



# Analysis of the Substitution between the Production Factors and Intermediate Inputs in the light of KLEMS Growth Accounting for Poland

**Dariusz Kotlewski - Warsaw School of Economics and Statistics Poland**

**and**

**Mirosław Błażej – Statistics Poland**

# Structure of the presentation:

**Part I Introduction**

**Part II The adopted methodology**

**Part III Discussion of the results**

# Part I

## Introduction

# Part I Introduction

- Although, in various releases of EU KLEMS database Poland is present no decomposition of GVA or GO growth is available there (with the exception of 2007 EU KLEMS release).

# Part I Introduction

The reason is that:

- no sufficient data are being sent to Eurostat on the one hand
- some data need to be imputed innovatively because they are not straightforwardly available on the other hand

# Part I Introduction

- For over 5 years a GVA decomposition is performed by Statistics Poland thanks to some developments lastly presented in:

Kotlewski D. and Błażej M. (2020), *KLEMS Growth Accounting Implemented in Poland*, Statistics in Transition 3/2020

# Part I Introduction

- Lastly, some new input data resource concerning the intermediate inputs in different prices became available.
- This turn has made possible to perform a **gross output decomposition** into the contributions of intermediate inputs, labor services, capital services and MFP.

# Part I Introduction

Having that in mind, it is now possible to compare the two kinds of MFP:

- gross-output-based
- gross-value-added-based

# Part I Introduction

- When comparing the two kinds of MFPs, it was assumed that they are both valuable analytical tools
- Therefore, the analysis of the substitution phenomenon between primary production factors and intermediate inputs is sensible and informative

## **Part II**

### **The adopted methodology**

## Part II The adopted methodology

The methodology is based on the well-known KLEMS type GO growth decomposition:

$$\Delta \ln Y_{jt} = \bar{v}_{jt}^X \Delta \ln X_{jt} + \bar{v}_{jt}^K \Delta \ln K_{jt} + \bar{v}_{jt}^L \Delta \ln L_{jt} + \Delta \ln A_{jt}^Y \quad (1)$$

and the well-known KLEMS type GVA growth decomposition:

$$\Delta \ln V_{jt} = \bar{w}_{jt}^K \Delta \ln K_{jt} + \bar{w}_{jt}^L \Delta \ln L_{jt} + \Delta \ln A_{jt}^V \quad (2)$$

**However, the decomposition (2) is the one that is usually performed because of data availability issues!**

## Part II The adopted methodology

It is best the calculations to remain consistent between (1) and (2). Some mathematical tool discrepancies will then be reduced. To do so, some values from (2) have to be transposed into (1) as following:

$$\Delta \ln Y_{jt} = \bar{v}_{jt}^X \Delta \ln X_{jt} + \overline{\left(\frac{V_{jt}}{Y_{jt}}\right)} \bar{w}_{jt}^K \Delta \ln K_{jt} + \overline{\left(\frac{V_{jt}}{Y_{jt}}\right)} \bar{w}_{jt}^L \Delta \ln L_{jt} + \Delta \ln A_{jt}^Y \quad (3)$$

## Part II The adopted methodology

$$\Delta \ln Y_{jt} = \bar{v}_{jt}^X \Delta \ln X_{jt} + \overline{\left(\frac{V_{jt}}{Y_{jt}}\right)} \bar{w}_{jt}^K \Delta \ln K_{jt} + \overline{\left(\frac{V_{jt}}{Y_{jt}}\right)} \bar{w}_{jt}^L \Delta \ln L_{jt} + \Delta \ln A_{jt}^Y \quad (3)$$

As can be seen in (3) the components from (2) have to be multiplied by the ratios between GVA and GO at the industry  $j$  level. Moreover, they should be averages for two discrete time periods  $t-1$  and  $t$ , which are calculated by linear interpolation in a similar way as the shares in the previous formulae (1) and (2).

## Part II The adopted methodology

The contributions of production factors services from (3) should therefore be further decomposed as following:

$$\overline{\left(\frac{V_{jt}}{Y_{jt}}\right)} \bar{w}_{jt}^K \Delta \ln K_{jt} = \overline{\left(\frac{V_{jt}}{Y_{jt}}\right)} \bar{w}_{jt}^{KIT} \Delta \ln KIT_{jt} + \overline{\left(\frac{V_{jt}}{Y_{jt}}\right)} \bar{w}_{jt}^{KNIT} \Delta \ln KNIT_{jt} \quad (4)$$

$$\overline{\left(\frac{V_{jt}}{Y_{jt}}\right)} \bar{w}_{jt}^L \Delta \ln L_{jt} = \overline{\left(\frac{V_{jt}}{Y_{jt}}\right)} \bar{w}_{jt}^L \Delta \ln H_{jt} + \overline{\left(\frac{V_{jt}}{Y_{jt}}\right)} \bar{w}_{jt}^L \Delta \ln LC_{jt} \quad (5)$$

## Part II The adopted methodology

The contribution of gross-output-based MFP from (1) and (3) can be made comparable to the contribution of gross-value-added-based MFP from formula (2), if it is multiplied by the inverse ratio between GVA and GO at industry  $j$  level taken from formula (3):

$$\Delta \ln A_{jt}^{V*} = \overline{\left(\frac{Y_{jt}}{V_{jt}}\right)} \Delta \ln A_{jt}^Y \quad (6)$$

## Part II The adopted methodology

$$\Delta \ln A_{jt}^{V*} = \overline{\left(\frac{Y_{jt}}{V_{jt}}\right)} \Delta \ln A_{jt}^Y \quad (6)$$

The asterisk indicates that the value from the left-hand side of (6) is derived from the gross-output-based MFP, that can be equal to gross-value-added-based MFP, on the condition that there is no substitution between the production factors services and intermediate consumption:

$$\Delta \ln A_{jt}^{V*} \approx \Delta \ln A_{jt}^V \quad (7)$$

## Part II The adopted methodology

If it is not so, then the phenomenon of substitution between primary production factors and the intermediate consumption is to be considered as substantial!

## **Part III**

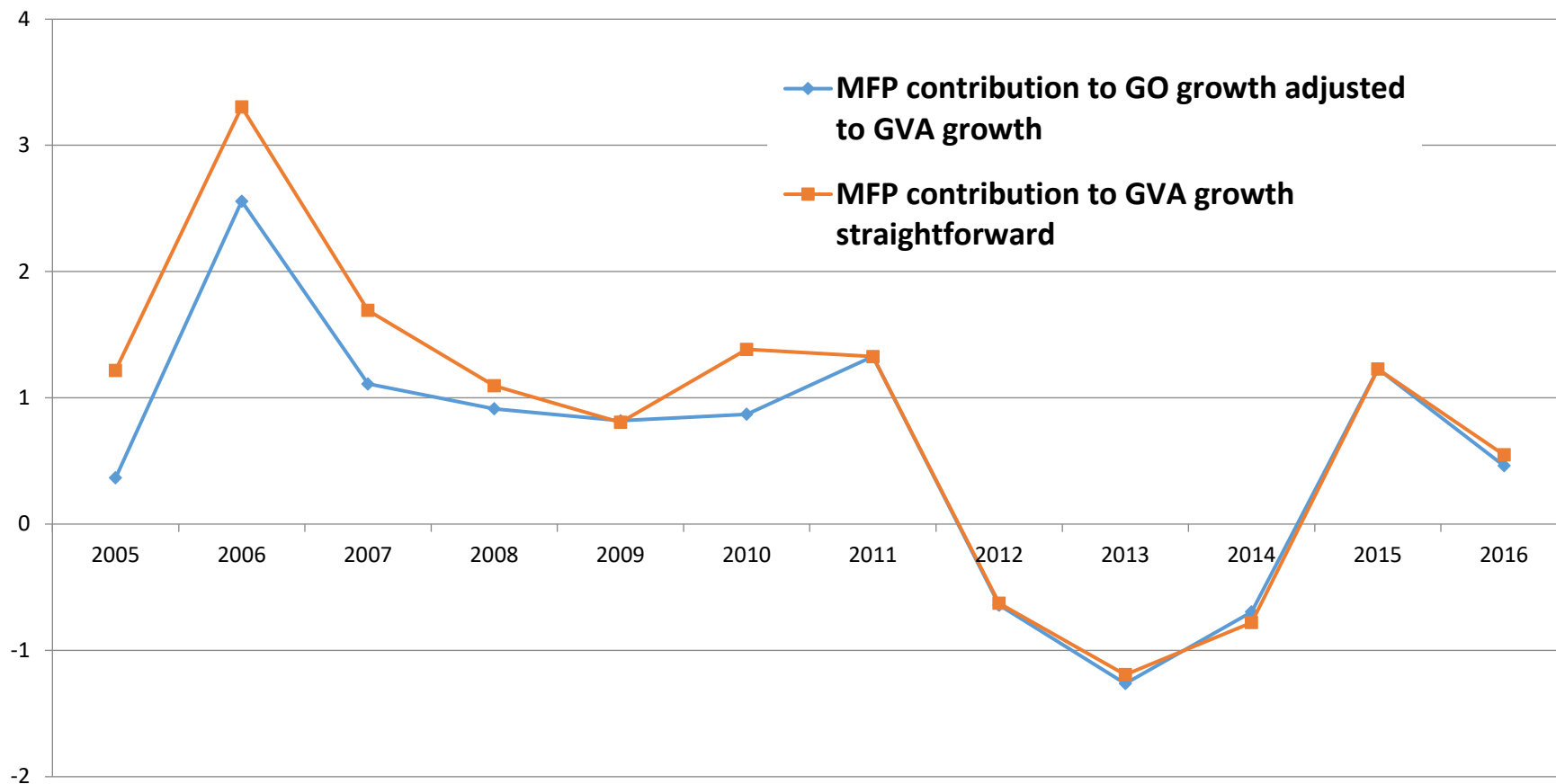
### **Discussion of the results**

## Part III Discussion of the results

- Having calculated MFP both ways we can now make the comparison and try to interpret the difference

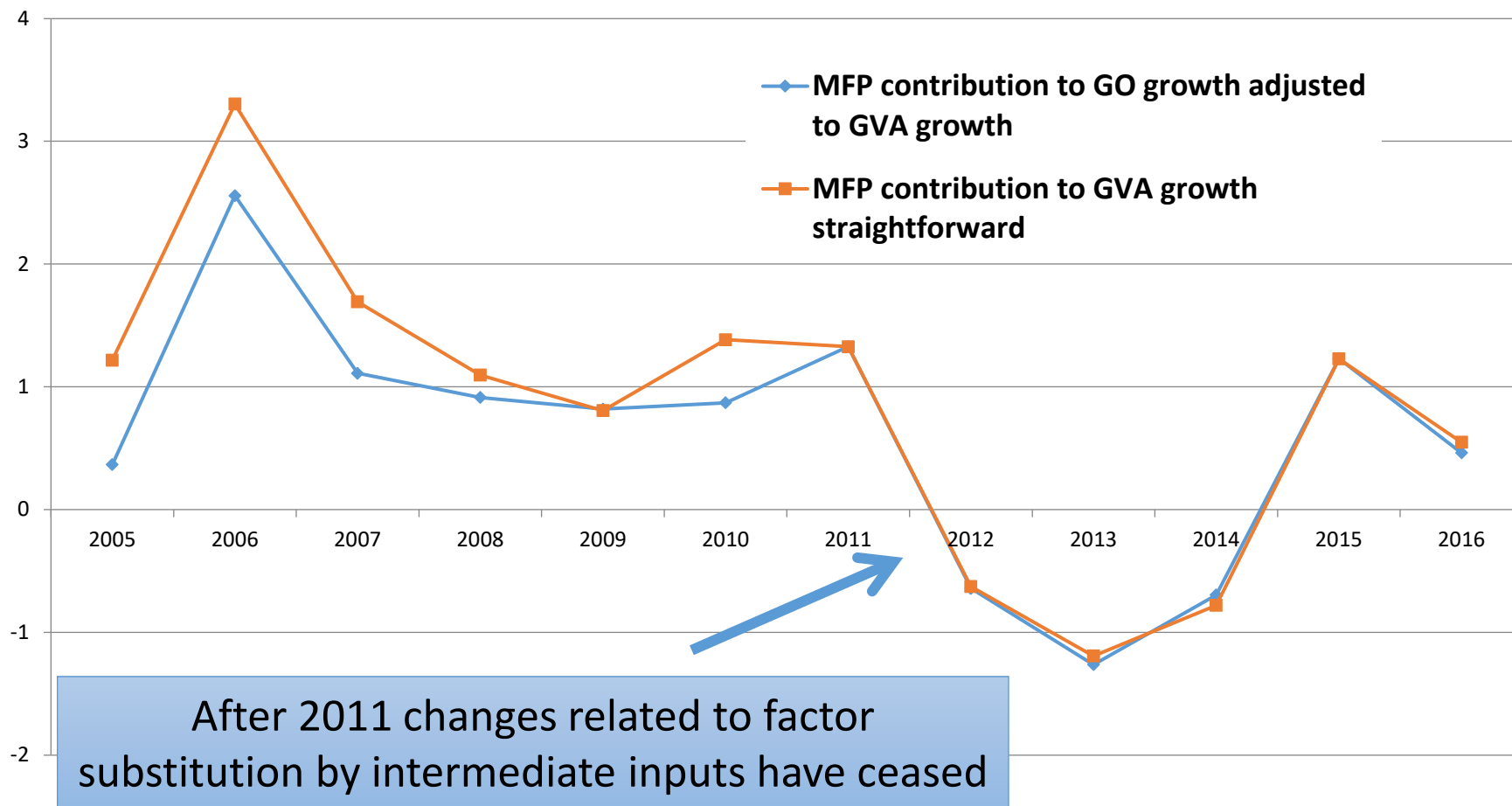
## Part III Discussion of the results

**MFP contribution to GO growth adjusted to GVA growth  
against MFP contribution to GVA growth straightforward**



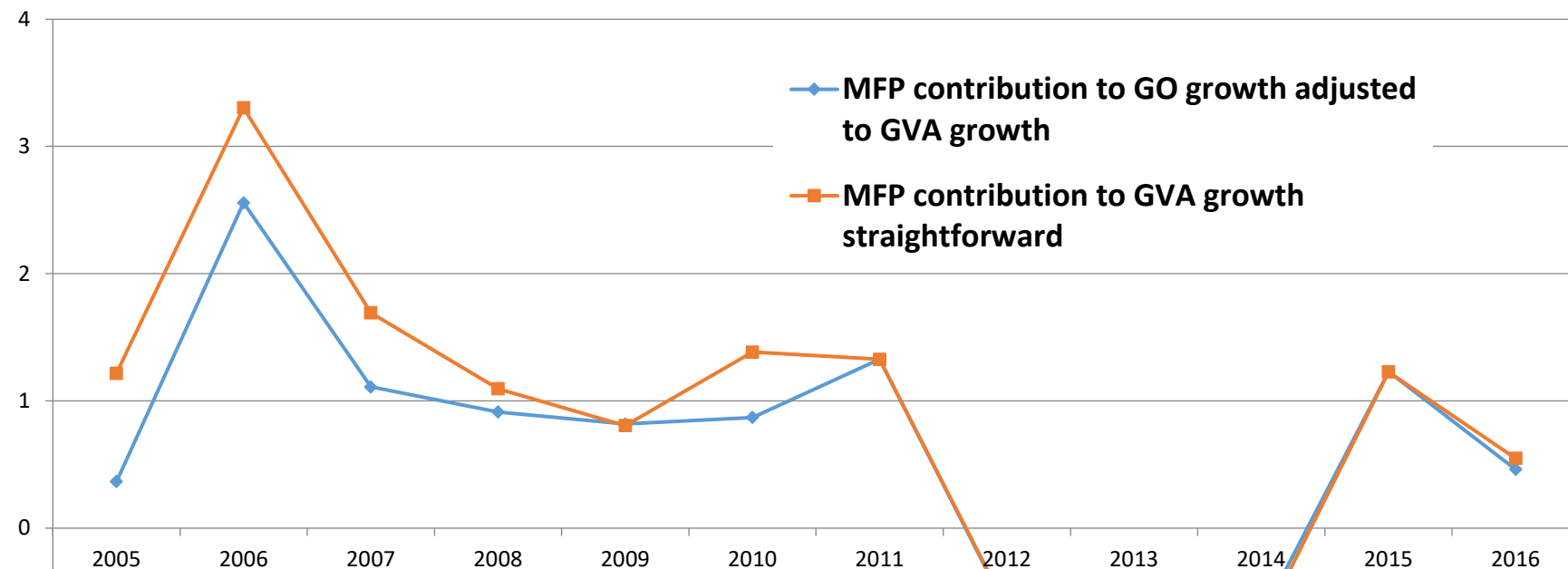
## Part III Discussion of the results

**MFP contribution to GO growth adjusted to GVA growth  
against MFP contribution to GVA growth straightforward**



## Part III Discussion of the results

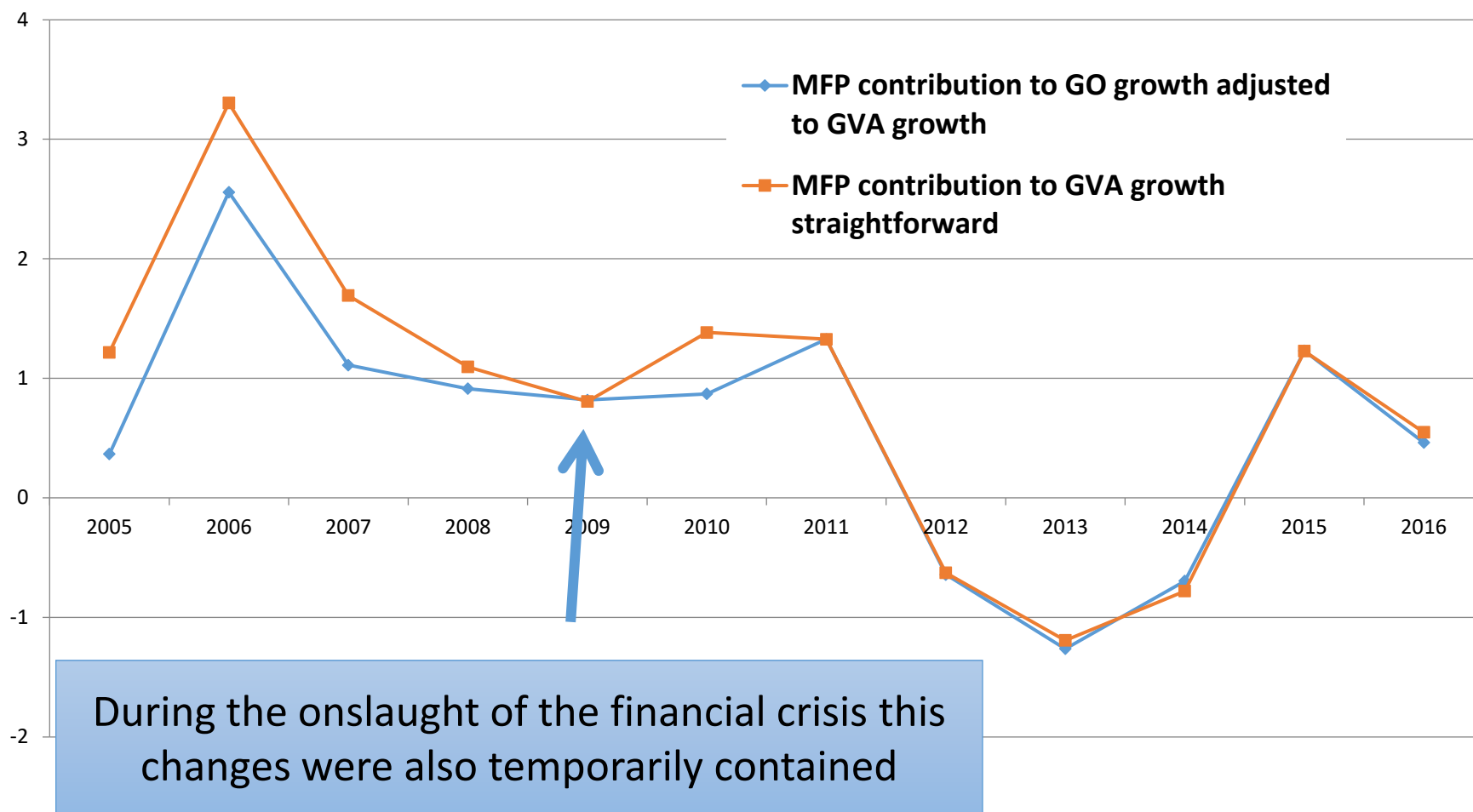
**MFP contribution to GO growth adjusted to GVA growth  
against MFP contribution to GVA growth straightforward**



...i.e. outsourcing growth (and additionally changes in some capital being treated as intermediate consumption) has ceased

## Part III Discussion of the results

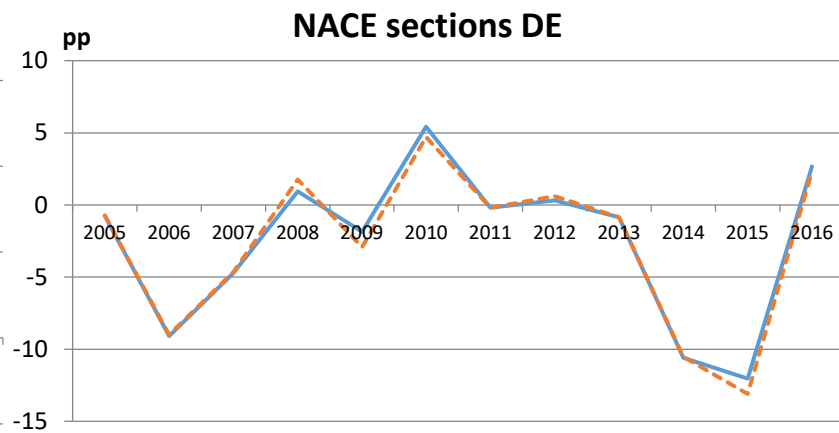
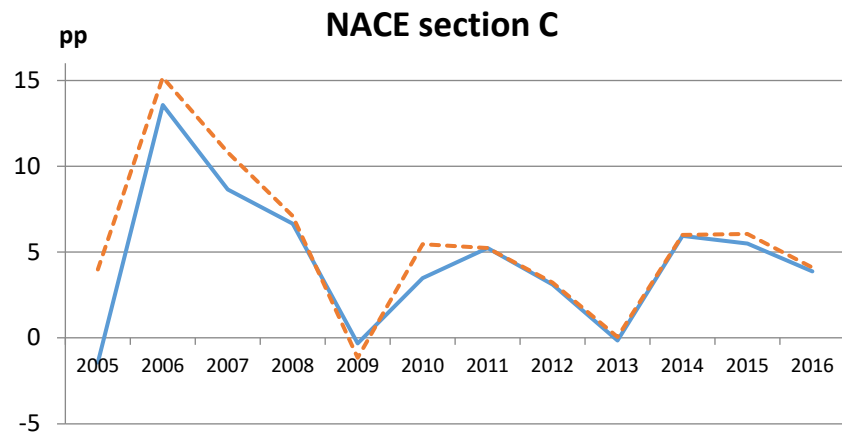
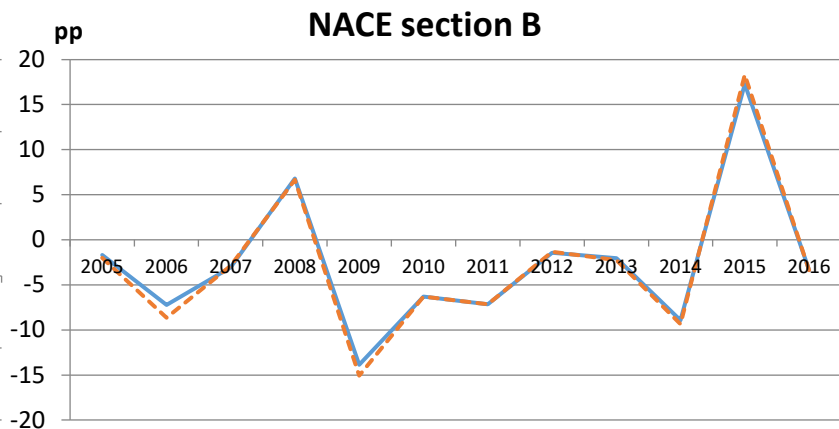
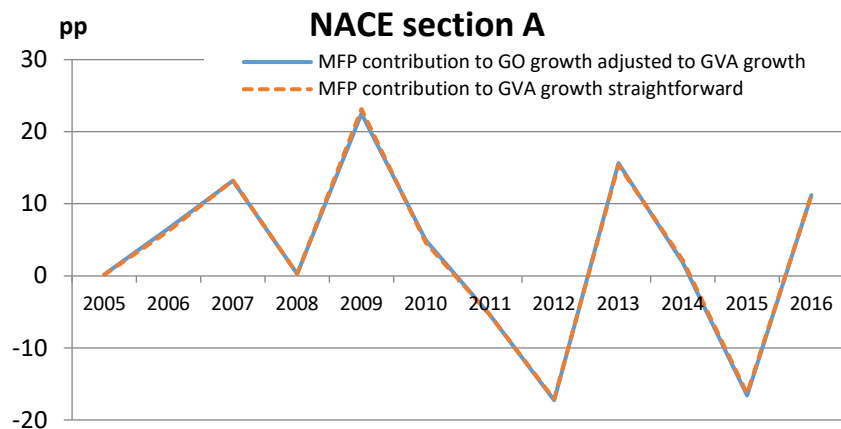
**MFP contribution to GO growth adjusted to GVA growth  
against MFP contribution to GVA growth straightforward**



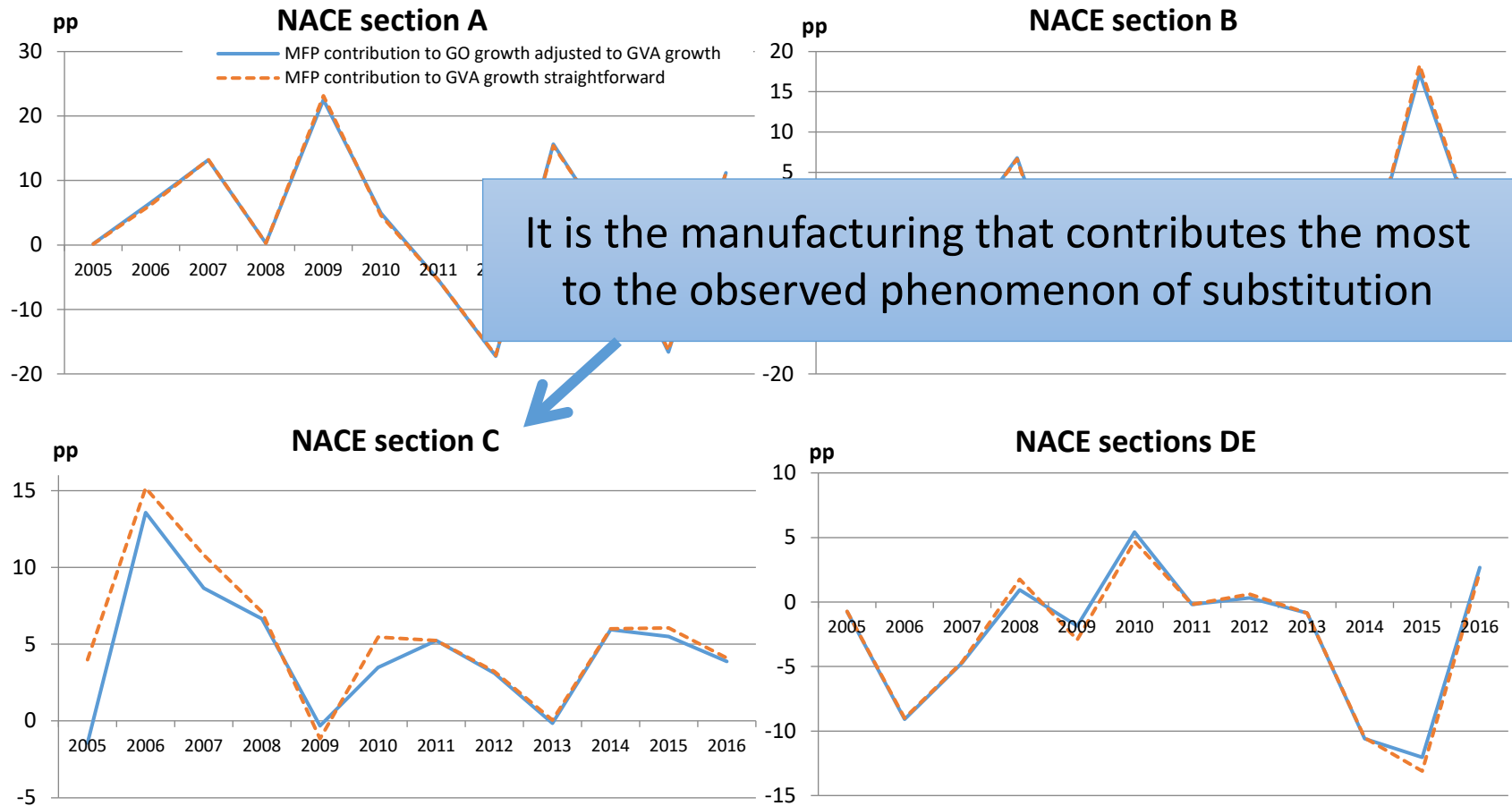
## Part III Discussion of the results

- A sectoral analysis can be also performed in order to establish where in the economy these changes mostly take place!

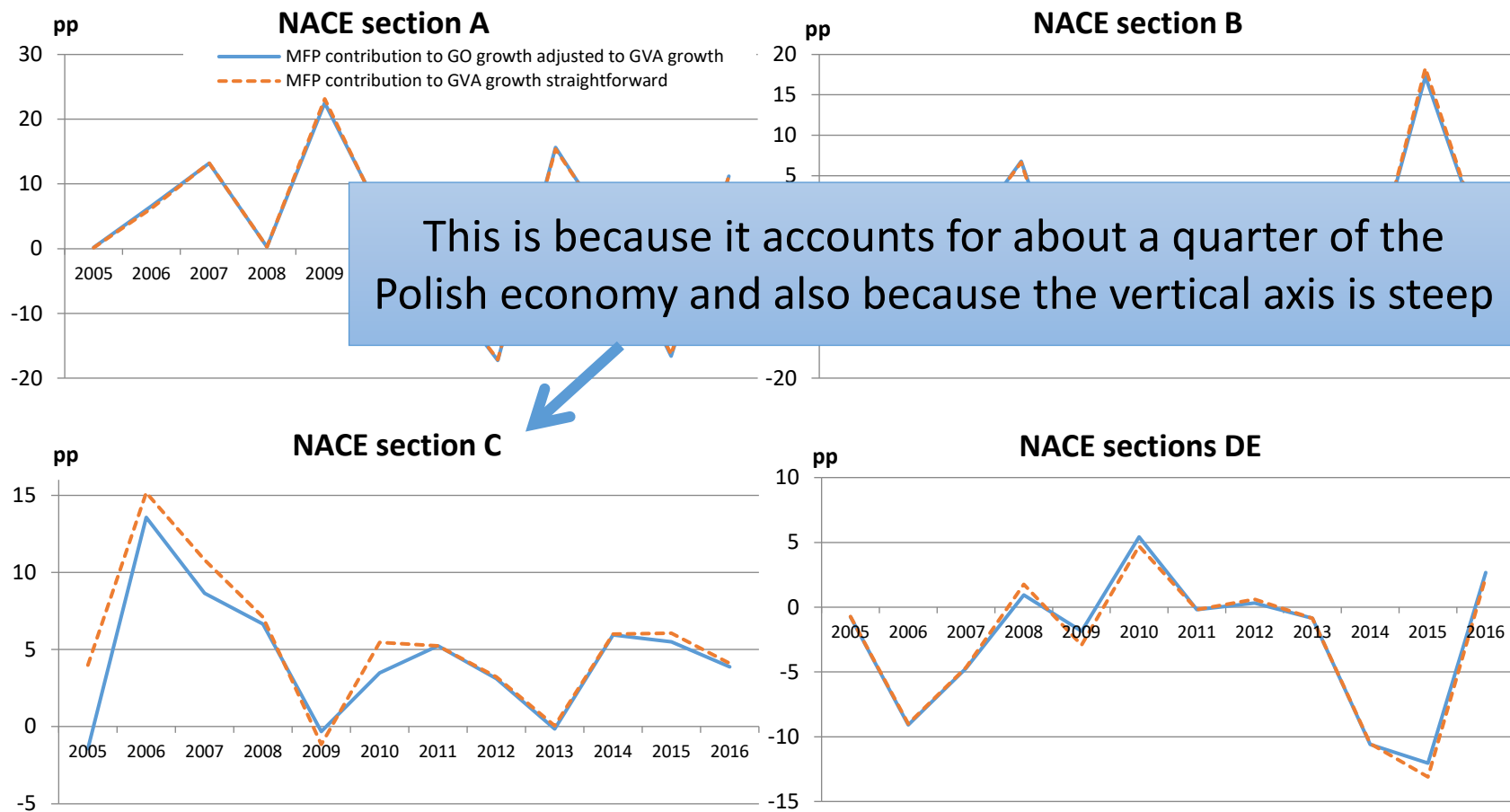
# Part III Discussion of the results



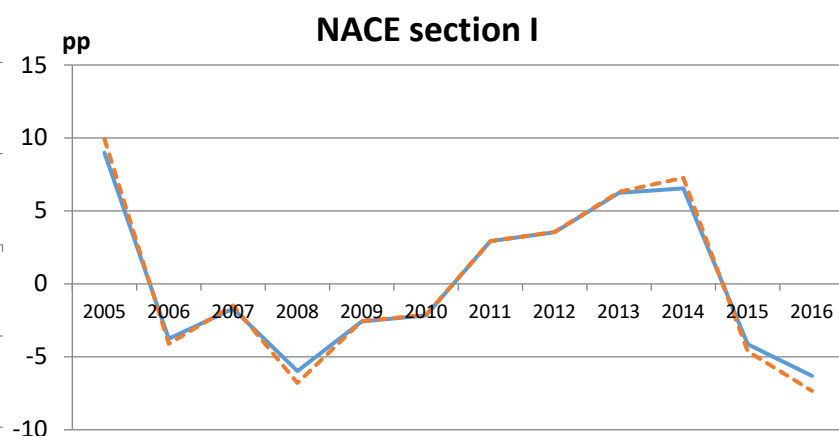
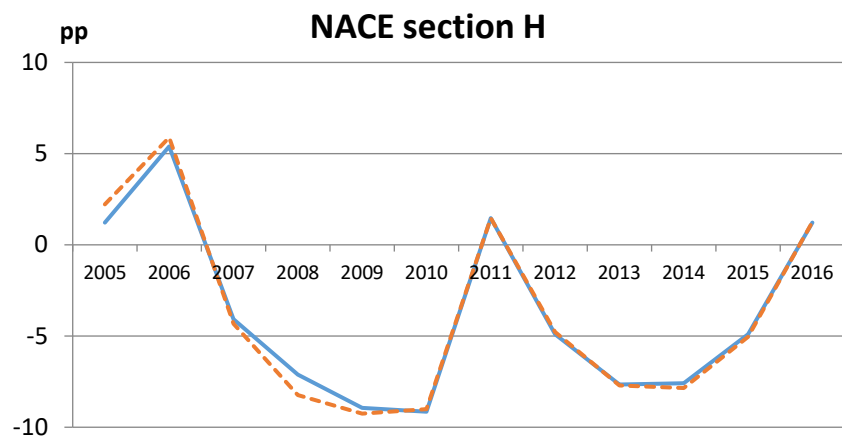
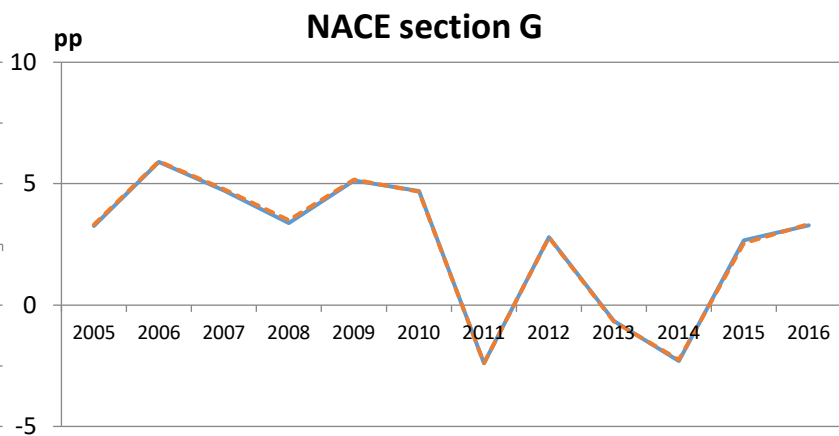
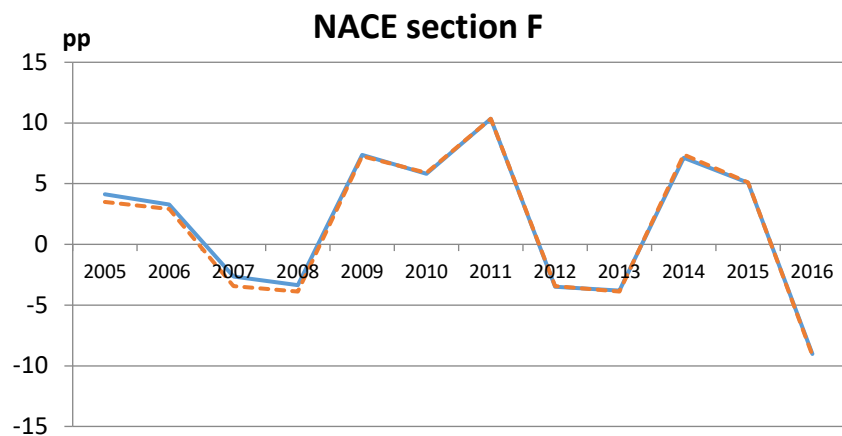
# Part III Discussion of the results



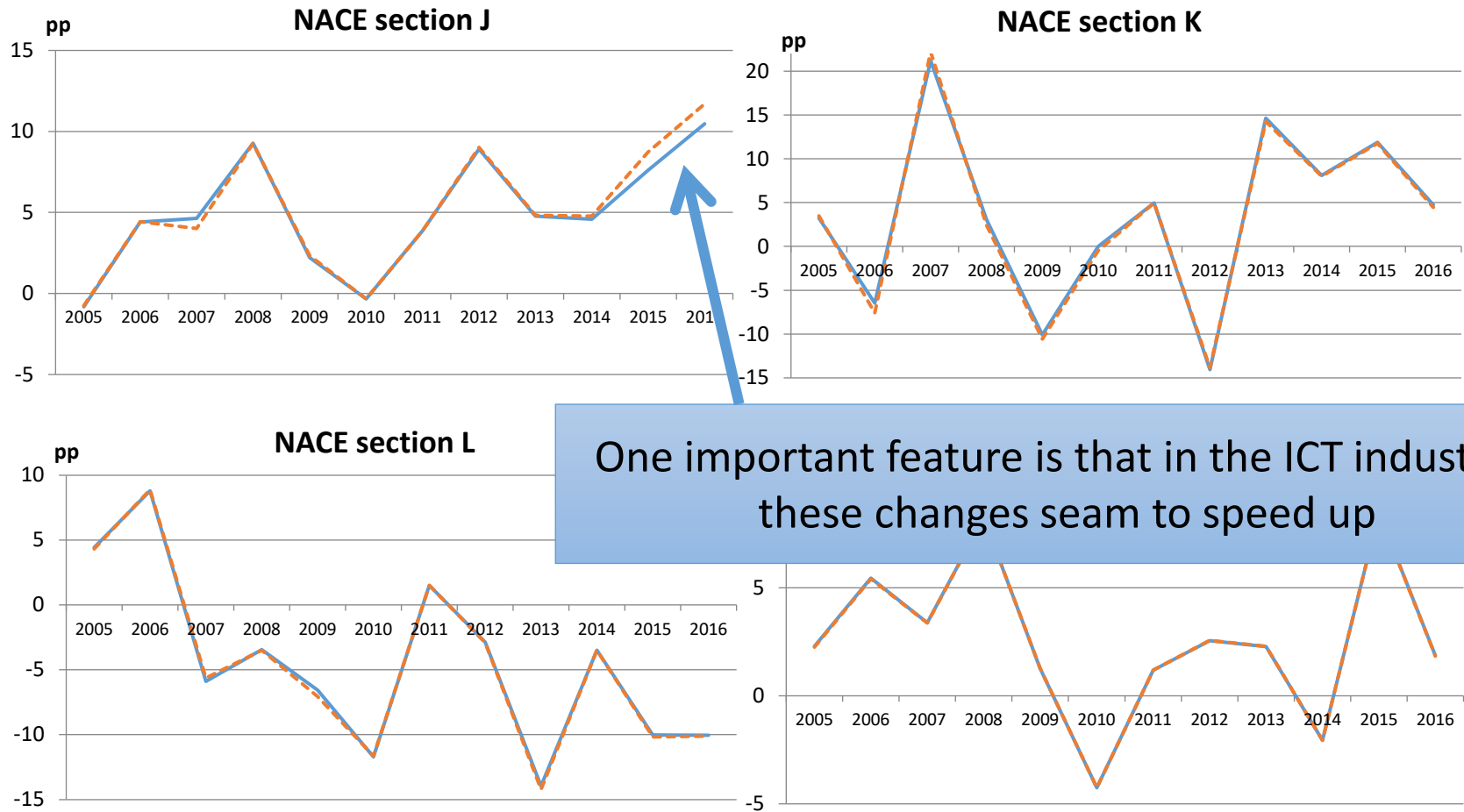
# Part III Discussion of the results



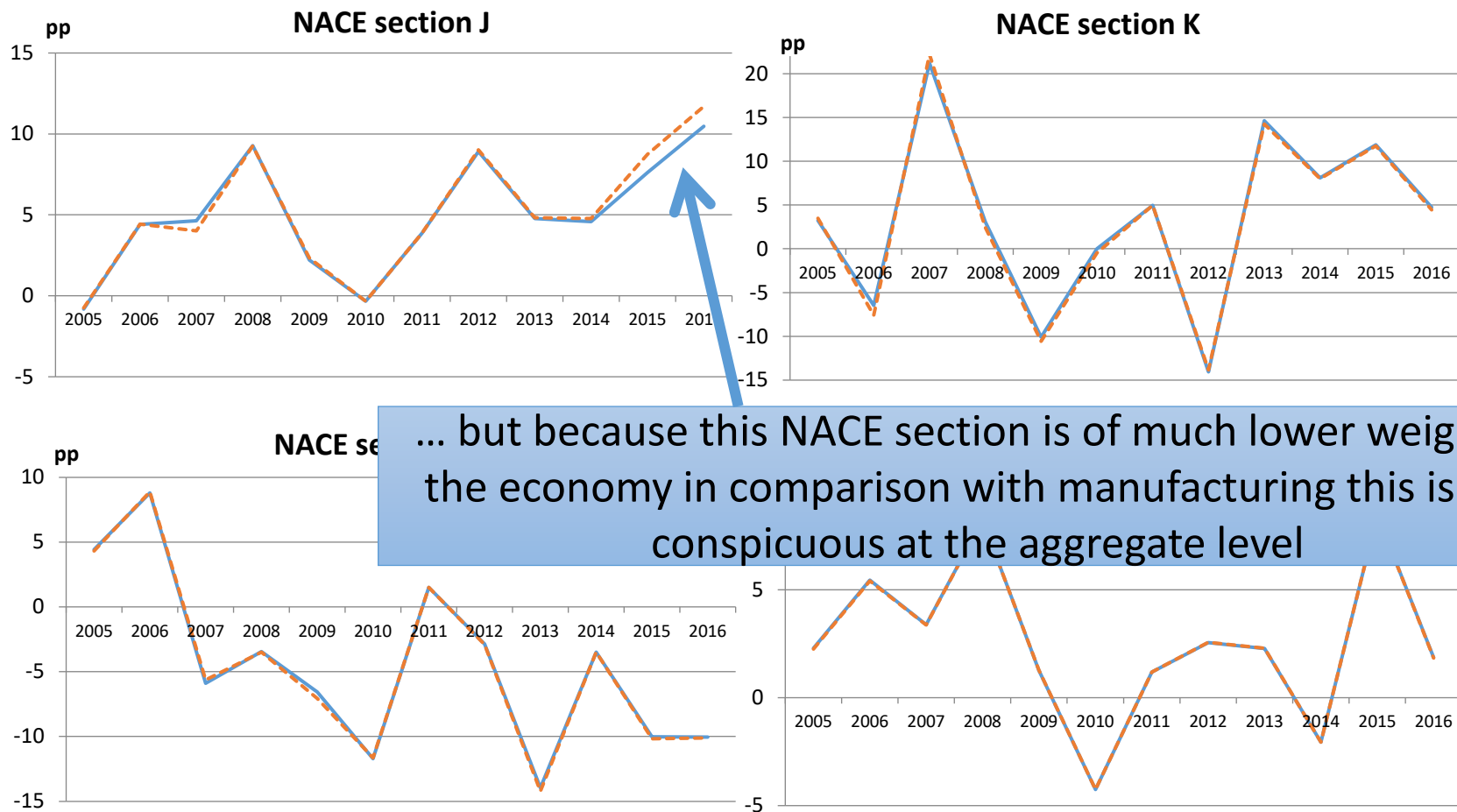
# Part III Discussion of the results



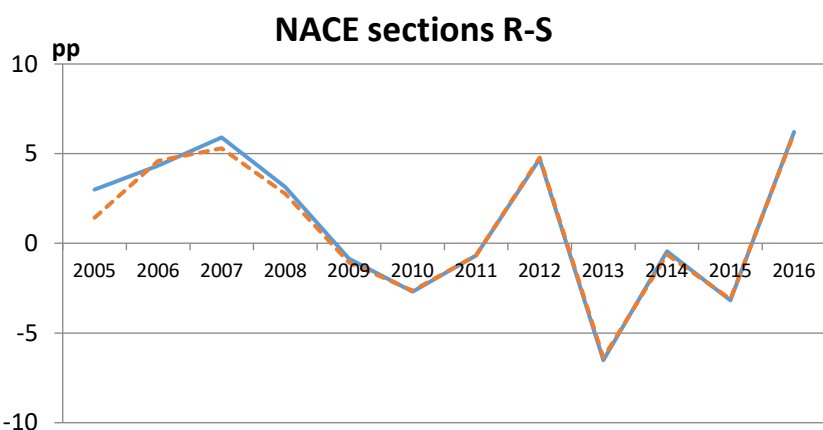
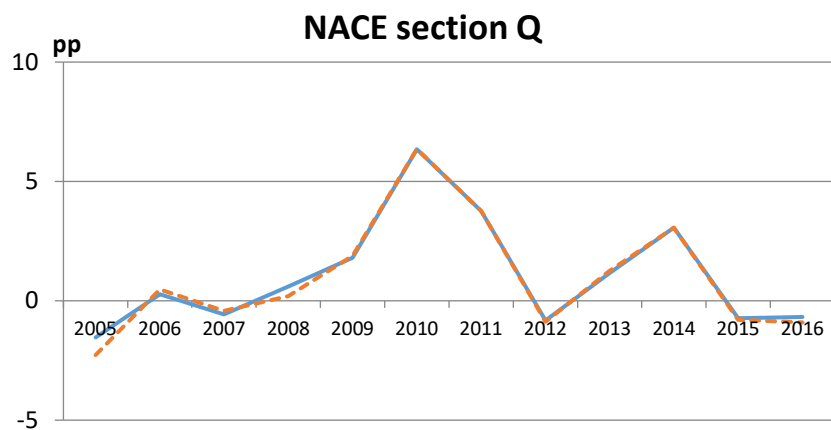
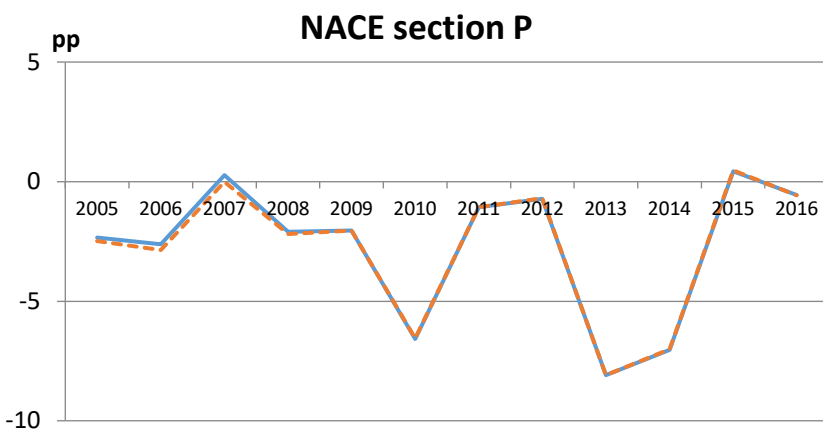
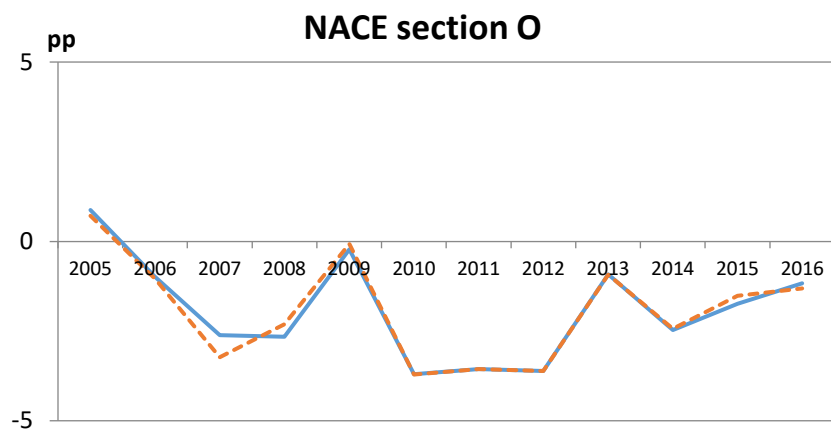
# Part III Discussion of the results



## Part III Discussion of the results



# Part III Discussion of the results



Access to data:

<https://stat.gov.pl/en/experimental-statistics/klems-economic-productivity-accounts>