports in the other regions, but those regions still manage to compensate that phenomenon by increasing their exports in the sectors in which China is now exporting less. This is illustrated in Figure 2 by the percentage changes in the four main sectors, which are calculated as the change in absolute values reflected in Table 4, with respect to the value of

[6] Figures describing these bilateral trade patterns are available from the authors upon request.

exports in each sector and region in the benchmark. Looking at China and its exports of Electronics and Machinery we find the important increases it experiences (29.6% and 16.2%, respectively) after the FDI shock. Its overall imports of Machinery will go down (-2.8%) because it will substitute imported Machinery by the cheaper Machinery it now produces. Imports of Electronics in China rise by (10.1%), since this production, in contrast with Machinery, relies very heavily on imported intermediates.

China will however, export considerably less of Metals (-19.2%) and services (-21.6%) of which it will import more (15.3% and 18.1%, respectively). This will expand heavily the exports of the rest of regions in these two sectors, which will go mainly to satisfy Chinese rising appetite from them, reducing the amount exported to other destinations.

All in all, Figure 2 shows that while exports of most regions in Electronics and Machinery fall there is a compensating force in the increase of exports from Services and Metals. We also find that overall imports and exports in the world increase after the shock across the four sectors considered.

Let us turn to analyze the evolution of East Asia, which is so heavily integrated with Chinese production. Table 4 shows that East Asia reduces total exports in the sectors in which Chinese export competition becomes more aggressive, despite its role as Chinese intermediate supplier in the Asian networks. It exports more to China but it is displaced by China in the other markets. We will briefly illustrate this point by showing the bilateral import and export trade in Electronics, where the largest volumes of trade are affected.

Figure 3 shows the bilateral trade changes (in billions of dollars) of Electronics after the shock. One of the axis shows the 'Exporter' and the other one the 'Importer'. Take 'China' in the 'Exporter' axis and the 'EU' in the 'Importer' axis as an example —the pink cone of Figure 3, the bilateral change of 20.9 means that the Electronics exports from China to Europe increase in 20.9 billions or the imports of Europe from China go up by that amount. 'Total imports' in the 'Exporter' axis, shows the overall import change of importers shown in the 'Importer' Axis. For instance, the navy blue cone, whose dimensions are 'Total imports' in 'Exporter' axis and 'CHN' in 'Importer' axis, means that the overall imports of China increase by 19.1 billions (which coincides with overall Chinese imports in

Electronics in Table 4). Similarly the light yellow cone, with dimension of 'China' in the 'Exporter' axis and 'total exports' in the 'Importer axis', means that the overall exports of China go up by 81.3 billions (as shown in Table 4).

Chinese exports mainly go to the U.S., Europe and ROW, which are the biggest markets for its exports (Figure 1). Overall exports across all regions are heavily crowded out, even though they all increase the exports going to China. East Asia experiences the highest increases in exports going to China but it faces the fierce competition of Chinese exports in the rest of markets. This latter effect predominates and its overall exports go down. This leads us to say that being integrated in Chinese production networks as an intermediate supplier does not guarantee profits.

4.2. Aggregate results

Table 5 presents the percentage change of the overall wage, the rental rate of capital, national income which is a proxy for welfare, the capital stock, aggregate imports and exports, as well as, GDP.

FDI accruing to China will increase its capital stock by 7.36%. This will improve labor productivity and therefore wages by 0.42%. An accumulation of capital causes a reduction in its remuneration of 1.99%. The increase in wages, together with a higher capital stock, leads to a strong expansion of national income and welfare (11.54%)[7]. As a result, aggregate imports rise heavily (7.84%), propelled by higher demand and production, while exports also rise although less intensively by 2.90%. Recall the sectors receiving the FDI increase heavily their exports but due to the rise of national income and production, exports in other sectors will be reduced. Finally, all these forces drive up GDP in China by 2.68%. These findings are in accordance with our previous studies on the impact of FDI on host economies (Gómez-Plana and Latorre, 2014; Latorre 2012, 2013).

The adjustments are logically of smaller magnitude for the rest of regions. Because production shrinks slightly in all of them (Table 4), wages, and often the rental rate of

[7] See Latorre et al. (2009) or Latorre (2010) for a full explanation about why national income can be used as a proxy for welfare in the GTAP model.

capital, will diminish. The decrease is most intense in East Asia, Japan and Europe. In these regions, the weight in GDP of the three sectors where Chinese exports increase most (Electronics, Machinery and Chemical) is the highest (Table 1). Chinese competition crowds out exports of the rest of regions in these sectors, thus, reducing their output. As shown in Table 1, East Asia is the region in which these sectors account for a higher GDP (13.3%). Accordingly, wages and the rental rate of capital experience the largest decrease in East Asia. In the opposite extreme, ROW and the U.S. exhibit the lowest weight of GDP in these three sectors (5.3% and 6.6%, respectively). This explains why the fall in wages is the smallest in these two regions and the capital rental even increases. This evolution of factor's remunerations lies behind the outcomes on national income and GDP. The latter decrease most in East Asia, followed by Japan and Europe. The U.S. also undergoes a reduction in national income and GDP, while ROW, whose capital rental increases heavily, exhibits rises in both national income and GDP. Recall the GDP structure in ROW is quite protected from Chinese competition, since it heavily relies on Mining, Agriculture and Services in which Chinese exports are going down.

The fall in national income, which drives down private consumption across all regions, explains the reduction in aggregate imports (except in China and ROW). Aggregate exports, by contrast, rise slightly due to the higher exports in the sectors in which China competes less.

All in all, China benefits from FDI inflows. ROW also benefits because its economic structure differs the one in China. The contrary applies to East Asia, whose GDP manufacturing structure closely follows that of the Asiatic giant. As a result, East Asia is heavily crowed out in important sectors that coincide with the ones in which China becomes very aggressive. Japan and Europe are intermediate cases in the sense that they are crowded out in some sectors but are able to compensate that by exporting more in others. Finally, the U.S. benefits mainly due to its low exposure to Chinese competition.

4.3. Sensitivity Analysis

We carry out an Unconditional Systematic Sensitivity Analysis (Harrison et al. 1997), in which we change two critical elasticities: 1) The Amington elasticity (substitution between imports and domestic production and 2) The elasticity of substitution between labor and capital. We halve and double their values in all the sectors and regions while keeping the rest of elasticities at their initial value.

Table 6 offers the percentage changes of the aggregate variables with the new elasticities. The row labeled "bench" repeats, for the sake of comparison, the results obtained with the original elasticities, i.e., the ones from Table 5. Percentages adjustments in GDP are negligible across regions, even though for China the higher the elasticities the slightly higher the GDP turns. This implies that more flexible technologies facilitate a more efficient use of resources leading to more growth. Across the rest of variables changes are very small with the different elasticities. The causation chain behind the results which has already been explained clearly remains applicable. ROW and China would be the only regions that win after the shock.

With the higher ("double") elasticity of substitution between imports and domestic production, production in the sectors receiving FDI increases more than in the benchmark case. Aggregate imports and exports will be somewhat higher because more imported intermediates will be used for production and higher production will lead to more exports in these sectors. In order to produce more in the FDI receiving sectors a higher amount of labor needs to be reallocated to them. This will raise the wage and bring about a lower rental rate of capital. The latter effect prevails reducing national income, always compared to the central case we had already analyzed.

With a lower ("half") elasticity of substitution between labor and capital production in the sectors receiving FDI is also larger than in the central scenario. Because more labor needs to go to those sectors the wage will be higher, but the rental rate of capital will be smaller leading to lower national income. Production in the FDI sectors is higher, which brings about higher aggregate imports of Chinese intermediates. However, their higher production does not translate in overall higher Chinese exports because other sectors are exporting less.

But note that the key for the adjustment in the rest of regions would be the weight in their GDP of the sectors involved in the FDI shock. We get a more negative outcome in East Asia because in that region the weight in GDP of Electronics, Machinery and Chemical is the highest across regions. GDP is also slightly worse in Japan and the EU and slightly better in ROW with the half value of this elasticity. These trends should be familiar to us since they again reflect that the higher the increase in production in the FDI receiving sectors in China the more harmful their effects for the rest of regions with the exception of ROW.

5. Conclusions

By 2007 China accounted for a relatively small share in World GDP (6.3%), exports (8.3%) and imports (6.4%). This was far from the weights of regions like Europe (31%, 39.7% and 40.8%, respectively) or the U.S. (25.2%, 9.2% and 14.5%, respectively). However, the arrival of FDI inflows to Chinese manufacturing seems to have produced negative effects in many regions of the world. When Chinese exports increase, due to FDI, exports and production shrink in the sectors that compete with them across the rest of regions. The latter experience an overall reduction in production which drives down wages and the capital rent, thus, reducing their national income and GDP.

We simulate the real FDI increases that have taken place in Chinese Electronics, Machinery, Chemicals and Textiles. These four sectors account for 64.5% and 53.5% of Chinese overall exports and imports, respectively, while their weight is of 38.1% in total world exports (or imports).

China benefits from the FDI inflows, since there is a rise in wages (0.42%), GDP (2.68%) and national income (11.54%). Chinese export competitiveness increases very heavily in Electronics, Machinery and Chemicals. East Asia is the region that is most negatively affected, even though it has strong connections through production networks with China. It will export more in those sectors in which China compete less after the FDI increase.

Further, it will, generally, supply important intermediates for the sectors in which China increases production, but it will be displaced by China in the rest of markets. The main negative outcomes for East Asia arise from its decrease in production in the sectors in which China is more aggressive (Electronics, Machinery and Chemicals). These three sectors explain 13.3% of GDP in East Asia, the highest share among all the regions considered. As a consequence, its fall in GDP is the largest across all regions (-0.4%, approximately).

In Japan and Europe the weight in GDP of Electronics, Machinery and Chemicals is 8.6% and 9.1%, respectively. Their Chemicals sectors are the only case of survival to Chinese competition in sectors that have received the FDI. Indeed, except in these latter cases, China crowds out exports across all regions when it becomes more competitive due to FDI. Despite this virtuous evolution of Chemicals, overall production still shrinks in Japan and Europe, driving their GDP down by 0.26% in both areas. In the U.S., the weight in GDP of the three sectors, in which Chinese competition rises strongly, is lower than the three previous regions. This, together with its smaller openness to trade and big importance in services (in which China export less), considerably reduces its negative outcomes in GDP (-0.10%).

The Rest of the world (ROW) is the only region that we have analyzed that is positively affected by the Chinese booming economy. ROW is protected from Chinese competition because in its GDP sectors like Mining and Agriculture account for the biggest shares. In fact, ROW's exports from these sectors are primarily going to satisfy Chinese rising demand for Agricultural products and Mining resources.

In the light of the literature on vertical specialization, this Chapter finds that engaging in networks in China does not guarantee profitable outcomes. Our general equilibrium analysis allows to further analyze the role of regions as final markets. We could a priori expect that consumers would benefit from cheaper Chinese imports. This does not seem to be the case, either. Europe, the U.S. and ROW are the main destinations of Chinese exports. These may become cheaper, but the point is that Europe, the U.S. and ROW are also important producers in the world.

Our analysis reveals that the forces from the production side of the economy are more important than the ones from the consumption side. As we have said, this benefits ROW but will harm Europe and the U.S. in a different magnitude.

All in all, our Chapter suggests that the best industrial policies outside China should further strengthen the comparative advantage in the sectors in which China competes less.

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Table 1: Definition of sectors and their relative importance in each region's GDP, Exports and Imports (2007)

Sector/Goods Definition	GDP (%)						Exports (%)						Imports (%)					
	CHN	JPN	EAS	US	EU	ROW	CHN	JPN	EAS	US	EU	ROW	CHN	JPN	EAS	US	EU	ROW
01-14 Agriculture	11.0	1.2	5.5	1.0	1.7	6.6	0.9	0.1	0.8	3.8	1.6	3.8	2.7	2.5	2.0	1.3	2.2	2.6
15-18 Mining	4.0	0.1	3.7	1.2	0.7	11.0	0.5	0.1	3.4	1.1	1.1	32.6	13.9	23.3	12.7	12.6	6.9	7.3
19-26 Food & Beverages	3.2	3.3	3.5	2.2	4.1	4.5	2.0	0.4	3.4	3.1	5.2	4.9	1.8	5.2	3.3	2.9	4.8	4.8
27-29 Textiles	**4.1**	**0.6**	**2.0**	**0.8**	**1.7**	**1.6**	**17.2**	**1.1**	**5.2**	**1.4**	**3.5**	**3.9**	**2.7**	**5.1**	**3.3**	**5.8**	**4.8**	**4.6**
30-31 Woods & Paper	2.1	1.8	1.6	2.4	2.3	1.5	4.2	0.7	2.3	2.7	4.0	2.6	1.9	2.7	1.7	3.6	3.7	3.0
32 Petroleum	0.6	2.6	2.3	0.5	2.1	1.3	1.8	1.5	3.9	4.1	2.2	6.3	2.4	3.8	4.3	3.5	3.0	4.4
33 Chemicals	**5.7**	**2.5**	**4.0**	**2.6**	**3.6**	**2.4**	**7.4**	**12.2**	**10.8**	**13.3**	**15.3**	**6.0**	**12.5**	**7.8**	**10.5**	**8.4**	**13.0**	**10.9**
34-37 Metals	7.4	3.0	3.7	2.2	3.7	3.5	9.8	9.2	6.5	6.1	9.5	10.2	8.4	6.8	10.0	6.7	9.5	9.8
38-39 Motor Vehicles	2.5	2.6	2.8	1.9	2.7	2.0	3.3	24.1	6.1	14.5	13.0	5.9	4.2	4.3	4.5	12.5	11.1	12.4
40 Electronics	**3.0**	**2.8**	**4.6**	**0.6**	**1.0**	**0.8**	**22.5**	**13.5**	**25.3**	**6.8**	**4.5**	**2.3**	**20.2**	**9.0**	**15.4**	**11.0**	**5.7**	**5.4**
41 Machinery	**6.5**	**3.2**	**4.8**	**3.5**	**4.4**	**2.1**	**17.4**	**26.6**	**13.3**	**16.5**	**16.5**	**5.2**	**18.2**	**10.5**	**14.0**	**13.5**	**12.5**	**15.3**
42 Other manufacturing	2.5	0.6	0.6	0.4	1.0	0.8	6.2	1.0	1.2	1.4	1.4	1.3	0.4	1.6	1.2	3.4	1.7	1.5
43-45 Electricity & Gas & Water	3.4	1.9	2.3	2.1	2.3	3.0	0.1	0.0	0.1	0.2	0.6	0.9	0.1	0.1	0.3	0.2	0.7	0.5
46 Construction	6.3	6.4	5.7	6.3	7.1	6.7	0.4	1.3	0.8	0.5	0.7	0.4	0.4	1.3	0.5	0.1	0.6	0.9
47-57 Services	37.9	67.4	52.8	72.5	61.5	52.2	6.2	8.2	16.8	24.5	21.1	13.8	10.3	16.0	16.2	14.3	19.8	16.5
Whole economy	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Authors' calculation based on GTAP 8 Data Base (Narayanan et al., 2012).

Note: The definition of sectors follows the ISIC Rev 3 Classification. CHN, JPN, EAS, US, EU and ROW stand for China, Japan, East Asia, United States, Europe and Rest of the world, respectively. East Asia is constituted by Republic of Korea, Taipei China, Hong Kong China, and ASEAN countries (Singapore, Cambodia, Indonesia, Republic Lao, Malaysia, Philippine, Thailand and Vietnam).

Table 2: Each region's GDP, exports and imports and their weight in the world (2007)

Region	GDP (Billions $)	GDP (%)	Exports (Billions $)	Exports (%)	Imports (Billions $)	Imports (%)
China	3494.1	6.3	1222.8	8.3	941.0	6.4
Japan	4377.9	7.8	742.1	5.0	670.2	4.5
East Asia	2917.8	5.2	1666.5	11.3	1435.6	9.7
United States	14061.8	25.2	1366.2	9.2	2139.5	14.5
Europe	17327.1	31.0	5867.3	39.7	6031.4	40.8
Rest of the world	13652.6	24.5	3914.2	26.5	3561.4	24.1
World	55831.3	100	14779.2	100	14779.2	100

Source: Authors' calculation based on GTAP 8 Data Base (Narayanan et al., 2012).

Table 3: Each region's weight in world GDP, exports and imports of Textiles, Chemicals, Electronics and Machinery (2007)

Sector	Regional % in world sectoral GDP						World	Regional % in world sectoral exports						World	Regional % in world sectoral imports						World
	CHN	JPN	EAS	US	EU	ROW		CHN	JPN	EAS	US	EU	ROW		CHN	JPN	EAS	US	EU	ROW	
Textiles	16.7	3.2	7.0	13.6	34.4	25.1	100 (1.5)	30.7	1.2	12.7	2.7	30.3	22.4	100 (4.6)	3.7	5.0	7.0	18.3	41.6	24.4	100 (4.6)
Chemicals	11.3	6.4	6.6	20.7	35.9	19.0	100 (3.1)	5.4	5.4	10.7	10.8	53.6	14.0	100 (11.3)	7.3	3.1	9.2	10.8	46.0	23.6	100 (11.3)
Electronics	14.3	16.9	18.6	10.8	24.3	15.2	100 (1.3)	22.1	8.1	34.0	7.5	21.1	7.2	100 (8.4)	15.3	4.9	17.8	19.0	27.7	15.4	100 (8.4)
Machinery	11.0	6.9	6.8	24.0	37.4	14.0	100 (3.7)	10.5	9.7	11.0	11.1	47.6	10.1	100 (13.7)	8.5	3.5	9.9	14.4	36.8	27.0	100 (13.7)

Source: Authors' calculation based on GTAP 8 Data Base (Narayanan et al., 2012).
Note: see Table 1

Table 4: Impact on output (% change), exports (change in billions $) and imports (change in billions $)

Sectors	Output (% change)						Exports (change in billions $)							Imports (change in billions $)						
	CHN	JPN	EAS	US	EU	ROW	CHN	JPN	EAS	US	EU	ROW	World	CHN	JPN	EAS	US	EU	ROW	World
Agriculture	2.0	0.3	0.3	0.4	0.3	0.2	-3.3	0.0	0.5	1.7	1.6	3.4	3.8	5.9	-0.3	-0.2	-0.1	-1.5	0.1	3.8
Mining	-0.3	0.8	0.1	0.2	0.3	0.1	-0.5	0.0	0.6	0.6	0.6	4.9	6.2	7.6	0.1	0.5	-2.0	-1.2	1.2	6.2
Food & Beverages	3.2	0.0	0.1	0.1	-0.0	0.2	-6.9	0.2	1.2	1.4	4.3	-0.1	0.1	4.4	-1.3	-0.5	-0.9	-2.7	1.1	0.1
Textiles	1.2	1.6	0.7	1.1	1.1	0.0	-9.7	0.5	1.0	0.7	5.1	-1.2	-3.6	1.6	-0.6	-0.2	-1.8	-3.1	0.4	-3.6
Woods & Paper	-2.5	0.6	0.7	0.6	0.7	0.1	-8.8	0.4	0.7	1.3	4.9	0.5	-0.9	2.3	-0.4	-0.1	-2.1	-0.9	0.4	-0.9
Petroleum	3.1	-0.2	-0.1	-0.6	-0.5	-0.2	-1.1	0.2	0.6	0.1	-0.2	0.0	-0.4	1.5	-0.1	-0.2	-0.4	-1.0	-0.2	-0.4
Chemicals	6.9	-0.1	-0.7	-0.1	0.1	-0.8	7.0	0.2	-1.2	-0.2	2.0	-4.4	3.5	2.1	0.2	0.1	0.1	-1.2	2.2	3.5
Metals	-0.2	1.4	0.8	0.8	1.2	-0.0	-23.0	4.2	2.5	3.9	15.3	1.7	4.7	12.0	-0.8	-0.8	-3.3	-1.5	-1.0	4.7
Motor Vehicles	-1.2	1.1	0.0	0.4	0.4	-0.5	-5.9	3.0	-0.1	2.1	6.3	-2.6	2.9	3.8	-0.2	-0.1	-0.7	-1.8	1.9	2.9
Electronics	30.3	-2.9	-2.0	-5.8	-4.6	-4.2	81.3	-5.2	-7.6	-8.6	-15.1	-6.7	38.0	19.1	3.4	0.0	10.8	0.8	3.8	38.0
Machinery	8.5	-0.9	-1.6	-1.0	-0.9	-2.2	34.6	-2.1	-4.2	-5.8	-11.8	-8.1	2.6	-4.7	0.8	-0.1	3.2	-0.4	3.9	2.6
Other manufacturing	-2.0	0.9	0.7	1.8	1.0	0.2	-8.1	0.4	0.3	0.7	3.2	0.1	-3.5	0.4	-0.4	-0.2	-1.5	-2.0	0.2	-3.5
Electricity & Gas & Water	3.6	-0.1	-0.1	-0.0	-0.0	-0.1	-0.4	0.0	0.0	0.1	0.5	-0.7	-0.4	0.2	-0.0	-0.1	-0.1	-0.5	0.1	-0.4
Construction	0.1	0.0	-0.0	-0.0	0.0	-0.0	-0.7	0.2	-0.0	0.1	0.8	-0.2	0.1	0.3	-0.1	-0.0	-0.0	-0.3	0.2	0.1
Services	2.9	0.0	0.2	0.0	-0.0	0.1	-16.3	2.2	5.6	4.7	18.7	-6.5	8.5	17.5	-1.6	-1.6	-1.8	-9.5	5.5	8.5
Total	3.8	-0.0	-0.1	-0.1	-0.0	-0.1	38.2	4.3	0.0	2.7	36.3	-19.7	61.8	73.9	-1.2	-3.5	-0.8	-26.5	19.9	61.8

Source: Authors' simulation based on GTAP 8 Data Base (Narayanan et al., 2012).

Note: See Table 1.

Table 5: Impact on aggregate variables (% change)

Aggregate variables	China	Japan	East Asia	United States	Europe	Rest of the world
Wage	0.42	-0.36	-0.58	-0.18	-0.33	-0.22
Rental rate of Capital	-1.99	-0.32	-0.31	0.06	-0.22	0.48
National income (Welfare)	11.54	-0.32	-0.41	-0.07	-0.81	0.51
Capital stock	7.36	0.00	0.00	0.00	0.00	0.00
Imports	7.86	-0.19	-0.25	-0.04	-0.44	0.56
Exports	2.90	0.60	0.02	0.25	0.63	-0.47
GDP	2.68	-0.26	-0.40	-0.10	-0.26	0.18

Source: Authors' simulation based on GTAP 8 Data Base (Narayanan et al., 2012).

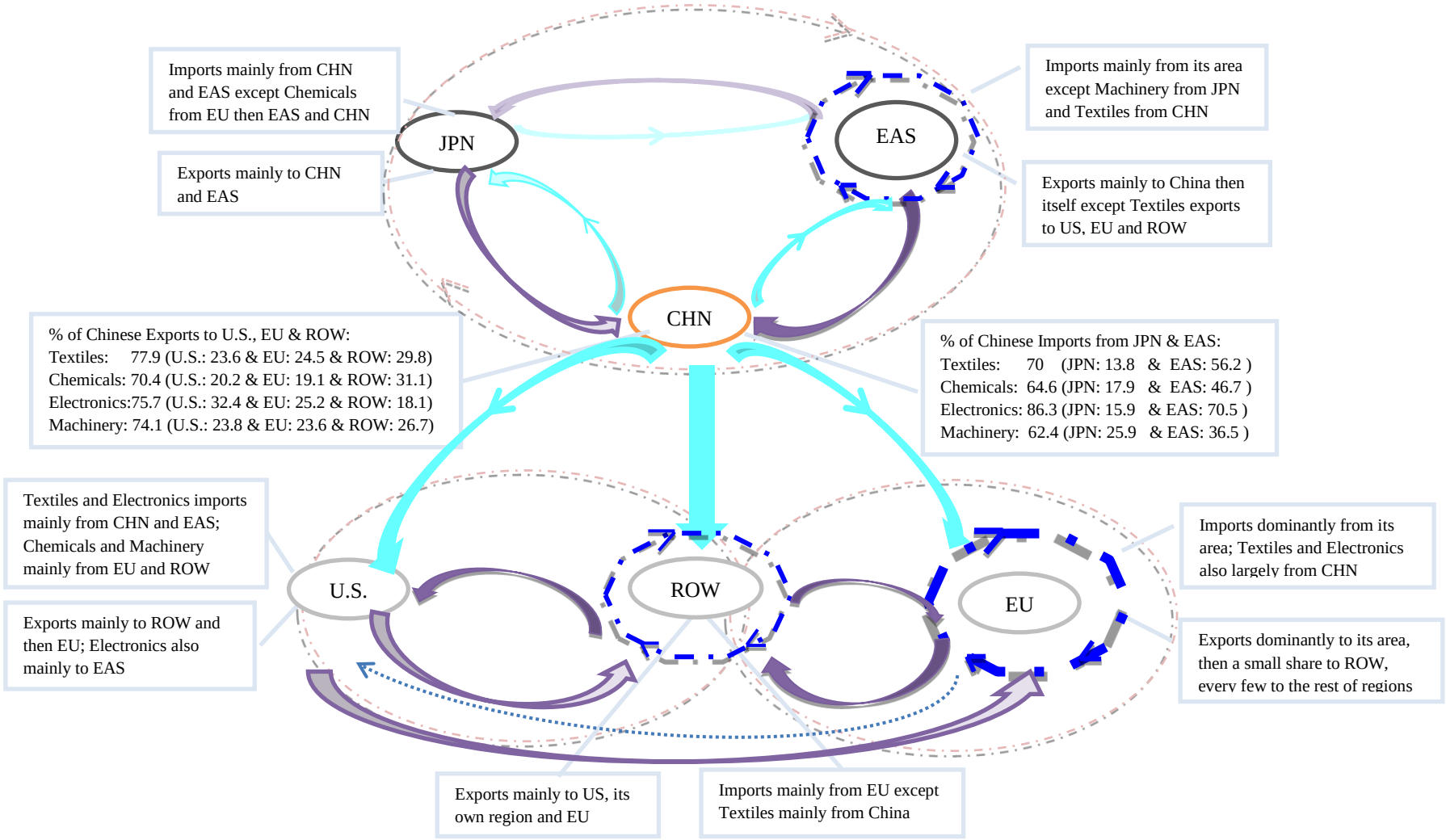
Table 6: Sensitivity analysis—impacts on aggregate variables (% change)

FDI shock		GDP						Imports						Exports					
		CHN	JAP	EAS	USA	EU	ROW	CHN	JAP	EAS	USA	EU	ROW	CHN	JAP	EAS	USA	EU	ROW
	Bench	2.7	-0.3	-0.4	-0.1	-0.3	0.2	7.9	-0.2	-0.2	-0.0	-0.4	0.6	2.9	0.6	0.0	0.2	0.6	-0.5
Elasticity of substitution between imports and domestic production	Half	2.6	-0.3	-0.4	-0.1	-0.3	0.2	7.3	-0.2	-0.2	-0.1	-0.3	0.3	2.0	0.6	0.0	0.2	0.8	-0.7
	Double	2.8	-0.3	-0.4	-0.1	-0.2	0.2	8.5	-0.1	-0.2	0.2	-0.6	0.9	3.9	0.6	0.1	0.5	0.4	-0.1
Elasticity of substitution between labor and capital	Half	2.3	-0.3	-0.6	-0.1	-0.3	0.2	9.6	-0.3	-0.3	-0.0	-0.6	0.7	2.7	0.7	0.1	0.3	0.9	-0.6
	Double	3.0	-0.2	-0.2	-0.1	-0.2	0.1	6.3	-0.1	-0.2	-0.0	-0.3	0.4	3.0	0.5	-0.0	0.2	0.4	-0.3
FDI shock		Wage						Rental rate of capital						National income					
		CHN	JAP	EAS	USA	EU	ROW	CHN	JAP	EAS	USA	EU	ROW	CHN	JAP	EAS	USA	EU	ROW
	Bench	0.4	-0.4	-0.6	-0.2	-0.3	-0.2	-2.0	-0.3	-0.3	0.1	-0.2	0.5	11.5	-0.3	-0.4	-0.1	-0.8	0.5
Elasticity of substitution between imports and domestic production	Half	0.2	-0.3	-0.6	-0.2	-0.3	-0.2	-1.9	-0.3	-0.3	0.0	-0.2	0.5	11.8	-0.3	-0.4	-0.1	-0.9	0.5
	Double	0.7	-0.4	-0.6	-0.2	-0.3	-0.3	-2.1	-0.3	-0.3	0.1	-0.2	0.5	11.1	-0.3	-0.4	-0.1	-0.7	0.5
Elasticity of substitution between labor and capital	Half	1.4	-0.5	-0.8	-0.2	-0.4	-0.3	-3.4	-0.4	-0.5	0.1	-0.3	0.6	12.2	-0.4	-0.6	-0.1	-1.1	0.6
	Double	-0.0	-0.2	-0.4	-0.1	-0.2	-0.2	-1.2	-0.2	-0.2	0.0	-0.2	0.4	10.9	-0.2	-0.2	-0.1	-0.5	0.4

Source: Authors' simulation based on GTAP 8 Data Base (Narayanan et al,. 2012)

Note: See Table 1.

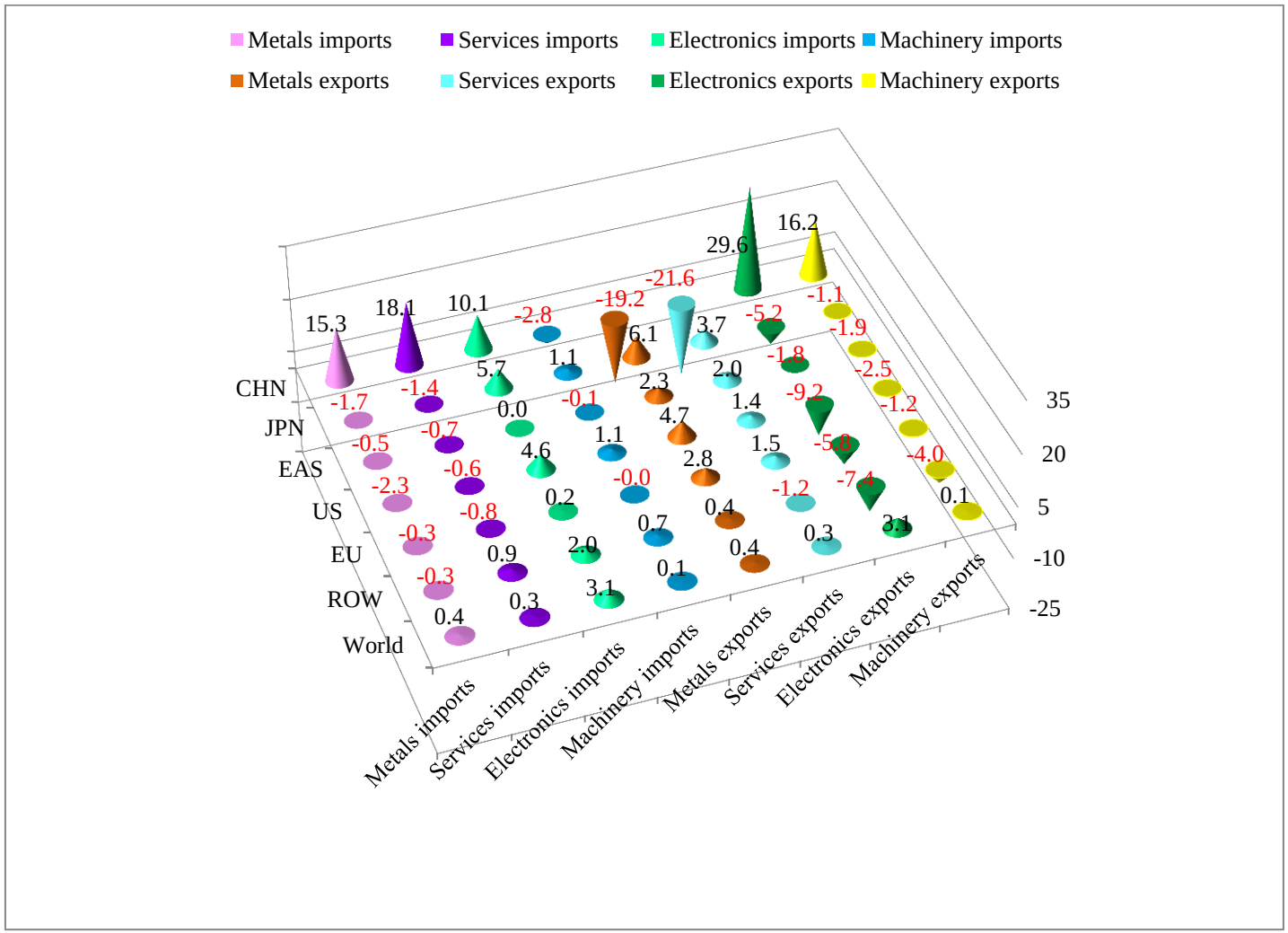
Figure 1: Main trade relationships of Textiles, Chemicals, Electronics and Machinery among regions



Source: Authors' caculation based on GTAP 8 Data Base (Narayanan et al., 2012)

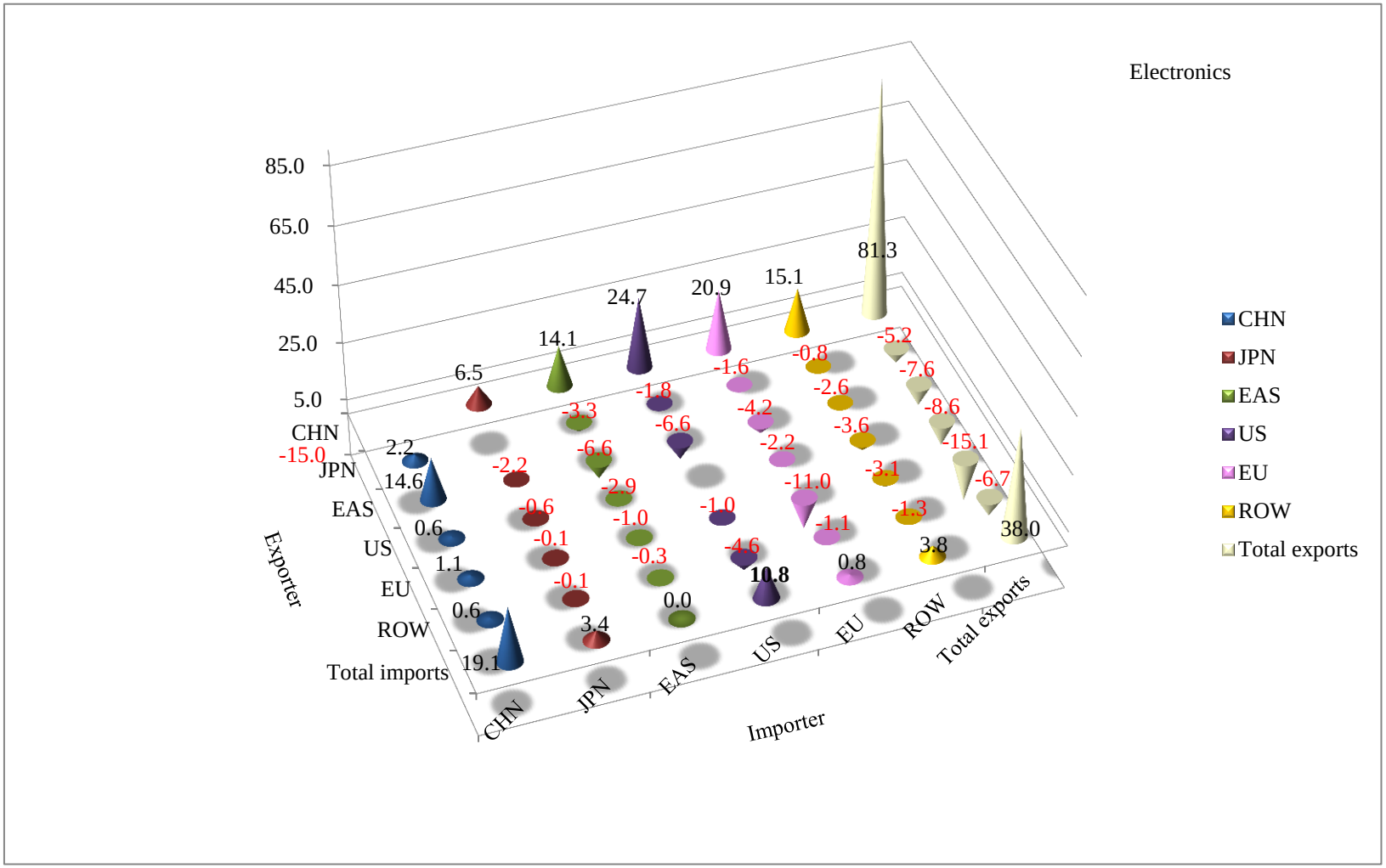
Note: see Table 1.

Figure 2: Impact on exports and imports of Metals, Services, Electronics and Machinery across regions (% change)



Source: Authors' calculation based on GTAP 8 Data Base (Narayanan et al., 2012).
Note: See Table 1.

Figure 3: Impact on Electronics bilateral trade (change in Billions $)



Source: Authors' calculation based on GTAP 8 Data Base (Narayanan et al., 2012).
Note: See Table 1.

Chapter 5. Conclusions

1. Main results

Regarding the sectoral adjustments…

We use a CGE model, namely, the GTAPinGAMS, whose equations appear in the appendix of Chapter 3, to analyze the interplay of FDI and global production networks (GPNs) in China. We provide an in-depth and step-by-step analysis of the evolution of trade patterns, as well as, a wide set of micro and macroeconomic results, analyzing the causation behind the adjustments after the FDI shock.

In Chapter 2 we focus on the analysis of FDI in Chinese Electronics, while Chapter 3 expands the study to FDI going to Machinery and Textiles in China. Finally, Chapter 4 examines the impact when FDI goes to the four most export oriented sectors of China, namely, Electronics, Textiles, Machinery and Chemicals. This progressive inclusion of new sectors allows deriving different patterns in their responses.

One important outcome is that the magnitude of the adjustments within each sector tends to be proportional to the amount of FDI received. Because Electronics experiences the highest increase in FDI inflows (100% increase), the scope of changes are largest within this sector. Next in importance come the adjustments in Machinery (50% of FDI increases), then Chemicals (30%) and, finally, Textiles (27%).

After discussing the magnitude of the adjustment let us turn to the patterns we find. The latter are graphically summarized in the diagram of Figure 2 in Chapter 3. The output of all the sectors receiving FDI inflows expands and their prices fall. This is a common pattern they all share. Some contrasts arise, however, in the adjustment of other variables in the different sectors to which FDI accrues. Most, but not all of them, will export more after the shock, while some will also import more and others will reduce imports.

The exports of Electronics, Machinery and Chemicals increase, contrasting with the reduced exports of Textiles. Chinese price reductions tend to increase its export competitiveness. The pattern in Textiles differs because, even though, it is a quite export oriented sector, it also exhibits a high weight in Chinese private consumption. After the shock of FDI national

income increases in China and private demand will go up. As a result, more Textiles will be demanded and less will be exported. What is more, the amount of Textiles imports increase, after the shock in China, in order to satisfy the rising demand for these goods. In fact, the imports of Electronics, Chemicals and Textiles go up while those of Machinery imports decrease after the same shock reflecting the arrival of FDI flows. Because imported intermediates in Electronics and Chemicals are very intensively used in their respective production processes, their output expansion will require more imported intermediates. The production technology in Machinery relies more heavily on domestic intermediates. That is why the cheaper domestic intermediates of Machinery will replace some of the previous imports of intermediates in this sector.

Regarding the regions involved…

East Asia, as the biggest supplier of Chinese imports, undergoes the most substantial changes in trade. When China enlarges the imports of Electronics, Chemicals and Textiles, the amount of exports increased mainly comes from East Asia. Similarly, when China reduces the Machinery imports, East Asia experiences the biggest reduction in Chinese imports. The U.S., Europe and ROW are the biggest markets for Chinese exports. So they are the main destinations of the increases in Chinese exports after the shock.

Our analysis confirms the existence of production networks. China relies heavily on East Asian intermediate supply and its increasing exports mainly go to the U.S., Europe and ROW. The "Triangular trade pattern" prevails among China, East Asia and the developed economies, especially in Electronics and Chemicals. Chinese Machinery also shows a strong production network with East Asia but less intensively than the other two sectors, because its production uses intensively domestic intermediates. Though Textiles has a close trade relation with East Asia, this production network is weaker than the previous ones, given that its production mainly relies on its domestic intermediate inputs and it is a more private consumption oriented sector. Our results are consistent with the analysis of Koopman et al. (2012), Haddad (2007), Dean et al. (2011) and Costinot et al. (2012). However, we also derive what the impact of these GPNs interacting with FDI is.

In chapters 2 and 3 our analysis has focused on four regions (China, East Asia, the U.S. and ROW). This multi-regional framework is expanded to two more regions in Chapter 4, separating Japan from East Asia and Europe from ROW. We analyze now these latter setting with richer results. Recall that FDI accrues also to the biggest number of sectors we have analyzed, four. Interestingly, at the aggregate level, the results vary substantially across the regions considered. Only China and ROW benefit from the FDI inflows, while the other regions get harmed according to the changes of GDP and welfare.

To be more specific, ROW, relying heavily on exports of Mining, gains from FDI inflows in China. The rest of regions, especially East Asia, experience a fall in their GDP and welfare. The essence for this contrast is the GDP, import and export structure across regions. The GDP structure of East Asia is close to that of China, i.e., their shares tend to be high or small across the same type of sectors in these two regions. The main negative outcomes for East Asia arise from its decrease in production in the sectors in which China is more aggressive (Electronics, Machinery and Chemicals). These three sectors explain 13.3% of GDP in East Asia, the highest share among all the regions considered. As a consequence, its fall in GDP is the largest across all regions (-0.4%, approximately).

Japan and Europe are intermediate cases in the sense that they are crowded out in some sectors but are able to compensate that by exporting more in other sectors. The GDP structure in the U.S. and ROW differs more than the ones of the two other regions, compared to the Chinese one. So they are least affected. As already noted, ROW even gets better off, because it is specialized in sectors from which China will demand more.

In the light of the literature on vertical specialization, this paper finds that engaging in networks with China does not guarantee profitable outcomes. As noted above, East Asia will, generally, supply important intermediates for the sectors in which China increases production, thus exporting more to China. But it will be displaced by China in the rest of markets. The latter effect prevails and East Asia will reduce its overall exports.

Our general equilibrium analysis allows to further analyze the role of regions as final markets. We could a priori expect that consumers would benefit from cheaper Chinese imports. This does not seem to be the case, either. Europe, the U.S. and ROW are the main

destinations of Chinese exports. These may become cheaper, but the point is that Europe, the U.S. and ROW are also important producers in the world.

Our analysis reveals that the forces from the production side of the economy are more important than the ones from the consumption side. As we have said, this benefits ROW but will harm Europe and the U.S. in a different magnitude. All these results are derived taking into account many different dimensions, such as, the particular production technologies of each of the sectors (e.g., the intensity of the use of imported versus domestic intermediates in production) and their demand orientation (e.g., the private consumption orientation of Textiles and export orientation of the rest of sectors). Furthermore, the proportions of each of the regions in world trade and GDP, as well as, the particular dimension of the sectors directly involved in the FDI shock, both within each region or country and in terms of the world have been deeply analyzed.

2. Main contributions

This PhD dissertation provides a holistic view of the interplay between FDI and GPNs. It uses a multiregional model which allows analyzing a rich set of micro and macroeconomic results. Unlike the existing literature on GPNs in which Input-Output analysis is the dominant methodology, we use a CGE. To the best of our knowledge no previous CGE analyses on the interactions between FDI and GPNs exist. Only Kawai and Zhai (2009) use a CGE to illustrate the transmission of global financial crisis through the reduction in final demand, which further impacts on the fall of Chinese demand for intermediate imports from Asian economies.

As noted in the introductory chapter, one of the main challenges for trade statistics nowadays is to combine the dimension of type of good traded (i.e., final versus intermediate) with that of country of origin. The Chinese trade data are however, so "extreme", that even in the absence of exact information on this double dimension, it *must be* the case that East Asia provides most of the imported intermediates of China and that most of Chinese final goods

are directed to Western Markets. The available data in the GTAP Data base have been explored in detail in Chapters 2, 3 and 4 and are graphically summarized in Figure 1 of Chapter 4. These analysis and data provide new evidence that confirms the existence of strong production networks in East Asia, which through China export the final goods to Western markets. However, giving a step further we find the outcomes we have just summarized above, many of which, to the best of our knowledge, were not present in the literature. We identify winners and losers, as well as, differential and common patterns across four sectors.

Some policy implications arise from our findings. FDI strengthens the role of China as a production center and export base in the world. However, FDI inflows pose an upward pressure on wages. As a consequence, China might lose its attractiveness for processing and assembly trade, as some authors have pointed out (Xing, 2010). Note, however, that we obtain an important qualification when we differentiate between skilled and unskilled wages in Chapter 3. There we model capital and skilled labor as sector-specific, while unskilled labor is fully mobile within but not across regions. The results derived show that the aggregate skilled wages are pushed up by 1.9%. By contrast, the unskilled wages are pulled down in China, 0.7%, following the entry of FDI in Electronics, Machinery and Textiles. So maybe, in the end, there is not such pressure for unskilled wages and China could continue being an attractive area for FDI in low value added products.

What is more, an increase in wages has the positive side of stimulating the private consumption in China, which may help to change the Chinese growth pattern. The latter is highly dependent on imports for key intermediates and on exports. This may well be limiting Chinese innovation. Instead, it could be better to develop production technology at home and rely more on domestic intermediates than imported ones, moving up in the value chain. Furthermore, the Chinese external dependence and exposure may imply other dangers. An additional danger of being so exposed to external markets is what Kawai and Zhai (2009) have found using a CGE model. As noted above, production networks are also a mechanism of transmission of vulnerabilities that arise elsewhere.

One way for China to move up in the value chain may, precisely, be FDI. This is an important instrument for policy intervention since we have seen that the magnitude of FDI

inflows proportionally affects the relevant changes in sectoral variables (such as exports, production, prices, and etc.). If China wishes to move up the value chain, they could set up incentives to attract FDI inflows in the high-tech sectors. Koopman et al. (2012) and Baldwin and Lopez-Gonzalez (2013) find that China is moving up to some extent in the value chain, although they point out that processing trade is still pervasive. Our results of Machinery, which substitutes the imported intermediates with domestic ones, fit well with the idea that China could be moving up in the value chain. The 'Xiaomi' smart phone[1] is also a typical case in which a Chinese domestic firm tries to catch up with the high-tech leader.

For the rest of regions, our results also point out that getting engaged in production networks can be a double-edged sword, if the regions that integrate later compete in export markets, as happens with East Asia and China. The best industrial policies outside China should further strengthen the comparative advantage in the sectors in which China competes less. Besides, final markets may not benefit from Chinese cheaper imports if they are also important producers and are displaced by Chinese competition, therefore, reducing their production.

In brief, our work has shed new lights, using a general equilibrium perspective, on the relative darkness regarding the effects of the FDI and GPNs.

3. Proposals for future research

We are aware of some limitations that are present in our current analysis. First, FDI is an activity of MNEs and MNEs have not been explicitly modeled in our CGE. To the best of our knowledge only Hosoe (2014), Latorre and Hosoe (2013) and Lakatos and Fukui (2013) have introduced different cost structures of national firms and MNEs operating within the same sector in a multi-regional CGE model of FDI. In our analysis, we focus on the presence and effects of GPNs and we do not have data on how the production, imports and exports within the production networks are related to domestic of foreign firms in China. Therefore,

[1] "Xiaomi Phone faster, cheaper than iPhone4", http://www.chinadaily.com.cn/kindle/2011-08/19/content_13151719.htm

we do not model MNEs but FDI, which accrues to particular sectors in China. This is a fairly good proxy in the case of Electronics in which 80% of the production is in the hands of MNEs, but it is not such a good proxy in Textiles, Machinery and Chemicals. In the latter, 24%, 27% and 24% of production are under MNEs' control in China, according to NBSC (several years). These sectors are constituted by domestic and foreign MNEs which we do not separate. Note, however, that the modelization of increases of FDI in particular sectors is only possible using the GAMS software for CGE models and is not possible with the alternative GEMPACK software. With GEMPACK only capital increases for the whole economy can be introduced in the shock, without being able to introduce them in selected sectors.

Second, introducing imperfect competition and increasing returns to scale is also another avenue for future research. Among the few CGE models with MNEs only Jensen and Tarr (2012) include it, although, they do not model explicitly a multi-regional framework. Latorre (2014), following Jensen, Rutherford and Tarr (2010) also develops a CGE with a climate of imperfect competition that is, however, a one-country model. It seems, therefore, that the combination of a multi-regional setting of MNEs with imperfect competition is a challenge in the CGE literature.

Additionally, since FDI is a form of investment another possible extension is to use recursive model like Hosoe (2014) and Latorre and Hosoe (2013) instead of a static one. We could also introduce unemployment in the line of the study by Gómez-Plana and Latorre (2014), which is to the best of our knowledge the only model that combines the presence of both MNEs and unemployment. These are the main suggestions for further work based on current work.

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