

# European trade in parts and components: searching (for a trade model for searching) for offshoring evidence

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What is this about? This is an attempt at contributing to the identification of evidence on and driving forces for offshoring.

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Fragmentation, relocation, and offshoring

Questions:

Can we find evidence for offshoring of capital goods production tasks from “old” to “new” EU in data on parts and components trade?

Can we say anything about the driving forces for offshoring?

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# Fragmentation, relocation, and offshoring

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*Fragmentation* describes the deepening of the division of labour by horizontally or vertically splitting the production process into smaller steps, or *tasks*.

Adam Smith's example of the making of pins

Deepening the division of labour makes more specialisation possible. Incentives to specialise are based on comparative advantage or economies of scale.

To realise more specialisation, firms may break up the spatial concentration of production: firms may relocate tasks.

- *Offshoring* describes the international aspect of this phenomenon, whether or not tasks leave the legal bounds of the firm.

Offshoring implies costs of coordinating an international production network (investment, communication and of trading intermediate products, i.e. the inputs to and/or outputs of offshored tasks).

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# Fragmentation, relocation and offshoring

## Who offshores what, why, and where?

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Firms offshore tasks when specialisation gains outweigh implied coordination costs, i.e., the volume of offshoring should increase with

- (i) fragmentation,
- (ii) declining coordination costs,
- (iii) the strength of international incentives to specialisation.

Remark: fragmentation and declining coordination costs may represent technical progress.

“Rich” country firms tend to offshore routine, “homogeneous” tasks, typically intensive in labour or even in low-skill labour.

Case study evidence points to machine building, or capital goods production in general, as the industries experiencing offshoring most pronouncedly (Breda et al., 2008; Kimura, 2006; see also Fig. 1, from Sinn, 2005)



# Fragmentation, relocation and offshoring

## Who offshores what, why, and where?

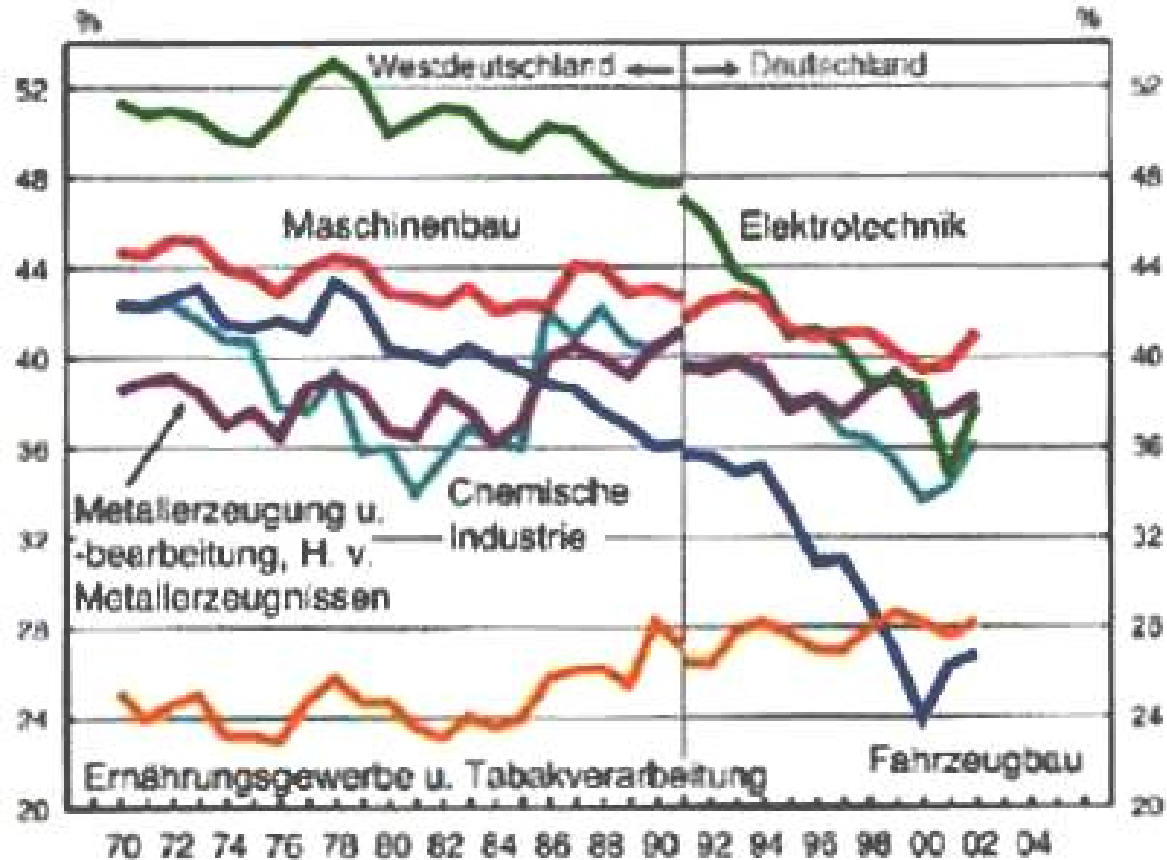


Fig. 1: Shares of gross value added in own production value, various German industries

Source : Sinn (2005, p. 100)

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# Research questions

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Describing offshored activities in terms of homogeneity and labour intensity points to Heckscher-Ohlin type comparative advantage determinants of offshoring, i.e., country differences

- in relative factor endowments
- or – absent factor price equalisation – in factor prices

Within Europe, there is significant variation in relative factor endowments or factor prices – “old” versus “new” EU.

We expect high-wage EU-15 firms to offshore tasks in the production of capital goods to low-wage EU-10 countries, generating – potentially two-way – trade in inputs to and/or outputs of offshored tasks.

Can we find evidence for the expected pattern of offshoring in Europe in data on trade in intermediate capital goods, i.e., in parts and components trade data?

Does analysing parts and components trade data tell us anything about the strength of the underlying incentives to offshore?



# Quick answers augmented gravity

The gravity equation relates *total* trade between two economies  $j$  and  $i$  and their respective size,  $Y_j, Y_i$  (+), other trade incentives (+) and trade barriers (–).

Typical empirical studies search for evidence of offshoring by using an ad hoc augmented gravity approach (Kimura et al., 2007).

$$\log Exp(PC)_{ji} = \beta_0 + \beta_1 \log Y_j + \beta_2 \log Y_i + \beta_3 \log |y_j - y_i| + \beta_4 Lan_{ji} + \beta_5 \log Dist_{ji} + \varepsilon_{ji} \quad (1)$$

$Exp(PC)_{ji}$  Parts and components exports from  $j$  to  $i$ .

$Y_j, Y_i$  GDP of export and import country, respectively

$|y_j - y_i|$  Per capita income gap

$Dist_{ij}$  Distance between  $j$  and  $i$

$Lan_{ji}$  Common language dummy

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# Quick answer: augmented gravity

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Expectations on four coefficients are straightforward :  $\beta_1, \beta_2, \beta_4 > 0$  and  $\beta_5 < 0$ .

Gravity equations are often eclectic combinations of explanatory variables taken from different trade theories. E.g., expectations on  $\beta_3$ , the coefficient for  $|y_j - y_i|$ , are formed according to different trade theories (Kimura et al., 2007).

“The existence of two-way trade driven by fragmentation and offshoring within international production networks *via* comparative/location advantages implies a positive coefficient for the per capita income gap.”

“The existence of horizontal intra-industry trade driven by new trade theories à la Krugman (1980) implies a negative coefficient for the per capita income gap.”

In general, this type of hypothesis can be found in many ad hoc gravity approaches, beyond the offshoring literature:

“Concerning the sign of the difference of GDP per capita, it is positive if the Heckscher-Ohlin (H-O) assumptions are confirmed. On the contrary, according to the new trade theory, the income per capita variable between countries is expected to have a negative impact” (Rault et al., 2009, p. 1551).



# Trade and gravity

Precondition for such a hypothesis: specification (1) is compatible with two trade models, especially with incomplete (Heckscher-Ohlin) as well as complete specialisation (Krugman, new new trade models).

Havemann and Hummels (2004): four sets of conditions imply simple gravity to hold, i.e. bilateral gross trade to be log-linear in incomes,  $Y_j, Y_i$ ,

- i. No trade barriers; each country's trade is balanced
- ii. Only trade in final (consumer) goods
- iii. Preferences are identical and homothetic, all products are consumed everywhere
- iv. Complete specialisation: each good is produced in only one country

Notation:  $C$ : consumption;  $X$ : production;  $Y$ : income;  $EX$ : exports;  $IM$ : imports; subscripts denote countries, superscripts products; all values are nominal.



# Trade and gravity

## Trade in final products with complete specialisation

In country  $j$ , production is distributed over different goods,

$$X_j^k = \delta_j^k Y_j, \quad \sum_k \delta_j^k = 1 \quad (2)$$

This is also true for the world as a whole,  $X_w^k = \delta_w^k Y_w$ .

Due to homothetic preferences,

$$C_j^k = \theta^k Y_j, \quad \sum_k \theta^k = 1 \quad (3)$$

This is again also true for the world as a whole,  $C_w^k = \theta^k Y_w$ .

Worldwide, consumption equals production for each good,  $C_w^k = X_w^k$ .

Thus, each country consumes its income share  $s_j = Y_j/Y_w$  of world production of each good,

$$C_j^k = s_j C_w^k = s_j X_w^k = s_j \delta_w^k Y_w = \frac{Y_j}{Y_w} \delta_w^k Y_w = \delta_w^k Y_j \quad (4)$$

# Trade and gravity

## Bilateral trade in final goods with complete specialisation

With complete specialisation,

$$X_w^k = X_j^k \text{ for some } j \quad (5)$$

such that imports to  $i$  from  $j$  are directly determined by consumption patterns,

$C_j^k = IM_{ij}^k = s_i X_j^k$  such that,

$$IM_{ij} = EX_{ji} = s_i \sum_k X_j^k = s_i Y_j = \frac{Y_i Y_j}{Y_w} \quad (6)$$

Bilateral trade in final goods with complete specialisation is thus log-linear in both countries' incomes,

$$\log EX_{ji} = c + \log Y_j + \log Y_i, \quad c = -\log Y_w \quad (7)$$

Frensch (2009): deviations from (i) – (iii) cannot imply (1). I.e.,

- for trade models with complete specialisation, (1) cannot be deduced, i.e., is no testable hypothesis.
- For trade models with incomplete specialisation, (1) is mis-specified (negative sign for the per capita income gap coefficient ?)

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# Trade and gravity

## Trade in intermediate goods with incomplete horizontal specialisation

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What should a gravity equation for analysing parts and components trade with incomplete specialisation look like?

Extend Haveman and Hummels (2004, trade in final goods with incomplete specialisation) to include production and trade also in parts and components

- No trade barriers; each country's trade is balanced
- Trade is in final and in intermediate goods  
Production is horizontally fragmented :  $n$  tasks are carried out, each of which results in a tradable intermediate good, i.e. a part or component. One final good is assembled from these  $n$  parts or components. All production is subject to homothetic derived demands, such that all variables can again be studied in nominal terms.
- Incomplete specialisation: each good is produced by at least one exporter; goods are not necessarily used everywhere.

Notation: see above, plus  $Z$ : value added.



# Trade and gravity

## Trade in intermediate goods with incomplete horizontal specialisation

Neglecting primary inputs, value added  $Z$  is distributed over intermediate goods and one final good,

$$Z_j^k = X_j^k = \delta_j^k Y_j, \quad k = 1, \dots, n \quad (8)$$

$$Z_j^{n+1} = X_j^{n+1} - \sum_{k=1}^n C_j^k = \delta_j^{n+1} Y_j, \quad \text{with } \sum_{k=1}^n \delta_j^k + \delta_j^{n+1} = 1 \quad (9)$$

With homothetic technology, intermediate goods are used according to,

$$C_j^k = \phi_j^k X_j^{k+1}, \quad \text{for } k = 1, \dots, n \quad (10)$$

With (8) and (9), value added in producing the final good can be written as,

$$Z_j^{n+1} = X_j^{n+1} \left( 1 - \sum_{k=1}^n \phi_j^k \right) \quad (11)$$

and

$$X_j^{n+1} = \frac{\delta_j^{n+1} Y_j}{\left( 1 - \sum_{k=1}^n \phi_j^k \right)} \quad (12)$$



# Trade and gravity

## Trade in intermediate goods with incomplete horizontal specialisation

Demand for the final product is  $Y_j$ . Thus, final goods net exports are,

$$X_j^{n+1} - C_j^{n+1} = \left[ \delta_j^{n+1} / \left( 1 - \sum_{k=1}^n \phi_j^k \right) - 1 \right] Y_j \quad (13)$$

Production and use of intermediate goods are given in (8) and (10), which again hold for the world as a whole. Therefore,

$$\frac{C_j^k}{C_w^k} = \frac{\phi_j^k \delta_j^{n+1} Y_j}{\phi_w^k \delta_w^{n+1} Y_w} \frac{1 - \sum_{k=1}^n \phi_w^k}{1 - \sum_{k=1}^n \phi_j^k} \quad (14)$$

$C_w^k = X_w^k$ , such that due to (16)  $\delta_w^{n+1} = 1 - \sum_{k=1}^n \phi_w^k$ . Then,

$$\begin{aligned} C_j^k &= \frac{\phi_j^k \delta_j^{n+1} Y_j}{\phi_w^k Y_w} \frac{1 - \sum_{k=1}^n \phi_w^k}{1 - \sum_{k=1}^n \phi_j^k} X_w^k = \frac{\phi_j^k \delta_j^{n+1} Y_j}{\phi_w^k Y_w} \frac{1 - \sum_{k=1}^n \phi_w^k}{1 - \sum_{k=1}^n \phi_j^k} \delta_w^k Y_w \\ &= \frac{\phi_j^k \delta_w^k \delta_j^{n+1}}{\phi_w^k} \frac{1 - \sum_{k=1}^n \phi_w^k}{1 - \sum_{k=1}^n \phi_j^k} Y_j \end{aligned} \quad (15)$$

## Trade and gravity

### Multilateral trade in intermediate goods with incomplete horizontal specialisation

Country  $j$ 's net exports of intermediate good  $k$  are thus described by,

$$X_j^k - C_j^k = \left[ \delta_j^k - \frac{\phi_j^k}{\phi_w^k} \frac{\delta_w^k \delta_j^{n+1}}{1 - \sum_{k=1}^n \phi_j^k} \right] Y_j \quad (16)$$

For balanced trade in final goods,

$$X_j^k - C_j^k = \left[ \delta_j^k - \frac{\phi_j^k}{\phi_w^k} \delta_w^k \right] Y_j, \quad \text{for } k = 1, \dots, n \quad (17a)$$

Countries net export those intermediate goods, in which they feature a high value added share or in which they are productive, relative to the world average.

Concentrating on intra-firm offshoring activities in the spirit of Grossman and Rossi-Hansberg (2008), firm-specific production technologies are available to all countries but used by firms in countries rather than by countries

$$X_j^k - C_j^k = (\delta_j^k - \delta_w^k) Y_j \quad (17b)$$

Summing over all  $k$ ,  $j$ 's net exports of intermediate goods to the world are,

$$X_j - C_j = Y_j \sum_{k=1}^n (\delta_j^k - \delta_w^k) \quad (18)$$



# Trade and gravity

## Multilateral trade in intermediate goods with incomplete horizontal specialisation

Country  $j$  either exports or imports a homogeneous good. Country  $j$  exports an intermediate good  $k$ , if its corresponding value added share ( $\delta_j^k$ ) is higher than world average ( $\delta_w^k$ ). With  $K_{E_j}, K_{I_j}$  denoting export and import sets,

$$EX_j = Y_j \sum_{k' \in K_{E_j}} (\delta_j^{k'} - \delta_w^{k'}) \quad (19)$$

$$IM_j = Y_j \sum_{k' \in K_{I_j}} (\delta_w^{k'} - \delta_j^{k'}) \quad (20)$$

Total intermediate goods exports are log-linear in income and a “specialisation pattern.”

With incomplete specialisation, we cannot apply a de-composition rule such as (5). But bilateral trade relationships are distributed in a statistical sense, as:

- For bilateral trade, specialisation patterns must be complementary.
- Countries' multilateral trade describe averages of bilateral relationships. Thus, (19) and (20) can be expected to be met by bilateral trading relationships.



# Trade and gravity

## Bilateral trade in intermediate goods with incomplete horizontal specialisation

(1) Larger countries trade more in the average of all their trading relationships. In a sample of heterogeneous countries, larger countries can be expected to trade more with each other.

- Bilateral trade volumes increase with  $Y_j \times Y_i$ .

(2) Analogously, countries more specialised *vis-à-vis* the world can be expected to trade more with each other, provided, their specialisation is complementary.

Incentives for incomplete specialisation and trade with parts and components are supply-side country differences (factor endowments and/or wages, can both be proxied by average GDP per capita,  $y_j$  and  $y_i$ ).

- Bilateral trade volumes increase with *relative per capita income differences*,  $|y_j - y_w| \times |y_i - y_w|$ , i.e., with the product of countries' respective per capita difference against the world (in analogy to Haveman and Hummels, 2004).

Problem: relative per capita income differences predict large trade volumes also for countries that lack complementary specialisation!

Correction: combine  $|y_j - y_w| \times |y_i - y_w|$  with dummies,  $DumKomp_{ij}$ , which take the value of one for country pairs with complementary specialisation.

# Trade and gravity

## Bilateral trade in intermediate goods with incomplete horizontal specialisation

Bilateral trade barriers should always be measured – such as trade incentives above – relative to the world, i.e., controlling for countries' *multilateral trade resistance*.

- Intuitively: the higher the trade barriers of a country with the world for fixed trade barriers with a specific country, the more the country will be driven to trade with this specific country (for formally linking this notion to complete specialisation and gravity, see Anderson and van Wincoop, 2003)
- Cheng and Wall (2005), Baldwin and Taglioni (2006) recommend making use of the panel structure of available trade data, and specifically doing so by subsuming trade barriers under time-invariant country-pair specific,  $c_{ij}$ , as well as country-pair invariant time-specific omitted variables,  $k_p$ , to be controlled for by appropriate fixed effects.

$$\log EX(PC)_{ji,t} = \beta_0 + \beta_1 \log(Y_{j,t} \times Y_{i,t}) + \beta_2 \log\left(\left|y_{j,t} - y_{w,t}\right| \times \left|y_{i,t} - y_{w,t}\right|\right) + \beta_3 DumKomp_{ji} \times \log\left(\left|y_{j,t} - y_{w,t}\right| \times \left|y_{i,t} - y_{w,t}\right|\right) + c_{ij} + k_t + \varepsilon_{ij,t} \quad (21)$$

# Trade and gravity

## Bilateral trade in intermediate goods with incomplete horizontal specialisation

### Notes:

- $EX(PC)_{ji}$  describes exports of parts and components of capital goods from country  $j$  to  $i$ . The definition of parts and components of capital goods follows the BEC categorisation of UN Statistics.
- We estimate (21) with panel data on bilateral capital goods parts and components trade flows between EU-25 countries. World average per capita incomes are computed from our largest sample.  $DumKomp$  is one for EU-10/EU-15 country pairs.
- Time specific effects also control for each year's data using a different numéraire since GDP and trade values are all current (Baldwin and Taglioni, 2006), where original US-\$-denominated data are converted to euros.
- Technical progress through decreasing coordination costs can be represented by time effects. As our motivation of offshoring implies complementarity between technical progress and supply-side country differences, we model this by interacting  $DumKomp \times |y_j - y_w| \times |y_i - y_w|$  with time-period effects.  
For this, we divide the sample period into four sub-periods of (almost) equal length.



# Trade and gravity

## Bilateral trade in intermediate goods with incomplete horizontal specialisation

- We allow for supply-side country differences to be represented by differences in factor prices, i.e., wages. As (21) is rooted in incomplete specialisation and trade models, such as Heckscher-Ohlin, wage differences may be subject to factor price equalisation tendencies by the very offshoring trade they induce.

I.e., factor price differences may not be exogenous; we apply the simplest possible remedy in choosing lagged explanatory variables as instruments.

- *A priori* expectations on coefficients:

$\beta_1 > 0$ ; we may even expect  $\beta_1$  to equal one, provided the extent of specialisation is uncorrelated with income.

We cannot form an *a priori* expectation on  $\beta_2$  without information on the sample: if the sample is sufficiently homogenous, with say all  $y_i > y_m$ , then there is no reason to assume the majority of country pairs to be complementarily specialised, in which case a higher  $|y_j - y_m| \times |y_i - y_m|$  will generate less trade, such that  $\beta_2 < 0$ .

With *DumKomp* picking the “right” country pairs with complementary specialisation based on prior information,  $\beta_3 > 0$ .

For the limiting case of complete specialisation, we would not find specialisation patterns to play any role, in which case  $\beta_2 = \beta_3 = 0$ .



## Gravity regressions for trade among EU-25, 1992–2004 (TSLS with asymmetric country-pair specific and time-specific effects)

		(1)	(2)	(3)
		Parts and components of capital goods	Other intermediate goods	Final (consumer and capital) goods
$\log Y_j Y_i$		0.85*** (16.66)	1.07*** (31.57)	0.99*** (27.83)
$\log ( y_j - y_w  \times  y_i - y_w )$		-0.11*** (-2.72)	-0.14*** (-5.10)	-0.07** (-2.35)
$\log ( y_j - y_w  \times  y_i - y_w )$ for EU-15 / EU-10 country pairs	1992–95	0.29*** (4.57)	0.19*** (4.93)	0.14*** (2.86)
	1996–98	0.32*** (5.11)	0.20*** (5.34)	0.15*** (3.20)
	1999–01	0.33*** (5.38)	0.20*** (5.49)	0.15*** (3.27)
	2002–04	0.34*** (5.56)	0.20*** (5.46)	0.16*** (3.35)
Observations (cross sections)		6 605 (552)	6 766 (552)	6 766 (552)
Adj. $R^2$		0.95	0.97	0.97

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# Results

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- (1) Augmented gravity approaches are mis-specified.
- (2) Using an adequate gravity specification, we find evidence for offshoring of tasks of the production of capital goods from “old” to “new” EU members.
- (3) Analysing trade data informs about the driving forces of offshoring.
  - a) Incentives for specialisation are supply-side country differences between EU-15 and the ten accession countries, rather than within each of the two country groups.

Compare second to third row, column 1
  - b) Technical progress in terms of declining coordination costs – as captured by the sub-period dummies – appears to positively influence offshoring  

In third row, column 1, for EU-15/EU-10 pairs,  $\beta_3$  is increasing over time
  - c) Trade in parts and components reacts about twice as elastic to supply-side country differences than trade in final goods: this is evidence for technical progress in terms of fragmentation to indeed yield increased incentives for specialisation.

Compare columns 1 – 3, third row

I.e., the volume of offshoring increases with the strength of international incentives to specialisation, declining coordination costs, and fragmentation.

**Gravity regressions** for parts and components trade among EU-25, 1992–2004 (TSLS with asymmetric country-pair specific and time-specific effects)

		(4)	(5)
		Along the <i>extensive</i> margin (# of exported goods)	Along the <i>intensive</i> margin (avg. value of exported goods)
$\log Y_j Y_i$		0.57*** (22.51)	0.28*** (6.61)
$\log ( y_j - y_w  \times  y_i - y_w )$		-0.14*** (-6.78)	0.026 (0.77)
$\log ( y_j - y_w  \times  y_i - y_w )$ for EU-15 / EU-10 country pairs	1992–95	0.21*** (6.58)	0.083 (1.61)
	1996–98	0.23*** (7.24)	0.10* (1.86)
	1999–01	0.23*** (7.45)	0.10** (2.06)
	2002–04	0.23*** (7.58)	0.11** (2.21)
Observations (cross sections)		6,605 (552)	6,605 (552)
Adj. R <sup>2</sup>		0.95	0.91

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## Further results

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We decompose the influences specified in (21) on parts and components trade along the two margins of trade, i.e., along *extensive* (number of exported goods) *versus* *intensive* import margins (average volumes per exported good), based on the highly disaggregated nature of our original trade data.

As LS is a linear operator, estimated coefficients given in columns (4) and (5) always sum up to the respective estimated coefficient in column (1).

Parts and components trade generated by offshoring activities across Europe is predominantly realised along the extensive margin: More offshoring of activities from the EU-15 to the EU-10 means predominantly offshoring of new activities rather than extending the scale of already offshored activities.

In contrast: extending offshoring from the EU-15 to east Asia takes place rather by expanding the scale of already offshored activities.

This may in part be due to a strong institutional trade liberalisation between the EU-15 and the EU-10 in the latter's run-up to EU membership. Such an argument is made in Frensch (2010), however, on the basis of recent complete specialisation models of heterogeneous firms and trade, such as Chaney (2008).



**Gravity regressions** for parts and components exports among a larger country panel, 1992–2004  
(TSLS with asymmetric country-pair specific and time-specific effects)

		(6)	(7)	(8)
		Exports	Along the <i>extensive</i> margin	Along the <i>intensive</i> margin
$\log Y_j Y_i$		0.82*** (26.78)	0.39*** (34.32)	0.43*** (18.19)
$\log  y_j - y_w  \times  y_i - y_w $		-0.10*** (-3.50)	-0.060*** (-3.80)	-0.045* (-1.95)
$\log  y_j - y_w  \times  y_i - y_w $ for exports from EU-10 to EU-15	1992–95	0.50*** (5.56)	0.31*** (6.49)	0.19*** (2.78)
	1996–98	0.53*** (5.90)	0.32*** (6.80)	0.21*** (3.01)
	1999–01	0.54*** (6.16)	0.32*** (6.89)	0.22*** (3.29)
	2002–04	0.54*** (6.25)	0.32*** (6.91)	0.23*** (3.40)
$\log  y_j - y_w  \times  y_i - y_w $ for exports from (HKG + KOR + THA + TWN) to EU-15	1992–95	0.22 (1.63)	-0.036 (-0.51)	0.25** (2.47)
	1996–98	0.21 (1.62)	-0.037 (-0.53)	0.25** (2.47)
	1999–01	0.21 (1.64)	-0.038 (-0.57)	0.24** (2.52)
	2002–04	0.20 (1.59)	-0.040 (-0.60)	0.24** (2.48)
$\log  y_j - y_w  \times  y_i - y_w $ for exports from CHN to EU-15	1992–95	0.43 (1.46)	0.015 (0.10)	0.41* (1.83)
	1996–98	0.44 (1.52)	0.017 (0.11)	0.43* (1.90)
	1999–01	0.45 (1.58)	0.015 (0.10)	0.43** (1.98)
	2002–04	0.47* (1.65)	0.014 (0.10)	0.45** (2.08)
Observations (cross sections)		21,819 (2,256)	21,819 (2,256)	21,819 (2,256)
Adj. R <sup>2</sup>		0.94	0.94	0.88

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# Quick answers: trade growth

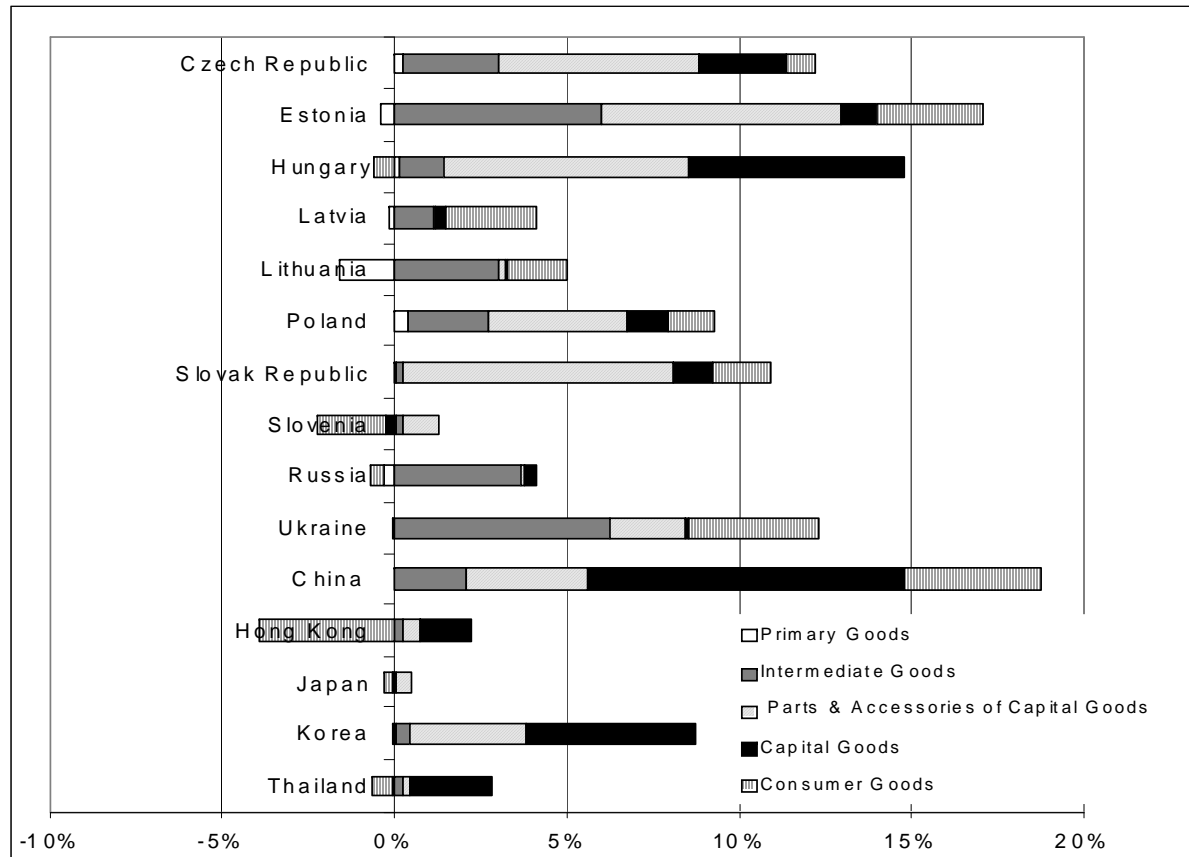


Figure 2: Average annual real rates of change of exports to Germany, 1996–2004. Split into growth contributions of different goods categories

Notes: UN ComTrade data are disaggregated according to SITC, Rev. 3, down to 3,114 *items* (without *fuels and lubricants*) and re-classified according to the UN Classification by Broad Economic Categories. “Parts and accessories of capital goods” are a subset of all intermediate goods. “Intermediate goods” in this and subsequent figures are therefore all intermediate goods other than parts and accessories. For more data background, see the appendix to Frensch and Gaucaite Wittich (2009).

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## Quick answers: trade growth

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High contributions of parts and accessories of capital goods to the export and import growth rates of EU-10 countries are an indication of offshoring activities with old EU members. This is exemplified in Figure 2, which allows a closer look at export growth by exporter and goods category specifically to the German market. The main contribution to export growth to Germany from the majority of EU-10 countries indeed comes from parts and accessories of capital goods (including transport equipment), i.e., from involvement in offshoring activities of firms especially in the Czech Republic, Estonia, Hungary, Poland, and Slovakia.

Growth rates of imports from Germany tend even to be higher than for exports, with considerable contributions from capital goods, and generally confirm the picture of a substantial two-way trade of the majority of EU-10 countries with Germany in parts and accessories, reflecting German firms' offshoring production tasks to these countries

**Quick answers:** Augmented Gravity regressions (OLS) for parts and components trade among selected East Asian and European countries

	(9)	(10)	(11)	(12)	(13)	(14)
	East Asia		Europe			
	Parts and components of machinery			Parts and components of capital goods		
	1995	2003	1995	2003	1995	2003
Explanatory variables:						
<i>Constant</i>	-1.51 (-0.32)	-6.02 (3.84)	-25.41*** (11.19)	-21.32*** (-8.85)	-26.05*** (-12.78)	-19.62*** (-8.02)
$\log ExGDP$	0.67*** (5.58)	0.69*** (6.90)	1.16*** (34.39)	1.02*** (20.40)	1.14*** (24.17)	0.96*** (17.72)
$\log ImGDP$	0.17 (1.31)	0.46*** (4.18)	0.86*** (17.20)	0.86*** (14.33)	0.92*** (19.58)	0.85*** (15.61)
$\log  y_j - y_i $	0.50*** (4.17)	0.12 (1.20)	-0.14** (-2.33)	-0.04 (-1.00)	-0.16*** (-3.53)	-0.067 (-1.27)
$\log capdistance$	-0.66*** (-2.87)	-0.63*** (-3.32)	-1.12*** (12.44)	-1.25*** (-11.36)	-1.16*** (-12.03)	-1.23*** (-12.35)
<i>ComLan</i>	1.07** (2.38)	1.65*** (5.89)	0.22 (1.16)	-0.55*** (-3.06)	-0.065 (-0.27)	-0.066 (-0.27)
Observations	72	72	306	306	342	342
Adj. R-squared	0.54	0.52	0.79	0.71	0.79	0.71

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## Quick answers: Augmented Gravity regressions (OLS) for parts and components trade among selected East Asian and European countries

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*Notes to Tables 1–5:* *t*-statistics in parentheses. \* (\*\*, \*\*\*) indicate significance at 10 (5, 1) per cent. (Parts and components of) capital goods always include (parts and components of) transport equipment. Transport equipment does not include passenger cars. For more details, see Appendix B. The cutoff-value for trade flows is 10,000\$. Variables are defined in Appendix Table B3. Export flows, GDPs and the absolute income gap in nominal U.S. dollars.

*Notes:* Columns (1–4): *t*-statistics in parentheses are imputed from standard errors as presented in the original source (Kimura et al., 2007). Country samples: East Asia is JPN, HKG, KOR, SGP, IDN, MYS, PHL, THA, CHN (9 countries), Europe is AUT, BEL, CHE, DNK, ESP, FIN, FRA, GBR, GER, GRC, IRL, ITA, NLD, NOR, PRT, SWE; (CZE+SVK), POL (18 countries). *Source:* Kimura et al. (2007).

Columns (5–6): Country sample: Europe is AUT, BEL, CHE, DNK, ESP, FIN, FRA, GBR, GER, GRC, IRL, ITA, NLD, NOR, PRT, SWE; CZE, SVK, POL (19 countries).



# Trade and gravity

## Multilateral trade in final goods with complete specialisation

For each good net exports from  $j$  are,

$$X_j^k - C_j^k = (\delta_j^k - \delta_w^k)Y_j$$

With complete specialisation, for each good produced in  $j$  we have,

$$\delta_j^k > 0 \Leftrightarrow \delta_w^k = \frac{X_w^k}{Y_w} = \frac{X_j^k}{Y_w} = \frac{X_j^k}{Y_w} \frac{Y_j}{Y_j} = s_j \delta_j^k$$

$$EX_j^k = (1 - s_j) \delta_j^k Y_j, \quad \text{bzw.}$$

$$EX_j = (1 - s_j) \sum_k \delta_j^k Y_j = (1 - s_j) Y_j$$

Complete specialisation implies a log-linear relationship between a country's exports to the world and country size,

$$\log EX_j = \log(1 - s_j) + \log Y_j$$



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## Discussion: panel data

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One drawback of using panel data lies in the potential non-stationarity of trade and income data, implying likely biased estimates with fixed effects models. Also, by the very construction of gravity equations, bilateral trade is explained by a combination of countries' aggregate output, introducing cross-sectional correlation.

Using cross-sectionally augmented panel unit root testing methods, Fidrmuc (2009) confirms that trade and income variables used in gravity regressions are integrated of order one. However, Fidrmuc (2009, p. 436) also finds that, although fixed effects estimators may be biased, they are not only asymptotically normal and consistent with large panels but also perform “relatively well in comparison to panel cointegration techniques (FMOLS and DOLS)” in finite samples, concluding the potential bias of fixed-effects gravity estimators to be rather small.

As for alternative dynamic panel estimators, the original Arellano and Bond (1991) performs poorly for persistent time series, while the Blundell and Bond (1998) system GMM estimator requires strict exogeneity of regressors, which is not fulfilled when variable such as income and trade are cointegrated.

This is of specific concern with our data, which span only over a period of 13 years, too short a period for proper panel unit root testing, which is why we estimate the simple panel version of the above motivated gravity model.

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# Discussion: margin effects and labour markets

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This margin distinction, however, may be of relevance for the labour market effects of offshoring, especially with respect to factor prices in the home country.

Estimating Mincer-type wage equations, augmented by offshoring treatment effects, to firm-level data, Geishecker and Görg (2008) demonstrate that offshoring low-skill tasks decreases the wages of German low-skill employees. Comparing wage and employment effects across countries features significant differences in this respect, which may be motivated by different labour market institutions, as suggested in Geishecker et al. (2008).

Margin results may be related to an alternative explanation for internationally varying labour market effects of offshoring, however.

Recent theoretical work generalises Feenstra and Hanson (1996) by introducing task-specific trade costs that potentially limit offshoring of a continuum of tasks (Grossman and Rossi-Hansberg, 2008). More offshoring of low-skill tasks, made possible by decreasing service link costs over all tasks, then *cet. par.* implies a positive productivity effect in the source country, which appears strongest in those firms that have already offshored most, and which therefore carries the highest potential benefits for skill groups hit strongest by offshoring.

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# Discussion: margin effects and labour markets

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Labour market effects to the disadvantage of skill groups hit strongest by offshoring, as already identified in Feenstra and Hanson (1996), are thus counterbalanced and may even be dominated under certain conditions. Firms that have already offshored most tasks are increasingly likely to strengthen already existing rather than creating new offshoring relationships.

In the terminology of recent theories of trade, existing offshoring relationships, in turn, get strengthened along the intensive margin, as opposed to strengthening along the extensive margin by new relationships. One might therefore suspect the unambiguous results of Geishecker and Görg (2008) to hold for offshoring relationships that get predominantly strengthened along the extensive, rather than along the intensive margin. This, in turn, seems to be the case for offshoring relationship between the EU-15 and the EU-10, i.e., the “old” and the “new” EU members.

The *caveat* here, of course is Table 4 results are based on macro, rather than micro, i.e. firm level data, where, however, the macro trade data are quite disaggregated to represent some 90 million trade flows.

# Appendix A

Handel in Zwischenprodukten bei unvollkommener vertikaler Spezialisierung in Wertschöpfungsketten



# Handel und Gravitation

## Handel in Zwischenprodukten bei unvollkommener Spezialisierung in Wertschöpfungsketten

Die folgende Argumentation basiert auf der Betrachtung in Haveman und Hummels (2004, für den Fall des Handels in Endprodukten bei unvollkommener Spezialisierung). Wie schon oben, abstrahieren wir auch hier von Handelshemmnissen.

- Unvollkommene Spezialisierung: Jedes Produkt wird von mindestens einem Exporteur hergestellt.
- Einige Annahmen: Produktion ist fragmentiert in Wertschöpfungsketten, d.h., mit primären Produktionsfaktoren werden  $n$  *tasks* ausgeführt, die in handelbaren Zwischenprodukten resultieren, die mit homothetischer Technologie in einer  $(n+1)$ sten *task* zu einem handelbaren Endprodukt zusammen gebaut werden. Nicht alle Güter werden von allen importiert.

Technologien sind identisch da firmenspezifisch und für alle Länder zugänglich (Motivation in Grosman und Rossi-Hansberg, 2008, d.h., wir betrachten den Fall unternehmensinternen Offshorings).

Handel ist ausgeglichen.

- Notation: so wie oben, zudem  $Z$ : Wertschöpfung; alle Größen sind nominal.



# Handel und Gravitation

## Handel in Zwischenprodukten bei unvollkommener Spezialisierung in Wertschöpfungsketten

Die Wertschöpfung verteilt sich auf  $n$  Zwischen- und ein Endprodukt über eine Wertschöpfungskette hinweg

$$Z_j^k = X_j^k - C_j^{k-1} = \delta_j^k Y_j, \quad k = 1, \dots, n+1 \quad (\text{A1})$$

Das gesamte Einkommen wird zum Konsum des einzigen Endproduktes verwendet,

$$\sum_k Z_j^k = Y_j = C_j^{n+1} \quad (\text{A2})$$

Gemäß identischer homothetischer Technologie,

$$C_j^{k-1} = \phi^k X_j^k \quad (\text{A3})$$

so dass,

$$X_j^k = \frac{\delta_j^k}{1 - \phi^k} Y_j \quad (\text{A4})$$

# Handel und Gravitation

## Handel in Zwischenprodukten bei unvollkommener Spezialisierung in Wertschöpfungsketten

A(3) gilt auch wieder für den Rest der Welt, so dass,

$$\frac{C_j^{k-1}}{C_w^{k-1}} = \frac{X_j^k}{X_w^k} = \frac{\delta_j^k Y_j}{\delta_w^k Y_w} \quad (\text{A5})$$

Weltweit entspricht die Produktion dem Verbrauch,

$$C_j^{k-1} = \frac{\delta_j^k Y_j}{\delta_w^k Y_w} X_w^{k-1} = \frac{\delta_j^k Y_j}{\delta_w^k Y_w} \frac{\delta_w^{k-1}}{1 - \phi^{k-1}} Y_w \quad (\text{A6})$$

so dass,

$$C_j^k = \frac{\delta_j^{k+1}}{\delta_w^{k+1}} \frac{\delta_w^k}{1 - \phi^k} Y_j \quad (\text{A7})$$



# Handel und Gravitation

## Multilateraler Handel in Zwischenprodukten bei unvollkommener Spezialisierung in Wertschöpfungsketten

Nettoexporte an Endprodukten aus  $j$ ,

$$EX_j^{n+1} - IM_j^{n+1} = X_j^{n+1} - C_j^{n+1} = \left( \frac{\delta_j^{n+1}}{1 - \phi^{n+1}} - 1 \right) Y_j \quad (\text{A8})$$

Für die Welt als Ganzes impliziert (A8), dass  $\delta_w^{n+1} = 1 - \phi^{n+1}$ , so dass,

$$EX_j^{n+1} - IM_j^{n+1} = \left( \frac{\delta_j^{n+1}}{\delta_w^{n+1}} - 1 \right) Y_j = \frac{1}{1 - \phi^{n+1}} (\delta_j^{n+1} - \delta_w^{n+1}) Y_j \quad (\text{A9})$$

(A4) und (A7) implizieren Nettoexporte an Zwischenprodukten aus  $j$ ,

$$EX_j^k - IM_j^k = \frac{1}{1 - \phi^k} \left( \delta_j^k - \frac{\delta_j^{k+1}}{\delta_w^{k+1}} \delta_w^k \right) Y_j \quad (\text{A10})$$



# Handel und Gravitation

## Multilateraler Handel in Zwischenprodukten bei unvollkommener Spezialisierung in Wertschöpfungsketten

Bezeichnet  $K_{E_j}$  die Menge (bzw. Vielfalt) der exportierten Güter von  $j$ ,

$$EX_j = Y_j \sum_{k' \in K_{E_j}} \frac{1}{1 - \phi^{k'}} \left( \delta_j^{k'} - \frac{\delta_j^{k'+1}}{\delta_w^{k'+1}} \delta_w^{k'} \right) \quad (\text{A11})$$

und die gesamten Exporte an Zwischenprodukten sind – wie für den Fall horizontaler Spezialisierung – wiederum log-linear in Einkommen und „Spezialisierungsmuster“,

$$\log EX_j = \log Y_j + \log \sum_{k' \in K_{E_j}} \frac{1}{1 - \phi^{k'}} \left( \delta_j^{k'} - \frac{\delta_j^{k'+1}}{\delta_w^{k'+1}} \delta_w^{k'} \right) \quad (\text{A12})$$