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Deindustrialisation in European Metro Regions: A common Feature in long-term Urban Dynamics?

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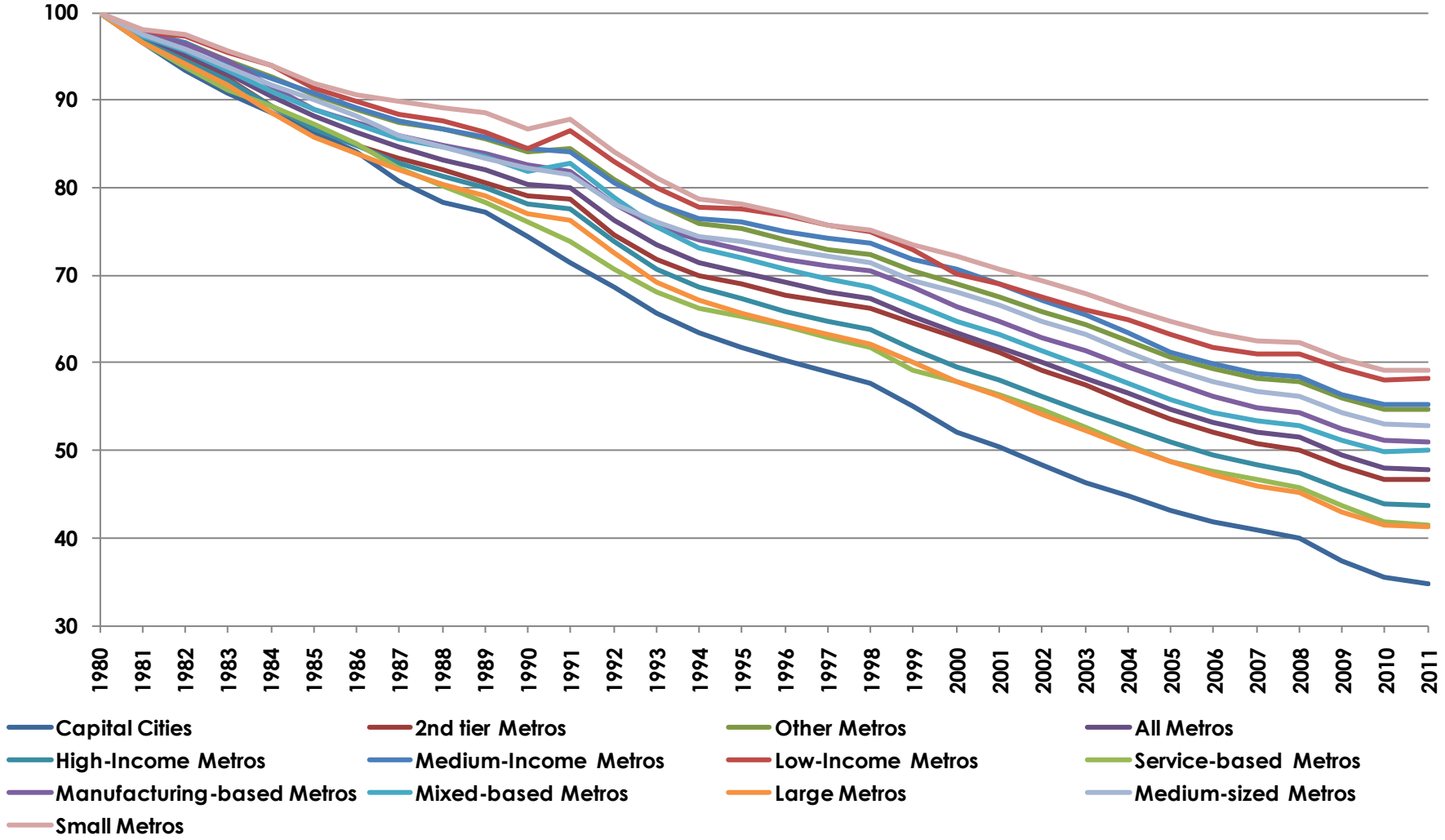
GFR Winterseminar 2015

Igls, 02/2015

Change in Manufacturing Employment Share by Metro Types

1980 = 100; 197 European Metropolitan Regions (EU 15)



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Research Questions

- Is deindustrialisation an ubiquitous and homogeneous phenomenon in European metropolitan regions, or are there differences in the manufacturing development paths?
- If there is heterogeneity in these tracks: Is it possible to distinguish different (policy-relevant) „types“ of manufacturing evolutions at the metro level?
- And if this is the case: Do metro characteristics (like size, income level, specialization ….) matter in this respect?

❖ Methodology used: (new) 4-way decomposition technique based on an approach proposed by *Tragenna* (2009)

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Data base

Data source:

- Basis: Time series data (1980-2010) on employment and (real) GVA in 1.294 NUTS-3-regions in the EU 27 (European Regional Database, Cambridge Econometrics)
- combined with a new EUROSTAT-Typology on (functional) metropolitan regions (> 250.000 inhabitants)
- Data for197 metropolitan regions (EU15) in 1980-2010
- Data for 255 metropolitan regions (EU27) in 1991-2010

Data characteristics:

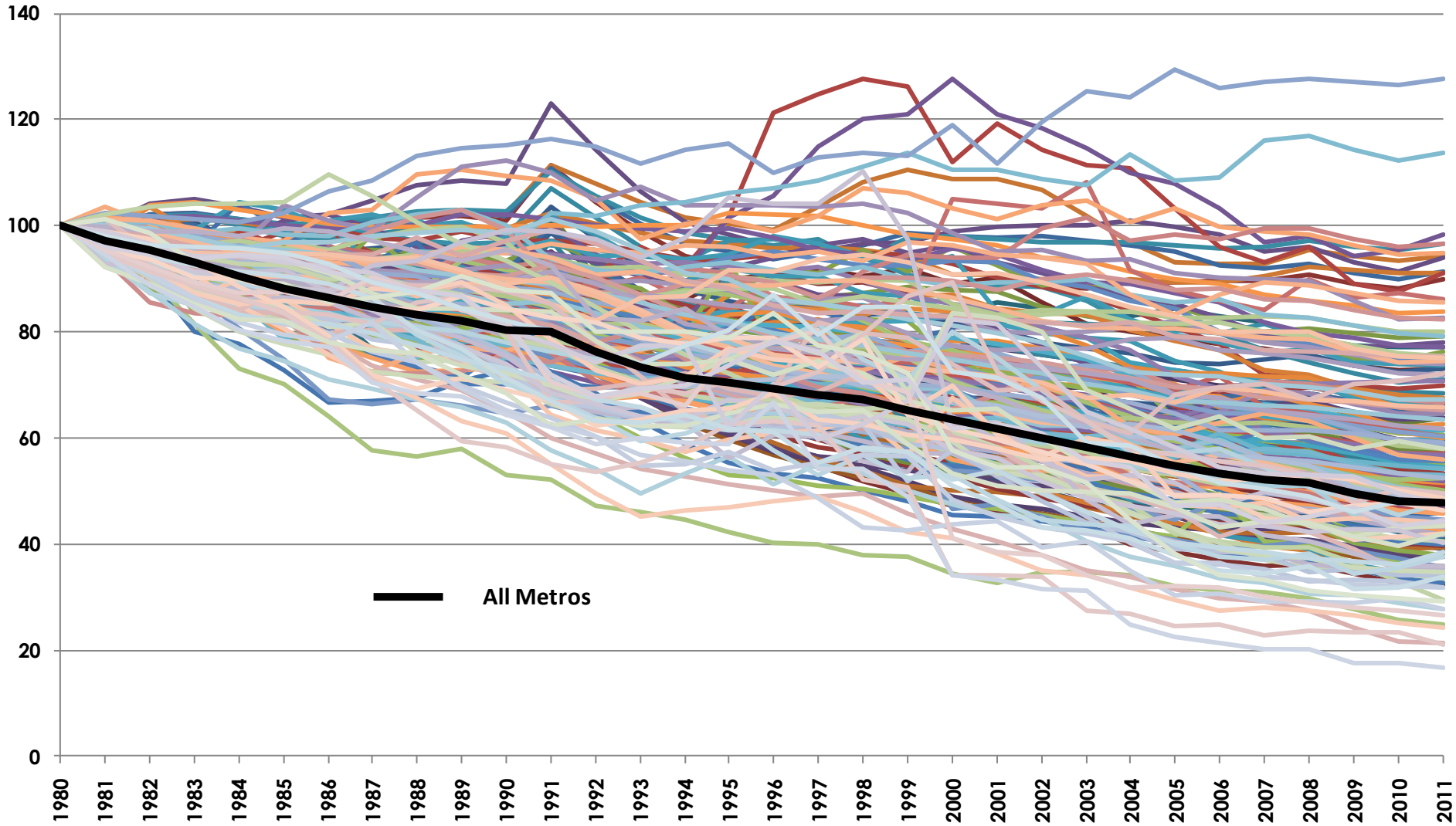
- Data from national accounts (feasible quality, fairly harmonized)
- Different vintages of regional accounts (ESA 79, ESA 95) chained up by national experts („longer“ time series)
- Data represent FURs (urban core + hinterland)

Metro groups used:

- Role in Metropolitan System (Capital/2nd tier/other): from Eurostat
- Size (large/medium/small): Population +/- ½ STDEV from Mean
- Income (high/medium/low): GDP/Cap +/- ½ STDEV from Mean
- Specialization (service-/manufacturing-/mixed based): based on LQs
- OLD MS/NEW MS: Metros from EU 15 and EU 12 resp.
- for presentability reasons only: 45 „primary“ Metros (Capital + 2nd tier > 1.5 Mio.)

Change in Manufacturing Employment Share

1980 = 100; 197 European Metropolitan Regions (EU 15)



2-way Decomposition of Manufacturing Employment Change

Tregenna (2009)

$$L_{jt} = \sum_{i=1}^{n} L_{ijt}$$

By Identity:

$$L_{ij\,t} = \varphi_{ijt}\, Q_{ijt} \quad ; \varphi_{ijt} = \frac{L_{ijt}}{Q_{ijt}}$$

Change in sectoral employment:

$$\Delta L_{ij} = \varphi_{ijt}\, Q_{ijt} - \varphi_{ijt\,-h}\, Q_{ijt\,-h} =$$

$$= \left(\varphi_{ijt} - \varphi_{ijt\,-h}\right)\left(\frac{Q_{ijt\,-h} + Q_{ijt}}{2}\right) + \left(Q_{ijt} - Q_{ijt\,-h}\right)\left(\frac{\varphi_{ijt\,-h} + \varphi_{ijt}}{2}\right)$$

↓ *Labor intensity effect*

↓ *Sector growth effect*

i = sector; j = metro region; L = employment; Q = Output (value added)

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Percentage Change in Manufacturing Employment:
Labor intensity- and Sector growth effect

$$Labor\ intensity\ effect = \left(\varphi_{ijt} - \varphi_{ij\,t-h}\right)\left(\frac{Q_{ijt-h} + Q_{ijt}}{2}\right)\left(\frac{100}{L_{ijt-h}}\right)$$

$$Sector\ growth\ effect = \left(Q_{ijt} - Q_{ijt-h}\right)\left(\frac{\varphi_{ijt-h} + \varphi_{ijt}}{2}\right)\left(\frac{100}{L_{ijt-h}}\right)$$

$$Labor\ intensity\ effect + Sector\ growth\ effect = \frac{100\Delta L_{ij}}{L_{ijt-h}}$$

4-way Decomposition of Manufacturing Employment Change I

By Identity:

$$L_{ijt} = \varphi_{ijt}\, \delta_{ijt}\, \varepsilon_{jt}\, Q_t$$

$$\varphi_{ijt} = \frac{L_{ijt}}{Q_{ijt}};\ \delta_{ijt} = \frac{Q_{ijt}}{Q_{jt}};\ \varepsilon_{jt} = \frac{Q_{jt}}{Q_t}$$

Change in sectoral employment:

$$\Delta L_{ij} = \varphi_{ijt}\, \delta_{ijt}\, \varepsilon_{jt}\, Q_t - \varphi_{ijt-1} \delta_{ijt-h} \varepsilon_{jt-h} Q_{t-h} =$$

i = sector; j = city; L = employment; Q = Output (value added)

4-way Decomposition of Manufacturing Employment Change II

$$\Delta L_{ij} = \varphi_{ijt}\,\delta_{ijt}\,\varepsilon_{jt}\,Q_t - \varphi_{ijt-1}\delta_{ijt-h}\varepsilon_{jt-h}Q_{t-h} =$$

$$= (\varphi_{ijt} - \varphi_{ijt-h})\left(\frac{\delta_{ijt-h}\varepsilon_{jt-h}Q_{t-h} + \delta_{ijt}\,\varepsilon_{jt}\,Q_t}{2}\right) + (\delta_{ijt} - \delta_{ijt-h})\left(\frac{\varphi_{ijt-h} + \varphi_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}Q_{t-h} + \varepsilon_{jt}\,Q_t}{2}\right)$$
$$+ (\varepsilon_{jt} - \varepsilon_{jt-h})\left(\frac{\varphi_{ijt-h} + \varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h} + \delta_{ijt}}{2}\right)\left(\frac{Q_{t-h} + Q_t}{2}\right)$$
$$+ (Q_t - Q_{t-h})\left(\frac{\varphi_{ijt-h} + \varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h} + \delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h} + \varepsilon_{jt}}{2}\right) =$$

$$= (\varphi_{ijt} - \varphi_{ijt-h})\left(\frac{\delta_{ijt-h} + \delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}Q_{t-h} + \varepsilon_{jt}\,Q_t}{2}\right) + (\delta_{ijt} - \delta_{ijt-h})\left(\frac{\varphi_{ijt-h}\varepsilon_{jt-h}Q_{t-h} + \varphi_{ijt}\,\varepsilon_{jt}\,Q_t}{2}\right)$$
$$+ (\varepsilon_{jt} - \varepsilon_{jt-h})\left(\frac{\varphi_{ijt-h} + \varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h} + \delta_{ijt}}{2}\right)\left(\frac{Q_{t-h} + Q_t}{2}\right)$$
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$$= (\varphi_{ijt} - \varphi_{ijt-h})\left(\frac{\delta_{ijt-h} + \delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h} + \varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h} + Q_t}{2}\right)$$
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$$= (\varphi_{ijt} - \varphi_{ijt-h})\left(\frac{\delta_{ijt-h} + \delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h} + \varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h} + Q_t}{2}\right)$$
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$$+ (\varepsilon_{jt} - \varepsilon_{jt-h})\left(\frac{\varphi_{ijt-h}\delta_{ijt-h} + \varphi_{ijt}\,\delta_{ijt}}{2}\right)\left(\frac{Q_{t-h} + Q_t}{2}\right)$$
$$+ (Q_t - Q_{t-h})\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}\varepsilon_{jt-h} + \varphi_{ijt}\,\delta_{ijt}\,\varepsilon_{jt}}{2}\right)$$

4-way Decomposition of Manufacturing Employment Change:
Labor intensity- and Sector share effect

Normalized labor intensity effect:

$$= \frac{1}{8}\left(\varphi_{ijt} - \varphi_{ijt-h}\right)\left\{\left(\delta_{ijt-h}\varepsilon_{jt-h}Q_{t-h} + \delta_{ijt}\,\varepsilon_{jt}\,Q_t\right) + \frac{\left(\delta_{ijt-h} + \delta_{ijt}\right)\left(\varepsilon_{jt-h}Q_{t-h} + \varepsilon_{jt}\,Q_t\right)}{2} + \frac{\left(\delta_{ijt-h} + \delta_{ijt}\right)\left(\varepsilon_{jt-h} + \varepsilon_{jt}\right)\left(Q_{t-h} + Q_t\right)}{2}\right\}\left(\frac{100}{L_{ijt-h}}\right)$$

Normalized sector share effect:

$$= \frac{1}{8}\left(\delta_{ijt} - \delta_{ijt-h}\right)\left\{\left(\varphi_{ijt-h}\varepsilon_{jt-h}Q_{t-h} + \varphi_{ijt}\,\varepsilon_{jt}\,Q_t\right) + \frac{\left(\varphi_{ijt-h} + \varphi_{ijt}\right)\left(\varepsilon_{jt-h}Q_{t-h} + \varepsilon_{jt}\,Q_t\right)}{2} + \frac{\left(\varphi_{ijt-h} + \varphi_{ijt}\right)\left(\varepsilon_{jt-h} + \varepsilon_{jt}\right)\left(Q_{t-h} + Q_t\right)}{2}\right\}\left(\frac{100}{L_{ijt-h}}\right)$$

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4-way Decomposition of Manufacturing Employment Change:
Metro share- and Economic growth effect

Normalized metro share effect:

$$= \frac{1}{8}(\varepsilon_{jt} - \varepsilon_{jt-h})\left\{(\varphi_{ijt-h}\delta_{ijt-h}Q_{t-h} + \varphi_{ijt}\delta_{ijt}Q_t) + \frac{(\varphi_{ijt-h}\delta_{ijt-h} + \varphi_{ijt}\delta_{ijt})(Q_{t-h} + Q_t)}{2} + \frac{(\varphi_{ijt-h} + \varphi_{ijt})(\delta_{ijt-h} + \delta_{ijt})(Q_{t-h} + Q_t)}{2}\right\}\left(\frac{100}{L_{ijt-h}}\right)$$

Normalized economic growth effect:

$$= \frac{1}{8}(Q_t - Q_{t-h})\left\{(\varphi_{ijt-h}\delta_{ijt-h}\varepsilon_{jt-h} + \varphi_{ijt}\delta_{ijt}\varepsilon_{jt}) + \frac{(\varphi_{ijt-h}\delta_{ijt-h} + \varphi_{ijt}\delta_{ijt})(\varepsilon_{jt-h} + \varepsilon_{jt})}{2} + \frac{(\varphi_{ijt-h} + \varphi_{ijt})(\delta_{ijt-h} + \delta_{ijt})(\varepsilon_{jt-h} + \varepsilon_{jt})}{2}\right\}\left(\frac{100}{L_{ijt-h}}\right)$$

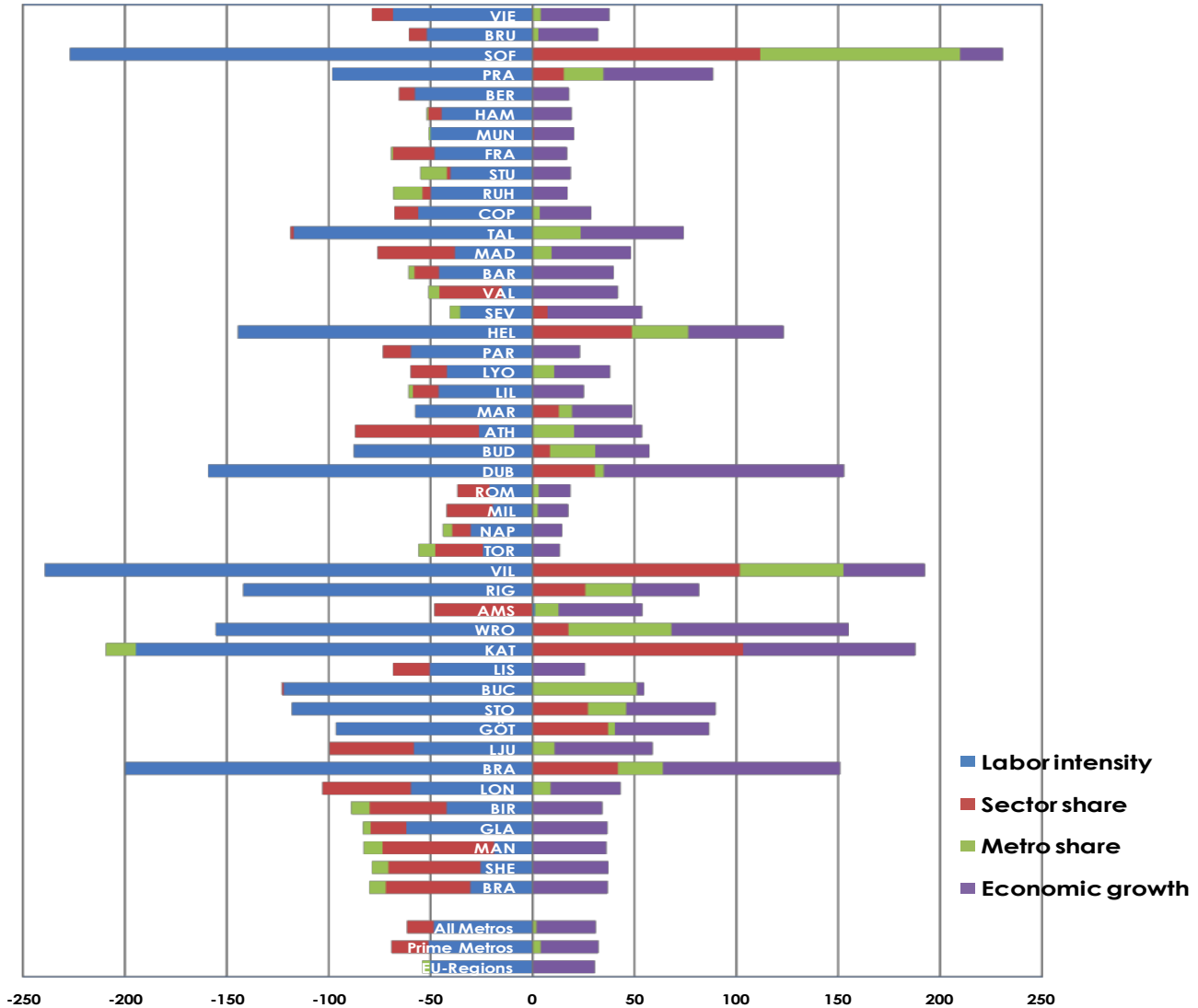
Components of Manufacturing Employment Change by Metro Groups

255 European Metros; 1991-2010

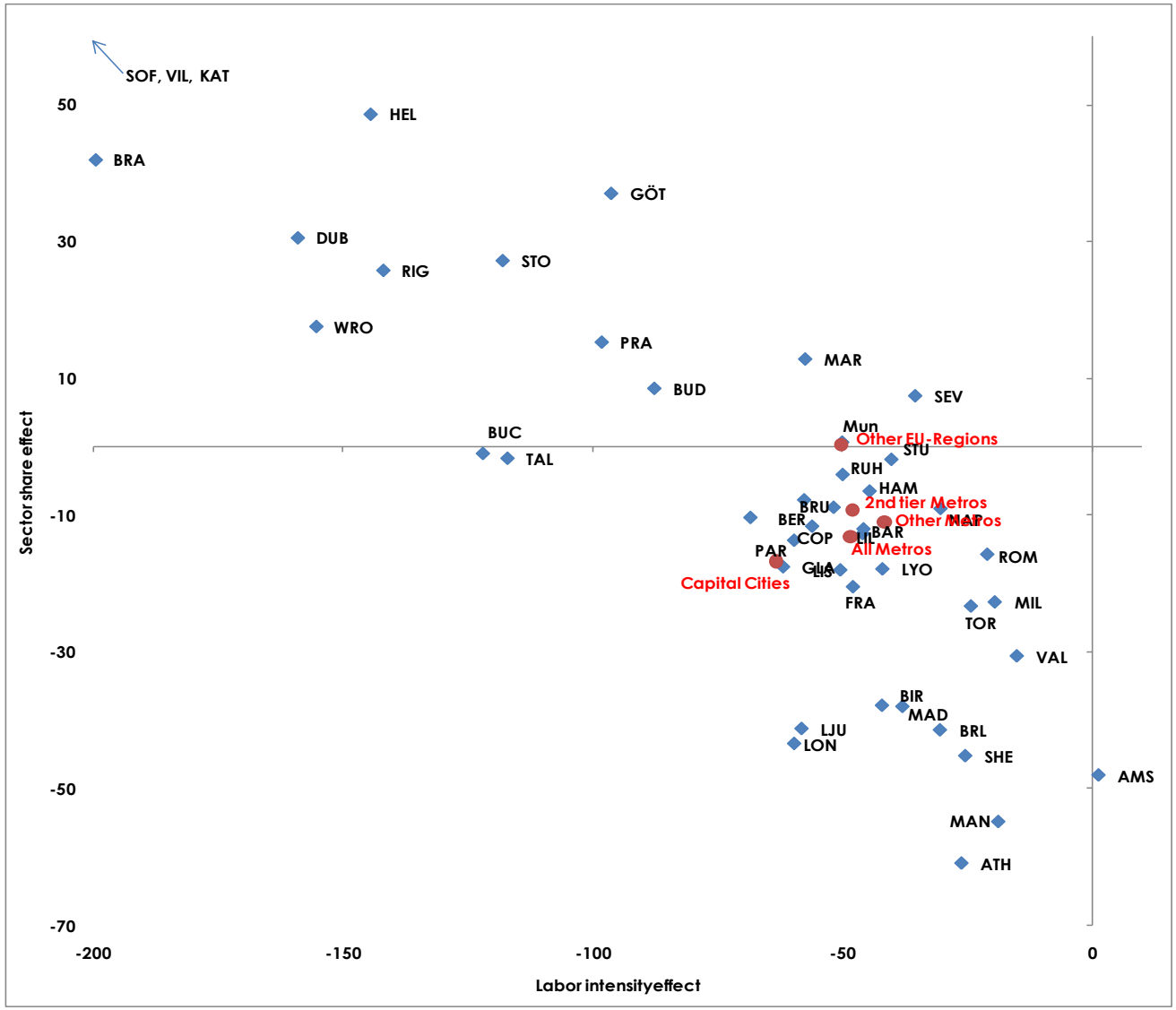
	Employment Change (%)	Labour intensity effect	Sector share effect	Metro share effect	Economic growth effect
All Metros	-30,5	-48,4	-13,2	+1,8	+29,2
Capital Cities	-40,0 *	-63,3 *	-16,8	+11,8 ***	+28,3
2nd tier Metros	-31,3	-47,9	-9,3	-3,0	+29,0
Other Metros	-25,2	-41,6 **	-11,0 **	-2,5	+29,9
Large Metros	-37,3 ***	-47,6	-19,6	+1,8	+28,1
Medium-sized Metros	-25,6	-48,6	-11,3	+4,3	+30,1
Small Metros	-24,4	-51,9	-1,7	-1,0 ***	+30,2
High-Income Metros	-32,6	-45,1	-14,7	-1,5	+28,8 **
Medium-income Metros	-32,3	-47,2	-18,2	+4,2	+29,0
Low-income Metros	-26,4 **	-73,3 ***	+3,4 ***	+12,7 **	+30,7 ***
Service-based Metros	-35,5 *	-51,5	-17,7 **	+5,1	+28,6
Mixed-based Metros	-26,3	-45,2	-10,8	-0,1	+29,8
Manufacturing-based Metros	-30,9	-50,3	-4,8	-4,9	+29,1
Old Member States	-31,3	-45,0	-15,8	+0,5	+29,0
New Member States	-27,6 **	-131,8 ***	+39,6 ***	+31,2 *	+33,5 ***

4-way Decomposition of Manufacturing Employment Change

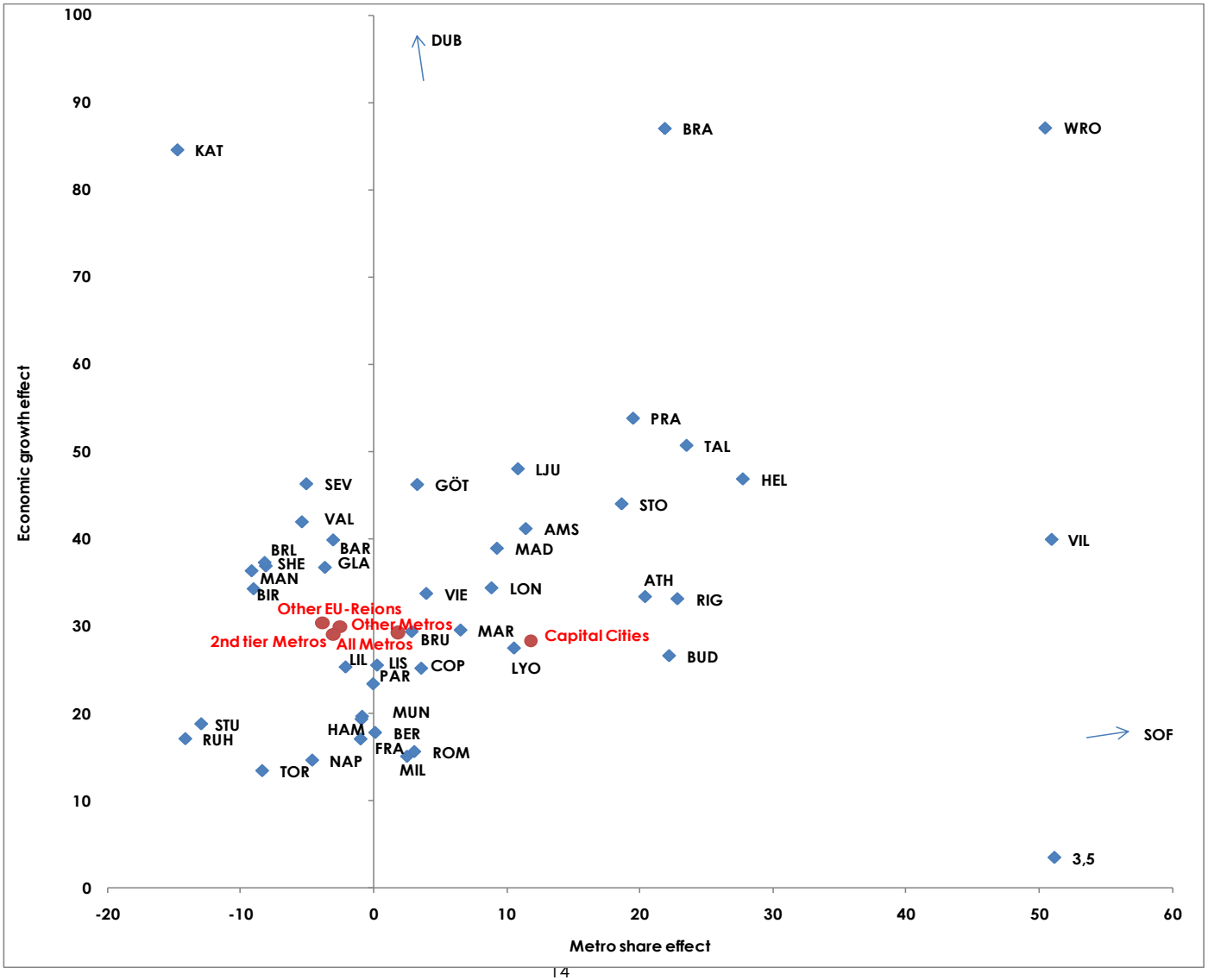
45 Primary Metro Regions, 1991-2010



4-way-Decomposition:
Labor intensity- and Sector share effect
45 Primary Metro Regions; 1991-2010

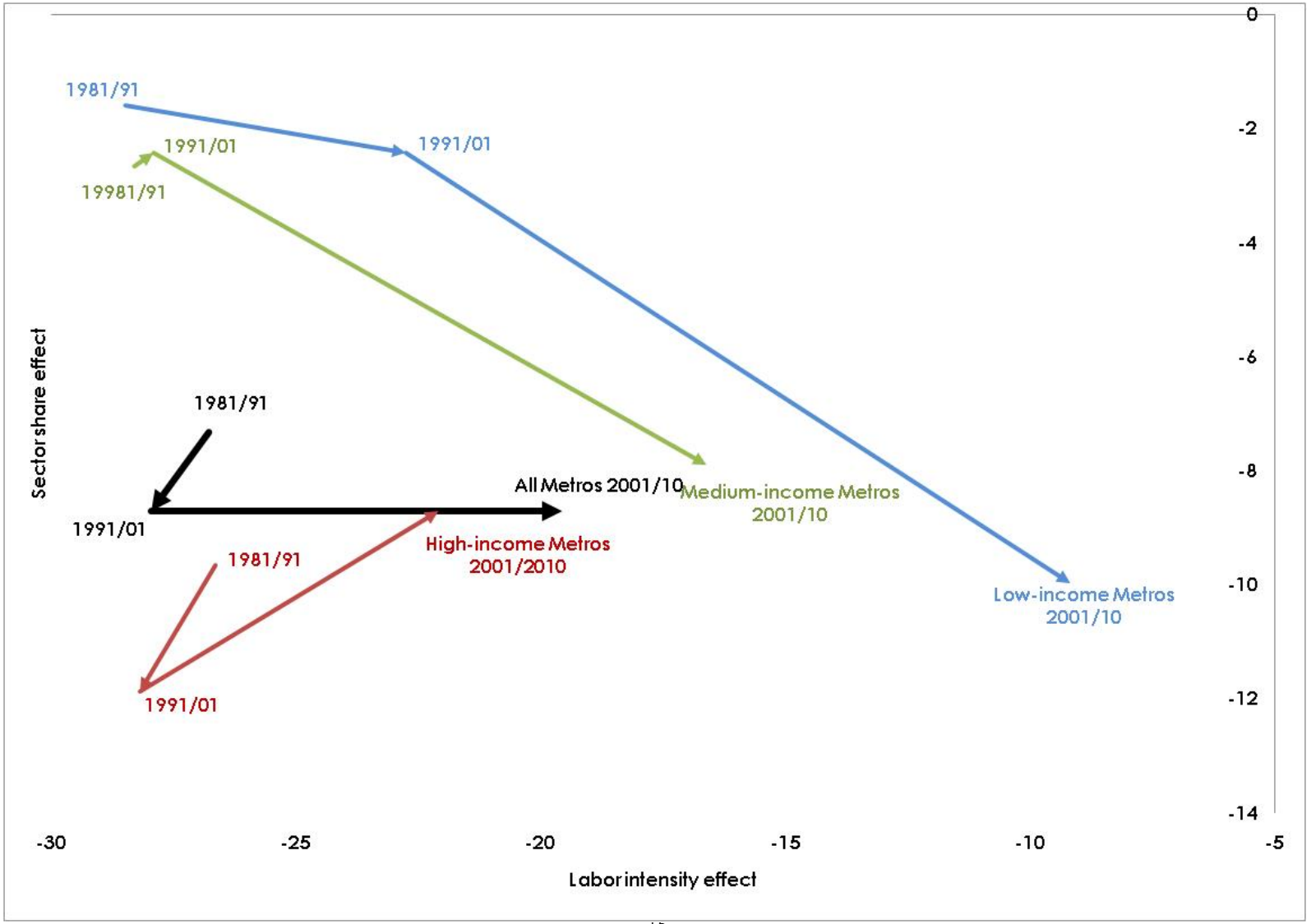


4-way-Decomposition:
Metro share- and Economic growth effect
45 Primary Metro Regions; 1991-2010



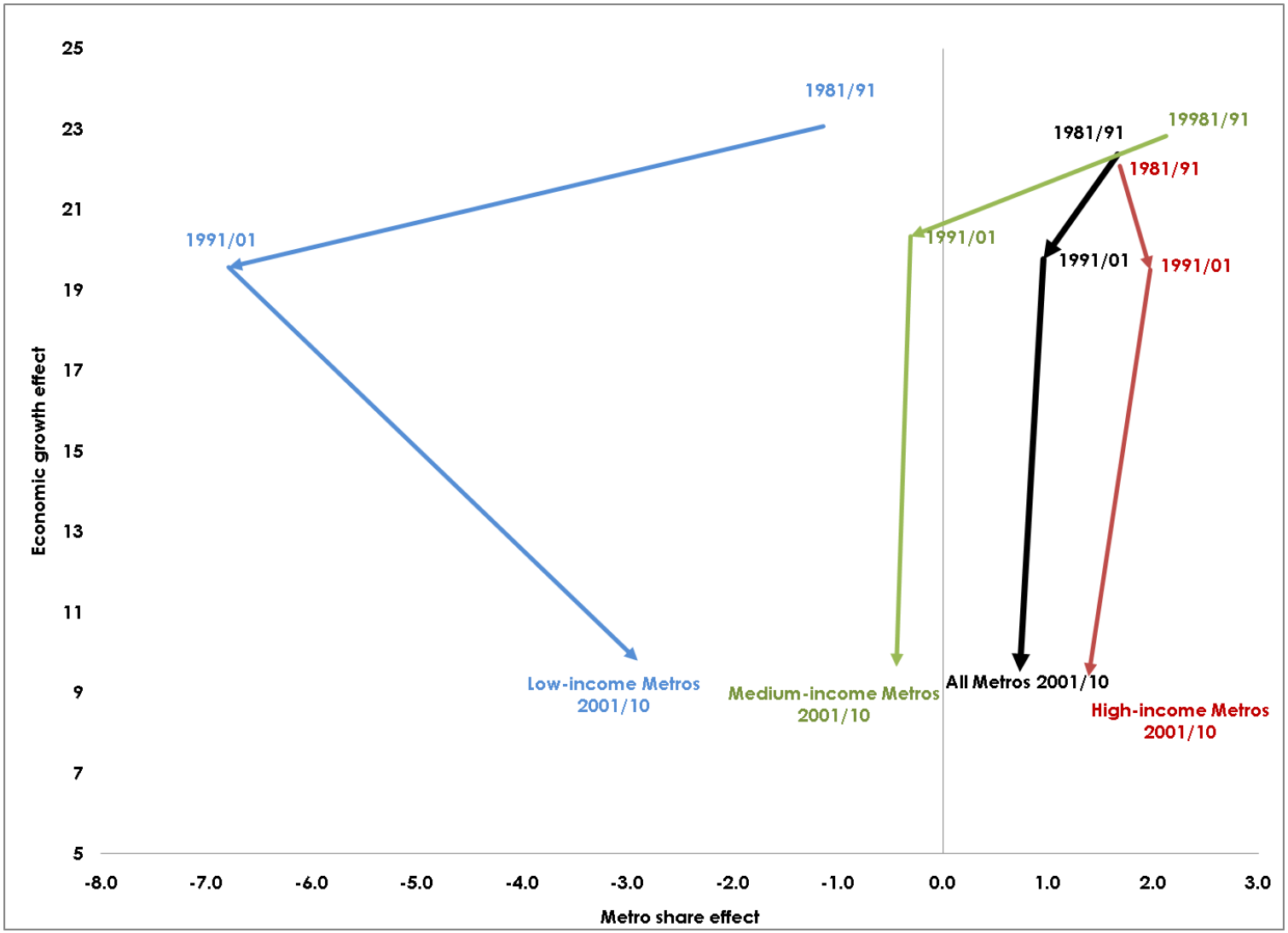
Dynamics in Labour intensity effect and Sector share effect by Metro Income

197 European Metro Regions (EU 15), 1981-2010



Dynamics in Metro share effect and Economic growth effect by Metro income

197 European Metro Regions (EU 15), 1981-2010



Types of manufacturing development I
Primary Metropolitan Regions (EU 27); 1991-2010

CITY	Country Type	Capital	Metro Income	Economic Base	Labor Intensity	Sector Share	Metro Share	National Growth
Type 1: Industrial Up-grading / Strong Metro Environment								
Sofia	NMS	yes	low	Mixed	-	+	+	+
Praha	NMS	yes	low	Mixed	-	+	+	+
Helsinki	OMS	yes	high	Services	-	+	+	+
Marseille	OMS	no	high	Services	-	+	+	+
Budapest	NMS	yes	low	Mixed	-	+	+	+
Dublin	OMS	yes	high	Services	-	+	+	+
Vilnius	NMS	yes	low	Manufacturing	-	+	+	+
Riga	NMS	yes	low	Manufacturing	-	+	+	+
Warszawa	NMS	yes	low	Mixed	-	+	+	+
Stockholm	OMS	yes	high	Services	-	+	+	+
Göteborg	OMS	no	high	Services	-	+	+	+
Bratislava	NMS	yes	low	Mixed	-	+	+	+
Type 2: Industrial Up-grading / Weak Metro Environment								
München	OMS	no	high	Services	-	+	-	+
Sevilla	OMS	no	low	Mixed	-	+	-	+
Katowice-Zory	NMS	no	low	Manufacturing	-	+	-	+

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Types of manufacturing development II

Primary Metropolitan Regions (EU 27); 1991-2010

CITY	Country Type	Capital	Metro Income	Economic Base	Labor Intensity	Sector Share	Metro Share	National Growth
Type 3: De-Industrialization / Strong Metro Environment								
Wien	OMS	yes	high	Services	-	-	+	+
Bruxelles / Brussel	OMS	yes	high	Services	-	-	+	+
Berlin	OMS	yes	medium	Services	-	-	+	+
København	OMS	yes	high	Services	-	-	+	+
Tallinn	NMS	yes	low	Manufacturing	-	-	+	+
Madrid	OMS	yes	medium	Services	-	-	+	+
Lyon	OMS	no	high	Mixed	-	-	+	+
Athina	OMS	yes	low	Mixed	-	-	+	+
Roma	OMS	yes	high	Services	-	-	+	+
Milano	OMS	no	high	Mixed	-	-	+	+
Lisboa	OMS	yes	low	Services	-	-	+	+
Bucuresti	NMS	yes	low	Manufacturing	-	-	+	+
Ljubljana	NMS	yes	low	Manufacturing	-	-	+	+
London	OMS	yes	high	Services	-	-	+	+
Type 4: De-Industrialization / Weak Metro Environment								
Hamburg	OMS	no	high	Mixed	-	-	-	+
Frankfurt am Main	OMS	no	high	Mixed	-	-	-	+
Stuttgart	OMS	no	high	Mixed	-	-	-	+
Ruhrgebiet	OMS	no	high	Manufacturing	-	-	-	+
Barcelona	OMS	no	medium	Manufacturing	-	-	-	+
Valencia	OMS	no	low	Manufacturing	-	-	-	+
Paris	OMS	yes	high	Services	-	-	-	+
Lille	OMS	no	medium	Services	-	-	-	+
Napoli	OMS	no	low	Services	-	-	-	+
Torino	OMS	no	high	Manufacturing	-	-	-	+
Birmingham	OMS	no	medium	Mixed	-	-	-	+
Glasgow	OMS	no	medium	Services	-	-	-	+
Manchester	OMS	no	medium	Services	-	-	-	+
Sheffield	OMS	no	low	Services	-	-	-	+
Bradford-Leeds	OMS	no	medium	Services	-	-	-	+
Type 5: De-Industrialization / Industrial Downgrading								
Amsterdam	OMS	yes	high	Services	+	-	+	+

Heterogeneity in manufacturing development paths

255 European Metros (EU 27); 1991-2010

In % of all metros in the respective metro type

	Up-Grading		De-Industrialization/ Down-Grading			Type 1: Up-grading/ strong Metro	Typ 2: Up-grading/ weak Metro	Type 3: De-Industrialization/ strong Metro	Typ 4: De-Industrialization/ weak Metro	Typ 5: Down-Grading/ strong Metro	Typ 6: Down-Grading/ weak Metro	
All Metros	38,0		62,0		100,0	19,6	18,4	22,7	35,7	1,2	2,4	100,0
Capital Cities	41,7		58,3		100,0	41,7	0,0	50,0	4,2	4,2	0,0	100,0
2nd tier Metros	47,5		52,5		100,0	23,7	23,7	13,6	39,0	0,0	0,0	100,0
Other Metros	34,3	*	65,7	*	100,0	15,1	19,2	22,1	39,0	1,2	3,5	100,0
Large Metros	27,9		72,1		100,0	16,3	11,6	30,2	39,5	2,3	0,0	100,0
Medium-sized Metros	32,5		67,5		100,0	22,5	10,0	28,8	31,3	2,5	5,0	100,0
Small Metros	44,7	*	55,3	*	100,0	18,9	25,8	16,7	37,1	0,0	1,5	100,0
High-Income Metros	24,8		75,2		100,0	14,2	10,6	23,9	48,7	0,9	1,8	100,0
Medium-income Metros	29,1		70,9		100,0	14,5	14,5	20,0	43,6	3,6	3,6	100,0
Low-income Metros	60,9	***	39,1	*	100,0	29,9	31,0	23,0	13,8	0,0	2,3	100,0
Service-based Metros	21,4	***	78,6	***	100,0	14,3	7,1	28,6	41,7	3,6	4,8	100,0
Mixed-based Metros	45,3		54,7		100,0	20,8	24,5	18,9	34,0	0,0	1,9	100,0
Manufacturing-based Metros	47,7		52,3		100,0	24,6	23,1	21,5	30,8	0,0	0,0	100,0
Old Menber States	26,1		73,9		100,0	14,5	11,6	26,1	43,5	1,4	2,9	100,0
New Member States	89,6	***	10,4	***	100,0	41,7	47,9	8,3	2,1	0,0	0,0	100,0

Conclusions

- Defining deindustrialisation solely by a fall of manufacturing employment share (as common in literature) is misleading
- When analyzing manufacturing employment and output simultaneously, the picture of a more or less uniformly „deindustrializing“ European metro system vanishes.
- On the contrary, a very heterogeneous picture of manufacturing evolutions arises: 40% of metros shed manufacturing employment at a growing output share, what points more to an (labor-saving) up-grading rather than to deindustrialization proper.
- Similar metros do not necessarily experience similar manufacturing developments
  - Urban policy: Learning from best practices makes sense
  - Research: further insights on the mechanisms behind these differences are needed
- Next step: Panel estimation approach on the determinants of the cities different manufacturing employment tracks („what ‚drives‘ deindustrialization?“)

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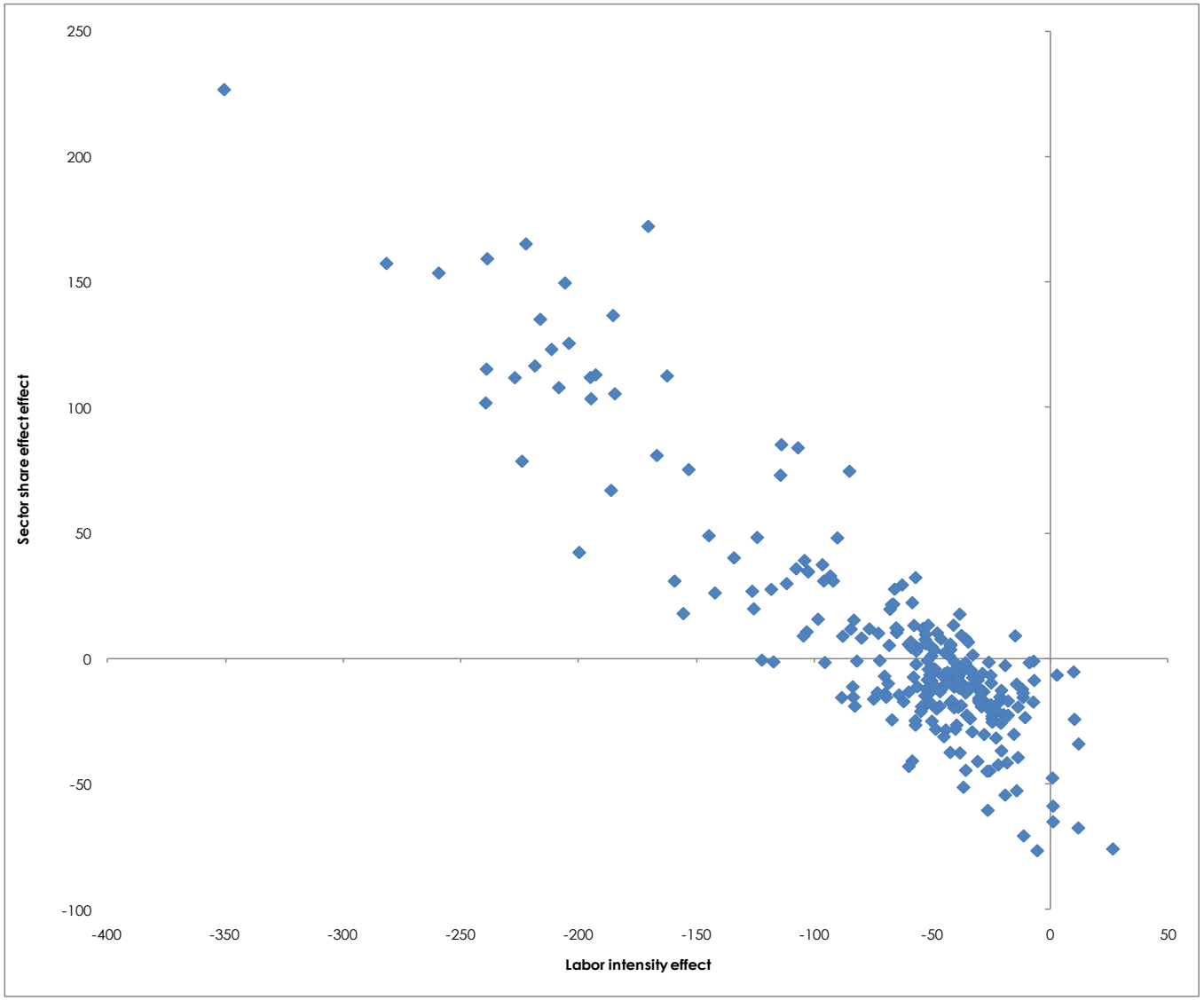
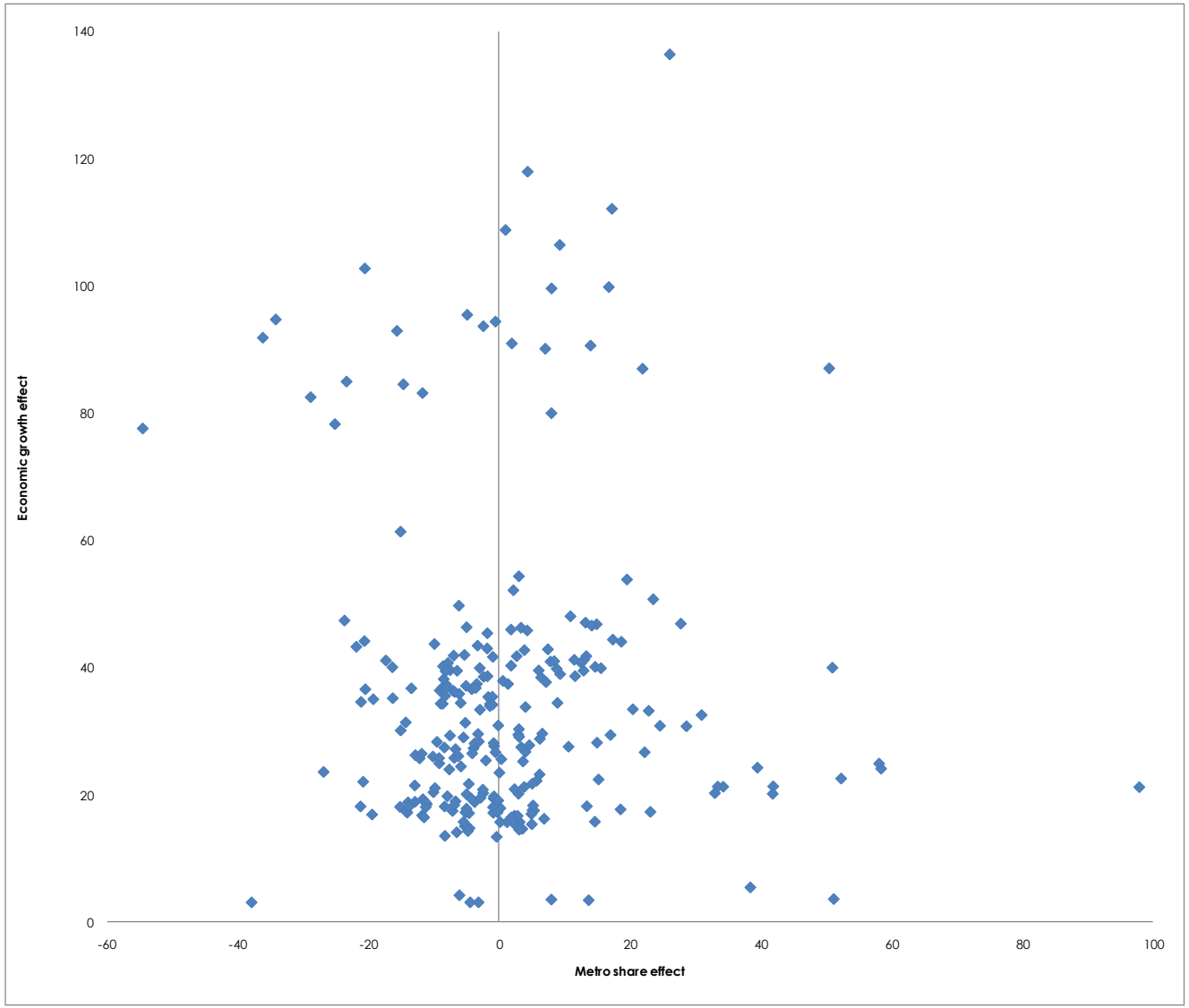
Thank You !

Comments are highly welcome!

4-way-Decomposition:
Labor intensity- and Sector share effect
255 European Metro Regions; 1991-2010

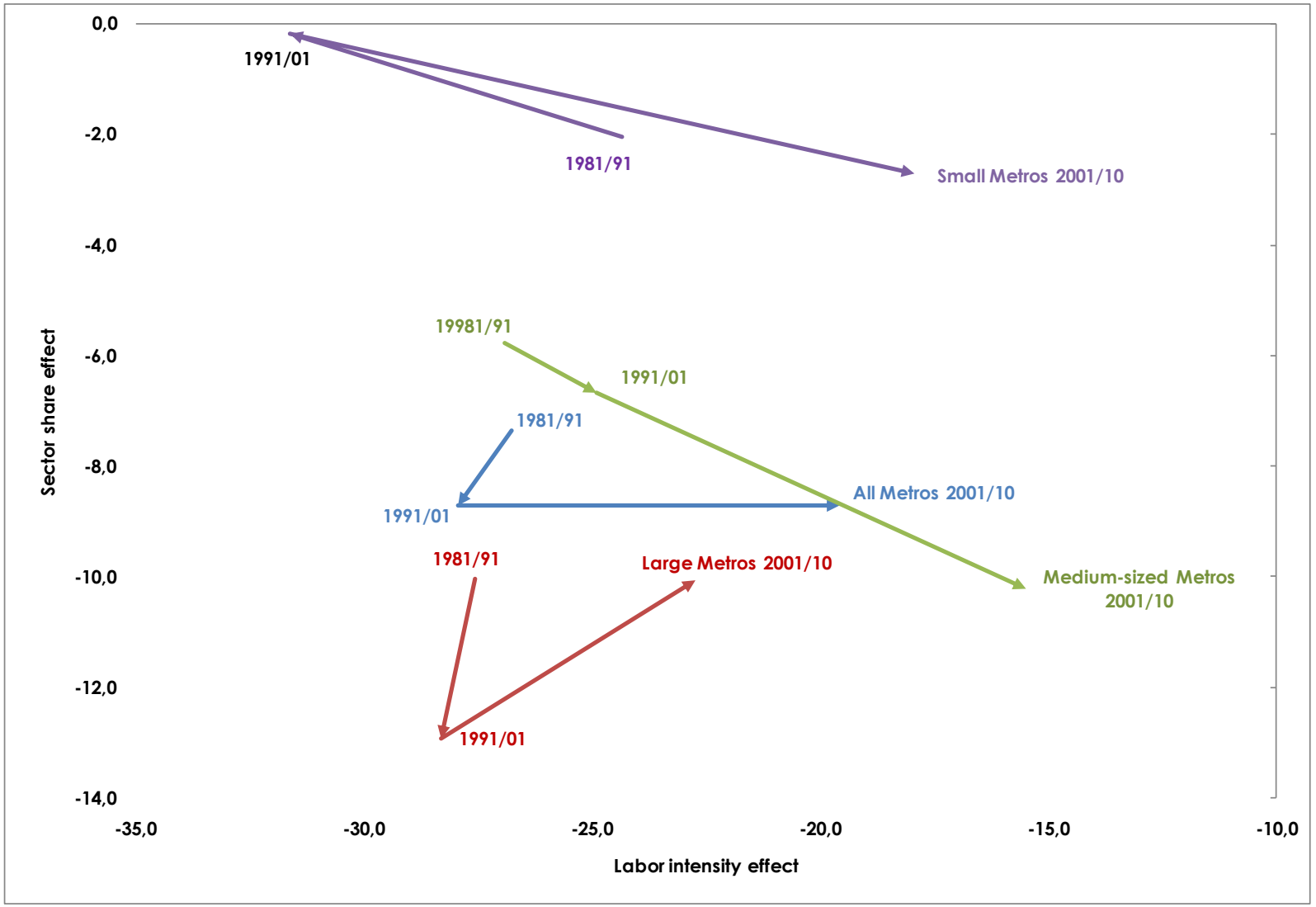


4-way-Decomposition:
Metro share- and Economic growth effect
255 European Metros; 1991-2010



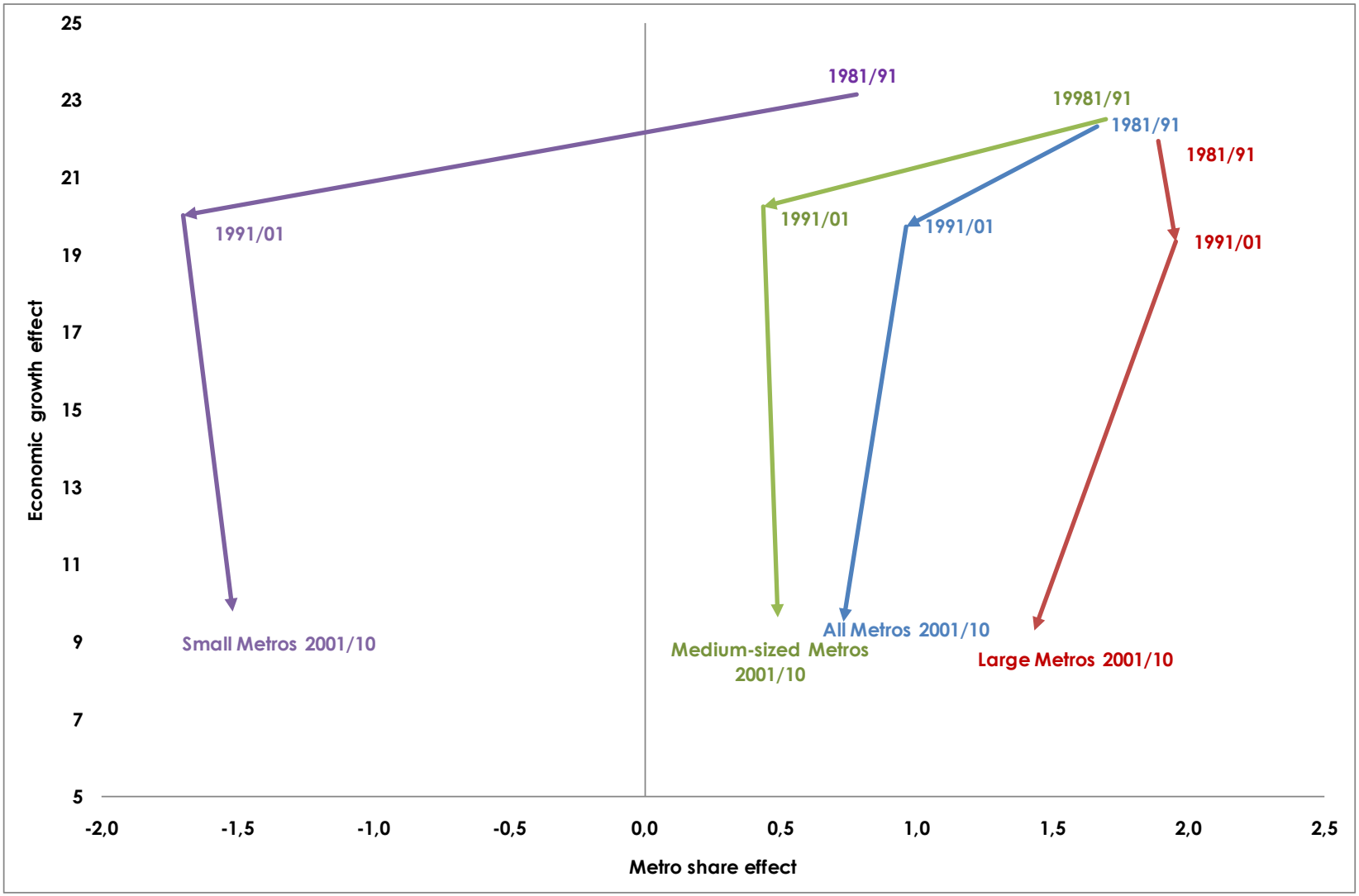
Dynamics in Labour intensity effect and Sector share effect by Metro Size

197 European Metro Regions (EU 15), 1981-2010



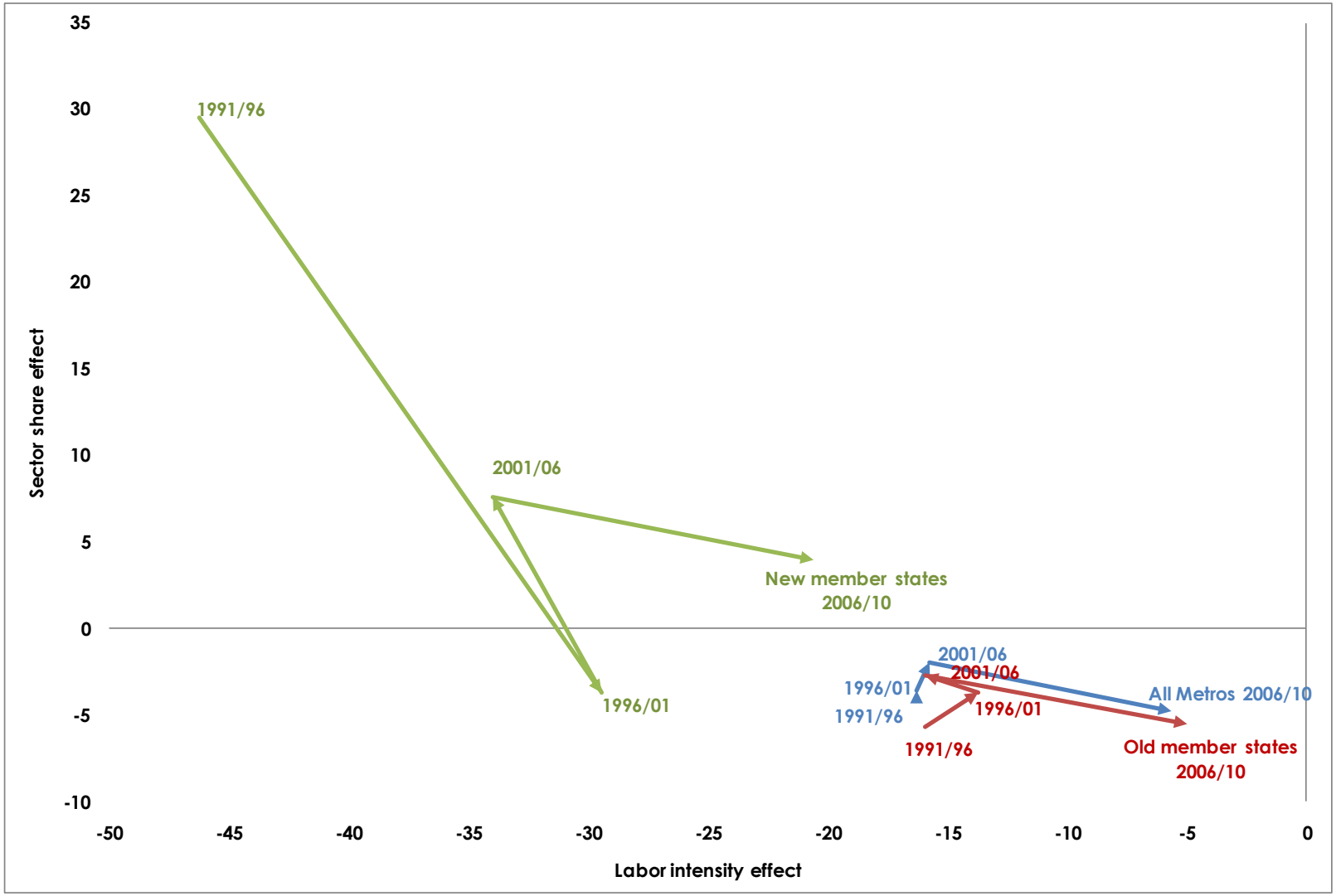
Dynamics in Metro share effect and Economic growth effect by Metro Size

197 European Metro Regions (EU 15), 1981-2010



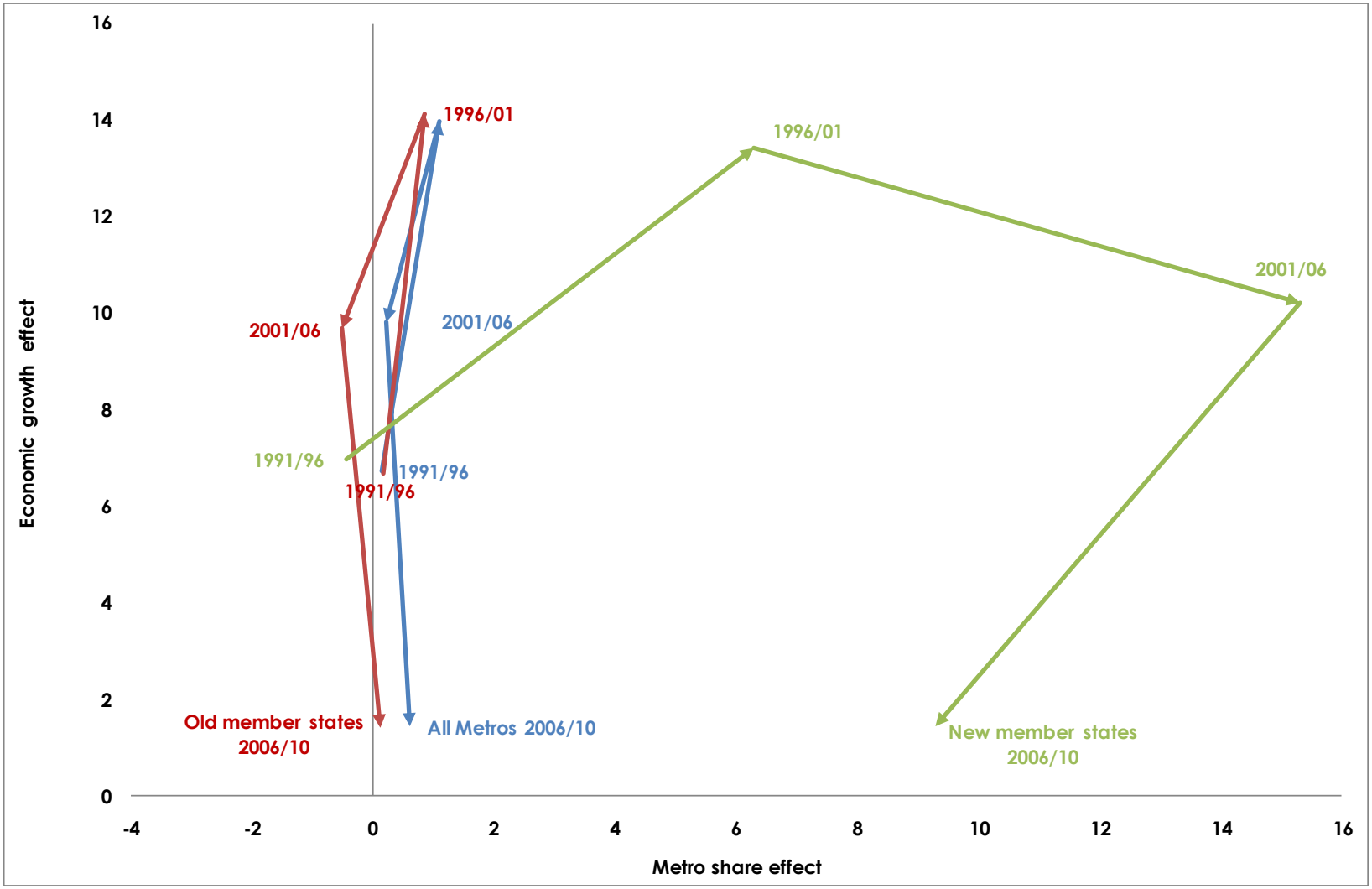
Dynamics in Labour intensity effect and Sector share effect: Old vs. new Member States

255 European Metros (EU 27), 1991-2010



Dynamics in Metro share effect and Economic growth effect: Old vs. new Member States

255 European Metros (EU 27), 1991-2010)



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Why bother about Deindustrialization in Cities?

Distributional / Social Perspective:

- Manufacturing offers „middle-class“ jobs; (business) services jobs show a sharp divide between high-paid (high-skilled) and low-wage (low-skilled) jobs. Therefore deindustrialization may spread the income distribution
- Employment security and job duration are superior in manufacturing; more evidence for casualisation and atypical employment in services

Growth Perspective:

- (Hirshmanian) Backward- and foreward linkages may be stronger in manufacturing
- Dynamic economies of scale in manufacturing from learning by doing
- Innovation input and output cluster in manufacturing; technology diffusion may be stronger (not the least via use of higher productivity manufacturing inputs in other sectors)
- Manufacturing is critical for the „economic base“ (due to issues of relative tradability of goods and services)

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Causes of „Deindustrialization“ in the Literature

- **„Productivity bias“: relative productivity gains in manufacturing (*Baumol*, 1967)**
- **„Demand bias“: Structural shift in final demand in course of economic development (*Clark*, 1940, 1957; *Bell*, 1974)**
- **Vertical Disintegration: Outsourcing of service functions (previously performed in-house in manufacturing)**
- **Globalization: Stronger international competitive pressure in (tradable) manufactures; „Slicing-up“ of the VA-chain (Baldwin, 2012,2013)**
- **„Dutch Disease“: Easing of BoP-constraints (*Palma*, 2005)**
- **Rising locational disadvantages of Cities in (mass) goods production proper:**
  - **Changing transport technologies (from rail to truck) (*Anas-Moses*, 1978)**
  - **Rising congestion costs in cities**
  - **Rising capital- and land intensity in production of manufactures**
  - **Organisational changes in production process (just-in-time-systems, zero-stock-strategies)**

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4-way Decomposition: Derivation of different Effects I

Labor intensity effect:

$$\frac{1}{4}\Bigg\{(\varphi_{ijt}-\varphi_{ijt-h})\left(\frac{\delta_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\delta_{ijt}\varepsilon_{jt}Q_t}{2}\right)+(\varphi_{ijt}-\varphi_{ijt-h})\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t}{2}\right)$$
$$+(\varphi_{ijt}-\varphi_{ijt-h})\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)$$
$$+(\varphi_{ijt}-\varphi_{ijt-h})\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)\Bigg\}$$
$$=\frac{1}{8}(\varphi_{ijt}-\varphi_{ijt-h})\Bigg\{(\delta_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\delta_{ijt}\varepsilon_{jt}Q_t)+\frac{(\delta_{ijt-h}+\delta_{ijt})(\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t)}{2}$$
$$+\frac{(\delta_{ijt-h}+\delta_{ijt})(\varepsilon_{jt-h}+\varepsilon_{jt})(Q_{t-h}+Q_t)}{2}\Bigg\}$$

Sector share effect:

$$\frac{1}{4}\Bigg\{(\delta_{ijt}-\delta_{ijt-h})\left(\frac{\varphi_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\varphi_{ijt}\varepsilon_{jt}Q_t}{2}\right)+(\delta_{ijt}-\delta_{ijt-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t}{2}\right)$$
$$+(\delta_{ijt}-\delta_{ijt-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)$$
$$+(\delta_{ijt}-\delta_{ijt-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)\Bigg\}$$
$$=\frac{1}{8}(\delta_{ijt}-\delta_{ijt-h})\Bigg\{(\varphi_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\varphi_{ijt}\varepsilon_{jt}Q_t)+\frac{(\varphi_{ijt-h}+\varphi_{ijt})(\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t)}{2}$$
$$+\frac{(\varphi_{ijt-h}+\varphi_{ijt})(\varepsilon_{jt-h}+\varepsilon_{jt})(Q_{t-h}+Q_t)}{2}\Bigg\}$$

4-way Decomposition: Derivation of different Effects II

City share effect:

$$\begin{aligned}
&\frac{1}{4}\Bigg\{(\varepsilon_{jt}-\varepsilon_{jt-h})\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}Q_{t-h}+\varphi_{ijt}\delta_{ijt}Q_t}{2}\right)+(\varepsilon_{jt}-\varepsilon_{jt-h})\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)\\
&\qquad+(\varepsilon_{jt}-\varepsilon_{jt-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)\\
&\qquad+(\varepsilon_{jt}-\varepsilon_{jt-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)\Bigg\}\\
&=\frac{1}{8}(\varepsilon_{jt}-\varepsilon_{jt-h})\Bigg\{(\varphi_{ijt-h}\delta_{ijt-h}Q_{t-h}+\varphi_{ijt}\delta_{ijt}Q_t)+\frac{(\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt})(Q_{t-h}+Q_t)}{2}\\
&\qquad+\frac{(\varphi_{ijt-h}+\varphi_{ijt})(\delta_{ijt-h}+\delta_{ijt})(Q_{t-h}+Q_t)}{2}\Bigg\}
\end{aligned}$$

Economic growth effect:

$$\begin{aligned}
&\frac{1}{4}\Bigg\{(Q_t-Q_{t-h})\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}\varepsilon_{jt-h}+\varphi_{ijt}\delta_{ijt}\varepsilon_{jt}}{2}\right)+(Q_t-Q_{t-h})\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\\
&\qquad+(Q_t-Q_{t-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\\
&\qquad+(Q_t-Q_{t-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon j_{t-h}+\varepsilon_{jt}}{2}\right)\Bigg\}\\
&=\frac{1}{8}(Q_t-Q_{t-h})\Bigg\{(\varphi_{ijt-h}\delta_{ijt-h}\varepsilon_{jt-h}+\varphi_{ijt}\delta_{ijt}\varepsilon_{jt})+\frac{(\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt})(\varepsilon_{jt-h}+\varepsilon_{jt})}{2}\\
&\qquad+\frac{(\varphi_{ijt-h}+\varphi_{ijt})(\delta_{ijt-h}+\delta_{ijt})(\varepsilon_{jt-h}+\varepsilon_{jt})}{2}\Bigg\}
\end{aligned}$$