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MEASURING QUARTERLY NET FIXED CAPITAL STOCK IN THE CZECH REPUBLIC

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Abstract

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Balances of fixed capital are ordinary part of annual national accounts statistics in most developed countries. Although quarterly data are useful for many applications and its existence would be consistent with other quarterly indicators, quarterly fixed capital stock are not officially published. Even though there is no official rule for estimation of quarterly fixed capital stocks, several methods are currently available to estimate quarterly stocks of fixed capital. The objective of this paper is to estimate the quarterly net fixed capital stock in the Czech Republic at constant prices in industry classification (CZ-NACE rev. 2) compatible with official quarterly statistics of the indicators on national economy. For this estimation we distinguish three basic flows of fixed capital. Firstly, gross fixed capital formation is estimated on the basis of official quarterly statistics which is published only in structure by types of assets. Flow of other changes is mainly uniformly distributed. Only in case of catastrophes it was possible to allocate these changes into appropriate quarter. Secondly, net fixed capital stock and consumption of fixed capital are estimated simultaneously on the basis of the assumption of relation between the value of the stock and its depreciation.

perpetual inventory method, net capital stock, consumption of fixed capital, national accounts, quarterly estimates

The most intensive debate on interpreting and measuring capital is called Cambridge capital controversy or Cambridge debate. The debate basically grew from the criticism of the measurement of capital (Robinson, 1953–54, Sraffa, 1960) used in neoclassical theory. The original critique aimed aggregation of the capital and expression of its value primarily in simple production function $Q = f(L,K)$, where L denotes labour in man-hours and K represents capital. The question was: in which units should be expressed variable of aggregated capital goods? Should be the capital stock expressed as a list of physical units, in labour necessary to produce the capital goods, in purchase prices or in terms of future earnings? Even though the debate was not clearly solved and calmed partially because of the death of main protagonists (Cohen, Harcourt, 2003), measuring of capital in OECD countries is mainly based on neoclassical capital theory (OECD, 2009).[1]

In respect to the part of the Cambridge debate, the official manual tries to reflect the 'dual nature of capital which is both the storage of wealth and a source of capital services in production' (OECD, 2009, p. 11). Such solution corresponds to Hicks (1974) who did not understand forward and backward look as competing approaches.

Nowadays, balances of non-financial[2] capital are standard part of national accounts. Estimates of different flows and stocks of non-financial capital

1 For more detailed information about development of Cambridge capital controversy see e.g. Mata (2004) or Cohen and Harcourt (2003)

2 Capital is mainly presented as storage of wealth. Only a few statistical offices publish data on capital services and productive stock.

are commonly published in annual periodicity. Capital goods represent one of the most important productive factors in national economy. This paper is focused on fixed capital that constitute the biggest part of the non-financial capital; only approximately 20% of the value of non-financial capital consists of other groups of assets, i.e. inventories, valuables and non-produced assets (Czech Statistical Office, 2013a). According to Czech Statistical Office (2013b) net fixed capital stock represented 85% of net worth in 2011. Based on System of National Accounts 2008 (SNA 2008, p. 125), the gross fixed capital stock is represented by 'assets surviving from investment and revaluated to at the purchasers' prices of current period'[3]. Net fixed capital stock additionally reflects the decreasing of value for moral obsolescence and physical deterioration (i.e. consumption of fixed capital).

Data on fixed capital stock represent important part of the productivity analysis and related potential output analysis. Indicators on fixed capital are published mainly on annual basis. The reason consists in the different aims of annual and quarterly statistics, demanding process of estimation by Perpetual Inventory Method (hereafter: PIM) and missing essential data. Even though the Czech Statistical Office (2008, 2013c) publishes quarterly gross fixed capital formation (only by types of assets) and consumption of fixed capital, the information about quarterly stock of capital is not published. Such situation is common for most statistical offices (OECD, 2009). This does not mean that there is no demand for quarterly fixed capital stock data.

Kamps (2006) speaks about the lack of quarterly data on capital stock, which leads to the usage of less appropriate data on investment for the analysis. Kendrick and Lee (1976) estimates quarterly net capital stock by the estimation of depreciation rate d, i.e. the official annual consumption of fixed capital is not used as explicit input for estimation. Fernald (2012) similarly estimates quarterly net fixed capital stock from annual data for total factor productivity analysis of the U.S. business sector. Levy and Chen (1994) propose four simple methods for estimation of quarterly net fixed capital stock with different interpolation of net stock and (in some cases) consumption of fixed capital. Bordo and Haubrich (2010) use one of these methods (linear interpolation) for total factor productivity calculation, which was used as input data for econometric model of credit crises. Levy (1995) discusses the impact of tax rules on investment behaviour. Quarterly data on net fixed capital stock from Levy and Chen (1994) were used for the analysis. Klacek, Vošvrda and Schlossser (2007) and Klacek and Vopravil (2008) estimates quarterly net fixed capital on the basis of investment fluctuation for the productivity analysis in the Czech Republic. Adamec and Střelec (2012) use flow indicator of gross fixed capital formation instead of capital stock for annual and quarterly potential product analysis of the Czech Republic.

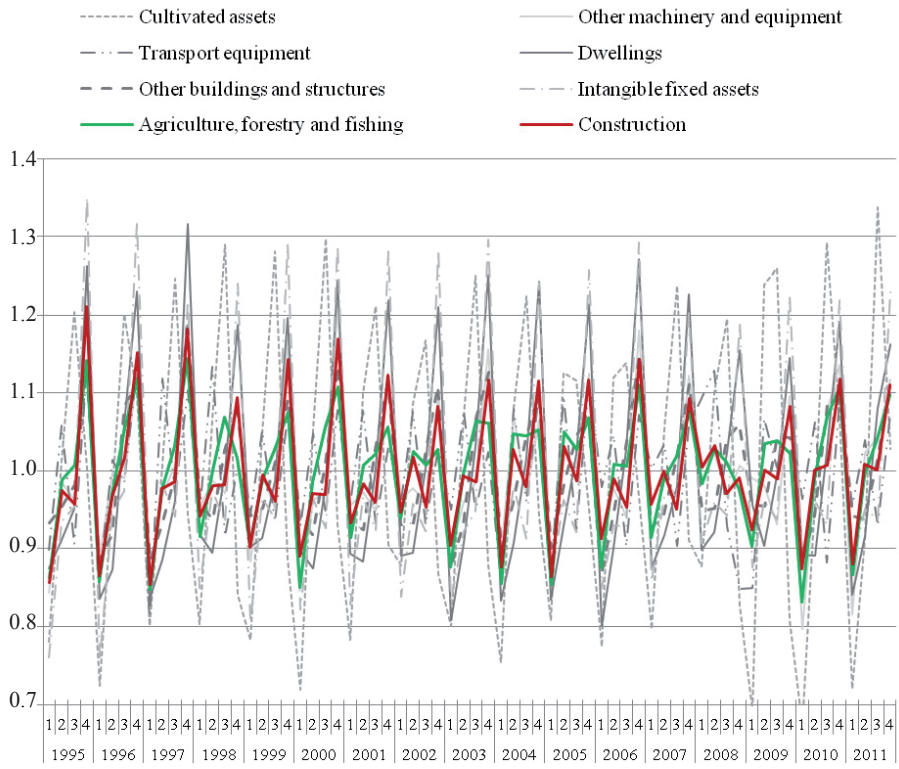
The aim of this paper is to estimate the quarterly net fixed capital stock in the Czech Republic in industry classification (CZ-NACE rev. 2) at constant prices of 2005 for the period between the years 1995 and 2011. Proposed method of estimation respects both annual data on stocks and flows. For this estimation we distinguish three basic flows of capital, which represent common part of annual balances of fixed capital and should be reflected for more accurate estimation. Each of these flows is based on different approach to divide annual data.

MATERIALS AND METHODS

The estimations of quarterly net fixed capital are based on the official data from the Czech Statistical Office. From the SNA 2008 point of view fixed assets represent assets that can be repeatedly used for more than one year. According to the threshold described in the European System of Accounts 1995 (ESA 1995) value of asset must be valued at least 20,000 CZK to be counted as fixed asset in the Czech Republic (Czech Statistical Office, 2002). Even Pigou (1935) stressed the importance of distinguishing the capital from point of view of the economic principles and business practice. Business accounting sums capital in prices from different time periods. Moreover, the depreciation period is commonly based on law, convention and ordinarily the decision of the owner. As a result, value of capital stock from business accounting is not appropriate for macroeconomic analysis. As a solution, statistical offices use model estimation. Perpetual Inventory Method is the most recommended approach by SNA 2008. PIM presents descriptive model with constant time step, which is fully described in OECD (2009). This method reflects the problems with collection of some necessary data, thus it is based on survey of gross fixed capital formation and other changes[4]. Processes of retirement and consumption of fixed capital are modelled on the basis of estimated service life and applied retirement and depreciation profile.

3 To illustrate the quality of Czech estimates of fixed capital balances we can mention the IMF and OECD (2011) conference focused on information gaps exposed by financial crisis. Even though this conference was primarily for G20 countries, information about compilation of non-financial balances in the Czech Republic was involved (see Ondruš, 2011).

4 Indicator 'other changes in volume of assets' contains catastrophes, unexpected losses, organisational changes, reclassification, statistical discrepancies etc. Many of these economic phenomena's are considered as very problematic for identification and surveying (Ondruš, 2011).



1: *Quarterly indices of gross fixed capital formation by type of asset and chosen industries*
Source: Czech Statistical Office, authors' computation

The Czech Statistical Office uses PIM based on age-price profile[5], mainly log-normal retirement distribution and straight-line depreciation profile, for the compilation of balances of fixed capital in the Czech Republic. Krejčí and Sixta (2012) extent the official data and present the balances based on geometric depreciation profile with use of double declining balance.

The Czech Statistical Office (2013a) publishes stock indicators to the end of the year that is why we already have value in the fourth quarter. It is necessary to estimate first three quarters in time series. For this purpose we distinguish three basic flows: gross fixed capital formation, consumption of fixed capital and other changes in volume of assets[6].

Quarterly gross fixed capital formation is published only by types of assets. We use these data as weights for annual data on gross fixed capital formation in industry structure. Each industry has different structure of investments by type of assets. Fig. 1 shows quarterly indices of gross fixed capital formation by type of assets and example of two industries (A – Agriculture, forestry and fishing; F – Construction).

Other changes in volume of assets represent all flows of assets that are not investment or depreciation. Because of the lack of any support information this indicator was mainly uniformly divided into quarters. Only in cases of loss from catastrophes it was possible to identify the appropriate quarter (e.g. floods in 2002 belongs to third quarter).

Finally, we simultaneously calculated quarterly fixed capital stock and consumption of fixed capital. Czech Statistical Office (2002) use straight-line depreciation profile[7]. This profile is expressed by equation (1) where p_0 represents initial value of the asset, p_n is value of n years old asset and L represents average service life of that asset. Each gross fixed capital formation is divided into sets by industry, year, institutional sector and type of asset. Considering the common lognormal retirement function each of these sets is divided into groups by service life for the processing by PIM.

$$\frac{p_n}{p_0} = 1 - \frac{n}{L}, n = 0, 1, \ldots, L. \quad (1)$$

The stock variable represents the accumulation of flows thus we can express the calculation of net capital stock by system of equations (2). $N_{t,q}$ is net fixed capital stock in qth quarter of year t, $I_{t,q}$

5 For more information about the Czech variant of PIM see e.g. Czech Statistical Office (2002), Sixta (2007).
6 In case of current prices, balances contain also flow of holding gain/loss see e.g. ESA 1995.
7 See e.g. Diewert (2005) for comparison of basic depreciation profiles.

represents gross fixed capital formation, $O_{t,q}$ is flow of other changes and $D_{t,q}$ represents consumption of fixed capital.

$$\begin{aligned} N_{t-1,4} + I_{t,1} + O_{t,1} - D_{t,1} &= N_{t,1} \\ N_{t,1} + I_{t,2} + O_{t,2} - D_{t,2} &= N_{t,2} \\ N_{t,2} + I_{t,3} + O_{t,3} - D_{t,3} &= N_{t,3} \\ N_{t,3} + I_{t,4} + O_{t,4} - D_{t,4} &= N_{t,4} \end{aligned} \tag{2}$$

The higher is the net stock, the higher is also the consumption of fixed capital. For estimation of quarterly consumption of fixed capital we use simplified computation (3) where the official annual consumption of fixed capital $D_{t,Y}$ is divided into quarters on the basis of value of quarterly net fixed capital stock. This computation is similar to Levy and Chen (1994) second method. However, Levy and Chen (1994) assume depreciation rate d_i (ratio of consumption on stock) to remain unchanged within year *i*. Moreover, the official annual value of consumption of fixed capital is not used. Levy and Chen (1994) use official annual depreciation in third and fourth method, but it is not divided on the basis of quarterly net fixed capital. In the first case, it is linearly interpolated. In the second case, the depreciation is simply divided by four.

$$\begin{aligned} D_{t,q} &= D_{t,Y} \frac{N_{t,q}}{N_{t,Y}} \\ N_{t,Y} &= N_{t,1} + N_{t,2} + N_{t,2} + N_{t,4} \end{aligned} \tag{3}$$

Adjusting the (2) by (3) we get system of equations (4). Net fixed capital stock in fourth quarter is equal to annual net capital stock from official statistics and gross fixed capital formation and other changes were already divided into quarters, the system of equations contains only three variables – net fixed capital stock in first, second and third quarter.

$$\begin{aligned} N_{t,Y}(N_{t-1,4} + I_{t,1} + O_{t,1} - N_{t,1}) - D_{t,Y}N_{t,1} &= 0 \\ N_{t,Y}(N_{t,1} + I_{t,2} + O_{t,2} - N_{t,2}) - D_{t,2}N_{t,2} &= 0 \\ N_{t,Y}(N_{t,2} + I_{t,3} + O_{t,3} - N_{t,3}) - D_{t,3}N_{t,3} &= 0 \\ N_{t,Y}(N_{t,3} + I_{t,4} + O_{t,4} - N_{t,4}) - D_{t,4}N_{t,4} &= 0 \end{aligned} \tag{4}$$

After omitting the fourth equation from (4), we solve the system of nonlinear equations for each year by Newton's iteration method. For initial step, we use uniform distribution of net fixed capital stocks. Iterations of Newton's method ends when the next step does not cause the change of the solution rounded on millions CZK, which corresponds with official statistics that is also rounded on millions.

RESULTS AND DISCUSSION

Based on the approach described in previous section we estimated quarterly net fixed capital stock in prices of year 2005 in classification CZ-NACE that is compatible with official quarterly statistics of Czech Statistical Office (2013b). The described calculation was applied on years 1995–2011 and 11 industries (containing also their aggregations). Concerning the common two-factor productivity analysis based on Cobb-Douglas production function[8], we added the last missing part for quarterly analysis. Table I shows our quarterly estimates of net fixed capital stock. Fourth quarter is similar to official annual data (Czech Statistical Office, 2013a). Industry structure is available in Annex A.

Tab. I contains also the estimation of net fixed capital stock without dwellings. We estimated this indicator primarily for the purposes of productivity analysis. Housing stock is commonly considered as mainly nonproductive (Appleton, Wallis, 2011) or with very low output elasticity (D'Auria *et al.*, 2010).

In comparison with our approach, Levy and Chen (1994) obviously compute quarterly net fixed capital stock in structure compatible with official data on quarterly investments, thus they do not deal with estimation of quarterly gross fixed capital formation. Indicator of other changes in volume of assets was introduced into official rules in SNA 1993 as 'complete reconciliation between the stocks and flows in the system' (Moulton, 2004, p. 261). Therefore, Levy and Chen (1994) also do not estimate quarterly flows of other changes.

There is no official statistics on productive stock for the Czech Republic[9]. Such stock estimated on basis of age-efficiency profiles is considered as best indicator of capital input in production function (OECD, 2001). In case of missing data on this stock, the net fixed capital stock[10] is commonly used. Adamec and Střelec (2011) used gross fixed capital formation for potential output analysis. Gross fixed capital formation is the flow of investments into fixed capital in current year and could not participate on the significant part of the current year's production. In case of measuring the potential, the stock variables are most appropriate

8 See Solow (1957).
9 See Sixta, Vltavská, Zbranek (2011) for total factor productivity analysis on basis of capital services in the Czech Republic.
10 Net fixed capital stock is also called 'wealth' (OECD, 2009).

I: *Quarterly Net Fixed Capital Stock in Constant Prices of 2005 (millions CZK)*

Year / Quarter		Total	Without dwellings	Year / Quarter		Total	Without dwellings
1995	Q1	10 403 640	7 218 489	2004	Q1	12 889 213	9 388 013
	Q2	10 708 869	7 438 454		Q2	13 046 056	9 508 785
	Q3	11 010 319	7 654 492		Q3	13 200 461	9 624 523
	Q4	11 345 636	7 899 433		Q4	13 374 785	9 754 694
1996	Q1	10 694 491	7 507 248	2005	Q1	13 198 768	9 648 586
	Q2	11 017 584	7 741 097		Q2	13 327 088	9 746 218
	Q3	11 354 029	7 985 009		Q3	13 454 869	9 840 988
	Q4	11 705 386	8 240 939		Q4	13 603 489	9 951 677
1997	Q1	10 923 911	7 721 813	2006	Q1	13 406 174	9 827 216
	Q2	11 248 584	7 956 815		Q2	13 541 904	9 930 273
	Q3	11 576 304	8 193 750		Q3	13 680 719	10 032 942
	Q4	11 935 953	8 455 888		Q4	13 856 225	10 165 496
1998	Q1	11 346 581	8 083 462	2007	Q1	13 565 151	9 979 448
	Q2	11 621 046	8 280 492		Q2	13 761 626	10 124 858
	Q3	11 897 068	8 477 221		Q3	13 957 909	10 268 123
	Q4	12 186 979	8 684 086		Q4	14 186 798	10 435 613
1999	Q1	11 844 114	8 451 505	2008	Q1	13 919 572	10 277 933
	Q2	12 009 060	8 575 426		Q2	14 104 976	10 409 083
	Q3	12 173 173	8 697 105		Q3	14 287 775	10 534 108
	Q4	12 362 567	8 839 468		Q4	14 477 919	10 661 987
2000	Q1	12 077 843	8 639 272	2009	Q1	14 447 783	10 644 050
	Q2	12 227 976	8 756 306		Q2	14 526 273	10 706 323
	Q3	12 382 905	8 875 719		Q3	14 608 684	10 769 709
	Q4	12 570 711	9 021 797		Q4	14 709 782	10 847 044
2001	Q1	12 318 491	8 854 172	2010	Q1	14 795 818	10 903 572
	Q2	12 466 348	8 970 458		Q2	14 812 511	10 915 942
	Q3	12 616 298	9 086 308		Q3	14 844 053	10 937 846
	Q4	12 791 140	9 222 217		Q4	14 883 688	10 963 633
2002	Q1	12 711 323	9 208 711	2011	Q1	15 686 239	11 635 967
	Q2	12 791 228	9 267 472		Q2	15 555 856	11 535 349
	Q3	12 873 420	9 326 638		Q3	15 444 216	11 451 114
	Q4	12 957 153	9 383 824		Q4	15 347 312	11 385 013
2003	Q1	12 846 813	9 330 530				
	Q2	12 938 676	9 400 202				
	Q3	13 040 760	9 477 261				
	Q4	13 165 228	9 571 725				

Source: authors' computation

to express what could be produced. According to the common practice and definition of fixed capital stocks we recommend adjusting that analysis and using the net fixed capital stock.

CONCLUSION

Quarterly estimates of net fixed capital stock in the industry structure extend official quarterly statistics. Official quarterly statistics contain relatively wide range of important indicators but the main part of net worth is missing. Results in this paper compensate this inconsistency, which is not caused by unwillingness of the Czech Statistical Office but by non-existing official rule for quarterly estimation of net fixed capital stock in combination with demanding process of even very simple estimation.

Our approach uses all possible additional information about flows of fixed capital. Quarterly gross fixed capital formation is estimated in industry structure (CZ-NACE rev. 2) on the basis of official data in structure by type of asset. Other flows in volume of assets are uniformly distributed, only identifiable parts (in our case only catastrophes like

II: *Annex A: Quarterly Net Fixed Capital Stock in Constant Prices of 2005, Industries, million CZK*

Year / Quarter		Total	Agriculture, forestry and fishing	Manufacturing, mining and quarrying and other industry		Construction	Trade, transportation, accommodation and food service	Information and communication	Financial and insurance activities	Real estate activities	Professional, scientific, technical and administrative activities	Public administration, education, health and social work	Other service activities
				Total	of which: Manufacturing								
NACE			A	B+C+D+E	C	F	G+H+I	J	K	L	M+N	O+P+Q	R+S+T+U
1995	Q1	10403640	171008	1652812	908547	119926	1211348	111642	113811	2970871	237612	3743006	185249
	Q2	10708869	177674	1711591	938617	124362	1246824	116413	122975	3053261	242680	3837549	189669
	Q3	11010319	184344	1769031	967702	128604	1281348	121143	131804	3135852	247404	3931610	194059
	Q4	11345636	191809	1838473	1003729	134039	1321052	126926	142457	3223004	254113	4029244	198884
1996	Q1	10694491	187554	1803386	983436	128924	1249443	130080	137901	2976992	241948	3730559	185844
	Q2	11017584	193888	1859855	1013993	133701	1292939	143065	144884	3062360	248323	3825864	190545
	Q3	11354029	200747	1919408	1045794	138657	1339272	157023	152228	3150789	254891	3922534	195448
	Q4	11705386	207959	1984486	1081100	144242	1387717	172027	160290	3241484	262056	4020538	200550
1997	Q1	10923911	196345	1890597	1024615	138124	1299753	171289	151957	2995953	246344	3704605	185576
	Q2	11248584	200529	1951666	1060044	144627	1344925	184149	158456	3080322	253991	3795435	190103
	Q3	11576304	204914	2013971	1096008	151059	1390160	197256	164911	3165780	261713	3886249	194599
	Q4	11935953	209789	2086489	1137902	158743	1441319	212820	172530	3257315	270646	3979048	199408
1998	Q1	11346581	216791	2031213	1109332	153455	1379338	213375	164832	3060047	258699	3715262	188317
	Q2	11621046	221380	2077680	1135448	158262	1419265	227158	169007	3136366	265245	3787734	192957
	Q3	11897068	226242	2124232	1161322	162983	1458846	240988	173031	3214359	271536	3860334	197678
	Q4	12186979	230745	2175331	1190069	168233	1500638	256151	177595	3295764	278378	3933754	202660
1999	Q1	11844114	224729	2135353	1172417	164754	1469716	254960	172933	3197128	274565	3779066	197497
	Q2	12009060	225333	2172864	1194540	167231	1501066	262210	174486	3240513	280699	3808604	200969
	Q3	12173173	226087	2209567	1215883	169513	1531531	269018	176014	3285463	286659	3838034	204532
	Q4	12362567	227012	2254896	1242660	172529	1567021	278141	178319	3334897	293771	3868558	208509
2000	Q1	12077843	221463	2224961	1232487	170582	1531412	279729	173945	3259745	288230	3741146	204131
	Q2	12227976	222808	2255783	1253499	174189	1557324	289154	176418	3296966	292697	3770774	207721
	Q3	12382905	224470	2287706	1275004	177721	1583431	298512	178678	3336938	297175	3800936	211434
	Q4	12570711	226355	2330159	1303521	182309	1614841	311327	181903	3383228	302876	3833606	215781

Year / Quarter		Total	Agriculture, forestry and fishing	Manufacturing, mining and quarrying and other industry		Construction	Trade, transportation, accommodation and food service	Information and communication	Financial and insurance activities	Real estate activities	Professional, scientific, technical and administrative activities	Public administration, education, health and social work	Other service activities
				Total	of which: Manufacturing								
NACE			A	B+C+D+E	C	F	G+H+I	J	K	L	M+N	O+P+Q	R+S+T+U
2001	Q1	12318491	221873	2309217	1298403	181941	1583301	314245	177730	3310660	297250	3719467	211865
	Q2	12466348	224895	2342453	1323725	186965	1608642	324077	179075	3348580	300571	3743124	215079
	Q3	12616298	227949	2375820	1348412	191711	1633397	333482	180334	3389625	303581	3767106	218453
	Q4	12791140	231161	2417039	1378786	197593	1661875	345728	182458	3436122	307373	3792290	222242
2002	Q1	12711323	231152	2434011	1417772	199174	1630857	357294	183907	3384160	310802	3759606	221246
	Q2	12791228	232074	2447938	1429089	202147	1609276	356972	185092	3418832	312624	3803662	224519
	Q3	12873420	232874	2461587	1439782	204668	1587989	356607	186032	3456213	314121	3848483	227755
	Q4	12957153	232704	2472139	1449187	207314	1566518	356337	187808	3497487	315691	3894141	231270
2003	Q1	12846813	227189	2476871	1452717	207709	1570788	349623	186928	3456310	311345	3829765	232577
	Q2	12938676	228620	2494487	1473457	210946	1593527	350327	187584	3487781	312047	3839119	236494
	Q3	13040760	230314	2514282	1495228	214068	1617725	351231	188175	3523053	312745	3850424	240864
	Q4	13165228	231968	2541016	1522382	218020	1645282	353602	189619	3564796	314306	3862861	245725
2004	Q1	12889213	225875	2512216	1514841	215056	1619274	349849	185291	3481313	309398	3751651	240037
	Q2	13046056	227174	2545996	1545150	218698	1647079	351205	186743	3527026	314800	3784432	243595
	Q3	13200461	228439	2576598	1572406	221963	1674483	351978	187892	3575511	319667	3817529	247071
	Q4	13374785	229720	2612276	1603719	226027	1704975	354240	189746	3630333	325444	3851790	250901
2005	Q1	13198768	226760	2599785	1606056	224950	1697993	352979	186984	3570928	325304	3764467	248618
	Q2	13327088	227540	2623229	1627234	227415	1730242	353053	187120	3612447	329785	3783895	252362
	Q3	13454869	228206	2645765	1647352	229564	1761526	352895	187050	3656570	333748	3803395	256149
	Q4	13603489	229049	2673810	1671985	232461	1796469	354425	187725	3706580	338916	3823784	260270
2006	Q1	13406174	225866	2646297	1667219	231081	1787245	351682	184984	3646126	338182	3738183	256528
	Q2	13541904	227129	2665051	1687516	234336	1821219	353167	185943	3692034	343955	3759435	259635
	Q3	13680719	228359	2683508	1707216	237300	1854875	354574	186657	3741863	349228	3781553	262803
	Q4	13856225	230078	2712653	1735318	241410	1895233	358486	188461	3800352	356229	3806711	266612

Year / Quarter		Total	Agriculture, forestry and fishing	Manufacturing, mining and quarrying and other industry		Construction	Trade, transportation, accommodation and food service	Information and communication	Financial and insurance activities	Real estate activities	Professional, scientific, technical and administrative activities	Public administration, education, health and social work	Other service activities
				Total	of which: Manufacturing								
NACE			A	B+C+D+E	C	F	G+H+I	J	K	L	M+N	O+P+Q	R+S+T+U
2007	Q1	13565151	225579	2678832	1722631	239943	1872745	351890	184411	3706538	353529	3691516	260573
	Q2	13761626	228682	2721254	1754991	244370	1908746	355261	186056	3769998	359726	3723538	264508
	Q3	13957909	231908	2763133	1786625	248347	1943877	358531	187425	3835593	365299	3755951	268474
	Q4	14186798	235446	2813801	1825037	253304	1984747	363541	189567	3911416	372283	3790473	272929
2008	Q1	13919572	232469	2797451	1825405	255144	1961174	355944	186515	3812284	373818	3679576	267589
	Q2	14104976	234533	2831576	1849587	260015	1998093	355885	189185	3874981	380262	3711359	271412
	Q3	14287775	236466	2863471	1871626	264227	2032870	355557	191468	3941443	385671	3743589	275207
	Q4	14477919	238165	2896910	1894808	268544	2067120	356441	194082	4012365	391128	3775936	279130
2009	Q1	14447783	233049	2885304	1881757	269204	2066222	361366	192306	4009782	395371	3756325	280747
	Q2	14526273	234223	2902565	1889258	272019	2088041	362241	191874	4033322	400431	3760896	282967
	Q3	14608684	235388	2919135	1895932	274696	2110599	362862	191376	4060243	405123	3766725	285313
	Q4	14709782	236464	2941579	1906834	278010	2135224	365367	191522	4092302	410877	3773752	287961
2010	Q1	14795818	237456	2963105	1915575	282561	2146551	366792	192781	4129272	415470	3775681	289397
	Q2	14812511	237176	2963095	1907193	284202	2152268	366847	192997	4140822	417228	3771451	289702
	Q3	14844053	237263	2966844	1901346	285857	2159812	367198	193254	4157970	418874	3770165	290281
	Q4	14883688	237425	2972107	1897132	288093	2168056	368430	194204	4180067	419566	3768276	290909
2011	Q1	15686239	241306	3079867	1983369	299584	2596542	365891	195362	4364533	441659	3825762	305952
	Q2	15555856	243661	3068197	1958408	297813	2550877	363498	194971	4325723	437373	3792894	302322
	Q3	15444216	246622	3062508	1936962	296450	2509011	361820	194805	4290601	433791	3763730	298924
	Q4	15347312	249996	3063087	1915031	295122	2468517	365055	193631	4253159	429835	3740146	295618

Source: authors' computation

floods or windstorms) are located into adequate quarters. Allocation of consumption of fixed capital into quarters is based on intuitive assumption of relation between the value of the stock and its depreciation. Fourth quarters are equal to official annual data; industry structure is similar to official quarterly data structure.

Having the quarterly net fixed capital stock our next research will focus on quarterly total factor productivity analysis. Our estimates also contain net fixed capital stock without dwellings that can be counted as non-productive part of fixed capital. These estimates are at everybody's disposal, thus we hope these data will be helpful for work of other researchers.

SUMMARY

The paper presents quarterly estimation of net fixed capital stock. This estimation enhances official statistics which produce only annual data on net fixed capital stock. The estimations of quarterly net fixed capital are based on the official data from the Czech Statistical Office and strict differentiation of three basic flows of fixed capital. First flow of quarterly gross fixed capital formation is officially published only by types of assets. These data are used for the estimation in this paper as weights for annual data on gross fixed capital formation in industry structure. Because of the lack of any support information, second flow of other changes in volume of assets is mainly uniformly divided into quarters. Only in cases of loss caused by catastrophes (floods and windstorms) it is possible to allocate the value into the appropriate quarter. Third flow of consumption of fixed capital was calculated simultaneously with net fixed capital stock. This calculation is based on previous estimation of quarterly gross fixed capital formation, other changes in volume of assets and assumption of relation between value of stock and its consumption. This assumption leads to the system of nonlinear equations that is solved by Newton's iteration method for each year. Iterations of Newton's method ends when the next step does not cause the change of the solution rounded on millions CZK that corresponds with official statistics that is also rounded on millions.

Quarterly net fixed capital stock is estimated in prices of year 2005. The described calculation is applied on years 1995–2011 and 11 industries (CZ-NACE rev. 2) or their aggregations. This classification is compatible with official quarterly statistics of Czech Statistical Office. Estimated quarterly net fixed capital stocks also contain option without the value of dwellings. This estimation is mainly for the purposes of productivity analysis. Housing stock can be considered as mainly nonproductive type of asset. Because stock indicators are estimated to the end of period, fourth quarters of net fixed capital stock must be equal to official annual data.

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REFERENCES

APPLETON, J., WALLIS, G., 2011: Volume of capital services: new annual and quarterly estimates for 1950 to 2009. *Economic & Labour Market Review*, 5, 5: 46–66. ISSN 1751-8326.

ADAMEC, V., STŘELEC, L., 2012: A study of potential output and output gap in the Czech Republic. *Acta univ. agric. et silvic. Mendel. Brunen.*, 60, 2: 9–16. ISSN 1211-8516.

BORDO, M., D., HAUBRICH, J., G., 2010: Credit crises, money and contractions: An historical view. *Journal of Monetary Economics*, 57, 1: 1–18. ISSN 0304-3932.

COHEN, A. J., HARCOURT, G. C., 2003: Whatever Happened to the Cambridge Capital Theory Controversies? *Journal of Economic Perspectives*, 17, 1: 199–214. ISSN 0895-3309.

CZECH STATISTICAL OFFICE, 2002: *Gross National Income Inventory*. [online], Praha: Czech Statistical Office, 447 s. [26. 9. 2011] Available: http://apl.czso.cz/nufile/GNI_CZ_en.pdf.

CZECH STATISTICAL OFFICE, 2008: *Quarterly National Accounts Inventories*. [online] Praha: Czech Statistical Office, 60 s. [3. 12. 2012], Available: http://www.czso.cz/csu/redakce.nsf/i/metodika_ctvrtletni_ucty/$File/09087474.pdf.

CZECH STATISTICAL OFFICE, 2013a: *Annual National Accounts*. [online]. [21. 5. 2013] Available: http://apl.czso.cz/pll/rocenka/rocenka.indexnu_en.

CZECH STATISTICAL OFFICE, 2013b: *Balance Sheets*. [online]. [20. 5. 2013] Available: http://apl.czso.cz/pll/rocenka/rocenkavyber.makroek_rozvaha_en.

CZECH STATISTICAL OFFICE, 2013c: *Gross Domestic Product – time series*. [online]. [20. 5. 2013] Available: http://www.czso.cz/eng/redakce.nsf/i/hdp_ts.

D'AURIA, F., DENIS, C., HAVIK, K. et al., 2010: *The production function methodology for calculating potential growth rates and output gaps*. Brussels: European Commission, Directorate-General for Economic and Financial Affairs Publications. 105 s. ISBN 978-92-79-14906-1.

DIEWERT, W. E., 2005: Issues in the Measurement of Capital Services, Depreciation, Asset Price Changes and Interest Rates. In: CORRADO, C., HALTIWANGER, J., SICHEL, D. eds. *Measuring Capital in the New Economy*. Chicago: University of Chicago Press, p. 479–542. ISBN 0-226-11612-3.

EUROPEAN COMMISSION, UNITED NATIONS, INTERNATIONAL MONETARY FUND, OECD, WORLD BANK, 1994: *System of National Accounts 1993*. New York, Brussels/Luxembourg, Paris, Washington: Commission of the European Communities-Eurostat, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations and World Bank, 838 p. ISBN 92-1-161352-3.

EUROPEAN COMMISSION, UNITED NATIONS, INTERNATIONAL MONETARY FUND, OECD, WORLD BANK, 2009: *System of National Accounts 2008*. New York: European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations and World Bank, 720 p. ISBN 978-92-1-131522-7.

EUROPEAN COMMISSION, 1996: *European System of Accounts 1995*. Brussels-Luxembourg: Eurostat, 383 p. ISBN 92-827-7954-8.

FERNALD, J., 2012: A Quarterly, Utilization-Adjusted Series on Total Factor Productivity. [online]. *Federal Reserve Bank of San Francisco Working Paper 2012-19*, 28 p. [20. 8. 2013]. Available: http://www.frbsf.org/economic-research/files/wp12-19bk.pdf.

HICKS, J., 1974: Capital Controversies: Ancient and Modern. *The American Economic Review*, 64, 2: 307–316. ISSN 0002-8282.

IMF, OECD, 2011: *Strengthening Sectoral Position and Flow Data in the Macroeconomic Accounts*. [online] Washington DC: IMF, OECD. [15. 5. 2013] Available: http://www.imf.org/external/np/seminars/eng/2011/sta/.

KAMPS, CH., 2006: New Estimates of Government Net Capital Stocks for 22 OECD Countries, 1960–2001, *IMF Staff Papers*, 53, 1: 120–150. ISSN 1020-7635.

KENDRICK, J., W. LEE, K., S., 1976: Quarterly Estimates of Capital Stocks in the U.S. Private Domestic Economy, by Major Industry Groups. *Review of Income and Wealth*, 22, 4: 345–352. ISSN 1475-4991.

KLACEK, J., VOPRAVIL, J., 2008: Total factor productivity in Czech manufacturing industry – KLEM framework. *Statistika: Statistics and Economy Journal*, 45, 5: 414–428. ISSN 1804-8765.

KLACEK, J., VOŠVRDA, M., SCHLOSSER, Š., 2007: KLE Translog production function and total factor productivity. *Statistika: Statistics and Economy Journal*, 44, 4: 261–274. ISSN 1804-8765.

KREJČÍ, I., SIXTA, J., 2012: Využití alternativních metod při odhadech stavů a spotřeby fixního kapitálu. *Politická ekonomie*, 60, 5: 780–800. ISSN 0032-3233.

LEVY, D., 1995: Capital Stock Depreciation, Tax Rules, and Composition of Aggregate Investment. *Journal of Economic and Social Measurement*, 21, 1: 45–65. ISSN 0747-9662.

LEVY, D., CHEN, H., 1994: Estimates of the aggregate quarterly capital stock for the post-war U.S. economy. *Review of Income and Wealth*, 40, 3: 317–349. ISSN 1475-4991.

MATA, T., 2004: Constructing Identity: The Post Keynesians And The Capital Controversies. *Journal of the History of Economic Thought*, 26, 2: 241–259. ISSN 1053-8372.

MOULTON, B. R., 2004: The system of national accounts for the new economy: what should change? *Review of Income and Wealth*, 50, 2: 261–278. ISSN 1475-4991.

OECD, 2001: *Measuring Productivity – OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth*. Paris: OECD Publishing. 155 p. ISBN 92-64-18737-5.

OECD, 2009: *Measuring Capital – OECD Manual 2009: Second edition*. Paris: OECD Publishing. 233 p. ISBN 978-92-64-02563-9.

ONDRUŠ, V., 2011: Compilation of Non-financial Balances in the Czech Republic. In: *Conference on Strengthening Sectoral Position and Flow Data in the Macroeconomic Accounts*, [online] Washington DC: IMF, OECD. Available: http://www.imf.org/external/np/seminars/eng/2011/sta/pdf/Czech.pdf [17. 5. 2011].

PIGOU, A. C., 1935: Net income and capital depletion. *The Economic Journal*, 45, 178: 235–241. ISSN 0013-0133.

ROBINSON, J., 1953-1954: The Production function and the Theory of Capital, *The Review of Economic Studies*, 21, 2: 81–106. ISSN 1467-937X.

SIXTA, J., 2007: Odhady spotřeby fixního kapitálu. *Statistika*, 87, 2: 156–163. ISSN 0322-788X.

SIXTA, J., VLTAVSKÁ, K., ZBRANEK, J., 2011: Souhrnná produktivita faktorů na službách práce a kapitálu. *Politická ekonomie*, 59, 5: 599–617. ISSN 0032-3233.

SOLOW, R. M., 1957: Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*, 39, 3: 312–320. ISSN 0034-6535.

SRAFFA, P., 1960: *Production of commodities by means of commodities: prelude to a critique of economic theory*. Cambridge: Cambridge university press, 98 p. ISBN 0-521-06539-2.

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