

LABOUR AS A FACTOR OF PRODUCTION IN THE CONTEXT OF GROSS VALUE ADDED GROWTH IN SECTOR A

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The present paper deals with identifying the importance of labour factor productivity in the context of gross value added growth in Sector A (Agriculture, Forestry, and Fishing according to NACE-CZ statistical classification) in the Czech Republic. The growth of gross value added was divided into extensive and intensive factor in Sector A and the entire national economy. Intensive factor was measured by total factor productivity. Extensive factor was focused on labour as one of factors of production. It was found that the importance of labour for the growth of gross value added in the monitored sector is not constant, but significantly changing partly in relation to a business cycle. On the other hand, the importance of other sources of growth (total factor productivity and factor of production capital) is acyclic and affected by other impacts.

agriculture; labour productivity; gross value added; economics growth

INTRODUCTION

The primary sector of the national economy, with Sector A – Agriculture, Forestry, and Fishing (see NACE-CZ – statistical classification of economic activities of the Czech Republic) constituting its main part, plays a significant role in the creation of the gross value added (GVA). Sector A is oriented toward agriculture, forestry, and fishing. When evaluating the economic growth of particular sectors of the national economy through the growth of GVA, some differences can be found mainly in the sources of growth. Labour is often considered as a key source of growth in GVA. Its importance in terms of GVA growth is not constant but varies due to many factors, the economic cycle and the branch of national economy being the most significant. The question is how is the dynamics of GVA growth in Sector A affected by the business cycle and other factors of production.

The starting point for measuring the growth of economy, and of the productivity of sectors and factors of production, is what is termed the ‘production function’. If Q represents output and K and L represent capital and labour inputs in ‘physical’ units, then the aggregate production function can be expressed as: $Q = F(K, L; t)$. The variable t for time appears in F to allow for a technical change. It will be seen that the phrase ‘technical change’ is used as a short-hand expression for any kind of shift in the production function (Solow, 1957). Output can be measured by GVA in sectors or small regions (Johnston, 2011).

We can see that labour is the basic factor of production. Efficiency in using labour can be measured by labour productivity. Labour productivity is the ratio of

production over the optimal amount of labour input. Labour productivity is usually measured as GDP per hour worked, but for a sector (industry), it is value added per labour (Oosterhaven, Broersma, 2007). There are two sources of labour productivity growth: technical progress and increases in the average capital-labour ratio (C-LR). The average capital labour ratio can be affected by the demographic change in two ways. The first is a mechanical effect as capital takes time to adjust to changes in labour for any equilibrium C-L ratio. (Guest, 2011). There are other types of productivity such as capital productivity or total factor productivity. Capital productivity shows how productively capital is used to generate value added. Total factor productivity measures technological change. Total factor productivity determines labour productivity, not only directly, but also indirectly by determining capital per worker (Prescott, Lawrence, 1997).

The sources of economic growth can be divided into extensive or intensive and, accordingly, the growth can be extensive and intensive. Extensive and intensive growth is actually a result of qualitative and quantitative changes in the productivity of factors of production (Hájek, Mihola, 2009) both individually and in the factors of production as a whole.

Economic growth and productivity are influenced by the business cycle. The basic theory is currently the real business cycle theory. The main authors of the theory of real business cycles (RBC) are Kydland, Prescott (1982), whose model is considered as a standard RBC model. This concept is focused on explaining economic fluctuations. The basic point is that prices, wages, and interest rates adapt quickly. The causes of business cycles consist of real changes

– real shocks. An important general characteristic of business cycles appears to be the tendency of outputs in different sectors to move together. This hypothesis was confirmed by Long, Plosser (1987) stating that some sectors display less coherence than other sectors. On the other hand, Bhattacharjee et al. (2009) showed that development of productivity in business cycles displayed substantial variation in different sectors. Investment and investment-specific technology play a significant role in the change of productivity in business cycles (Ireland, Schuh, 2008).

MATERIAL AND METHODS

The main aim of this paper was to assess the labour as factors of production through various ratio indicators (indicators levels and their dynamics) in Sector A within the classification NACE-CZ and within the entire national economy of the Czech Republic (CR). Another objective was to determine the significance of the influence of the volume change of factors of production with the focus on the labour (an extensive factor of growth) and the meaning of the influence of the production factors' effectiveness measured by the TFP (intensive factor of growth) on the relative change in GVA in Sector A (NACE-CZ) and the entire national economy.

Data were collected from the national accounts published by the Czech Statistical Office within the period 1996–2011, i.e. an interval of 16 years. The selected indicators were: labour productivity – LP (i.e. gross value added/hours worked (Gutiérrez, 2000), the capital-labour ratio – C-LR (i.e. gross fixed capital formation/employment rate (full-time jobs)), nominal unit labour costs – NULC (i.e. employees compensation at current prices/gross value added). Indicators mentioned above (excluding employees' compensation) were measured as real indicators, i.e. at comparable prices in 2005. The same methodical approach was used by Jílek, Moravcová (2007) or Eurostat. Total factor productivity (TFP =) can be calculated as follows:

$$\frac{A_t}{A_{t-1}} = \frac{Y_t}{Y_{t-1}} \cdot \left(\frac{C_t}{C_{t-1}} \right)^{-\alpha_{Ct}} \cdot \left(\frac{L_t}{L_{t-1}} \right)^{-\alpha_{Lt}} \quad (1)$$

where:

Y_t/Y_{t-1} is the index of real output (gross value added)
 C_t/C_{t-1} is the index of real gross stock of long-term property (index of gross fixed capital formation)

L_t/L_{t-1} is the index of number of hours worked off (Larsen et al., 2007)

α_{Lt} is the arithmetical mean from the compensation of employees' ratio in GVA in the previous and present period is the arithmetical mean from the gross operating surplus in GVA in the previous and present period, thus it applies that $\alpha_{Lt} + \alpha_{Ct} = 1$.

t is a present period

$t-1$ is a previous period

When calculated, the Tornquist formula of discrete approximation of Divisio's integral index was used, namely:

$$\ln A_t - \ln A_{t-1} = (\ln Y_t - \ln Y_{t-1}) - \alpha_{Ct} (\ln C_t - \ln C_{t-1}) - \alpha_{Lt} (\ln L_t - \ln L_{t-1}) \quad (2)$$

and:

$$\begin{aligned} (\ln Y_t - \ln Y_{t-1}) = \\ = [(\ln A_t - \ln A_{t-1})] + [\alpha_{Ct} (\ln C_t - \ln C_{t-1}) + \alpha_{Lt} (\ln L_t - \ln L_{t-1})] \end{aligned} \quad (3)$$

The first square bracket of the formula represents the intensive factor of the real product (i), the second square bracket represents the extensive growth factor (e).

Both factors can be expressed as:

$$i = \frac{\ln A_t - \ln A_{t-1}}{[(\ln A_t - \ln A_{t-1})] + [\alpha_{Ct} (\ln C_t - \ln C_{t-1}) + \alpha_{Lt} (\ln L_t - \ln L_{t-1})]} \quad (4)$$

$$e = \frac{\alpha_{Ct} (\ln C_t - \ln C_{t-1}) + \alpha_{Lt} (\ln L_t - \ln L_{t-1})}{[(\ln A_t - \ln A_{t-1})] + [\alpha_{Ct} (\ln C_t - \ln C_{t-1}) + \alpha_{Lt} (\ln L_t - \ln L_{t-1})]} \quad (5)$$

while between the two parameters the following relation applies:

$$|i| + |e| = 1.$$

The relation ensures that both considered factors cover 100%, taking into account the possibility of their opposed and fully compensating effect.

The influence of the extensive factor can be further divided into the labour impact (the first summand of the formula 6) and the capital impact (the second summand of the formula 6), i.e.:

$$\begin{aligned} e = \frac{\alpha_{Ct} (\ln C_t - \ln C_{t-1}) + \alpha_{Lt} (\ln L_t - \ln L_{t-1})}{[(\ln A_t - \ln A_{t-1})] + [\alpha_{Ct} (\ln C_t - \ln C_{t-1}) + \alpha_{Lt} (\ln L_t - \ln L_{t-1})]} = \\ = \frac{\alpha_{Ct} (\ln C_t - \ln C_{t-1})}{[(\ln A_t - \ln A_{t-1})] + [\alpha_{Ct} (\ln C_t - \ln C_{t-1}) + \alpha_{Lt} (\ln L_t - \ln L_{t-1})]} + \\ + \frac{\alpha_{Lt} (\ln L_t - \ln L_{t-1})}{[(\ln A_t - \ln A_{t-1})] + [\alpha_{Ct} (\ln C_t - \ln C_{t-1}) + \alpha_{Lt} (\ln L_t - \ln L_{t-1})]} \end{aligned} \quad (6)$$

RESULTS AND DISCUSSION

The first step of the analyses was to find out the level of monitored indicators in the course of 16 years including the assessment of differences in the indicators level in Sector A: Agriculture, Forestry, and Fishing compared to the average level in the entire economy (Table 1).

It is evident, from the development of labour productivity figures, that throughout the period Sector A reaches roughly a 43–64% level of labour productivity in the entire economy. The capital-labour ratio in

Table 1. Development of indicators in the entire economy and in Sector A (NACE-CZ), Czech Republic (CR)

Year	Labour productivity (in CZK per worked hour)		Capital labour ratio (in thousands of CZK per employed person)		Nominal unit labour costs (in CZK)	
	CR	Sector A	CR	Sector A	CR	Sector A
1996	230.2	111.4	136.9	106.1	0.332	0.543
1997	227.2	109.5	128.7	75.8	0.370	0.616
1998	228.4	112.0	129.2	71.2	0.389	0.612
1999	236.0	125.0	129.3	61.0	0.393	0.554
2000	248.0	126.4	139.0	74.3	0.399	0.558
2001	267.5	131.4	145.3	92.8	0.418	0.575
2002	273.4	146.8	149.0	106.8	0.437	0.563
2003	285.8	162.0	151.9	84.6	0.447	0.522
2004	298.3	176.6	156.8	94.1	0.462	0.498
2005	312.7	197.5	163.5	103.6	0.462	0.469
2006	335.7	190.5	172.3	111.9	0.461	0.522
2007	349.7	157.9	191.3	150.5	0.474	0.689
2008	354.4	164.6	194.4	137.4	0.487	0.672
2009	346.5	221.3	177.2	115.5	0.498	0.500
2010	354.4	166.7	179.0	126.9	0.489	0.642
2011	356.4	154.5	175.6	178.3	0.492	0.685

Source: own calculations based on the data of national accounts (in CZK)

Sector A had been below the average in the CR until 2004. Since joining the EU, the index shift has been obvious, thus Sector A has been gradually coming to the level of the national average and in the last reporting year, the value of the capital-labour ratio was even by 1.53% higher than the national average. The assessment using the nominal unit labour costs indicator is quite different. The value of the indicator in Sector A is above the national average in all of the years. At the beginning of the monitored interval it is by 60% higher, but at the end of this period the difference is not so significant. It is due to the fact that Sector A is one of more labour-intensive sectors (i.e. the costs of the labour form a significant proportion of the total costs in agriculture). In 2009 (known as the year of global crises), the indicator level of nominal unit labour costs (NULC) in Sector A was nearly identical to the average in the CR. This year was successful concerning agriculture, i.e. there was not a big fall recorded in GVA growth compared to GVA growth in other sectors, thus the level of nominal unit labour costs was lower compared to previous years.

The dynamics of indicators in relation to the real business cycle

The next step of the analysis was to divide the 16-year period (1996–2011) into intervals corresponding to the various phases of the real business cycle. As an instrument, the dynamics of GVA in the CR was chosen, on the basis of which the following periods were identified (Novotná, Volek, 2011):

1996–2000 and 2003–2006 – increasing GVA growth rates,

2000–2003 – relatively stable increases in GVA, 2006–2009 – declining increases in GVA, in 2009 falling into negative values,

2009–2011 – slow recovery of the increasing GVA growth rates.

Figs. 1 and 2 indicate the dynamics of the labour productivity in the context of other measured indicators in Sector A and in the entire CR. The dynamics of these indicators is measured through annual indices (the average growth rates in the intervals are not calculated because of expected different development in Sector A). Assuming the illustration of the average growth rate in the intervals mentioned above, it could lead to biased results. The purpose of this paper was to find out whether the fluctuations in GVA due to the real business cycle are in accordance with the fluctuations of monitored indicators in the CR and in Sector A.

In the intervals of increasing GVA growth rate in the CR (1996–2000 and 2003–2006), especially in 2003–2006, the dynamics of labour productivity was stable (annual growth rate was about 4.5%). At the same time the growth rate of the capital-labour ratio increased within this period. The nominal unit labour costs were rising slowly when compared with labour productivity, which positively affected the output of the economy. In Sector A (NACE-CZ), labour productivity growth fluctuated in this period. Since 2004, this sector has recorded a high growth rate of the capital-labour ratio (in 2004 the annual growth represented 11.1%). The reason for this situation is not only in the

positive development of the Czech economy, but the development of this indicator was also significantly influenced by the CR joining the European Union and therefore the change of subsidy policies in Sector A (NACE-CZ). This included investment activity support of agricultural enterprises which was even more evident in the following years. The nominal unit labour costs tended to decline.

In the period of stable growth and slightly increasing growth rate of GVA in the CR (2000–2003), the labour productivity growth rate in the CR differed from the development in Sector A. Capital-labour ratio was growing rapidly in Sector A (in 2001 – an increase of 24.8%, which could have been caused by the declining number of employees in agriculture). The growth rate of nominal unit labour costs in the CR in Sector A was lower (except for 2002 in the CR) than the growth rate of labour productivity (Fig. 2).

In the interval of reducing GVA growth rate (2006–2009), the development of the indicators was different. This period was characterized by an average annual decline of labour productivity in the CR, of the capital-labour ratio, and of a stable growth rate of nominal unit labour costs. An example of a completely different development in Sector A can be observed in the acyclic development of this sector. The highest increase in labour productivity in Sector A could be monitored just during the greatest economy downfall, i.e. in 2009, when the growth rate of this index was 34.43%. The capital-labour ratio, as well the entire economy, were decreasing (decrease of about 16%), while the largest decrease could be observed in nominal unit labour costs (decrease by 25.52%). The results were explained above in the paper. In 2009–2011, all indicators monitored in the CR showed only minor changes. The situation was different again in Sector A, where the labour productivity index was below the index value 1 and labour productivity growth rate exceeded the nominal unit labour costs quite sig-

nificantly. Despite the unfavourable development of labour productivity, the investments in the long-term possession per employee increased and even in 2011, these investments increased by 40.47% compared to the previous year.

It is evident from Figs. 1 and 2, that the average growth rates of monitored indicators in Sector A are subject to much higher fluctuations than the average of monitored indicators in the CR. These fluctuations are not in accordance with the development of the average volume of indicators in the economy. However, from the dynamics of the monitored indicators it is obvious that Sector A (NACE-CZ) is subject to acyclic development. The other factors (non-market ones), which are not related to the development of the real business cycle, are the result of this situation.

Effectiveness of TFP factors in the context of the real business cycle

For a more detailed analysis the indicator of overall efficiency of factors of production (TFP) was monitored (see Methods). From Fig. 3 it is clear again that indicators development shows significantly higher fluctuations in Sector A. From indicators development in the CR in relation to Fig. 4, it is possible to find out the following:

- if the value of TFP is higher than the GVA index (I_{GVA}), then the extensive factor is negative (1997, 1998, 1999, 2009)
- if the value of TFP is less than the GVA index and at the same time $I_{GVA} < 1$, then the intensive factor is negative (2007).

In connection with the growth of GVA, there was an intention to elaborate on the analysis and to reveal the sources of growth with a focus on the influence of labour production factors. To determine whether GVA growth in particular phases of development is influenced by both intensive or extensive factors, or

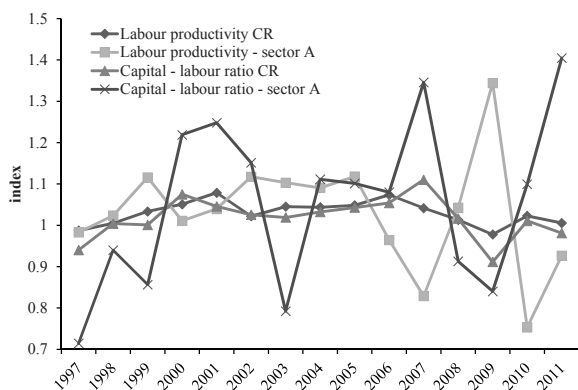


Fig. 1. Annual growth rates of indicators (labour productivity, capital-labour ratio)

Source: own calculations based on the data of national account

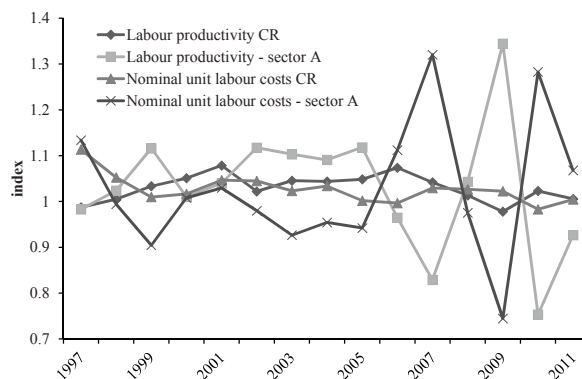


Fig. 2. Annual growth rates of indicators (labour productivity, nominal unit labour costs)

Source: own calculations based on the data of national account

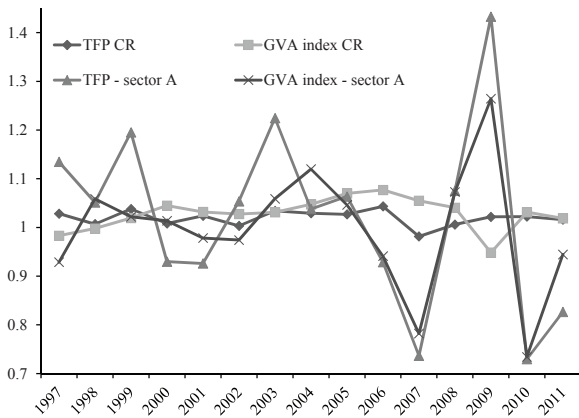


Fig. 3. Development of TFP and growth rates of GVA
Source: own calculations based on the data of national accounts

whether one factor compensates the other factor, was the objective of this analysis. The extensive factor (i.e. increase or decrease in labour and capital) was then divided into the influence of the labour and capital as factors of production (Figs. 4 and 5). From the analysis of GVA changes in the entire economy (Fig. 4), it is possible to state the following:

- during the period of increasing GVA growth rates, the intensive factor has a significant influence
- during stable GVA growth, the extensive factor, namely the labour, whose influence in this period is relatively stable (the absolute value of this coefficient is about 0.83), is, for the most part, the source of the growth factor
- during the period of decreasing GVA growth rates, the source of GVA growth cannot be unequivocally determined. In 2009 it is obvious that both factors contributed significantly to the reduction in the GVA growth rate (GVA index < 1 in 2009).

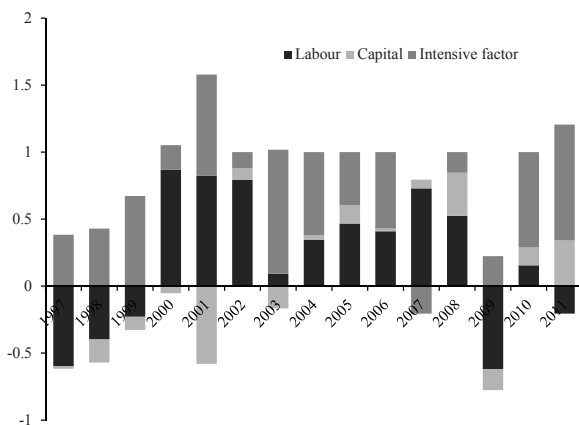


Fig. 4. Source of growth rates of gross value added in the Czech Republic*
Source: own calculations based on the data of national accounts
*Extensive factor (Labour + Capital) + Intensive factor = 1

The same, however, cannot be completely confirmed in Sector A (Fig. 5). For this sector the following applies:

- if $TFP (I \frac{A_1}{A_0}) > I \text{ GVA}$, then the extensive factor is negative (1999, 2002, 2003, 2009), the same finding can be monitored for the whole economy
- if the $TFP (I \frac{A_1}{A_0}) < I \text{ GVA}$ and at the same time $I \text{ GVA} < 1$, then not only the intensity factor is negative in the whole national economy, but the negative impact of the capital can be monitored as well (2001, 2006, 2007, 2010)
- since 2005, the intensity factor has had the predominant influence on GVA growth, whether acting positively or negatively.

DISCUSSION

The results show that the labour productivity in Sector A (Agriculture, Forestry and Fishing) within the reporting period amounted to a level of 43–64%, in comparison to other sectors in the CR. From the viewpoint of dynamics the situation is different. This indicator for the whole of the CR is developed in the context of the business cycle. In Sector A, it is clear that the dynamics of labour productivity is influenced by other factors. One of them can be investments aimed at Sector A (after the CR joining the EU) which can influence the development of the second monitored indicator – the capital-labour ratio. The productivity of these investments is not the main objective. At the same time the investments effect usually comes with a certain delay. This also implies the difference in the dynamics of the index labour productivity and the capital-labour ratio. In the national economy, the

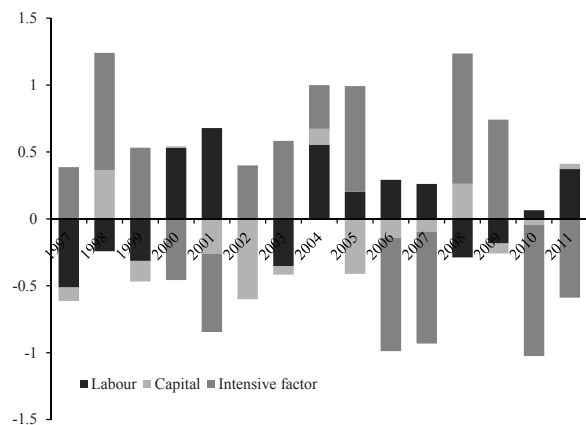


Fig. 5. Source of growth rates of gross value added in Sector A (NACE-CZ)*
Source: own calculations based on the data of National accounts
*Extensive factor (Labour + Capital) + Intensive factor = 1

relationships between the third monitored indicator nominal unit labour costs and labour productivity (in terms of increasing competitiveness the nominal unit labour costs index should be lower than labour productivity index), are achieved in a period of rising growth and in a period of steady GVA growth. Therefore the connection with the real business cycle is obvious. In Sector A the mutual relationship of these indicators is influenced by both non-market factors (climate effects) or market factors (e.g. the exercise price, the price of inputs...). Generally, the opinion can be expressed that in Sector A the monitored indicators are subject to significantly higher fluctuations in the CR and these fluctuations are not in compliance with the development of the average indicators in the economy. The dynamics of the monitored indicators indicates that this sector of the national economy exhibits acyclic development. Da-Rocha, Restuccia (2006) found the similar conclusion in the development output and employment in agriculture (main part of sector A). They found that agriculture has certain distinctive features over the business cycle: output and employment in agriculture are more volatile than and not positively correlated with output and employment in the rest of the economy.

Factors arising from both the internal or external environment, in which the changes of the latter have only a gradual impact (Petrick, Zier, 2012), are the results of this situation. Non-market factors which are not in connection with the real business cycle, particularly climate effects and non-productive investment orientation, can be classified as the main reasons. On the other hand, market factors such as the trade of agricultural goods, may also play a certain role (Restuccia et al., 2008).

In terms of identifying the main sources of GVA growth, the impact of intensive or extensive factors was analyzed. The extensive factor (i.e. increase or decrease in labour and capital) was divided into the influence of the labour and capital. The analysis conducted showed the following conclusions: if the total factor productivity is higher than the GVA index, then the extensive factor is negative. On the other hand, if the total factor productivity is lower than the GVA index, while the value of the TFP is lower than one, then the intensity factor is negative, but in Sector A, the influence of the capital is negative as well. In Sector A, since 2005, the intensity factor has had the dominant influence on GVA growth whether acting positively or negatively and large fluctuations are obvious. The volatility and often negative impact of intensive factor can be explained by investment activity that is influenced by the Common Agricultural Policy (CAP). This policy is not focused on increasing production, but to improve product quality and production conditions. A similar conclusion found Mary (2013) in French farms.

CONCLUSION

The present paper focused primarily on identifying the importance of labour factor productivity in the context of GVA growth in Sector A, which is the main part of the primary sector of the economy. It was found that the importance of labour for the growth of gross value added in the monitored sector is not constant, but significantly changing partly in relation to a business cycle. On the other hand, the importance of other sources of growth (total factor productivity and factor of production capital) is acyclic and affected by other impacts.

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