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The Trade Impact of China on EMU: Is It Even Across Members?

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Abstract

This paper investigates the asymmetries in trade spillovers from sector-specific technology shocks in China to selected euro area countries. We use a Ricardian-gravity trade model to estimate sectoral competitiveness in individual euro area countries. Simulations on the impact of productivity shocks in Chinese textiles and machinery suggest that the required adjustment in wages, prices, and factor re-allocation is widely heterogenous across euro area countries on accounts of their different specialization patterns. This raises the question of the distribution of gains and losses from external trade shocks.

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I. INTRODUCTION

Economic integration as experienced by EMU countries can potentially result in significant changes in specialization patterns. Trade theory offers different predictions as to how integration affects specialization. Classical theory suggests that the elimination of obstacles to trade leads to greater divergence in the productive structures and the deepening of comparative advantages. The new trade theory, by contrast, holds that integration encourages the use of economies of scale and is likely to reduce cross-country sectoral specialization. One decade later production structures remain diverse. This paper investigates how different specialization patterns expose countries asymmetrically to external competitiveness shocks, in particular sector-specific technological progress in China.

To this aim, we adopt a multi-sector Ricardian-gravity trade model (Eaton and Kortum, 2002; Shikher, 2004) where specialization and trade flows are shaped by technology, factor costs and trade barriers. Unlike conventional gravity models (starting with Tinbergen, 1962), which assume complete specialization arising from either differences in factor endowments (Evenett and Keller, 2002) or economies of scale (Krugman, 1991), our framework postulates incomplete specialization.

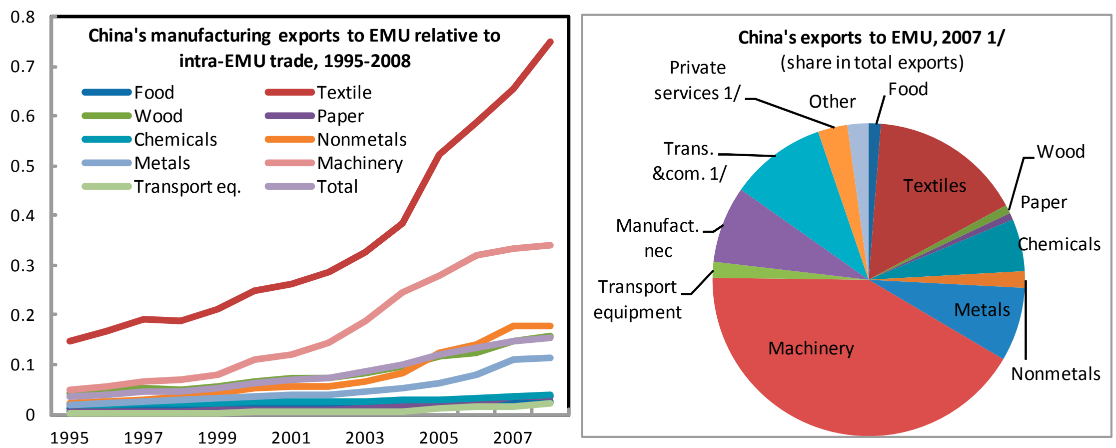
We use the model to answer two distinct questions. First, what is the relative competitiveness position of individual euro area countries and China in key economic sectors? Second, how does specialization shape the adjustment to technological progress in Chinese textiles and machinery? We address this question both in a flex-price-full-mobility model and where these adjustment mechanisms are defective. The focus on these two industries, which is merely illustrative, is justified by the fact that they represent China's largest export sectors.

The rest of the paper is organized as follows. Section II describes trade and specialization patterns in euro area countries and China. Section III presents the model that is used to estimate relative competitiveness positions in Section IV. Section V gauges the general equilibrium impact on nine euro area countries of sector-specific technology shocks in China. Section VI concludes with a number of policy implications.

II. Trade and Sectoral Specialization: China and the Euro Area

Chinese exports to the euro area have largely outpaced intra-EMU trade since the start of the single currency (Figure 1). By sectors, imports from China (relative to intra-EMU trade) went up quickly in textiles and machinery—respectively from 20 and 10 percent in 1999 to around 80 and 35 percent one decade later. By 2007, the two industries accounted for more than half of all Chinese exports to EMU, with machinery featuring as the largest export sector to the euro area (and to the world) in absolute terms.

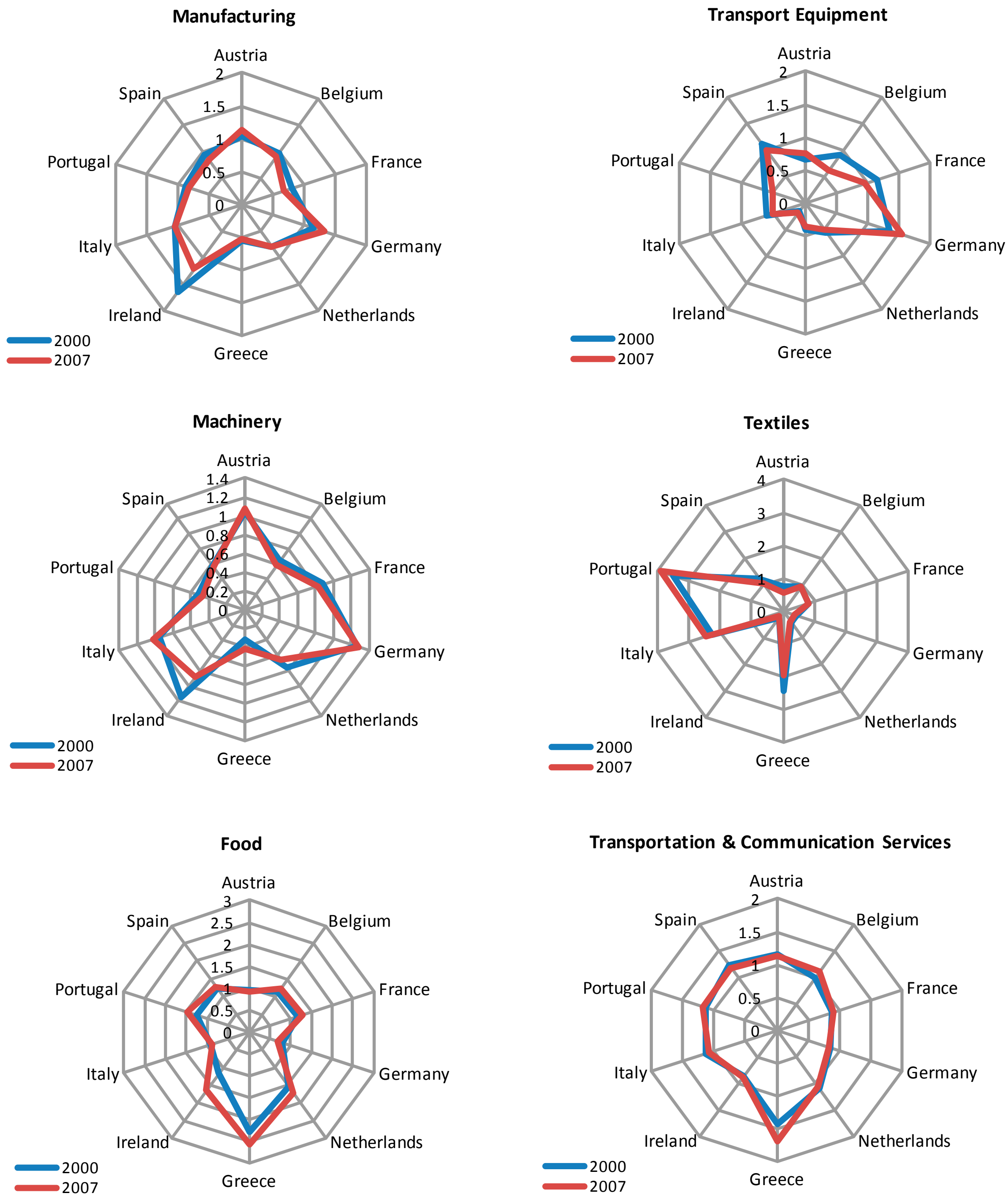
Figure 1: China's Exports to the Euro Area



Source: OECD Bilateral Trade Database and Global Trade Analysis Project (GTAP).
1/ Data for services is from 2004.

There is little evidence of convergence in specialization patterns during the past decade, but rather production structures have remained remarkably stable and distinct across countries (Figure 2). Production is concentrated on textiles in Portugal, Italy, and Greece; food in Ireland, Greece and the Netherlands; machinery in Austria, Italy and also Germany, where transport equipment is equally predominant; transportation and communication services (related to tourism) in Greece; and non-tradables, such as construction, in Greece, Portugal, and Spain (not reported).

Figure 2. Sectoral Specialization in ten Euro Area Countries, 2000 and 2007 1/



Source: OECD STAN.
1/ All charts show Balassa indices, defined as industry *j*'s share in country *i*'s overall value added relative to the same ratio in the euro area. A value larger than one indicates that the country is relatively specialized in sector *j*.

III. A Ricardian-Gravity Trade Model

Divergent specialization patterns can expose euro area countries asymmetrically to external competition. To explore this hypothesis, we present a general equilibrium model where competitiveness is sector-specific and influenced by technology, factor costs, and trade barriers. The world economy is made of N countries and J sectors. Each sector j is made of a continuum of goods $q_j \in [0,1]$ which can be used either for final consumption or as intermediate inputs. Both firms and consumers operate in competitive markets and combine goods in a CES fashion with elasticity σ_j[2]. There are two inputs, labor and capital. Capital is fully mobile, while labor is mobile across sectors but immobile across countries.

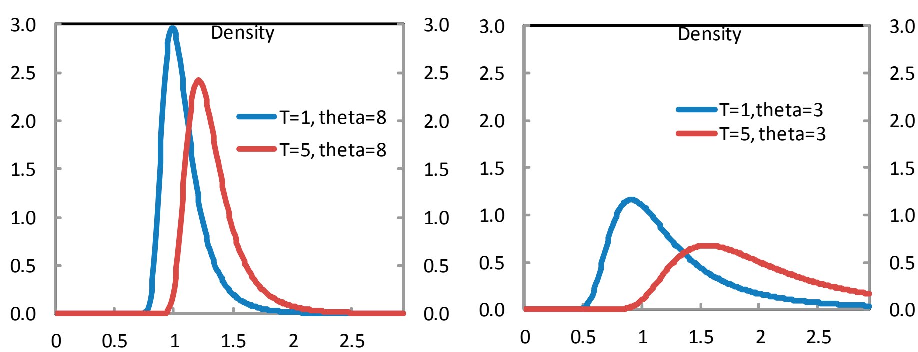
Technology and Price Formation

Producing one unit of good q_j requires $1/z_i(q_j)$ input bundles, where $z_i(q_j)$ denotes country i's technology, as given by the Frechet cumulative distribution[3]

$$F_{i,j}(z) = e^{-T_{i,j} z^{-\theta_j}} \tag{1}$$

where parameters $T_{i,j} > 0$ and $\theta_j > \sigma_j - 1$ respectively shape the distribution's scale and dispersion (Figure 3). With the Frechet specification, goods are produced using the frontier technology distribution, prices follow an extreme value distribution, and expressions for trade shares can be easily obtained.

Figure 3: Density Function for Technology 1/



Source: The authors.
1/ The charts illustrate the effect of θ and T for the technology draws from the Frechet distribution.

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[2] Algebraically, the CES aggregator is $Q_{n,j} = \left[\int_0^1 Q_n(q_j)^{\frac{\sigma_j - 1}{\sigma_j}} dq_j\right]^{\frac{\sigma_j}{\sigma_j - 1}}$ with $Q_{n,j}$ the quantity of composite sector j good in country n and $Q_n(q_j)$ the quantity of individual sector j good q_j.

[3] For the micro-foundations of this assumption see Kortum (1997).

Let us denote by $c_{i,j}$ the cost of producing one input bundle (see further below), of which $1/z_i(q_j)$ is required to produce q_j , and $d_{ni,j} > 1$ the units of good q_j foregone as a result of trade barriers to deliver q_j from country i to country n. The overall production costs of q_j are therefore given by

$$p_{ni}\left(q_j\right)=\frac{c_{i,j}}{z_i\left(q_j\right)}d_{ni,j} \tag{2}$$

thus the price paid by country n for good q_j when delivered by country i is driven by country i's technology and input costs, as well as the trade barriers between n and i. To see how these factors shape trade patterns, we compare the expected foreign price from (2) with the expected cost of producing j good domestically

$$\frac{E\left(p_{ni}\left(q_j\right)\right)}{E\left(p_{nn}\left(q_j\right)\right)}=\left(\frac{T_{n,j}}{T_{i,j}}\right)^{1/\theta_j}\frac{d_{ni,j}c_{i,j}}{c_{n,j}} \tag{3}$$

Expression (3) links the ratio of external to domestic prices with relative technology, factor costs and trade barriers. $T_{i,j}$ and θ_j respectively govern comparative advantages across and within sectors. If, for instance, $\frac{T_{DEU,Mach}}{T_{DEU,Text.}} > \frac{T_{CHN,Mach.}}{T_{CHN,Text.}}$ and $\theta_{Mach.} = \theta_{Text.}$, Germany holds comparative advantage against China in machinery and draws for high values of z will be more likely for German machinery products relative to textiles as compared with China. In addition, with limited within-sector technological dispersion (high θ_j as in Figure 3, left) the exporter of a particular j good will most likely be the country with comparative advantage in that sector, and countries' gains from trade will be more muted.

Production of Input Bundles

Input bundles which are produced using labor, capital, and intermediate inputs through a Cobb-Douglas technology[4]

$$B_{i,j}=\kappa_{i,j}\left(L_{i,j}^{\delta_{i,j}}K_{i,j}^{1-\delta_{i,j}}\right)^{\beta_{i,j}}\left(\prod_{k=1}^{J}M_{i,jk}^{\gamma_{i,jk}}\right)^{1-\beta_{i,j}} \tag{4}$$

where $B_{i,j}$ denotes sector $j's$ input bundles produced in country i; and $L_{i,j}, K_{i,j}$ and $M_{i,jk}$ are labor, capital and the amount of sector k goods employed in j's production. The distribution parameters include: the share of value added in $j's$ output $\beta_{i,j}$; the share of intermediates in

[4] This implies that prices are also in Cobb-Douglas factor and intermediate inputs, which makes the model tractable.

$j's$ output $1-\beta_{i,j}$; the labor's share in value added $\delta_{i,j}$; and sector k's share of intermediates in j's output $\gamma_{i,jk}$ (with $\sum_{k=1}^{J}\gamma_{i,jk}=1$). The coefficient $\kappa_{i,j}$ is a convolution of all four distribution parameters[5].

The cost of producing one input bundle is minimized at

$$c_{i,j}=\left(w_i^{\delta_{i,j}}r_i^{1-\delta_{i,j}}\right)^{\beta_{i,j}}\left(\prod_{k=1}^{J}p_{i,k}^{\gamma_{i,jk}}\right)^{1-\beta_{i,j}} \quad (5)$$

where w_i is wages, r_i is the capital's rental rate, and $p_{i,k}$ is sector $k's$ price index consistent with a CES aggregator[6]. From (2) and the assumption of Frechet distributed technology (1) the aggregate price index for sector j in country n is

$$p_{n,j}=\tau_j\left[\sum_{i=1}^{N}T_{i,j}\left(c_{i,j}d_{ni,j}\right)^{-\theta_j}\right]^{-1/\theta_j} \quad (6)$$

where τ_j is a parameter that depends on σ_j, the elasticity of substitution between goods, and θ_j, the technology dispersion, both assumed to be equal across countries[7]. Figure 4 provides a characterization of the production structure in the model, which is the starting point for the determination of trade flows.

Trade Flows

With perfect competition goods are supplied by the country than can deliver at the lowest costs. Given a continuum of sector j goods, the probability that country i becomes the lowest cost provider to country n of a sector j product, $\pi_{ni,j}$, is equal to the fraction of goods that n imports from country i in sector j. For a Frechet distribution, this is

$$\pi_{ni,j}=\frac{X_{ni,j}}{X_{n,j}}=\eta^{-1}E\left(\frac{p_{n,j}/\tau_j}{p_{ni}\left(q_j\right)}\right)^{\theta_j} \quad (7)$$

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[5] Specifically, $\kappa_{i,j}=\left(\delta_{i,j}\beta_{i,j}\right)^{\delta_{i,j}\beta_{i,j}}\left[\left(1-\delta_{i,j}\right)\beta_{i,j}\right]^{(1-\delta_{i,j})\beta_{i,j}}\prod_{k=1}^{J}\left[\gamma_{i,jk}\left(1-\beta_{i,j}\right)\right]^{\gamma_{i,jk}(1-\beta_{i,j})}$.

[6] Specifically, sector js price in country n is given by $p_{n,j}=\left[\int_0^\infty p^{1-\sigma_j}dG_{n,j}(p)\right]^{\frac{1}{1-\sigma_j}}$ where $G_{n,j}(p)$ is the cumulative distribution of prices paid in country n for j goods. As technology follows a Frechet distribution, this is given by $G_{n,j}(p)=1-e^{-\sum_{i=1}^{N}T_{i,j}(c_{i,j}d_{ni,j}/p)^{-\theta_j}}$.

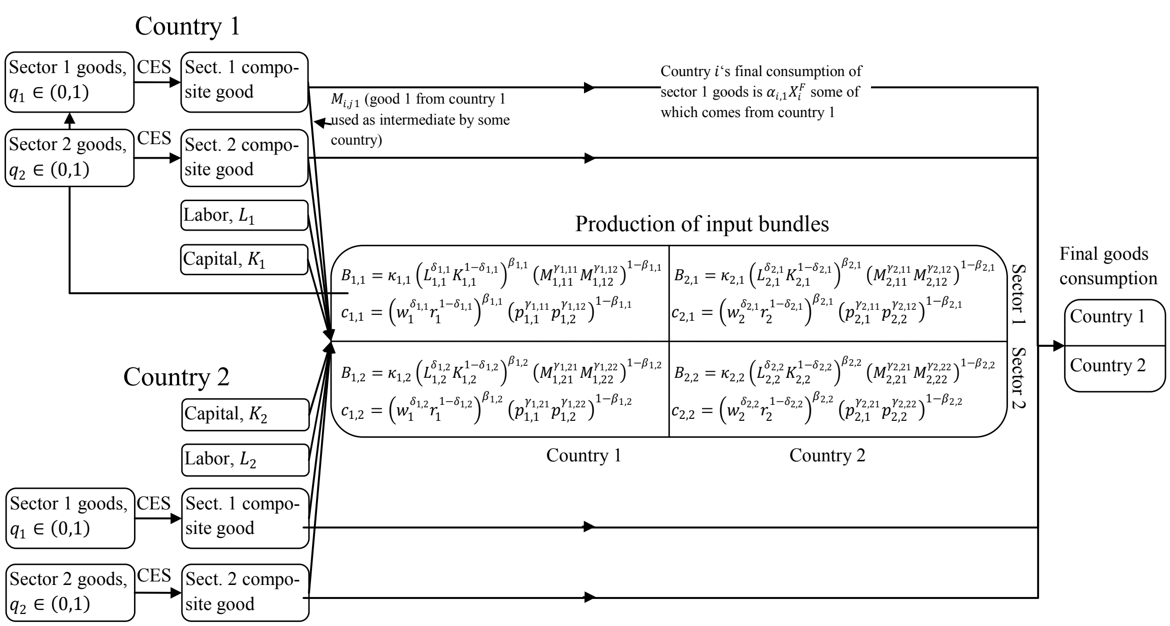
[7] As in Waugh (2010), our specification allows for country-specific technological levels, but restricts technological dispersion to be the same across countries (i.e. different $T_{i,j}$, but similar in θ_j across countries). Similar σ_j implies that the degree of substitutability between goods is the same across countries.

which shows that country n's imports from country i of sector j goods ($X_{ni,j}$) as a share of country n's overall expenditure on sector j goods ($X_{n,j}$) is higher the lower the ratio of (expected) foreign prices, $p_{ni}(q_j)$, to domestic prices, $p_{n,j}$. Inserting the price rule (6) and the expected value of technology into the equilibrium condition for trade flows (7) yields

$$\pi_{ni,j} = \frac{X_{ni,j}}{X_{n,j}} = \frac{T_{i,j}\left(c_{i,j}d_{ni,j}\right)^{-\theta_j}}{\sum_{s=1}^{N} T_{s,j}\left(c_{s,j}d_{ns,j}\right)^{-\theta_j}} \tag{8}$$

whereby country $i's$ export share in country n is influenced by technology, factor costs, and trade barriers. Expression (8) is a conventional gravity equation augmented with technology. When technological dispersion is limited (high θ_j), trade shares become more elastic with respect to costs and trade barriers. In Section IV we use (8) to estimate sector-specific competitiveness in nine euro area countries and China.

Figure 4 –Production Structure with 2 Countries and 2 Sectors



IV. Estimating Relative Competitiveness

From (8), the share of n's imported j goods from i relative to n's home expenditure in j goods is given by[8]

$$\ln\left(\frac{X_{ni,j}}{X_{nn,j}}\right) = \ln\left(T_{i,j}c_{i,j}^{-\theta_j}\right) - \ln\left(T_{n,j}c_{n,j}^{-\theta_j}\right) - \theta_j \ln d_{ni,j} \tag{9}$$

with the share being larger the higher i's cost and technological advantage over n and the lower the trade barriers $d_{ni,j}$ between the two countries. As in the gravity literature, let $d_{ni,j}$ be given by

$$\ln d_{ni,j} = dist_{ni,j} + b_{ni,j} + l_{ni,j} + RTA_{ni,j} + CU_{ni,j} + ex_{i,j} \tag{10}$$

where $dist_{ni,j}$, $b_{ni,j}$, $l_{ni,j}$, $RTA_{ni,j}$ and $CU_{ni,j}$ are (sector-specific) dummies for distance, shared border, common language, regional trade agreements, and membership to a currency union. The remaining barriers are captured by the fixed effect, $ex_{i,j}$. Inserting (10) into (9) gives

$$\ln\left(\frac{X_{ni,j}}{X_{nn,j}}\right) = S_{i,j} - S_{n,j} - \theta_j dist_{ni,j} - \theta_j b_{ni,j} - \theta_j l_{ni,j} - \theta_j RTA_{ni,j} - \theta_j CU_{ni,j} \tag{11}$$

where $S_{i,j} = \ln\left(T_{i,j}c_{i,j}^{-\theta_j}\right) - \theta_j ex_{i,j}$ and $S_{n,j} = \ln\left(T_{n,j}c_{n,j}^{-\theta_j}\right)$ are treated as fixed effects in (11). It is now possible to extract technological coefficients relative to a reference country by: using (5) and (6) in $S_{n,j} = \ln\left(T_{n,j}c_{n,j}^{-\theta_j}\right)$ with the estimates for $S_{i,j}$ and $S_{n,j}$ from (11); and using data on factors' remuneration, trade flows, and domestic expenditure on final and intermediate goods. Specifically

$$\begin{aligned}\ln\frac{T_{n,j}}{T_{DEU,j}} &= \ln\frac{\hat{S}_{n,j}}{\hat{S}_{DEU,j}} + \theta_j\beta_{n,j}\left(\delta_{n,j}\ln\frac{w_n}{w_{DEU}} + \left(1-\delta_{n,j}\right)\ln\frac{r_n}{r_{DEU}}\right) + \\ &\left(1-\beta_{n,j}\right)\sum_{k=1}^{J}\gamma_{n,jk}\left(\ln\frac{X_{nn,k}/X_{n,k}}{X_{DEU,DEU,k}/X_{DEU,k}} - \ln\frac{\hat{S}_{n,k}}{\hat{S}_{DEU,k}}\right)\end{aligned} \tag{12}$$

Equation (11) is estimated with 2005 data on bilateral imports ($X_{ni,j}$), expenditure on domestically produced goods ($X_{nn,j}$), and data for trade barriers. The sample comprises nine

[8] With $X_{nn,j} = Y_{n,j} - EX_{n,j}$ and $X_{n,j} = Y_{n,j} + IM_{n,j} - EX_{n,j}$, then $X_{nn,j} = X_{n,j} - IM_{n,j}$.

euro area countries (Austria, Belgium, Finland, France, Germany, Greece, Italy, Portugal, and Spain); six additional EU countries (Czech Republic, Hungary, Poland, Slovenia, Sweden, and the United Kingdom); and Japan, US, and China. The sample covers 11 tradable sectors (9 manufacturing, 2 services) and one non-tradable sector[9]. Appendix 1 describes in detail the data sources and sample countries and sectors.

To extract the technological coefficients using (12) we calibrate distribution parameters $\gamma_{i,jk}$, $\beta_{i,j}$, and $\delta_{i,j}$ using OECD input-output tables.[10] The values for sector-specific technology dispersion θ_j are taken from Caliendo and Parro (2011). However, our findings are qualitatively robust to alternative values of θ_j. Data for wages, w_n, are compensation per employee obtained from UN's INDSTAT database. The assumption of full capital mobility ($r_i = r_n$) implies that capital costs are equalized across countries[11].

Based on this data, we compute countries' competitiveness $T_{n,j}c_{n,j}^{-\theta_j}$ relative to Germany, which takes value one. We place countries along "iso-competitiveness curves" (Figures 5a–5b)[12], defined as the locus of technology values and factor costs that render the same competitiveness level (with higher competitiveness on curves at further distance from the origin).

China is most competitive in the textile industry, followed by a considerable distance by nonmetals, food and chemicals. By contrast, it performs poorly in service sectors. The euro area periphery (and, to a lesser extent, France) fares well in sectors in which China is also competitive, alongside metals and tradable services, while the core is most competitive in machinery and transport equipment.

Focusing on specific competitiveness factors, China's strong performance primarily stems from low production costs (its position on the "iso-unemployment curves" is leaning towards the Y-axis). The picture in the euro area is mixed. Portuguese and Greek competitiveness in textiles is mainly driven by low costs while Germany's and Finland's strong position in machinery relies on their superior technology. In addition to technology and cost

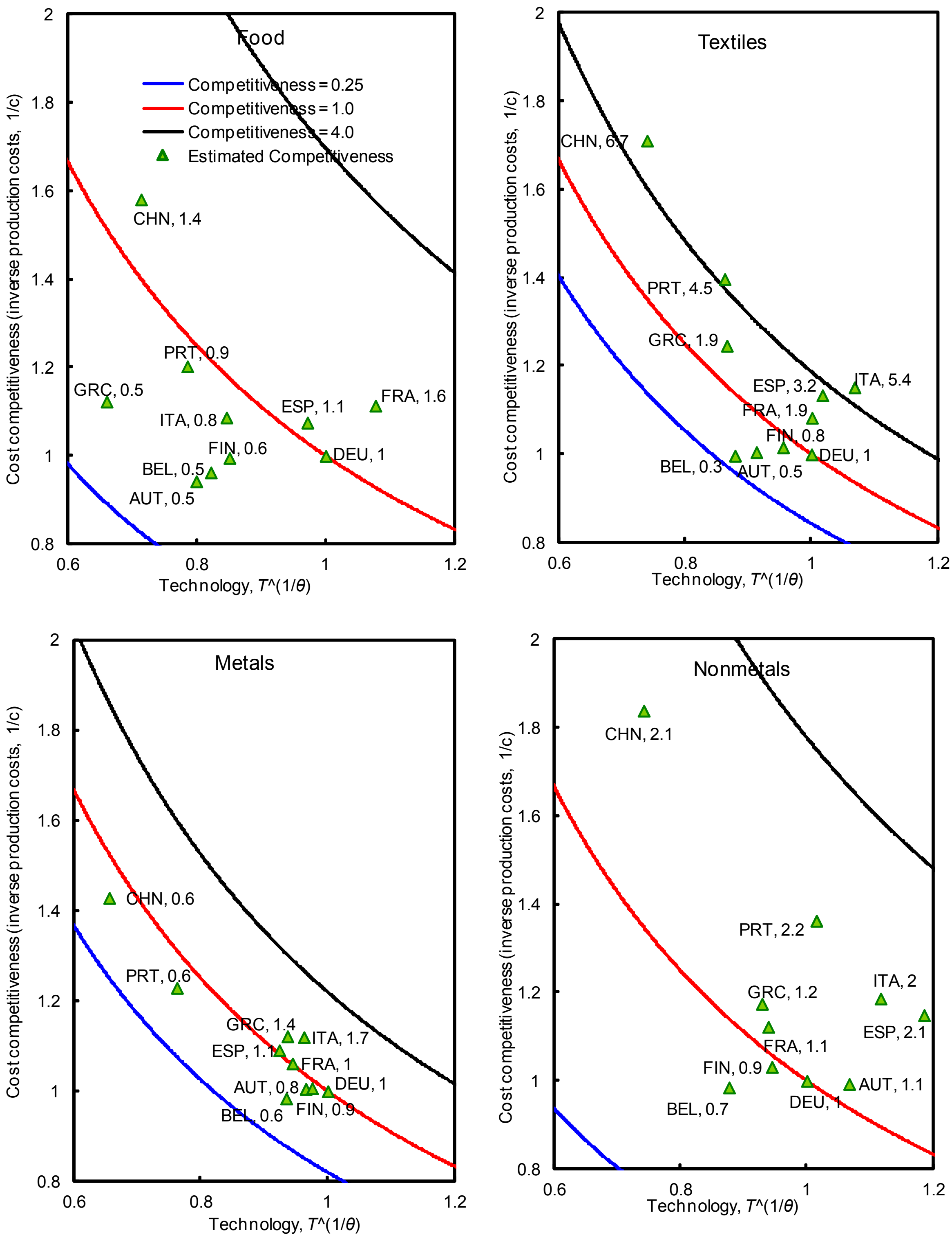
[9] The non-tradable sector acts as a numeraire.

[10] For $\delta_{i,j}$ we take the cross-country sample average.

[11] If, as argued by IMF (2011), capital costs in China are below normal due to various distortions, our estimates will understate China's production costs and overstate its technological level, but with no impact on competitiveness.

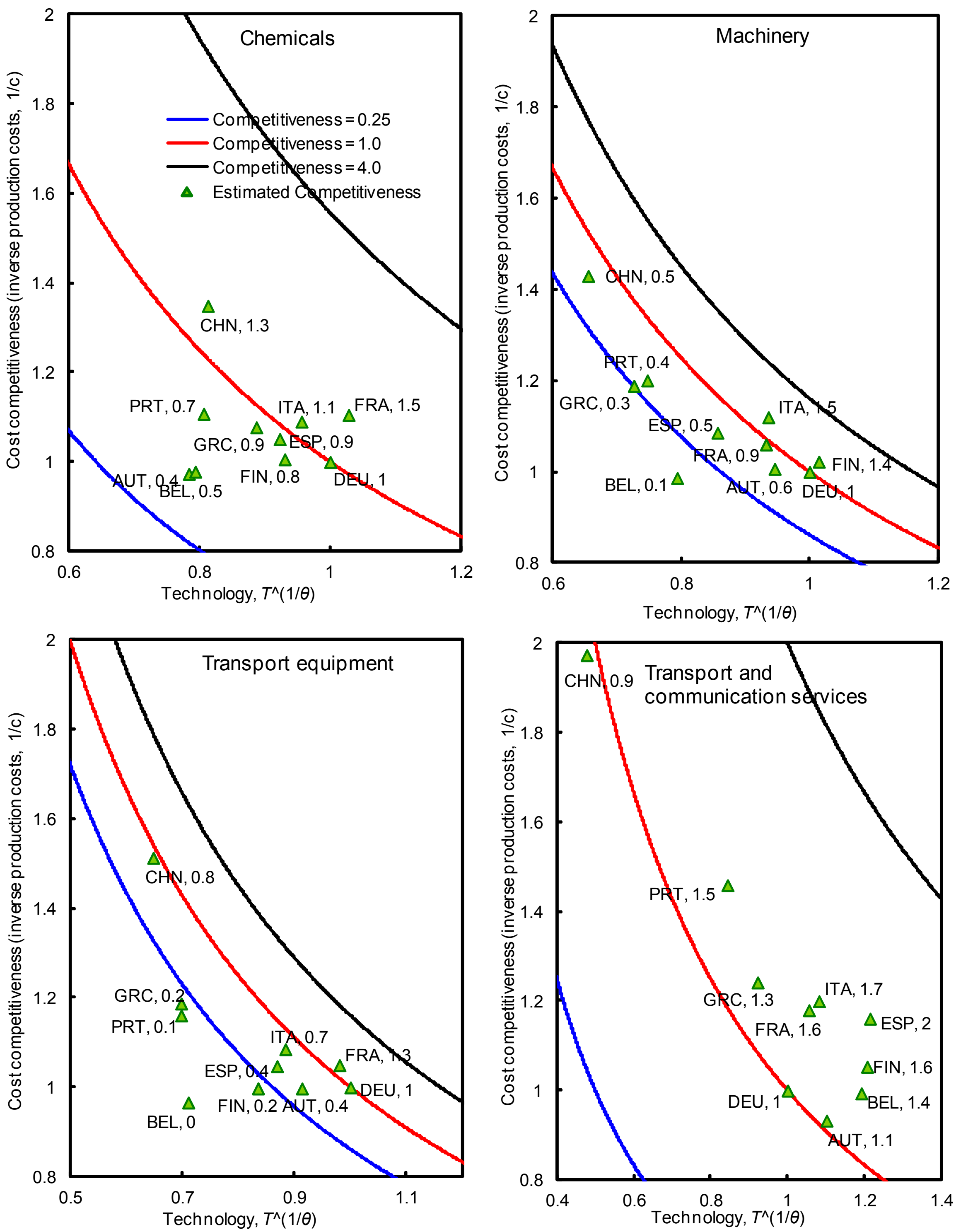
[12] Figures 5a–5b report estimated competitiveness for 8 out of the 11 sectors included in the sample. Relative competitiveness positions for paper, wood and private financial and other services (not reported) are available upon request.

Figure 5a. Competitiveness in nine Euro Area Countries and China (I)
2005 (Index numbers, Germany = 1)



Source: Authors' estimates of competitiveness with a breakdown into technology and factor costs; based on the model and UN Comtrade data.

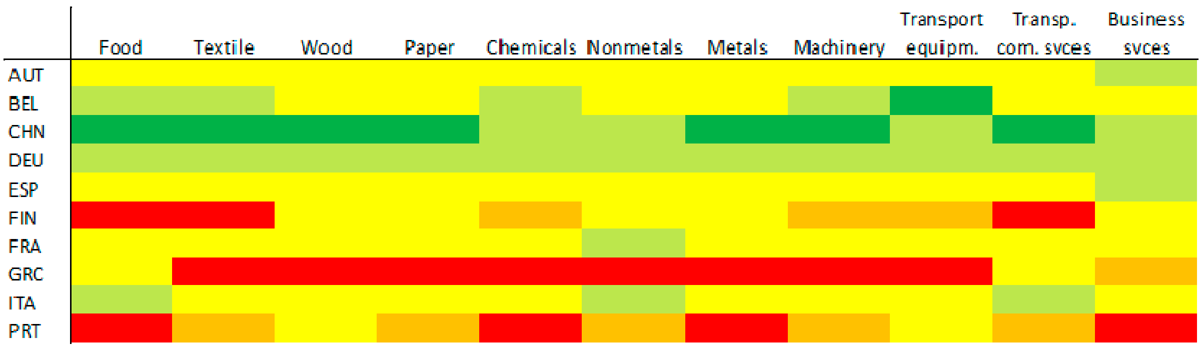
Figure 5b. Competitiveness in nine Euro Area Countries and China (II)
2005 (Index numbers, Germany = 1)



Source: Authors' estimates of competitiveness with a breakdown into technology and factor costs; based on the model and UN Comtrade data.

competitiveness, trade barriers also shape countries' export performance (Figure 6). Estimated sector and country-specific export barriers[13] are low in China and Germany and high in Greece, Portugal and Finland.

Figure 6. Barriers to Export, 2005



Source: A dark green color indicates that the country has low barriers to export calculated by subtracting exporter fixed effects from importer fixed effect obtained from the regression equation (11). The ordering of colors is dark green (<- 1 std. dev), yellow green (-1 std. < -½ std.), yellow (- ½ std. < +½ std.), orange (½ std. < 1 std.), and red (> 1 std. dev.).

V. Illustrative Scenarios

After fully characterizing the general equilibrium in section A, we use the calibrated model in section B to gauge the impact on individual euro area countries of technological progress in the two largest China's export sectors, textiles and machinery.

A. General Equilibrium

The general equilibrium is characterized by market clearing conditions in all N countries and J sectors in the model. This is represented by a set of prices, costs, and trade shares that satisfy (5), (6), and (8), together with the equilibrium conditions for goods and input factors specified in this section. In solving for the general equilibrium world GDP is assumed to be constant. For the sake of clarity, Box 1 gives an overview of the variables involved in the characterization of the general equilibrium.

[13] Export barriers $\theta_j ex_{i,j}$ can be calculated by subtracting exporter fixed effects, $S_{i,j} = \ln\left(T_{i,j} c_{i,j}^{-\theta_j}\right) - \theta_j ex_{i,j}$ from importer fixed effects, $S_{n,j} = \ln\left(T_{n,j} c_{n,j}^{-\theta_j}\right)$.

Equilibrium in Goods and Factor Markets

The equilibrium in the international goods market is satisfied when supply matches demand for each sector *j*, that is

$$Y_{i,j} = \sum_{n=1}^{N} \pi_{ni,j} X_{n,j} \quad (13)$$

Equation (13) states that i's production of j goods, $Y_{i,j}$, is equal to the sum of all countries' spending of j goods in which country i is the lowest cost provider (hence the exporter). Country n's demand of sector j goods is given by

$$X_{n,j} = \alpha_{n,j} X_n^F + \sum_{k=1}^{J} \gamma_{n,kj} \left(1 - \beta_{n,k}\right) Y_{n,k} \quad (14)$$

where X_n^F denotes country n's total spending on final goods, $Y_{n,k}$ is country *n's* production of sector *k* goods, and $\alpha_{n,j}$ the fraction of sector *j* goods in country n's total final goods spending.

As labor is immobile across countries, the labor market clearing condition (operating at the national level) is given by[14]

$$Y_i^F = w_i L_i \quad (15)$$

with $L_i = \sum_{j=1}^{J} L_{i,j}$. Let $\beta_{i,j}$ be the value added share in sector *j*. Thus, as implied by equations (13) and (15), each sector *j's* wage bill is given by

$$w_i L_{i,j} = \beta_{i,j} \sum_{n=1}^{N} \pi_{ni,j} X_{n,j} \quad (16)$$

General Equilibrium

Country i's total spending on final goods is equal to its GDP plus the overall trade deficit

$$X_i^F = Y_i^F + D_i \quad (17)$$

Inserting expressions (15) and (17) into (14) gives the following $N \cdot J$ equations

$$X_{n,j} = \alpha_{n,j} \left(w_n L_n + D_n\right) + \sum_{k=1}^{J} \gamma_{n,kj} \left(1 - \beta_{n,k}\right) \sum_{i=1}^{N} \pi_{in,k} X_{i,k} \quad (18)$$

[14] For the simulations we assume one value adding factor which we call labor throughout.

determining $N \cdot J$ unknowns values for expenditures, $X_{n,j}$ as functions of endogenous wages. Further, for each country it holds that total expenditure (on final and intermediate goods) minus the overall trade deficit equals total gross production,

$$\sum_{j=1}^{J} X_{i,j} - D_i = \sum_{j=1}^{J}\sum_{n=1}^{N} \pi_{ni,j} X_{n,j} \tag{19}$$

The general equilibrium is a set of costs, prices, trade shares, expenditures, and wages that satisfy the simultaneous equation system (5), (6), (8), (18), and (19)[15]. The cost minimizing functions (5) and the price indexes (6) give $2NJ$ equations. The gravity expression (8) gives NNJ equation and equilibrium in all countries' goods and production factor markets gives $NJ + N$ clearing conditions. The model's unknowns are NJ prices, $p_{n,j}$; NJ costs, $c_{n,j}$, N wages, w_n, NNJ trade shares, $\pi_{ni,j}$; and NJ goods spending quantities, $X_{n,j}$.

Box 1: Definition of Variables Characterizing the General Equilibrium

X_i^F: Country i's total spending on final goods (all sectors).

$X_{i,j}$: Country i's total expenditure of sector j goods. This consists of two terms

1) $\alpha_{i,j} X_i^F$: Country i's requirements of sector j goods for final demand, with $\alpha_{i,j}$ sector j's share in total final goods spending.
2) $p_{i,j} \sum_{m=1}^{J} M_{i,mj}$: Country i's requirements of sector j goods for intermediate consumption (production of input bundles in sectors, $m = 1,2, \dots, J$), with $p_{i,j}$ the price index for sector j in country i.

$Y_{i,j}$: Country i's gross production (for final goods and intermediate inputs) of sector j goods.

$D_{i,j} = X_{i,j} - Y_{i,j}$: Country i's trade deficit in sector j.

$Y_i^F = \sum_{j=1}^{J} \beta_{i,j} Y_{i,j}$: Country i's GDP, with $\beta_{i,j}$ the value added share in sector j.

$\sum_{j=1}^{J} D_{i,j} = D_i = X_i^F - Y_i^F$: Overall trade deficit of country i.

[15] The system determines $3NJ + N + NNJ$ of unknowns out of the same number of equations.

B. The Impact of Trade Shocks on Euro Area Countries: Some Illustrative Scenarios

We use the calibrated model to illustrate the impact of technological progress in Chinese textiles and machinery on individual euro area countries[16]. The shocks assume that sectoral productivity increases by 20 percent relative to all other countries, which roughly closes the gap to the euro area laggards. We quantify the impact on countries' GDP, prices, real wages, and labor reallocation as a result of the shock. We inspect the general equilibrium response both in a flex-price-full-mobility model where these adjustment mechanisms fail to operate.

Adjustment under the Flex-Price-Full-Mobility Model

In this scenario (Figures 7a–7b), countries adjust to increased competition in a sector by reducing wages and reallocating labor to ensure that trade balances remain unchanged at the pre-shock levels.

Following a positive technology shock in Chinese textiles (machinery), employment, production and exports all increase in that sector relative to baseline to level out productivity and wage gaps with other sectors. In parallel, European production of textiles (machinery) becomes relatively expensive at pre-shock levels and the domestic and international demand for European textiles (machinery) shrinks. To restore profitability in these sectors, wages in textiles (machinery) have to decline and labor needs to move to other industries whose production value is higher at international prices.

The economy-wide nominal wage reductions needed to regain competitiveness are estimated at 0.9 percent in the euro area for a shock in textiles. Wage declines are more marked in textile exporting countries, reaching 1 ½ on average in Portugal, Italy, Spain and Greece, against only 0.4 percent in Germany. If the productivity shock occurs in machinery, euro area nominal wages decline by 1.3 percent relative to baseline. The burden of adjustment now falls on Germany, Austria and France where wage losses are estimated at 1.7, 1.5, and 1.3 percent respectively, against less than 1 percent in Portugal, Greece and Belgium.

Euro area job losses are estimated at 2 ½ and 2.9 percent of manufacturing employment in, respectively, textiles and machinery. By countries, job losses in textiles range from 7½ percent of manufacturing employment in Portugal to 1.2 percent in Germany; and from 4.7 percent of manufacturing employment in Finland to 1 ½ percent in Greece in machinery. In most countries, textiles' share in total manufacturing is almost half of its pre-shock level. In the larger machinery industry, post-shock output represents around 85–90 percent of its ex ante level.

[16] For the simulations we build on the model in changes (see Dekle, Eaton, and Kortum, 2008; and Eaton and others, 2011).

In the flex-price-full-mobility model, nominal wage reductions are largely offset by declines in prices thus there is a limited impact on real wages. This is because overall prices decline following reductions in nominal wages and the price of imported intermediate goods. Real wage gains and losses are within ¼ percent both for textiles and machinery and slightly positive for the euro area as a whole.

Immobile Labor

As labor movements of the magnitude illustrated above are likely to take time, we also calibrate the impact of the shocks assuming immobile labor. The overall nominal wage and price reductions are similar to the mobile labor case and more marked in countries specialized in the shocked industry. However, since shocks are fully absorbed by sectoral wages to preserve trade balances, there are large distributional impacts between industries. In most countries, real wages in the textile industry decline by about 15 percent and by about 6–8 percent in machinery in response to sector-specific productivity shocks.

Widening Trade Deficits

In the model's logic, sector-specific productivity shocks will inevitably increase Chinese trade shares since countries purchase goods from the lowest cost provider. If countries do not go through internal devaluation and labor reallocation in response to increased external competition, a boom in domestic demand could still sustain employment and wage levels temporarily at the cost of deteriorating trade balances. Algebraically[17]

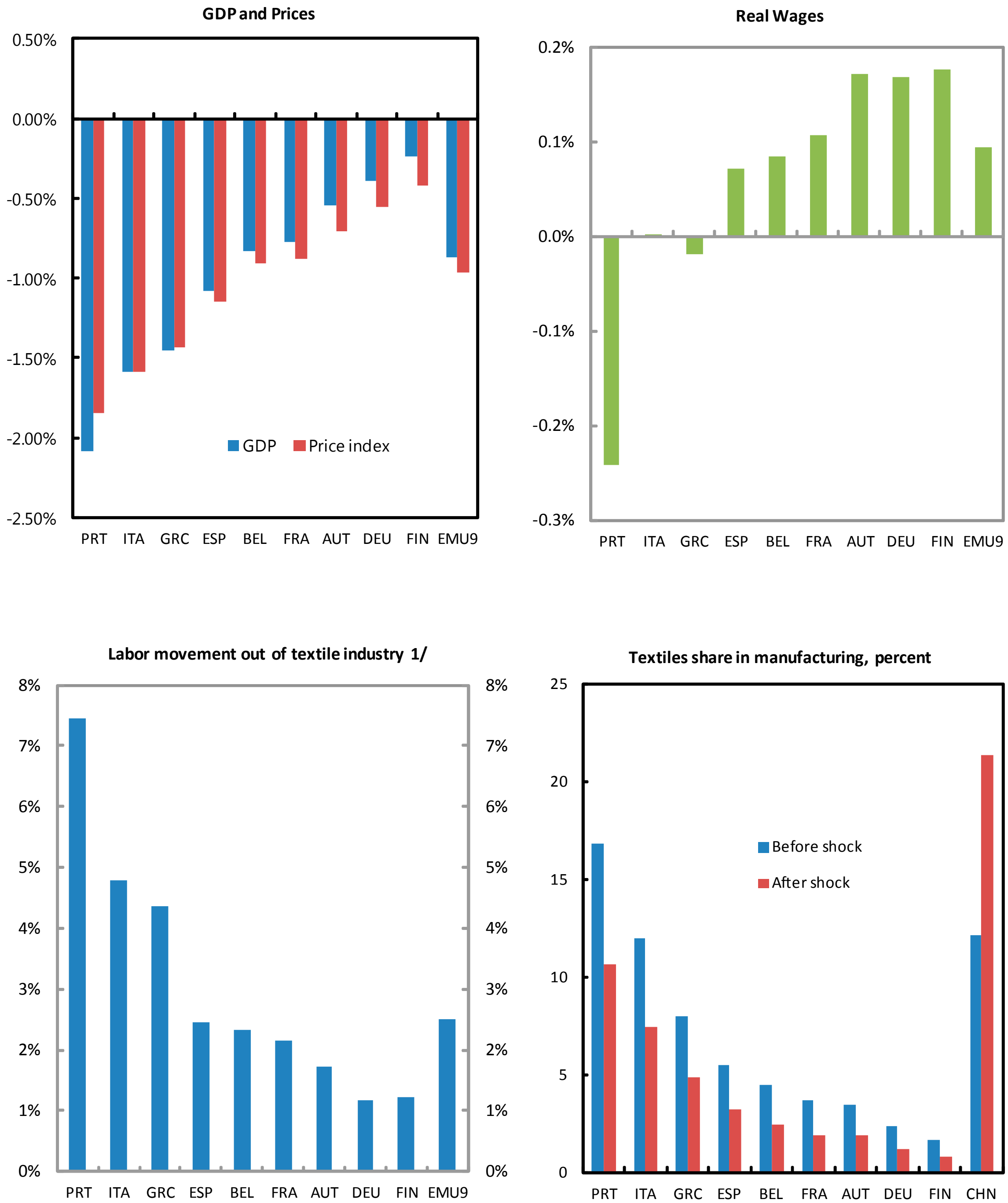
$$X'_{n,j} = \overbrace{\alpha_{n,j}\left(\hat{w}_n Y_n^F + D_n\right)}^{\text{Demand for final goods}} + \overbrace{\sum_{k=1}^{J} \gamma_{n,kj}\left(1-\beta_{n,k}\right)\sum_{i=1}^{N} \pi'_{in,k} X'_{i,k}}^{\text{Demand for intermediate goods}} \tag{20}$$

$$\overbrace{\sum_{j=1}^{J} X'_{n,j}}^{\substack{\text{Country } n\text{'s} \\ \text{gross expenditure}}} - D_n = \overbrace{\sum_{j=1}^{J}\sum_{i=1}^{N} \pi'_{in,j} X'_{i,j}}^{\substack{\text{Country } n\text{'s} \\ \text{gross production}}} \tag{21}$$

where we see that pre-shock production can be sustained provided that domestic absorption increases sufficiently to offset the initial deterioration in (national and foreign) demand arising from the technology shock, which is associated with a worsening trade deficit D_n. Assuming that domestic demand expands to keep GDP unchanged after the shock, trade

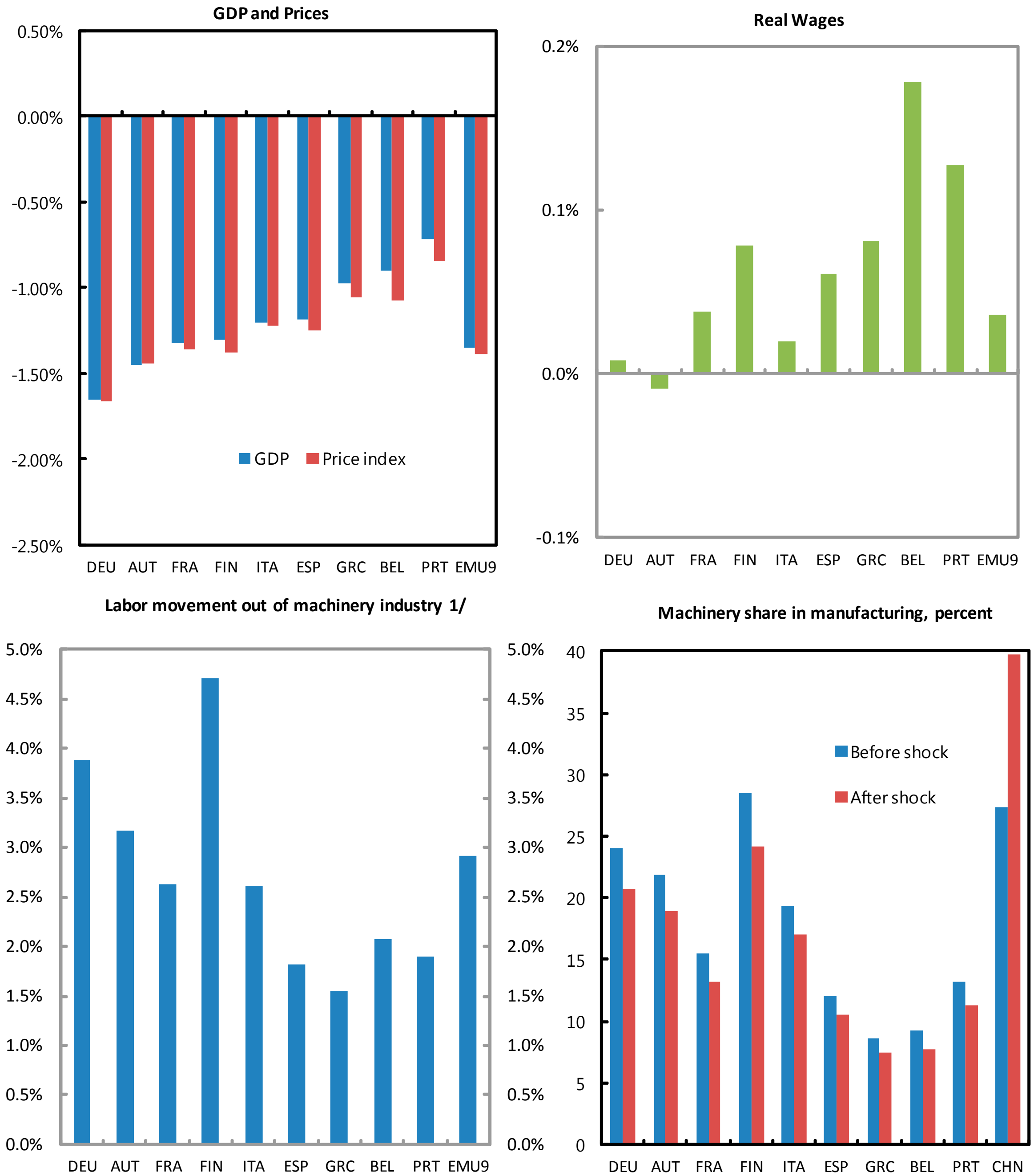
[17] $\hat{x} \equiv x'/x$ denotes the counterfactual value, x', relative to the original value, x.

Figure 7a: Adjustment to a Productivity Shock in Chinese Textiles
Flex-Price-Full-Mobility Model



Source: Authors' simulations.
1/ Percent of total manufacturing employment.

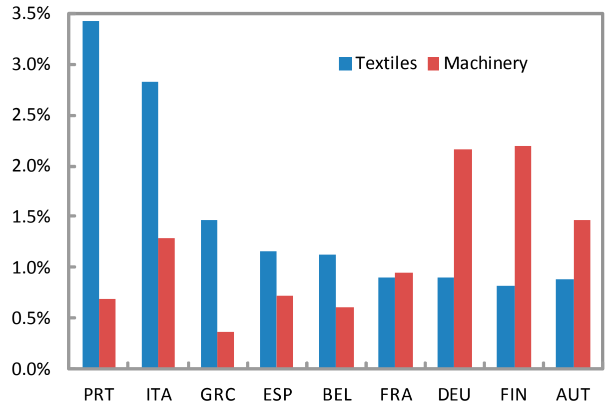
Figure 7b: Adjustment to a Productivity Shock in Chinese Machinery
Flex-price-full-mobility Model



Source: Authors' simulations.
1/ Percent of total manufacturing employment.

deficits would increase by around 1½ to 3½ percent in Portugal, Italy and Greece in response to a productivity shock to textiles, against 1 percent in Germany. In the event of a shock to the machinery industry, euro area's surplus nations would be the most affected, with trade deficits deteriorating by more than 2 percent of GDP in Germany and Finland (against less than 1 percent in Greece, Belgium, Portugal, and Spain).

Figure 8: Adjustment Via Higher Trade Deficits
(Percent deviations from baseline)



Source: Authors' simulations.

VI. Conclusion

This paper uses a Ricardian-gravity trade model to estimate sectoral competitiveness and investigate trade spillovers to euro area countries from improved productivity in China's two largest export sectors, textiles and machinery. Our estimates suggest that the euro area periphery fares well in sectors in which China is most competitive, while many core euro area economies are strong performers in industries where Chinese position is weaker, such as machinery and transport equipment.

Simulations suggest that the exposure of euro area countries to external competition is markedly asymmetric on accounts of their different specialization patterns. Absent nominal exchange rate adjustments, member countries can restore competiveness through internal devaluation and factor reallocation to new sectors, or else trade deficits will worsen. Our simulated scenarios provide evidence that the required adjustments are asymmetrically distributed across countries on accounts of their different specialization patters. Although China is at present most competitive in textiles, its trade shares in key sectors of the core euro area economies are rapidly increasing. This raises the question of the distribution of gains and losses from trade shocks over time—perhaps featuring as one relevant dimension of a broader fiscal union project.

APPENDIX: SAMPLE AND DATA

The sample comprises nine euro area members (Austria, Belgium, Finland, France, Germany, Greece, Italy, Portugal, and Spain); six EU countries (Czech Republic, Hungary, Poland, Slovenia, Sweden, and the United Kingdom); and the US, Japan, and China. Cyprus, Latvia, Lithuania, and Malta were excluded lack of GTAP data for the two service sectors included in the model. Denmark, Estonia, Ireland, Luxembourg, Netherlands, and Slovakia were excluded because measured export is larger than gross production in some sectors, thus the model is unable to handle the implied negative values for home expenditure, $X_{nn,j}$.

In estimating competitiveness by the gravity equation (11) we follow Eaton and Kortum (2002) and use six dummies for six distance intervals. The intervals (in miles) are $[0{,}375)$, $[375{,}750)$, $[750{,}1500)$, $[1500{,}3000)$, $[3000{,}6000)$, $[6000, \infty)$. Data for bilateral distances, common language, and shared border are obtained from the CEPII database of geographical variables. We include dummies for both EU and EMU membership.

We obtain trade data from the UN COMTRADE database for manufacturing industries at 4-digit SITC. The concordance we use to aggregate this to 2-digit ISIC is from World Integrated Trade Solution (WITS). For wages (compensation per employee), value added and gross production we use UNIDO's INDSTAT2 database at a 2-digit ISIC level. For the service sectors we use the Global Trade Analysis Projects (GTAP) 2004-database which reports bilateral trade flows and production data for all sample countries. We obtain bilateral trade shares for the two service sectors by combining the ISIC level classification with actual gross production in 2005 from OECD. To calculate αs βs, δs, and γs we use OECD's input-output tables, which are available for 2005 for all countries in the sample. Country deficits and GDPs are compatible with the model's parameters and observed trade data.

The impact of a sector-specific Chinese productivity shock is affected by the choice of the trade elasticity θ along two dimensions. First, the lower technology dispersion in the affected sector (high θ), the more responsive trade shares will be to prices and the larger the impact on the sector. Second, the lower trade elasticities in other sectors, the larger the wage reductions required to increase the country's trade shares in the non-affected sectors and make up for the lost competitiveness in the hard-hit sector. In our benchmark simulations we rely on the estimates of Caliendo and Parro (2011) where available. For "Chemicals, rubber, plastics and fuel products" we use the estimated elasticity for Chemicals given that their importance in the sectoral trade shares. For machinery and transport equipment we use the overall manufacturing estimate. We assume that goods in the two service sectors are relatively inelastic with respect to trade barriers and costs and choose a low elasticity of 2. For the shocks we experimented with different values for θ such as the lower and median estimates of Eaton and Kortum (2002). The ranking of countries on how they are affected by the shocks is robust to these alternative values of θ.

Table A1: Sectors

Sector	Short name	ISIC codes	θ_j
Food products, beverages and tobacco	Food	15-16	2.62
Textiles, textile products, leather and footwear	Textiles	17-19	8.10
Wood and products of wood and cork	Wood	20	11.50
Pulp, paper and paper products	Paper	21	16.52
Chemical, rubber, plastics and fuel products	Chemicals	23-25	3.13
Other non-metallic mineral products	Non-metals	26	2.41
Basic metals and fabricated metal products	Metals	27-28	6.99
Machinery and equipment	Machinery	29-33	9.29
Transport equipment	Transport equipment	34-35	9.29
Transportation & Communication	Transp. & Comm. Serv.	50-52, 55, 60-64	2.00
Private Financial & Other Services	Financial and other serv.	65-67, 70-74, 90-93	2.00
Non-tradable sectors	Non-tradables	All other	NA

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