Input-Output Tables for Regions of the Czech Republic

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Abstract

Regional Input-Output Tables represent a powerful statistical tool for deep economic analysis. They belong to a group of detailed statistical indicators linked to the information contained in national accounts and they are widely demanded by skilled users. Unfortunately, Regional Input-Output Tables are rarely officially compiled since they are strongly dependent on demand extensive statistical surveys. With respect to users' needs, we constructed symmetric regional tables for 14 regions (NUTS 3 level) of the Czech Republic for 2011. These tables are compiled at basic prices and broken down by 82 products. They arise from officially published data covering mainly Supply and Use Tables, Symmetric Input-Output Tables and regional accounts. The key approach lies in the decomposition of the output vector into the regions and applying national technological relations. The paper brings both a brief description of the methodology of our freely available tables and a basic description of possibilities of Regional Input-Output Tables for economic analysis.

Keywords

Input-output analysis, national accounts, regional accounts

JEL code

C67, R15

INTRODUCTION

Regional Input-Output Tables (RIOTs) have represented an object of long economic research since the introduction of Symmetric Input-Output Tables (SIOT) (Leontief, 1966). Efficient regional policy requires detailed description of regional economy and therefore lots of researchers look for RIOTs to use them in their analyses. In many cases this effort fails. Compiling RIOTs is expensive since official statistical agencies employ their own standard procedures to compile statistical indicators. They typically arise from direct data surveys ensuring required quality of data. Obtaining data on regional cost structures for both intermediates and primary inputs proves very difficult for both statistical agencies and respondents. It causes that only few statistical offices publish RIOTs or RIOT based multipliers, e.g. these tables were constructed for Spain (INE, 2010), Finland (Piispalla, 1999) and Italy (Benvenuti et al., 1995). On the contrary, even though academic approach consists in many simplifying assumptions that may not meet the requirements applied to official statistics, the results should suffice for researchers.

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The issue of the construction of RIOTs is theoretically very well described. Miller and Blair (2009) offer a comprehensive introduction, foundations and classification of the types of RIOTs. Louhela and Koutaniemi (2006) describe practical experience with constructing regional tables.[3] One can find lots of available scientific literature dealing with Regional Input-Output Tables but practical manual is unavailable. It is partly due to specifics of each country's statistical system. The estimation of regional output vector represents the most important issue connected with the definition of statistical units, mainly local kind-of-activity units.

Our paper briefly illustrates the methodology of pure RIOTs compilation on the case of the Czech Republic. We constructed regional tables for all 14 regions (NUTS 3 level) at basic prices for 2011. These tables are derived from officially published national and regional accounts according to our specific approach. RIOTs are symmetric, product-by-product type and based on European System of Accounts ESA 1995 (Eurostat, 1996) and System of National Accounts SNA 1993 (United Nations, 1993) methodology. Even though ESA 2010 (Eurostat, 2013) is currently in effect the difference for input-output analysis are irrelevant. The tables reflect the specifics of the Czech national accounts mainly the concepts of kind-of-activity units.

Besides the methodological points dealing with the construction of RIOTs, we present differences in using input-output analysis based on national and regional data. Regional Input-Output Analysis (RIOA) provides a powerful tool for studying regional specifics.

1 METHODOLOGY OF CONSTRUCTION

Regional input-output tables can be constructed by various methods. The most comprehensive and demanding methods arise from detailed regional surveys aimed at regional cost structure, regional production, final consumption, employment, etc. These approaches are usually very costly and allow a direct calculation of supply and use tables or symmetric input-output tables. On the contrary, a similar way remains far from researchers' possibilities, including ours. We focused on the compilation of RIOT from available (published) data sources with minimum additional (qualitative) information.

From the perspective of researchers, studying regional economy through RIOTs provides lots of interesting data with interconnections. RIOTs provide detailed description of regional economy and the data can be easily extended to multiregional models. The following description of methodology was used to compile fourteen individual regional input-output tables for the Czech Republic, product-by-product type.[4]

RIOTs compilation is based on several assumptions. For our purposes, we adopted the following ones:

a) The level of independence in decision making of local units is irrelevant, all the data originate in individual companies' accounting and no inter-company sales are recorded.
b) The Czech Statistical Office does not follow the definition of local kind-of-activity and therefore simplification is necessary. It refers to the industrial structure of the data.[5] The headquarters of a company and all subsidiaries are classified according to the principal activity of the whole company. This simplification influences the interpretation of data and transformation from industry-based data to product-based data.

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[3] Detailed literature review can be found in Sixta (2017).

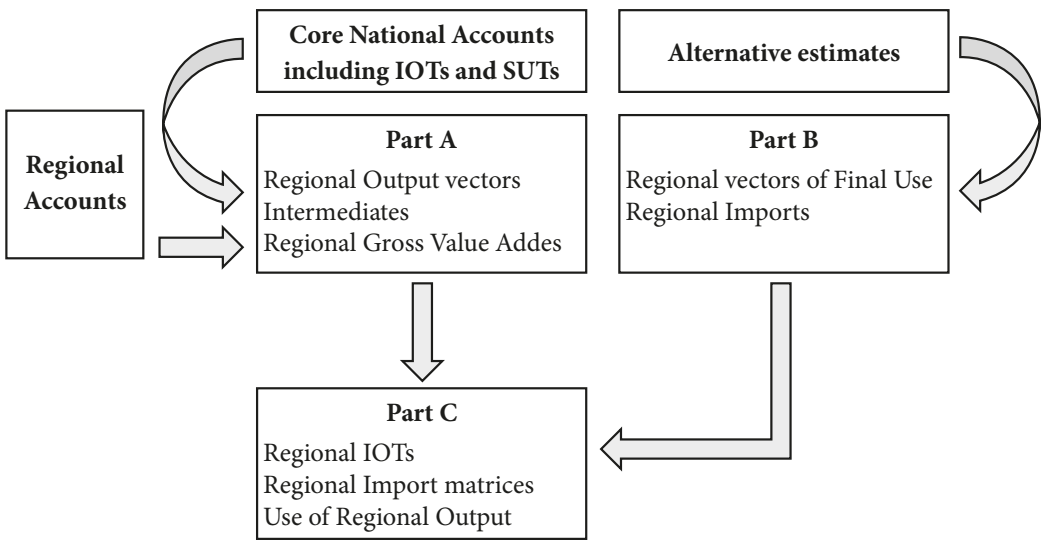
[4] The issue of combining our RIOTs into multiregional input-output tables is a subject of research of collaborating researcher Karel Šafr. The first estimate should be published during 2017.

[5] The case of electricity represents an illustrative case. The headquarters of a company providing electricity is located in Prague. Even though the power plants are situated elsewhere, the amount of wages paid to management, accounting, legal and similar services reach significant proportion. The output of the headquarters is interpreted as a service invoiced to the customer originated in Prague.

c) The key frame is set by the estimation of the output vector. Its estimation arises from a combination of regional and national accounts.
d) National technology given by existing SIOT for the Czech Republic is applied on a detailed level (82 products).

In some aspects, our approach is similar to the GRIT method[6] where national input-output tables undergo redistribution into regions. The substance of the process lies in constructing regional output vectors (x^R) and applying national technology to the estimates of intermediates and primary inputs. Figure 1 describes these steps.

Figure 1 Process of estimation



Source: Authors' elaboration

The difference between our approach and approaches recommended in contemporary literature lies in statistical matter. We do not focus primarily on regional relations, the links between regional and national multipliers.[7] We strictly focus on compilation issues; the compilation of RIOTs should follow the procedure of compiling SIOTs as much as possible.

The link between officially published regional gross value added for particular region and the result obtained as the difference between estimated regional output and regional intermediate consumption represent the principal issue. With respect to users' needs, we fitted regional gross value added to official figures. Intermediates are increased proportionally. The following formula explains the transformation of gross value added from industry based figures to product based ones:

$$v^{R,P} = v^{R,I}(X')^{-1}(\hat{x}), \tag{1}$$

[6] Generation of regional input-output tables, see Miller and Blair (2009).
[7] See Deng et al. (2014).

where:

$v^{R,P}$ estimated regional gross value added by products,
$v^{R,I}$ published regional gross value added by industries,
X output matrix,
$(\hat{x})$ diagonal output matrix.

Output vectors were estimated using allocation keys for each industry in all fourteen regions. These allocation keys arise from the decomposition of output within institutional sectors. For example, the output of public infrastructure influences the output of ancillary activities in transport industry (NACE code 52) significantly. It means that the value of products of roads and railways within the government sector is allocated according to their length in individual regions. Therefore, it is necessary to take into account the sector composition of output. Final estimates of regional output vectors broken down by industries (CZ-NACE) undergo transformation into a product-by-output matrix obtained from annually published supply and use tables, for details see Sixta and Vltavská (2016). Estimates of output, intermediate consumption and independent estimation of gross value added have to be put together, checked and balanced. It is useful to discuss these results with experts on regional economy since on the level of all products (*i*) following condition applies:

$$x_j^R - \sum_i c_{i,j}^R = v_j^R, \tag{2}$$

where:

x_j^R output of product j in the region R,
$c_{i,j}^R$ intermediate consumption of *i* for *j*,
v_j^R gross value added by product *j* in the region R.

Initial estimates of intermediate consumption result from applying national technology coefficients (input coefficients) to output. Applying national technology means that we multiplied coefficients of intermediates ($a_{i,j}$) and primary inputs (w_j) by output vectors for all regions. Since the breakdown goes into considerable detail (two-digit level, 82 product groups), results are reasonable even for the first estimate. Finally, another condition applied to intermediates is:

$$c_{i,j} = \sum_R c_{i,j}^R. \tag{3}$$

A well-known method, called RAS method[8] allows to keep the condition given by Formulas (2) and (3). Usually several rounds of iterative procedures are necessary.

We did not deal with the third quadrant (primary inputs, structure of value added) in detail. Hence, we obtain the total value added from Formula (2). A different approach is used for the estimation of final use. Some economists do not focus on final use (see Nosková, 2016) since they primarily need regional Leontief matrices (see Eurostat, 2008). However, we consider it necessary, at least for the consistency of the tables. Two approaches are available. One consists in applying output coefficients on output and other comprises an effort to tackle final use separately and combine with the first and third quadrant. We adopted the latter and with the help of our collaborating researches Musil and Kramulová, (Kramulová and Musil, 2013)[9] we received initial estimates of regionalised final use. Independent estimates were checked and adjusted to fit the condition (2) where instead of intermediate consumption (*c*), matrix (arranged vectors) of final use (*Y*) is used.

[8] Trinh and Phong (2013) describe the RAS method in detail.

[9] A thorough description of regionalisation of final use would make up a subject of an entire paper.

The next stage tackles exports and imports. The key assumption says that both exports and imports split between international and inter-regional trade. International exports are allocated into the region according to the regional output, proportionally, product-by-product. International imports are allocated according to domestic use, i.e. total use less exports. Inter-regional trade (exports or imports) arises from the balancing difference on the regional level. Insufficient resources (uses exceed resources) for a particular product represent imports needed. On the contrary, if regional resources (output plus imports) exceed regional use, the surplus of product is exported. Of course, it represents a simplification since a product is only exported or imported between regions and no re-exporting of products (or exporting and importing of the same type of products) is assumed. The sum of inter-regional exports equals the sum of inter-regional imports, see Formula (4):

$$\sum_{R=1}^{14} e\,i^{R} = \sum_{R=1}^{14} m\,i^{R}, \tag{4}$$

where:

ei^R inter-regional regional exports,

mi^R inter-regional regional imports.

Finally, all the figures were checked, combined and balanced. Balancing input-output tables is not a very common procedure since they arise from balanced supply and use tables but the principle remains the same (Kahoun and Sixta, 2013). Such statistical exercise aims mainly at providing analytical material for economists. Therefore, we hope that all the assumptions and simplification mentioned above do not distort these economists' analyses.

2 RESULTING REGIONAL INPUT-OUTPUT TABLES

RIOTs incorporate several pieces of important information used in describing regional economy as well as in regional modelling. As RIOTs represent a considerable data source, we chose only several results

Table 1 Production approach, regional structure, 2011, mil CZK

Region	Output	Intermediate consumption	Net taxes on products	GDP
CZ	9 784 432	6 339 967	378 936	3 823 401
Pha	2 383 174	1 526 468	65 926	922 632
Stc	1 202 298	828 636	46 971	420 633
Jhc	475 328	299 696	20 759	196 391
Plz	458 501	290 171	19 424	187 754
Kar	172 979	102 086	9 144	80 037
Ust	672 570	456 204	28 207	244 573
Lib	301 634	191 221	13 843	124 256
Krh	424 476	267 094	18 215	175 597
Par	458 280	319 796	18 346	156 830
Vys	388 428	246 977	16 777	158 228
Jhm	945 857	589 141	39 874	396 590
Olm	403 541	241 954	19 653	181 240
Zln	447 197	283 746	19 241	182 692
Mrs	1 050 169	696 777	42 556	395 948

Note: CZ – the Czech Republic, Pha – Prague, Stc – Central Bohemia Region, Jhc – South Bohemia Region, Plz – The Plzen region, Kar – the Karlovy Vary Region, Ust – the Usti Region, Lib – the Liberec Region, Krh – the Hradec Kralove Region, Par – the Pardubice Region, Vys – the Vysocina Region, Jhm – the South Moravian Region, Olm – the Olomouc Region, Zln – the Zlin Region, Mrs – the Moravian-Silesian Region.

Source: Authors' calculations

for an illustration of their possibilities. Complete sets of RIOTs including technical coefficients for 82 products[10] are available at the website of the Department of Economic Statistics.[11]

Tables 1 and 2 represent two main approaches to gross domestic product (GDP) estimation. The production approach indicates that Prague reaches the highest regional output, with 24% of the national output. Central Bohemia Region that surrounds Prague and the Moravian-Silesian Region represent other comparatively powerful regions (based on the value of the output) with the share of regional output about 12% and 11% respectively.

Similar to other countries, Czech capital stands out in terms of all indicators (see Table 2). The expenditure approach to GDP indicates that Prague records the highest final consumption expenditures. It is caused mostly by a high share of final consumption expenditures by government (see Figure 2) with 39% unlike other regions. Final consumption expenditures also constitute an important part of regional GDP in the South Moravian Region (77% of regional GDP).

Gross fixed capital formation (GFCF) shows the value of investment in the particular region. GFCF is allocated notably in Prague and Central Bohemia Region. Export and import in the perspective of RIOTs cover both international and interregional trade. This proves the dominancy of Prague with 845 bn. CZK for export and 643 bn. CZK for import. These results were expected as Prague comprises the centre for Central Bohemia Region whose inhabitants commute to Prague for work, shopping and entertainment. Central Bohemia Region and the Moravian-Silesian Region reach significant values of import and export as well.

Table 2 Expenditure approach, regional structure, 2011, mil CZK

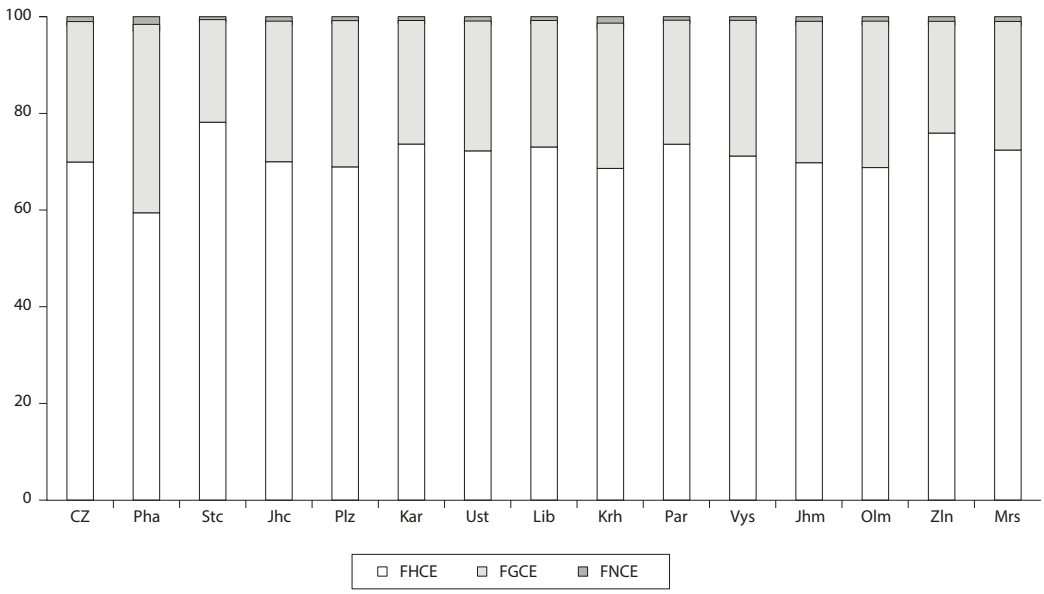
Region	FCE	GFCF incl. valuables	Changes in inventories	Export*	Import*	GDP
CZ	2 727 725	926 270	10 824	3 899 905	3 741 323	3 823 401
Pha	488 163	232 805	–1 156	845 565	642 745	922 632
Stc	303 567	113 613	3 542	556 880	556 969	420 633
Jhc	154 132	45 199	1 156	170 394	174 490	196 391
Plz	141 697	41 075	1 033	184 569	180 620	187 754
Kar	69 309	24 123	112	77 096	90 603	80 037
Ust	195 977	73 294	833	279 971	305 502	244 573
Lib	102 986	27 961	311	125 629	132 631	124 256
Krh	136 841	31 660	827	175 983	169 714	175 597
Par	120 288	34 633	1 132	228 007	227 230	156 830
Vys	123 368	35 253	510	158 796	159 699	158 228
Jhm	307 196	97 515	760	301 872	310 753	396 590
Olm	157 218	40 624	247	143 163	160 012	181 240
Zln	133 292	36 635	115	210 723	198 073	182 692
Mrs	293 691	91 880	1 402	441 257	432 282	395 948

Note: FCE – final consumption expenditures, GFCF – gross fixed capital formation, * the total value for the Czech Republic is different since the trade between regions is included.
Source: Authors' calculations

[10] We use the standard European classification of products, CPA (CZ-CPA).

[11] <http://kest.vse.cz/veda-a-vyzkum/vysledky-vedecke-cinnosti/regionalizace-odhadu-hrubeho-domaciho-produktu-vydajovou-metodou>.

Figure 2 Structure of final consumption expenditures, regions, 2011 (in %)



Note: FHCE – final consumption expenditures of households, FGCE – final consumption expenditures of government, FNCE – final consumption expenditures of non-profit institutions serving households.
Source: Authors' calculations

Table 3 Structure of regional export and import, 2011 (in %)

Region	Export		Import	
	International	Interregional	International	Interregional
CZ	72.3	27.7	71.1	28.9
Pha	43.4	56.6	65.2	34.8
Stc	82.3	17.7	70.1	29.9
Jhc	72.0	28.0	71.4	28.6
Plz	81.1	18.9	74.6	25.4
Kar	74.6	25.4	50.5	49.5
Ust	71.4	28.6	73.9	26.1
Lib	86.3	13.7	68.1	31.9
Krh	85.3	14.7	73.9	26.1
Par	87.3	12.7	76.1	23.9
Vys	74.0	26.0	68.2	31.8
Jhm	79.9	20.1	79.3	20.7
Olm	81.1	18.9	70.1	29.9
Zln	73.3	26.7	70.5	29.5
Mrs	85.5	14.5	75.1	24.9

Source: Authors' calculations

Table 3 describes the structure of regional import and export. Clearly, only Prague reaches a higher share on interregional export (56.6%) than on international export (43.4%). Central Bohemia Region achieves a high share of international export (82.3% of total export, i.e. 147 bn. CZK). The main commodities belong to the category of Manufacturing since automobile industry dominates this region as well as the Moravian-Silesian Region. In the Usti Region, mainly the export of coke and refined petroleum products push the share on interregional export up to 28.6%.

International import into Prague comprises services of Wholesale and retail trade and Crude petroleum and natural gas products. A significant share of Central Bohemia international import belongs to the category of Manufacturing. The South Moravia Region imports mainly ICT products. The Moravian-Silesian Region interregional import consists mainly of Wholesale and retail trade services.

3 INPUT-OUTPUT ANALYSIS BASED ON REGIONAL DATA

RIOTs represent an important tool for modelling economic impact in individual regions based on different inputs into the regional economy. The wide range of analytical possibilities covers mainly assessments of regional impacts of different events or policies. The easiest example consists in modelling of the changes in final use (e.g. investments shocks), changes in regional wages, regional tax and price incentives, etc. The most demanding models are based on the organisation of regional matrices in a big single matrix that illustrates flows of products between the regions. Such inter-regional models can be constructed on the basis of regional input-output tables where the inter-regional flows are estimated by different methods, see Šafr (2016).

For the purpose of this paper, we prepared an illustration based on a simple static input-output model (Eurostat, 2008). The effect is demonstrated on the influence of the investment of households into dwellings amounting to 10 bn. CZK (Buildings and building construction works, CPA 41). The analysis is presented separately on national input-output tables for the Czech Republic (i.e. country average) and 3 regional tables. This division reveals the differences of the impact using national IOTs and RIOTs for individual regions.

Table 4 presents the overall impact of an investment on the economy. The results show that even if an investment is made in the same amount in all regions and the Czech Republic as a whole, the impact differs significantly. South Bohemia Region (4.6%), the smallest region in our selection (according to the portion of the regional output on national output), records the highest increase of output. The lowest increase of output is achieved when using data for the Czech Republic as a whole. South Bohemia Region along with the Moravian-Silesian Region scored the highest increase of gross fixed capital

Table 4 The total impact of the investment into Buildings and building construction works, 2011 (in %)

		CZ	Mrs	Stc	Jhc
P.1	Output (basic prices)	0.2	1.9	1.6	4.6
D.21-D.31	Net taxes on products	0.0	0.3	0.3	0.5
P.7	Import	0.1	0.8	0.9	2.4
	Resources	0.2	1.6	1.4	3.9
P.2	Intermediate consumption	0.2	2.0	1.8	5.3
P.3	Final consumption expenditures	0.0	0.0	0.0	0.0
P.5	Gross capital formation	1.1	10.7	8.5	21.6
	of which GFCF incl. valuables	1.1	10.9	8.8	22.1
P.6	Export	0.0	0.0	0.0	0.0
	Total uses	0.2	1.6	1.4	3.9

Source: Authors' calculations

formation, with 22.1% and 10.9% respectively. This implies that the smaller area of region the higher the impact achieved.

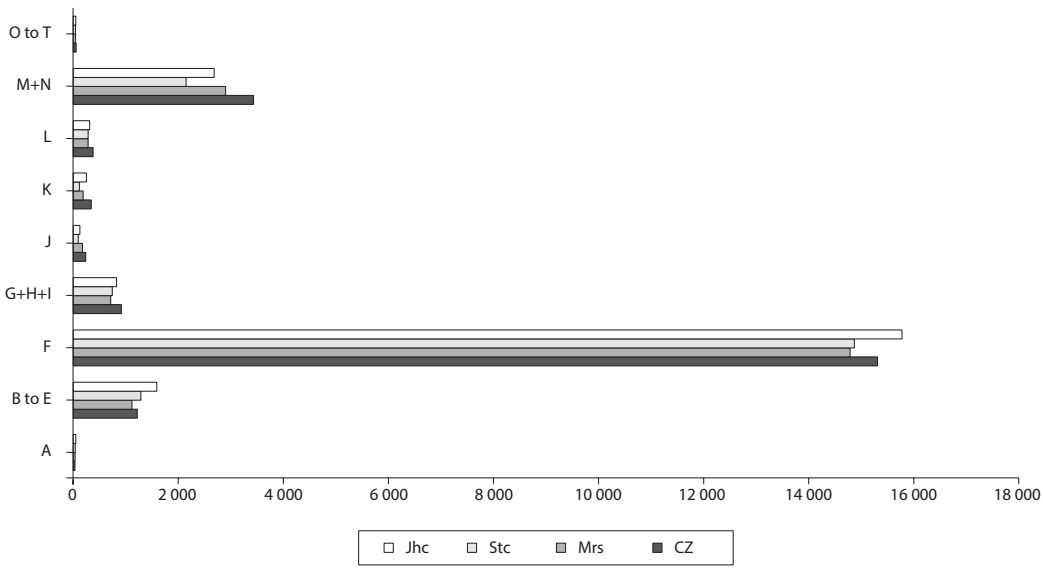
When analysing the increase of the investment into the Buildings and building construction works (Table 5), the Moravian-Silesian Region achieved the highest increase of gross value added (6 466 mil CZK). Gross value added increased less in Central Bohemia Region (4 939 mil CZK) and South Bohemia Region (5 763 mil CZK) compared to the average of the Czech Republic (6 251 mil CZK).

Table 5 The total impact of the investment into Buildings and building construction and works on gross value added, mil CZK

	CZ	Mrs	Stc	Jhc
A	15	10	18	26
B to E	363	309	375	467
F	3 779	4 307	3 120	3 336
G+H+I	395	335	352	401
J	125	95	37	59
K	195	116	59	146
L	183	135	191	175
M+N	1 163	1 128	761	1 120
O+P+Q	21	18	15	18
R to T	12	13	11	14
Total	6 251	6 466	4 939	5 763

Source: Authors' calculations

Figure 3 Total change of output, mil CZK



Source: Authors' calculations

Beside the structure of gross value added, the structure of output differs among regions as well (Figure 3). The Moravian-Silesian Region and South Bohemia Region represent regions closest to the average of the Czech Republic while Central Bohemia Region deviates the furthest from it. The most visible impact is observable within the Construction industry (F) with more than 14 bn. CZK in each region.

All results of IOA show that using only national IOTs does not capture what happens to the economy in individual regions. IOTs disregard the impact of a single investment. Employing RIOTs and investigating the impact of the same investment in individual regions allows us to describe the changes in regional economy more precisely.

SUMMARY AND CONCLUSION

Regional Input-Output Tables are used for many kinds of economic analysis, ranging from simple description of regional economy to sophisticated modes containing links among regions. Unfortunately for researchers, these tables are rarely compiled. The fact that RIOTs are occasionally available for some countries allows testing some theoretically described methods and models. However, a complete data set used for e.g. European regional economic policy remains out of reach. When analysing regional policy impacts on value added and employment, it represents the most suitable tool.[12]

Our paper brought a brief description of the construction of regional input-output tables based on the model approach combining official data and technological assumptions. Experts on regional economy verified the results several times and we updated them according their comments. Basic data come from officially published Supply and Use Tables and Regional Accounts. RIOTs for the Czech Republic were constructed at basic prices for the year 2011. The dimension of 82 × 82 products allows sufficient detail for most economic studies. The tables follow the ESA 1995 methodology but its differences from the recently used ESA 2010 would provide negligible effects on their use. However, we will prepare RIOTs for the Czech Republic using the presented methodology according to ESA 2010 for the year 2013 as officially published national IOTs by the Czech Statistical Office have been made only up to this date.

The presented simple static input-output analysis on the case of regional investments was selected for illustration purposes. It clearly shows that one can hardly study detailed regional effects using only tables for the whole economy. Regional tables are especially suitable for modelling of the impact of regional investments, investment incentives or holding important events (e.g. Olympic Games).

The Czech Statistical Office belongs to the most developed statistical agencies in the compilation of input-output tables since it publishes both product-by-product and industry-by-industry tables more frequently than it is required by the EU regulations. As the construction of Regional Input-Output Tables represents a task that lies somewhere between official statistics and academic research, the Czech Statistical Office considers this issue rather as scientific then the task for official statistics. The academic approach allows lots of simplification and a model oriented attitude. Official statistics usually rely on hard, i.e. surveyed, data. With respect to that, possibilities of regional surveys aimed at the structure of costs of local units (intermediates) are very limited. An optimal mix of procedures used in official statistics and models (verified by experts) can become a breakpoint for a future upturn in this area.

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[12] A detailed regional structure of uses as defined in national accounts also allows the computation of specific purchasing power parities, e.g. Čadil et al. (2014).

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