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Has the agricultural productivity increased after European Union enlargements in Central European countries? Evidence from four countries' cereal production

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Abstract: It was widely expected that following European Union's enlargement in 2004, farmers in new member states would improve their performance by increasing the efficiency of their production processes. In this study, using the Farm Accountancy Data Network data, we look at changes in total factor productivity, a measure which captures how efficiently and intensely inputs are utilised in production, that took place in farms producing cereals in the Czech Republic, Hungary, Poland, and Slovenia between 2004 and 2017. We find that in all four countries total factor productivity increased in the first years after the accession, but later declined. Overall, in the three former countries, total factor productivity in 2017 was higher than observed in 2004, whereas in Slovenia it was lower. This pattern largely corresponds to the dynamics observed with technological change: an initial technological progress was followed by a technological regress. Our results also suggest that over time farmers faced increasing problems with finding an optimal size of their operation. Finally, we observe that the technologies adopted on the farms were not used in an efficient way.

Keywords: Central Europe; cereal farms; scale efficiency; technological change; technical efficiency; total factor productivity

The accession of new member states (NMS) to the EU in 2004 led to many expectations and fears among farmers in old member states (OMS), as well as in NMS. The hopes of farmers from NMS were especially based on expectations concerning the positive effects of subsidies, and the opening up of the common EU market (Csaki and Jambor 2009). In particular, EU subsidies were expected to mitigate or remove financial constraints and thus to spur technological improvements that would enable farmers in NMS to catch up with farmers in OMS in terms of productivity and efficiency (for a theoretical argument see Ciaian and Swinnen 2009). In addition, the Common Agricultural Policy (CAP) and other accompanying policy initiatives were expected to lay the foundations for prosperity by eroding regional economic disparity and enhancing cross-border activity (Baráth and Fertő 2017). Accordingly, support from the CAP, together with the accompanying changes in the political and institutional environment, were expected to drive convergence among poor and

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rich farmers and regions (Wilkin 2007). An interesting question is to what extent this scenario came true, and whether the expected increase in productivity and efficiency in farm sector in NMS has materialised.

In this study, we seek to address this challenge on farm efficiency and productivity. We look at the evolution of total factor productivity (TFP), a measure which captures how efficiently and intensely inputs are utilised in production, in four NMS: the Czech Republic, Hungary, Poland, and Slovenia (NMS-4 from now on). We contribute to an extensive literature on factors affecting agricultural productivity in the EU and its changes over the last two decades. One strand of the literature to which our work is related focuses specifically on NMS-4 (see, for example, Latruffe et al. 2005; Bojnec and Latruffe 2013). These and other similar works improve our understanding of the changes in agricultural productivity and farm efficiency. Their usefulness is limited, however, by the fact that they focus only on single countries. In addition, and equally important, the available studies often differ in terms of the investigated sub-sector, the time period covered and methodology. In effect, empirical portrayal based on these works is difficult to interpret (especially given the fact that the choice of methodology seems to affect the received results, Bravo-Ureta et al. 2007; Minviel and Latruffe 2017). We address these difficulties by adopting a multi-country perspective. Furthermore, for each country we study the same time-period, the same type of farms (as regards their production structure) and use the same methodology. We believe that this approach allows for making much more reasonable assessment of the changes in agricultural productivity and farm efficiency in various settings.

Our paper is related to other works that also investigate several countries at the same time. The latter studies, however, focus mostly on OMS (e.g. Zhu and Oude Lansink 2010; Rizov et al. 2013; Kazukauskas et al. 2014), and the number of works devoted to NMS is relatively small. In addition, if it exists, the evidence on NMS comes from studies which are relatively old (Gorton and Davidova 2004; Swinnen and Vranken 2010). Furthermore, the existing evidence comes either from studies focusing on partial productivity measures (and not on TFP, Swinnen and Vranken 2010) or from the survey of the literature that collects the results from various settings and time-periods (Gorton and Davidova 2004). In this context, our paper tries to complement these works by providing a more recent portrayal on agricultural productivity and farm efficiency in NMS-4 based on a consistent methodological approach.

Our focus is on cereal production. This choice is motivated by the fact that this sector dominates the crop production in the Central Europe. Furthermore, it is very important intermediary input for livestock production. Our study covers the period 2004–2017. While caution needs to be exerted when generalising our findings to the whole region, it should be noted that the countries covered in our study account for a considerable share of agricultural output produced in all NMS (as reported, for example, by Eurostat). At the same time, they exhibit a considerable degree of heterogeneity such as in terms of farm structure, geographical conditions, historical institutions and influences and in that sense they may be used as a reference point for analyses made for other countries.

MATERIAL AND METHODS

In order to evaluate TFP dynamics, we followed most topical approaches used in the literature. The recent developments in the stochastic frontier literature focused on coping with the problem of biased estimates of technology parameters and technical efficiency arising in the context of firm unobserved heterogeneity. The literature acknowledged the importance of distinguishing between firm unobserved heterogeneity and two components of technical efficiency – persistent technical efficiency and transient technical efficiency (e.g. Tsionas and Kumbhakar 2014). While transient technical efficiency represents short-term deviations from the frontier technology (e.g. due to the presence of non-systematic management problems), the persistent part of efficiency is supposed to capture systematic deviations due to some structural problems in firm organisation or/and management. Moreover, we employ an estimation procedure that accounts for another two sources of potential endogeneity (Bokusheva and Cechura 2017; Bokusheva et al. 2022): (*i*) simultaneity of input use with both types of technical efficiency and (*ii*) correlation of the regressors with the noise term.

We assume that the transformation process can be well represented by stochastic frontier input distance function (IDF) (Karagiannis et al. 2004). We use IDF with three outputs (cereals output, other crop output and other farm output), four inputs (land, labour, capital and material) and four components of the error term (firm-specific time-invariant latent heterogeneity, time-invariant or persistent component of technical efficiency, time-varying – transient – component of technical efficiency and the stochastic error term; Tsionas and Kumbhakar 2014) in Equation (1).

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$$-\ln x_{1it} = \alpha_0 + \sum_{m=1}^{M} \alpha_m \ln y_{mit} + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{M} \alpha_{mn} \ln y_{mit} \ln y_{nit} + \sum_{k=2}^{K} \beta_k \ln x^{*}_{kit} + \frac{1}{2}\sum_{k=2}^{K}\sum_{l=2}^{K} \beta_{kl} \ln x^{*}_{kit} \ln x^{*}_{lit} + \sum_{k=2}^{K}\sum_{m=1}^{M} \gamma_{km} \ln x^{*}_{kit} \ln y_{mit} + $$
$$+ \delta_t t + \frac{1}{2}\delta_{tt} t^2 + \sum_{m=1}^{M} \alpha_{mt} t \ln y_{mit} + \sum_{k=2}^{K} \beta_{kt} t \ln x^{*}_{kit} + \mu_i - \eta_i - u_{it} + v_{it} \tag{1}$$

where: i, with $i = 1, 2,\dots,N$ – the i^{th} producer; t, with $t = 1, 2,\dots,T$ – time (year); y – a $[Mx1]$ vector of outputs; x – $[Kx1]$ vector of inputs; $x^{*}_{kit} = \frac{x_{kit}}{x_{1it}}$; α, β, γ and δ – vectors of parameters; μ_i – firm-specific time-invariant latent heterogeneity; η_i – persistent technical inefficiency; u_{it} – time-varying – transient technical inefficiency; v_{it} – stochastic error term; $\eta_i + u_{it}$ – overall technical inefficiency.

We impose following distributional assumption on the four error terms: $\mu_i \sim N\left(0,\sigma^2_\mu\right)$, $\eta_i \sim N^{+}\left(0,\sigma^2_\eta\right)$, $u_{it} \sim N^{+}\left(0,\sigma^2_u\right)$ and $v_{it} \sim N\left(0,\sigma^2_v\right)$. Moreover, we assume that the error terms are independently distributed to each other.

We apply the 4-step procedure to get feasible and consistent estimates of technology and components of the error term. This procedure is an extension of the heteroskedastic four-component stochastic frontier (SF) model formulation proposed by Kumbhakar et al. (2012) that captures all necessary error term components but does not address the endogeneity problem. We follow Bokusheva and Cechura (2017) who use system generalised method of moments (GMM) estimator (Arellano and Bover 1995) to get unbiased parameters estimate in the first step. Then, in the second step, the residuals from GMM level equations are employed in the estimate of the SF random effects model using the Generalised Least Squares (GLS) estimator. The next steps provide the estimates of transient, persistent and heterogeneity component.

The system GMM estimates a model in both differences and levels. The method uses two types of instruments: the level instruments for the differenced equations and the lagged differences for the equations in levels (Arellano and Bover 1995) and, thus, makes it more robust to address the problem of weak instruments.

Total factor productivity (TFP) is calculated in the form of Törnqvist-Theil index which represents the ratio of the revenue share weighted geometric mean of individual outputs to the cost-share weighted geometric mean of individual inputs. We use the extended version of Caves et al. (1982) allowing for multilateral comparisons. Moreover, we decompose TFP into a scale effect, a technical efficiency effect and a technological change effect.

$$\underset{}{\ln TFP_{it}} = \underbrace{\ln \iota_{it}}_{SE} + \underbrace{\ln \upsilon_{it}}_{TE} + \underbrace{\ln \tau_{it}}_{TCH} \tag{2}$$

Scale effect (SE) captures influences resulting from changes in the intensity of factor use with respect to the optimal size representing the scale of operations at maximum of inputs productivities in Equation (3).

Technical efficiency (TE) effect captures changes in efficiency of input use. In particular, technical efficiency indicates how efficiently farms use their resources given the existing technology.

$$\ln \upsilon_{it} = \ln TE_{it} - \ln\overline{TE_{it}} \tag{4}$$

where: $TE_{it} = \exp(-u_{it})$ – transient technical efficiency.

The technological change (TCH) tells us about how innovative activities have changed the production process, and provides information on whether the sector has entered a development path leading to long-term growth.

$$\ln \tau_{it} = \phi_t - \overline{\phi_t} \tag{5}$$

where: the technical change – $\phi_t = -\frac{\partial \ln D_I\left(y_{it}, x^{*}_{it}, t; \alpha, \beta, \gamma\right)}{\partial t}$.

Data. We use farm level data from Farm Accountancy Data Network (FADN) and cover the period

$$\ln \iota_{it} = \frac{1}{2}\sum_{m=1}^{M}\left[\left(\zeta_{it,m} + \overline{\zeta}_m\right)\left(\ln y_{it,m} - \overline{\ln y_m}\right) + \overline{\zeta}_m \overline{\ln y_m} - \overline{\zeta_{it,m} \ln y_{it,m}}\right] \tag{3}$$

where: $\zeta_{it,m} = \left(1 - RTS^{-1}\right)\frac{\partial \ln D_I\left(y_{it}, x^{*}_{it}, t; \alpha, \beta, \gamma\right)}{\partial \ln y_{it,m}}$; return to scale ($RTS$) – $RTS^{-1} = \sum_{m=11}^{M} -\frac{\partial \ln D_I\left(y_{it}, x^{*}_{it}, t; \alpha, \beta, \gamma\right)}{\partial t}$.

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2004–2017. The access to the data was provided by European Commission – Directorate-General for Agriculture and Rural Development (EC DG AGRI). The use of FADN has one important consequence that needs to be kept in mind when interpreting our results: FADN data concentrates on farms that can be considered commercial ones, thus smaller, not viable farms are underrepresented, or not represented at all (EC 2021). Since our analysis is focused on TFP dynamics in cereal production, we applied the cereal specialisation criterion; that is, we retained in our panel data set only farms with 30% or more cereal output in total farm output. However, for Slovenia we could not use such a threshold due to the much lower number of observations. As a result, the sampled farms in the Czech Republic, Hungary, and Poland show much higher dependence on cereal production compared to the Slovenian farms. Moreover, we use in the model estimate only farms with 5 and more consecutive observations to comply with the requirements of system GMM estimator.

Outputs and inputs variables in IDF are defined as follows. *Cereals output* represents the value of the total cereal output; *other crops output* is the difference between the value of total crops output minus cereals output; and *other farm output* is the difference between the value of farm total output and the value of total crops output. *Land* is expressed in hectares of farm utilised agricultural area (UAA); *capital* is represented by capital depreciation and contract work; *labour* is measured in annual working unit (AWU, where one AWU represents 1 800 working hours per year); and *materials* is defined as total intermediate consumption. The price indices for crop output and agricultural goods output (Eurostat 2019; 2010 = 100) were used to deflate output variables. The price index for machinery and other equipment was used to adjust the capital inputs and the price index for goods and services currently consumed in agriculture was employed to deflate materials (Eurostat 2019; 2010 = 100). The output and input variables were logarithmically transformed and normalised by their mean (i.e. the estimated first order parameters represent the elasticities with respect to single outputs and inputs, evaluated on the sample mean). Summary statistics of output and input variables are provided in Table S1 (Electronic Supplementary Material – ESM). Moreover, we used the dummy variable for less favoured area (LFA) and year dummy variables in the body of input distance functions except for Slovenia. Year dummy variables (Year 2008 and Year 2009) aim to filter out, at least partly, the negative effects of financial crises on the market environment. Finally, lagged outputs and inputs variables were used as internal instruments and output/input indices, contract use share, cereal yield, arable land, seed expenses, year dummy variables, total subsidies per hectare and economic size as additional instruments. The correct selection of instruments was tested using Hansen (1982) J test.

RESULTS

Trends in total factor productivity (TFP). Figure 1 demonstrates the production structures in selected NMS-4 countries using the shadow output shares that are calculated as negative values of the first order derivatives with respect to particular output and are evaluated assuming constant returns to scale (that is, each output elasticity is normalised by the country estimate of economies of scale). Parameter estimates of country IDFs are provided in Table S2 (ESM). The average share of cereal output in total farm output in the Czech Republic, Hungary, and Poland accounts for about 55%. While the rate of specialisation in cereal production is comparable in these countries, the Czech Republic and Hungary show higher overall orientation on another crop production as compared to Poland. Slovenia has a different structure with low share of cereal output, but higher dependence on other crop outputs and other farm outputs.

The analysed countries also differ with respect to farm-size distribution. Poland and Slovenia generally have

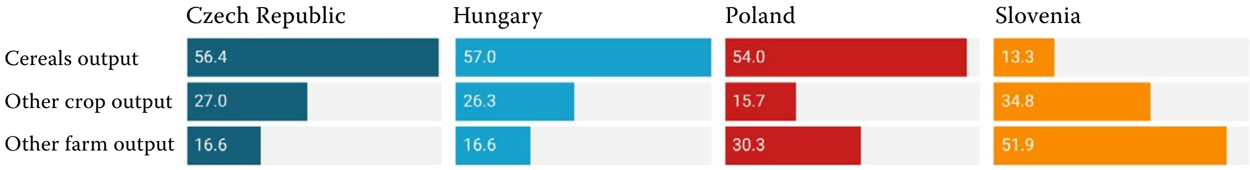

Figure 1. Production structure in NMS-4 (the Czech Republic, Hungary, Poland, and Slovenia), the average for the period 2004–2017

Source: Authors' estimates

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smaller farms. Hungary and the Czech Republic, in contrast, have a dual farm-size structure of many small-size family farms and fewer large-size commercial farms. In the Czech Republic, however, the discrepancies between small and large farms are much more pronounced than in Hungary. These differences are clearly visible in the average farm size for each country. In our FADN sample, the average Czech cereal farm cultivates 675 ha, the average Hungarian cereal farm cultivates 398 ha, whereas the average cereal farm in Poland and Slovenia cultivates 50 ha and 21.5 ha, respectively. With this information at hand, we now move to our TFP estimates.

Our findings are summarised in Figure 2, which shows the estimated trends in the distribution of TFP over time and across countries as compared to those in 2004. The first thing to observe is that the pattern for the Czech Republic and Hungary is broadly the same, whereas Poland and Slovenia each display a different path. The second thing to observe is that, in contrast to the Czech Republic, Hungary, and Poland, the estimates for Slovenia, not counting the first year, are consistently below 1. This suggests that while in the other three countries TFP on average improved during the period under analysis, in Slovenia it declined, on average. Some authors link the latter finding to the fact that in case of Slovenian farms the level of TFP was largely unaffected by CAP subsidies (Baráth et al. 2020). According to this explanation, this is due to an increasing role of less favoured area (LFA) and agri-environmental (AE) subsidies which do not have significant effect on TFP and its components. The fact that Slovenia is the only country of the four considered to have adopted Euro may also play a role. While our estimates for the Czech Republic, Hungary and Poland do include time dummy variables to control for financial crisis and its potential impact on local currencies, one may wonder whether this crude approach can fully take into account the effect that movements in exchange rates might have had on the value of agricultural output (expressed in EUR) at that time. In addition, the previously mentioned differences in production structures between Slovenia and the other three countries should also be kept in mind here. The third thing to observe is that overall changes in TFP over the thirteen years under study were fairly low in all countries. Fourth, these overall changes mask important dynamics that took place in-between those years. For the Czech Republic and Hungary, in the first five/six years we observed a quite substantial increase in TFP, which was then followed by almost equally spectacular decline. This development pattern was driven mainly by the technological improvements in the first half of the studied period and by both technological regress and changes in the scale of operations in the second

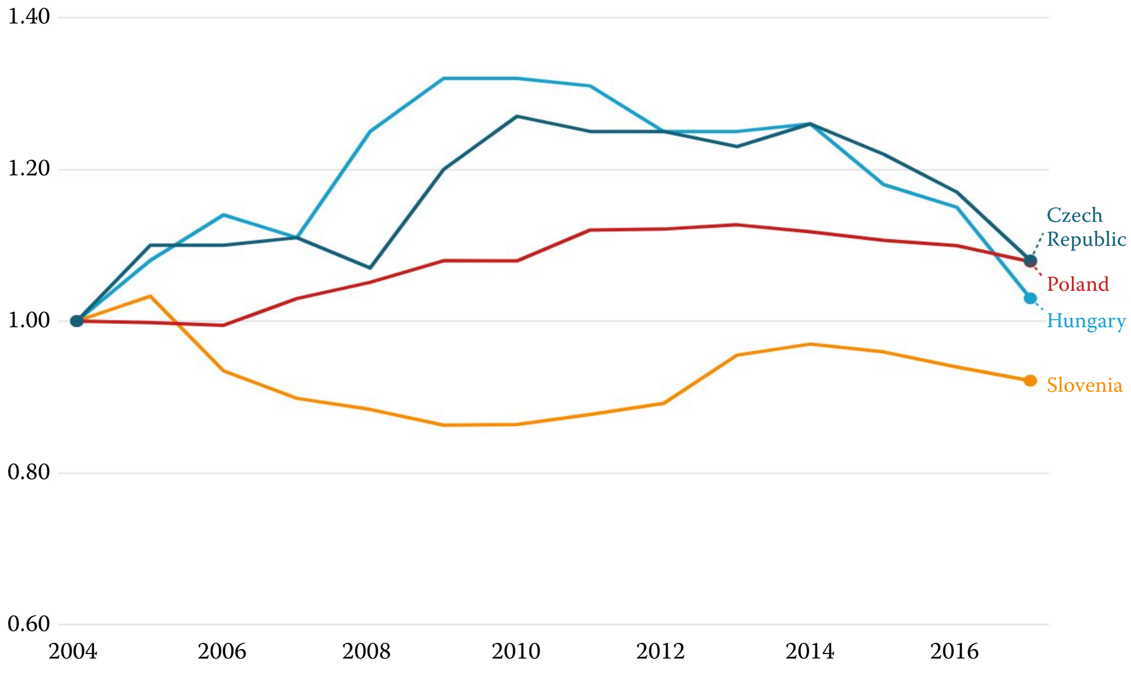

Figure 2. Evolution of total factor productivity (2004 = 1)

Source: Authors' estimates

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half. In the case of Poland, the initial increase was more modest, and the later decline was even milder. In this case technological changes seem to be the main driver of TFP dynamics (see below). Finally, for Slovenia TFP initially declined, but later on started to slowly make up for these losses. As opposed to other countries changes in Slovenian TFP were mainly driven by the changes in the scale of operation of the local farmers.

In order to bring additional insights on these findings, below we look at the changes in the subsequent components of TFP. This allows us to highlight the key factors behind the developments depicted on Figure 2. Our focus is on: scale efficiency (which refers to whether or not farms are able to achieve optimal size), technical efficiency (which refers to the efficiency with which technologies are used, in particularly, it gives evidence about the efficiency of input use), and technological change (which refers to whether or not farms take advantage of technological improvements).

Trends in scale efficiency. Figure 3 shows that the last two decades have been characterised by an overall decline in scale efficiency in all countries under study. This implies that over time farmers faced increasing difficulties in finding the optimal size for their operation. The largest decline was observed for the Czech and Hungarian cereals farms – i.e. in the two countries with dual farm size distribution. Further, for both these countries this trend was very persistent over time. A different picture may be observed for Poland and Slovenia. While in both countries there was an initial decline in scale efficiency, in the case of Slovenia the trend reversed after five or six years, whereas in Poland it stabilised. In the case of the former country, both the initial decline and the later reversal were relatively steep. It might be also noted that the rapid increase in scale efficiency in Slovenia after 2009 correspond with an increase in overall TFP (Figure 2). This in turn suggests that improvements in the scale of operations might be perceived as the main source of growth of Slovenian TFP in this period. One way to account for the diverging patterns in scale efficiency between the analysed countries could be as follows. The initial decline was likely to be driven by the effect of CAP direct payments that took place right after EU accession. In that period small- and medium-sized farms kept on cultivating land to receive such subsidies which prevented land reallocation to potentially more efficient users. This changed after a few years once these farms, especially medium-sized ones, started to exit the sector, not being able to remain viable even with these subsidies. This led to an increase in the number of larger-size farms, and consequently to improvements in scale efficiency (Bojnec and Latruffe 2013). Another important factor that likely contributed to the scale efficiency dynamics was the change in farm production structures. More specifically, in all the NMS-4 there was a shift from livestock production to crop production,

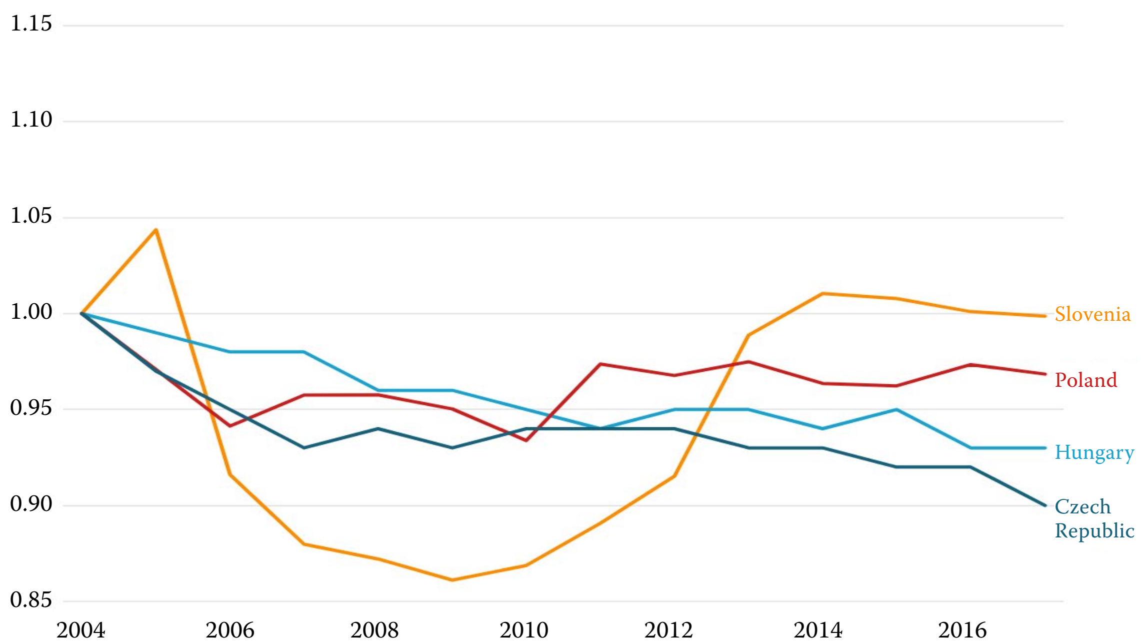

Figure 3. Evolution of scale efficiency (2004 = 1)

Source: Authors' estimates

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with the latter being much more extensive than the former. Put differently, the output per unit of production in livestock sector is larger than in crop sector. The shift from livestock to crop production therefore resulted in a decreasing scale efficiency. While this had a negative effect on scale efficiency for cereal farms in all countries, it seems to hold true especially for the Czech Republic and Hungary (recall the statistics presented in Figure 1).

Trends in technical efficiency. In the next step, we examine trends in the changes in the efficiency with which farmers use their production inputs (as measured by technical efficiency). This allows us to elaborate on the improvements in TFP originating from the elimination of redundancies in input use. This part of the analysis is undertaken only for the Czech Republic, Hungary, and Poland, as for Slovenia we did not obtain significant technical efficiency estimates. The relevant patterns are depicted in Figure 4. For Poland we observe only marginal changes in this component of TFP. This is largely due to the fact that Poland exhibited the highest initial level of technical efficiency (94.5%, with 100% representing the technological potential of inputs use). Consequently, in this case there was relatively little scope for further improvements in this regard. This allows us to conclude that changes in transient technical efficiency were rather unlikely to contribute to TFP development on Polish cereal-producing farms. As regards Hungary, a rather stochastic development in technical efficiency can be observed. Importantly, however, the level of technical efficiency in 2017 was very similar to the initial level. Given the fact that at the beginning of our period Hungarian farmers operated at 85% of technological potential these findings indicate prevailing obstacles in the farms' ability to produce a given level of outputs from a minimum set of inputs. Overall changes in technical efficiency are visible only for the Czech Republic. In this case, we observe a quite rapid increase in the first years following EU accession, and stabilisation afterwards. The reason behind these changes might be a considerable low initial level of technical efficiency (77%). When collated with the pattern depicted in Figure 2, the trend in technical efficiency suggests that the improvements in technical efficiency may be seen as a significant and positive source of Czech TFP growth between 2004 and 2010. This might be also related to the evolution of Czech technological component (Figure 5) indicating the efficiency catch-up through the fast speed and broad extent of innovation diffusion.

Trends in technological change. In the last step, we look at the evolution of the remaining TFP component – i.e. technological change, which can be understood as improvements in productivity driven by advances in technology, learning by doing and the organisation in production. Our estimates for all four countries are presented in Figure 5. The first thing

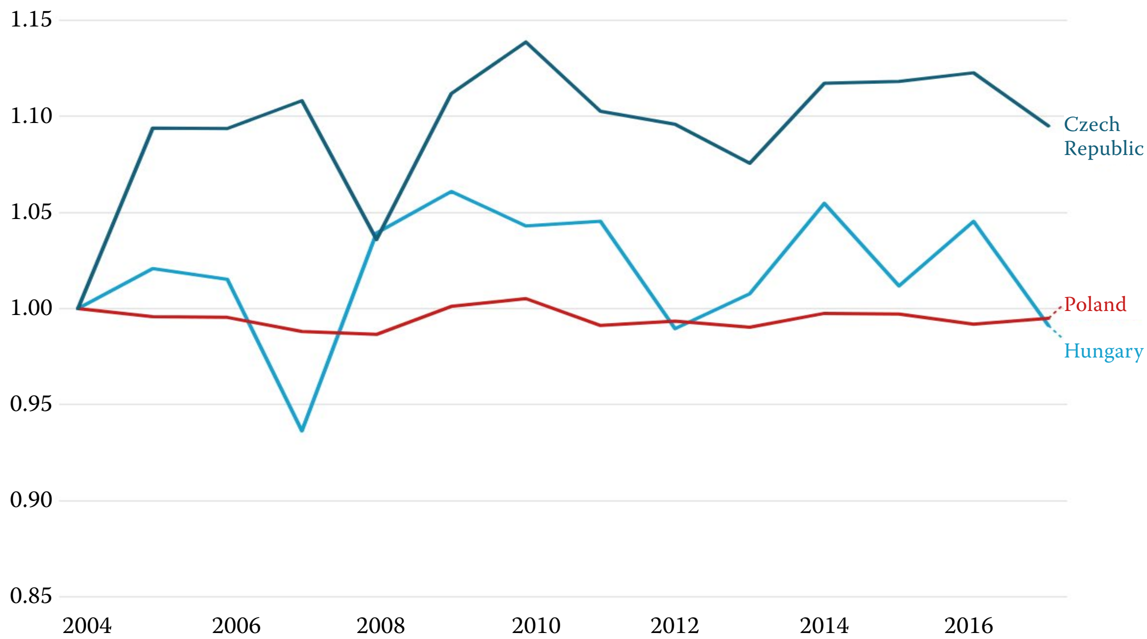

Figure 4. Evolution of technical efficiency (2004 = 1)

Source: Authors' estimates

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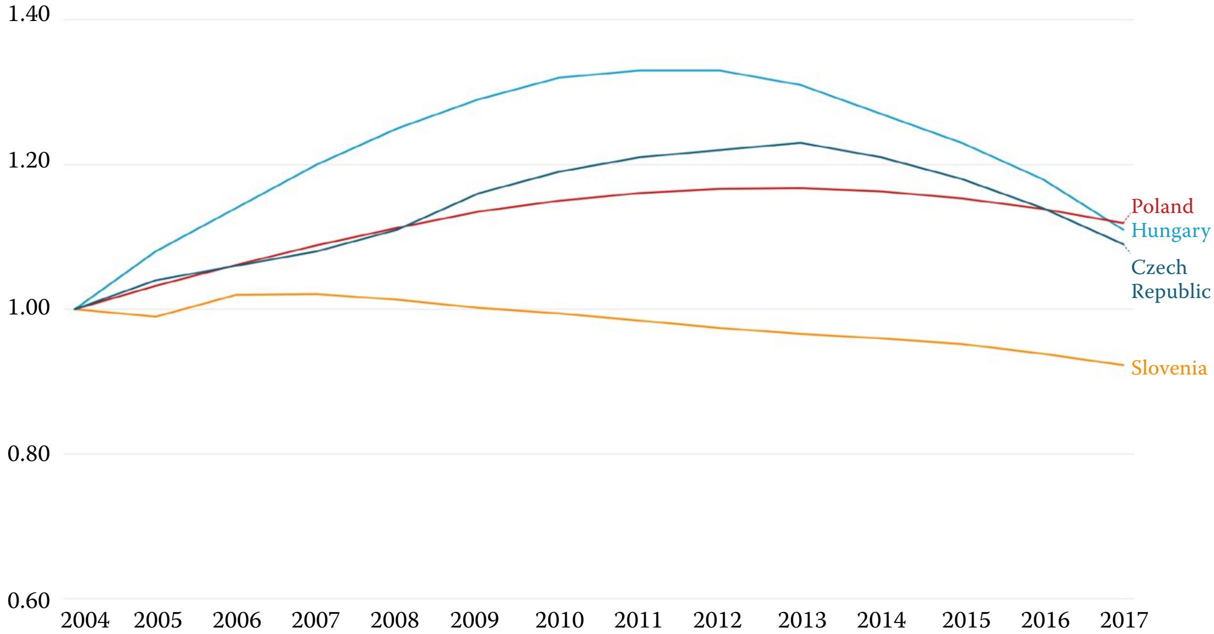

Figure 5. Evolution of technological change (2004 = 1)

Source: Authors' estimates

to observe is that the Czech Republic, Hungary, and Poland display a similar inverse-U shaped pattern. Interestingly, even though each country has its own parabola (the highest for Hungary and the lowest for Poland) they finish with a very similar score in 2017. Most importantly, in all these countries we observe an overall increase in technological change in the period under study. Furthermore, the pattern that is observable for technological change is very similar to those patterns observed earlier for TFP, which allows one to assume that they are associated. Slovenia, however, clearly stands out from the other countries. Except for the three starting years, the country experienced a modest but constant decline in technological change.

The initial strong positive technological change in the first half of the analysed period is likely to be related to considerable increases in subsidies that each of the NMS-4 experienced after being embraced by the CAP. This interpretation is supported by an extensive literature arguing that subsidies (especially those introduced as single area payment scheme) mitigate or remove financial constraints and allow farmers to invest into the new technologies (see Minviel and Latruffe 2017 for the review of the relevant literature). Support for this claim can be found in the development of the average depreciation cost in the farm sample that can be used for renewal investment in new technologies. As regards the decline in technological change in the second half of the period under study, this can potentially be linked to less on-farm investment and the fact that farms more and more commonly undertook different kinds of innovation activities, including eco-innovation and those aiming at increasing agri-environmental outputs in line with the overall changes in CAP which puts an increasing emphasis on environmental outputs. The change in farm production structures, as described earlier, might have also contributed to this state of affairs.

DISCUSSION

Farm structure heterogeneity and subsidies. The NMS-4 display a number of similarities and differences in terms of cereal farm efficiency: the Czech Republic, Hungary, and Poland display similar trends in overall TFP, as well as in the TFP components: technological change, and, to a lesser extent, scale efficiency. The three countries differ in terms of the dynamics of technical efficiency. A different path (both in TFP and its subcomponents) was recorded for Slovenia. What needs to be emphasised, however, is that this difference could be driven, at least to some extent, by the fact that while in the former three countries our focus was on farms specialising in cereal production, in the case of Slovenia our sample was more diversified with a greater role of farms combining cereal

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production with other outputs. The fact that Slovenia is characterised by the most fragmented farm structure could have also played a role, as farm size directly affects the scale efficiency and potential benefits that farmers can achieve thanks to technological improvements. The relative similarities between the Czech Republic, Hungary, and Poland show, however, that heterogenous farm structures do not automatically imply different patterns of farm productivity. It also might be of interest from a policy making perspective. This is because it is typically assumed that farm structure will greatly affect changes in TFP.

As far as the dynamics of TFP is concerned, our results are partially in line with the findings of Bokusheva and Cechura (2017), who analysed the period between 2004 and 2007 and found TFP improvements for Czech and Polish farms. Their estimates for Hungary, however, contrast with ours. The difference might be caused by our focus on farms with cereal specialisation. On the other hand, the results are in line with findings by Baráth and Fertő (2017), who found a considerable increase in TFP for EU NMSs between the years 2004 and 2013. Further analysis is required to fully understand where do the (dis)similarities come from.

One potential direction in which one may wish to extend the presented results is to delve more deeply into the role of different types of CAP subsidies. The literature provides mixed results and findings on the relationship between subsidies and farm technical efficiency (Minviel and Latruffe 2017) and TFP (Baráth et al. 2020). The evidence shows that the association between TFP and different types of subsidies can vary between countries and over time. On the one hand, subsidies may negatively impact farm TFP by causing allocative and technical inefficiency or soft-budget constraints (Kornai 1986). On the other hand, subsidies are reported to improve farms' access to innovative technologies and speed up technological change (Bezlepkina et al. 2005). The overall effect is due to a combination of these channels.

CONCLUSION

Our results suggest that – at least in the early years – NMS-4 countries exploited the opportunities of EU accession and improved their cereal farm TFP through intensifying technological change. It seems however, that this effect was only short-term and did not bring a persistent shift in TFP growth. Some authors link this to the potentially negative impact of CAP subsidies on TFP. The extent to which this could have been indeed the case seems to provide a fruitful avenue for further research. In this context it might be noted that the impact of subsidies on TFP can also be importantly related to the changes in CAP and the support it offers. The continuous greening of the policy with an increasing emphasis placed on the adoption of green farming practices may tend to reduce TFP when only the economic dimension of the production is considered. However, the picture of TFP dynamics might be different when the environmental dimension is included. Achieving a better understanding of these issues provides an important research area for subsequent work. Having a closer look at upstream and downstream sector market instabilities could also be informative for this debate. Last but not least, re-examining the existing analyses with different approaches to control for output price volatilities and movements in exchange rates offers an additional potential area for research in future.

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