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RESEARCH ARTICLE

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Accession impact and outlook for Croatian and EU crop and livestock markets

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Abstract

Aim of study: To investigate the impact of Croatia's accession to the EU on its agricultural sector, its market outlook and the EU's key agricultural products up to 2030.

Area of study: Croatia and European Union member states

Material and methods: Comparative approach was used in order to identify similarities of the changes that took place when other Central and Eastern European Countries (CEEC) acceded to the EU (results of previously conducted research) with the changes that happened in Croatia (historical data between 2010 and 2016). The second approach involved the AGMEMOD partial equilibrium model, which has been used as a comprehensive tool to model the complex outlook of Croatian agricultural markets. The results of the Croatian outlook were compared to the EU's AGMEMOD outlook results in order to identify future trends in key agricultural market development (production, yield and net trade) and whether these newly established trends were comparable with EU trends.

Main results: The changes that took place in the Croatian agricultural sector during and after the EU accession period are not significantly different from the trends and changes observed in other Central and Eastern EU member states. Similarities can especially be found in neighbouring CEEC countries (Hungary and Slovenia), which kept their producer prices close to EU levels prior to accession. Furthermore, the results indicate a similarity with CEEC trends in terms of the strengthening of crop production compared to livestock.

Research highlights: Positive effects of EU integration on the Croatian agricultural sector took place after a few years of adjustment. Simulations of future market developments indicate many similarities between Croatia and EU 13 member states.

Additional key words: agricultural market outlook; Croatia; European Union; partial equilibrium model.

Abbreviations used: AGMEMOD (Agriculture Member State Modelling); CAP (Common Agricultural Policy); CEEC (Central and Eastern European Countries); CGE (Computable General Equilibrium); EU (European Union); GDP (Gross Domestic Product); GVA (Gross Value Added); PE (Partial Equilibrium); SPS (Single Payment Scheme)

Authors' contributions: DK: data collection, statistical analysis and drafting of the manuscript. KZ: technical control and supervision of study. IG: data collection and supervision of study. PS: statistical analysis and supervision of study. EE: coordination of manuscript structure and critical revision of the manuscript.

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Introduction

Since their accession to the European Union (EU), the agricultural sectors of EU member states from Central and Eastern European countries (CEEC) have lagged behind in productivity, with lower prices and levels of support and dual farm structures (Swinnen & Vranken, 2009). Since joining the EU, the productivity lag of the CEEC has decreased compared to the old member states (EU-15), but has remained notable. The accession of the CEEC to the EU has boosted the growth of agricultural production, but it has also changed the structure of production (Csaki & Jambor,

2013), resulting in a decrease in the value of livestock production in relation to crop production.

Croatia is the last country of the CEEC that joined the EU, on July 1st, 2013. Its agricultural sector is characterized by features similar to those of most post-communist member states: dual farm structure, consisting of large economic entities (agri-complexes) and a high share of small family farms with low production capacities and productivity levels. The accession to the EU significantly changed the economic environment for the agricultural sectors in the CEEC (Erjavec *et al*., 2006). The economic conditions of the single market, adoption of the common agricultural policy's (CAP) mechanisms and the convergence of domestic prices are a result of the integration processes that significantly affected the agricultural sector.

The effects of market integration and the changes in policy instruments in agricultural markets can be successfully analysed using partial equilibrium (PE) and computable general equilibrium (CGE) models (Van Tongeren *et al*., 2001; Domínguez *et al*., 2008). CGE models provide a general picture of national economies, with the specification of trade relations between economies as well as the interaction between different sectors of the observed economy, assessing the role and importance of agriculture in the overall economy, with few details about the sector itself. PE models, on the other hand, place greater emphasis on sector analysis, providing observations of the entire agricultural sector with multiple activity levels, with more details on production and the policy instruments involved (Salvatici *et al*., 2001).

The results of previous studies on the impact of EU accession on CEEC agricultural sectors using PE (Czapla *et al*., 2002; Banse, 2003; Erjavec *et al*., 2006) and CGE models (Jensen *et al*., 1998; Jensen & Frandsen, 2004) indicate a positive effect of the accession in terms of the growth in the volume of agricultural production due to increased market prices, the introduction of direct payments and a significant increase in farm investment support. The results of the simulations conducted by economic models showed certain changes in production structure related to a stronger growth of the crop sector compared to the livestock and dairy sectors.

Csaki & Jambor (2009) confirmed the simulations conducted by economic models in their research, where the results, which were based on data collected after the accession of CEEC to the EU, indicate that the livestock and dairy sectors recorded weak growth or stagnation. Several countries are an exception to this, showing a recorded growth of production in the pork and poultry sectors, such as Poland, the Czech Republic and Lithuania. By contrast, the accession to the EU had a mostly positive impact on the crop sectors in most CEEC. Research conducted on the same topic ten years after CEECs joined the EU confirms the aforementioned changes in the structure of agricultural production and trends in CEEC (Csaki & Jambor, 2013).

During the pre-accession period and following Croatia's accession to the EU, significant changes in agricultural markets were recorded as a result of changes in the economic environment (Franić & Ljubaj, 2015; Zrakić, 2016). Since gaining independence in 1990, Croatian agricultural policy can be divided into three stages. In the 1990s up to 2000, agricultural policy measures were focused primary on the reconstruction of production facilities in specific areas devastated by war, along with establishing strong market price support-based trade protection measures. The second stage in the 2000s was marked by a rapid and strong increase of budgetary transfers based on coupled direct payments to various agricultural sectors. The last stage, between 2010 and accession in 2013, an intensive CAP harmonization period began with the introduction of decoupled payments with strong historical components and a significantly shorter list of coupled direct payments.

The impact of accession on Croatia's agricultural sector was analyzed using PE and CGE models before and after accession (Lejour *et al*., 2009; Witzke *et al*., 2009; Boulanger *et al*., 2013; Phillipidis *et al*., 2015). The main findings of these studies indicate that Croatia's accession to the EU will generally have a positive impact on the agricultural sector in a few years. However, the results also suggest that a stronger growth of crop production is expected in relation to livestock production, whereas a decline in production or stagnation is expected in certain livestock sectors.

The aim of the paper was therefore to: I) define the changes in the agricultural sector following Croatia's accession by analyzing historical data between 2010 and 2016, identify whether they are similar/they correspond to the projections of previously conducted research and whether the changes that took place when other CEEC acceded to the EU are similar to the Croatian case; II) analyse and compare the outlook (by 2030) for key Croatian agricultural markets with that of other CEEC countries generated by the AGMEMOD PE model, and compare the results with EU projections (EC, 2018). To validate the results of the simulation, the outlook for Croatia was presented to domestic market experts.

Macroeconomic indicators, prices and agricultural policy measures of the Croatian agricultural sector before and after EU accession in 2013

The share of agriculture in Croatia's gross domestic product (GDP) has constantly been decreasing since

2005. The value of the total agricultural output first declined after accession to the EU and began to recover in 2015 as a result of the stronger growth of crop production, while livestock production has continued to decline slightly, as presented in Table 1. This corresponds with the trend that occurred in CEEC after accession; after the structural break that saw a decline in CEEC agricultural production, crop production and, to a lesser extent, livestock production, increased (Erjavec *et al*., 2006). In Croatia's near future, the volume of agricultural production is expected to increase, with a stronger growth in crop production, while some livestock sectors will also begin to recover.

Prior to the last phase of the EU accession process (2008-2010), most producer prices of key agricultural products in Croatia were on average higher (10-12%) than EU-27 average producer prices, except for oilseeds and cow's milk, which were just below EU-27 average producer prices (Fig. 1). After the period of intensive CAP harmonization began in 2010, Croatian domestic producer prices started to drop, especially in grain markets (10-12% below EU average producer prices)

Table 1. Macroeconomic indicators of Croatian agriculture before and after EU accession (on 2013)

	2005	2010	2011	2012	2013	2014	2015	2016	Change '05-'10	Change '10-'16
Share of agriculture in GDP (%)	4.3%	4.2%	4.0%	3.8%	3.7%	3.5%	3.5%	3.5%	-2.38%	-16.67%
GVA (million EUR (nominal)	1116.48	1327.66	1283.38	1172.74	1014.30	798.35	896.49	969.68	15.91%	-36.92%
Index of agricultural output in real value 2005 = (100)	100	114.66	114.78	112.48	97.91	83.09	85.18	88.24	12.79%	-29.94%
Share of crop output	55.67%	62.10%	61.74%	63.52%	63.35%	59.78%	61.30%	62.99%	10.35%	1.42%
Coverage of import by export	56.93%	62.50%	60.18%	62.91%	57.87%	56.86%	61.02%	62.50%	8.91%	0.00%
Average farm size (ha)	4.60	5.65	5.87	6.40	6.70	7.45	8.33	9.18	22.83%	62.48%
Number of large farms (> 100 ha)	580	850	911	1045	1098	1275	1436	1624	46.55%	91.06%

GDP: gross domestic product. GVA: gross value added. *Source:* Authors' calculations based on available data from the Croatian Bureau of Statistics (CBS, 2016)

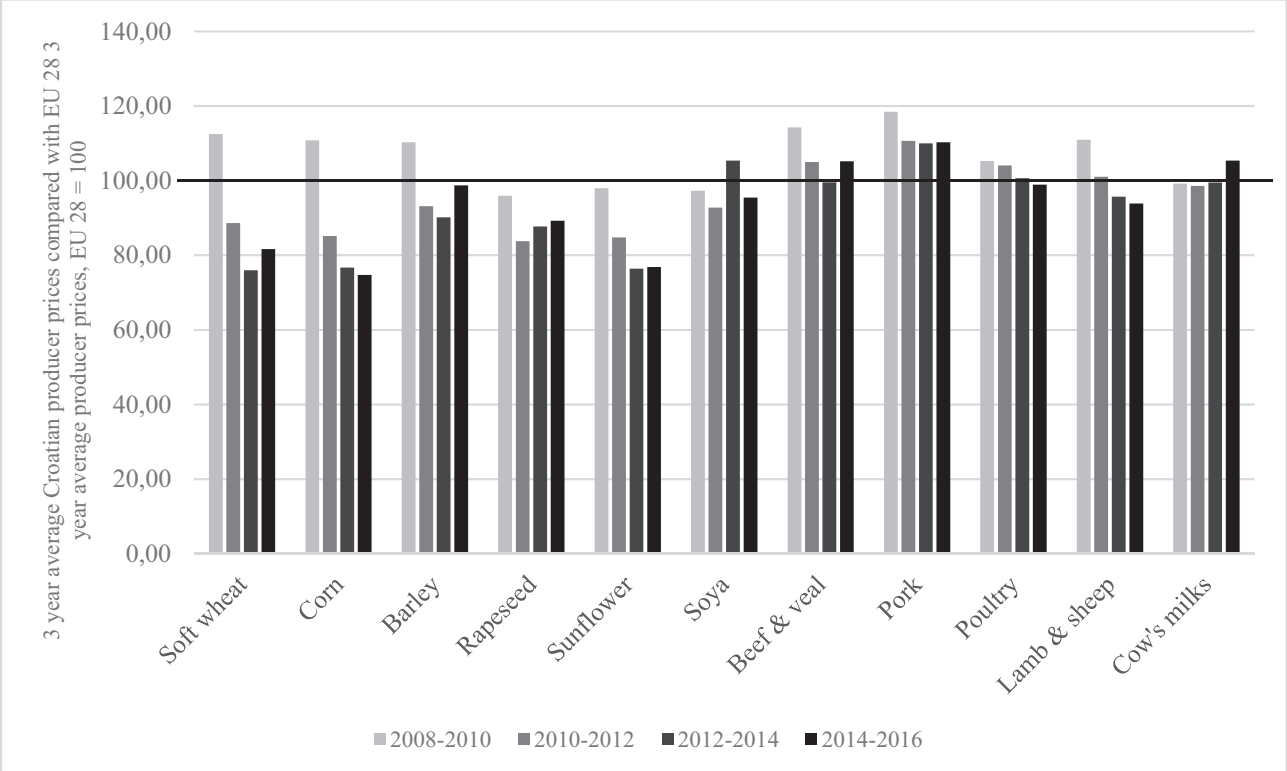

Figure 1. Comparison of Croatian 3-year average producer prices with EU-28 3-year average producer prices, for the period 2008-2016. EU-28 average producer price = 100. *Source*: Authors' calculations based on available OECD statistics (OECD, 2016) and data from the Croatian Bureau of Statistics (CBS, 2016)

and to a lesser extent in livestock markets, where domestic prices were approximately 5% higher compared to EU-27 average producer prices. After joining the EU, Croatian crop prices remained 10-20% below average EU-28 producer prices, while the prices of beef and veal, pork and cow's milk remained approximately 5-6% higher than EU-28 prices.

These price developments prior to and after the accession show that Croatia was somewhat different in terms of price levels than most CEEC countries during their accession period. In most other CEECs, crop and livestock prices in the pre-accession period were 10-20% and 20-35%, respectively, below average EU producer price levels. After accession, quick adjustment took place. Only Hungary, Romania and Slovenia kept prices close to EU levels and this led to minimal price adjustment for producers (Csaki & Jambor, 2009), which is similar to Croatia's case.

Before Croatia joined the EU (Table 2), agricultural support was strong. A large share of this support was related to producer support in the form of coupled direct payments (such as CAP 1st Pillar measures), while rural development (such as CAP 2nd Pillar measures) received less support. Since its accession, Croatia has applied a regional model of direct payments, the Single Payment Scheme (SPS), with a strong historical component.

The production focus of the current distribution of envelope for direct payments is presented in Table 3. In addition to payments under the CAP, in accordance with the Accession Treaty, farmers receive state aids, which are not part of the CAP, for a period of three years after accession, in the total annual amount up to 22.3 million EUR. State aids are payments in highly sensitive sectors for olives, olive oil, tobacco, dairy cows and breeding sows. The current amounts and distribution of envelopes provide stronger financial support for crop production as compared to livestock production.

Material and methods

The AGMEMOD (Agriculture Member State Modelling) model is an econometric, dynamic, multiproduct, multi-country partial equilibrium (PE) model. The main purpose of the model is to produce medium-term projections or market outlooks for key agricultural products by 2030. The modelling strategy uses the *bottom-up* approach, based on country-level models, using a common country model template, which are combined into a composite EU model (Chantreuil *et al*., 2012). The Member State model is composed of commodity market sub-models (for grains: soft and durum wheat, barley and corn; for oilseeds: rapeseed, soybean and sunflower; for livestock and meat: cattle, beef, pigs, pork, poultry, sheep and mutton; and for milk and dairy products: cheese, butter, whole milk

Table 2. Allocations for agricultural policy measures (divided as CAP 1st and 2nd Pillar) in total before and after Croatia's EU accession (2005 = 100)

		2005(1)	2010	2016	Change '05-'10	Change '10-'16
Market and direct producer support measures	million EUR	305.4	387.4	423.4	+26.85%	+9.29%
	2005=(100)	100	126.85	138.64		
Structural and rural development measures	million EUR	20.05	110.5	216.0	+451.12%	+95.48%
	2005=(100)	100	551.12	1002.49		

(1) Author's own assessment based on publicly available data and internal documents of the Ministry of Agriculture. *Source:* Ministry of Agriculture (2018).

Table 3. Distribution of financial envelope for direct payments in measures in 2016 for Croatia

Measure or priority	Direct payment measures	
	million EUR	%
Basic payment	185.942	43.00
Green payment	129.728	30.00
Redistributive payment	43.243	10.00
Young farmers	8.649	2.00
Voluntary coupled supports (milking cows, beef fattening, suckler cows, sheep and goats, vegetables, fruit, sugar beets and protein crops)	64.863	15.00
Total	423.425	100

Source: Ministry of Agriculture (2018)

powder and skimmed milk powder), where each commodity market is based on annual time-series data. In the case of Croatia, the data range from 1995 to 2016 and are compiled mainly from national sources (CBS, 2016; Ministry of Agriculture, 2018). The database covers data on production, food and feed consumption, imports and exports in the form of market balance sheets.

Commodity markets are modelled as interrelated in such way that they reflect the competition between different products for resources, various interactions between crop and livestock markets, etc. Supply and demand, international trade and prices are endogenously determined in the commodity market sub-models (Chantreuil *et al*., 2012). Country-specific models demonstrate changes in the behaviour of economic stakeholders (producers and users), changes in exogenous data (macroeconomic variables, technical progress, policy instruments) and prices. Using sets of econometrically estimated equations, the model generates projections of endogenous variables from exogenous and endogenous data.

The policy-harmonized approach (Salputra *et al*., 2011) used in the model equations includes 2015-2020 CAP measures (SPS regional payments and coupled payments). Regional and coupled payments, as well as state aid payments for Croatia, are recalculated and included as policy price add-ons to the producer price for a specific commodity, in order to form the reaction price that affects production levels, areas harvested, average slaughter weights, and so on. Rural development support is not included in the model, because these types of models cannot include second pillar support. Examples of econometrically estimated equations used in commodity market sub-models of the AGMEMOD country-level models are presented in general terms.

Crop policy price add-on equation:

$$prc_{t,j} = ((cpm * cpt_{t,j} / \left(ah_{t-1,j}\right) + \\ + \left(rpm * rpt_t / \left(ah_{t-1,j}\right)\right) / \ yield_{t-1,j} \quad (1)$$

where *cpm* and *rpm* = multipliers of coupled and regional payments; *cpt* = ceiling for total coupled payments envelope for crop culture *j*; *rpt* = regional payments envelope; and *ah* = area harvested for crop culture *j*.

Livestock policy price add-on equation:

$$prc_{t,i} = (cpm * cpt_{t,i}) / cct_{t-1,i} + \\ + \left((rpm * rpt_t) / ah_{t-1}\right) / ltd_{t-1}) / slw_{t,i} \quad (2)$$

where *cpt* = in this case indicates ceiling for total coupled payments envelope of animals in group *i*; *cct* = number of animals in group *i*; *ltd* = average livestock density; and *slw* = average slaughter weight of animals in group *i.* The multipliers determine effects on the specific producer price where different effects of coupled (*cpm*) and decoupled regional payments (*rpm*) are taken into account. The multiplier coefficients present the share of particular support in reaction prices or expected gross margins. Coupled payments exert a greater influence, because they directly support specific commodities therefore multiplier coefficient for fully coupled production is set at 1.0, and for regional payments it is set at 0.3.

— Crop equation examples:

Land allocation for crop sub-models (grains and oilseeds) is determined in a two-step process. The first step implies that producers are expected to allocate their total land area to the culture groups (*i*) for grains and oilseeds. Then, in the second stage, the shares of the land areas allocated to grains and oilseeds are allocated to each culture *j* belonging to the corresponding culture group (*i*). Thus, the total area harvested equation for grains and oilseeds sub-models can be expressed as:

$$ah_{i,t} = f\left(p^j_{i,\ t-1}, + prc^j_{i,t-1}\right), ah_{l,t-1}, V) \\ j = 1,\ldots,\ n; \quad i,l = 1,\ldots,\ 3; \quad i \neq l \quad (3)$$

where *ah* = area harvested in year *t* for culture group *i*; *p* = real price in year *t*-1of culture *j* belonging to the culture group *i*; *prc* = change in price reaction in year *t*-1 of culture *j* that belongs to the group culture *i,* as on the principle of effective prices as Jongeneel (2003) proposed*; V* = vector, indicating an exogenous variable that can affect the harvested area groups and cultures.

To determine the share of the culture *k* belonging to the culture group *i* ($sh^k_{i,t}$), the following equation was used:

$$sh^k_{i,t} = f\left(p^j_{i,\ t-1}, sh^k_{i,t-1}\right) \qquad j,\ k = 1,\ldots,\ n \quad (4)$$

The equation for the yield of a particular culture *k* in the culture group *i* is expressed as:

$$r^k_{i,t} = f\left(p^j_{i,\ t-1}, + prc^j_{i,t-1}\right), r^k_{i,\ t-1},\ V) \qquad j,i = 1,\ldots,\ n \quad (5)$$

where *r* = yield per hectare of culture *k* that belongs to the culture group *i*; *p* = real price for the year *t*-1 of culture *j*; *prc* = price reaction change in year *t*-1 of culture *j* that belongs to the group culture *I; V* = vector, meaning an exogenous variable that can affect the yield of the culture *k.*

— Livestock equation examples:

The structure of the livestock and meat sub-model may vary, but its general structure is similar to crop

equations, therefore ending breeding numbers of animals can be expressed as:

$$cct_{i,t} = f\left(cct_{i,t-1}, \left(p_{i,t} + prc_{i,t}\right), V\right) \quad i = 1,\ldots, n \quad (6)$$

where *cct* = ending number in year *t* for breeding animal *i; p* = real price in year *t*-1 of the animal *i; prc* = price reaction change in year *t* of the animal *i* considered; *V* = vector, meaning an exogenous variable that can affect the ending numbers (*i.e*. specific national policy instruments).

The number of animals produced by the breeding animals can be expressed as:

$$spr_{i,t} = f\left(cct_{i,t-1}, ypa_{i,t}\right) \quad i = 1,\ldots, n \quad (7)$$

where *spr* = number of animals produced from breeding herd; *ypa* = yield per breeding animal concerned. Within each animal species *i* there may be *m* categories of slaughter *j*. The number of animals in animal species *i* that are slaughtered in slaughter category *j* can be expressed as:

$$ktt_{i,t}^{j} = f\left(cct_{i,t}^{j}, p_{i,t}, z_{i,t}^{j}, V\right) \quad i = 1,\ldots, n \quad j = 1,\ldots, m \quad (8)$$

where *ktt* = number of animals slaughtered in category *j* of animal species *i* in year *t*; *cct* = ending number of animals in year *t*; *p* = real price in year *t* of the animal *i*; *z* = endogenous variable that represents the share of different categories of animals slaughtered for the animal species concerned; *V* = vector of exogenous variables.

The average slaughter weight in animal species *i* can be expressed as:

$$slw_{i,t} = f\left(slw_{i,t-1}, z_{i,t}^{j}, \left(p_{i,t} + prc_{i,t}\right), V\right) \quad i = 1,\ldots, n \quad j = 1,\ldots, m \quad (9)$$

Total meat production from animal species *i* is derived as the product of the average slaughter weight, multiplied by the total slaughter in that culture, which can be expressed as:

$$ktt_{i,t} = \sum_{j} ktt_{i,t}^{j} \quad i = 1,\ldots, n \quad j = 1,\ldots, m \quad (10)$$

— Trade equation examples:

Imports (*Im*) and exports (*Ex*) equations both for crop and livestock commodities can be expressed as:

$$Im_{i,t}^{k} = f\left(PR_{i,t}^{k}, DU_{i,t}^{k}, Im_{i,t-1}^{k}\right) \quad (11)$$

$$Ex_{i,t}^{k} = f\left(PR_{i,t}^{k}, DU_{i,t}^{k}, Ex_{i,t-1}^{k}\right) \quad (12)$$

where *Im* and *Ex* = imports and exports of culture *k* in the group culture *i* for year *t*; *PR* = production of culture *k* in the group culture *i* for year *t*; *DU* = domestic consumption of culture *k* in the group culture *i* for year *t*.

The prices of each agricultural product are defined differently, depending on of whether the national product market is a key market with a key EU price or not. Since agricultural products in Croatia do not have production that affects the European price, the equilibrium price in the Croatian market for all products is expressed as:

$$p_{i,t} = f\left(Kp_{i,t}, p_{i,t-1}, ssr_{i,t}, Kssr_{i,t}, V\right) \quad i = 1,\ldots, n \quad (13)$$

where *p* = Croatian price of commodity *i* in year *t*; *Kp* = key price of commodity *i* in same year *t*; *ssr* = self-sufficiency ratio of Croatian commodity *i* in year *t*; *Kssr* = self-sufficiency ratio of the same commodity *i* in year *t* in the EU market; *V* = vector of exogenous variables that may affect the Croatian domestic price of commodity *i*.

Further details on the AGMEMOD modelling approach and equations can be found in Chantreuil *et al*. (2005), Erjavec & Donnellan (2005) and Salamon *et al*. (2008).

Econometric behavioural equations were estimated using appropriate econometric methodology as described by the general rules of the AGMEMOD modelling approach (Hanrahan, 2001). However, due to shorter time series data (1995-2016) compared to other countries (1973-2016), occasional poor national data quality, structural breaks in production caused by policy changes and the economic crisis, econometrically estimated equations for the Croatian model had to be calibrated to represent supply and demand responses with theoretical requirements, biological constraints, and standard statistical tests. After the Croatian model was calibrated, it was validated in two steps. In the first step, an expert in agricultural market economics (agricultural economist) check the consistency of the estimated behavioural equations. In the second, two domestic commodity market experts were included in addition to the agricultural economist, one specialising in crop markets and the other in livestock markets. The experts examined the provisional model baseline simulation results and provided feedback on the model's projections.

The authors developed the Croatian country-level model according to the AGMEMOD modelling approach, which is now an integral part of the EU-28 model, and from which the results of the Croatian medium-term outlook of key agricultural markets were derived. The aggregated EU outlook results presented in the paper, which were used for comparing the development of key agricultural markets with Croatian markets, are taken from the AGMEMOD project No. QLRT-2001-02853 partnership (AGMEMOD v8.0 from April 2018).

The Croatian and EU agricultural outlooks were modelled under baseline assumptions that the average weather conditions for the period 2016-2030 will be the same as in the period 2000-2016; that there will be no major shocks in agricultural commodity markets (breakdowns) and that the existing structure of CAP (2015-2020) measures will remain in place up to 2030. The model simulations, *i.e.*, the outlook for crop and livestock production, yield and net trade for Croatia, were compared to the EU-13 and EU-15 aggregated simulation results.

The results are presented in tables showing pre-accession historical data from the beginning of the intensive CAP harmonization period in Croatia in 2010, while from 2016 onwards, model simulation results are presented. Historical data on the main Croatian agricultural markets were taken from the Croatian Bureau of Statistics (CBS) and compared with previously conducted research projections regarding the impact of other CEE countries' accession to the EU. Furthermore, historical data on average Croatian producer prices prior to accession were compared to EU-27 average producer prices, while post-accession data were compared to EU-28 average producer prices. Croatian average producer prices were taken from CBS statistical data (2008-2016), while EU-27 and EU-28 average producer prices were acquired from the OECD statistical database 2008-2016 (OECD, 2016).

Results

Crop results

The model simulation results, *i.e.*, the outlook projections for crop markets, generally show positive growth patterns of production yield and net trade across the EU as well as in Croatia (Table 4). The simulated positive pattern developments of crop markets are more pronounced in the EU-13. In particular, we can observe differences between the EU-13 and the EU-15 in production growth patterns in grains and sunflower markets by 2030. Higher increases in production levels of soft wheat (16%), corn (25%), barley (16%) and sunflower (18%) in EU-13, compared to EU-15 increases (10%, 15%, 6% and 9%, respectively), are expected by the end of the simulated period. The main reason for such developments lies in the increase of yields in new member states due to technological changes, availability of investment supports, and changes in land use concentration (the productivity increase is related to larger, more efficient farms). Meanwhile, in the same period, grain and oilseed areas remain relatively stable in the EU-28 (Salamon *et al*., 2019). Given the expected positive production patterns, the Croatian and EU-13 aggregated results indicate that those member states will remain net exporters of crop commodities, and their net export is expected to keep increasing up to 2030.

For the two main crop cultures in Croatia (corn and soft wheat), historical data (2010-2016) show production growth patterns similar to those of the EU-13. The model simulation results indicate the continuation of similar growth patterns, especially for corn, where a 20% production increase in Croatia and a 25% increase on the EU-13 aggregate level is expected by 2030, mainly driven by an increase in yields. The production of barley is expected to stagnate in Croatia in the projected period, as opposed to the EU-13 and EU-15, where the positive production trend continues. Barley is primarily used in livestock nutrition, but because of the decline and projected negative trends in the number of breeding animals of the Croatian livestock sector, its production is expected to stagnate. The EU outlook results also indicate another trend in crop production, which is related to the growth of oilseeds production slowing down in the next decade in the EU-28, but to a lesser extent in the EU-13.

In contrast, in Croatia, the area sown with oilseeds, especially soybean, is expected to increase. Namely, economic and natural conditions (higher profitability and climate) favour the increase of areas sown with oilseeds in Croatia (Zmaić *et al*., 2014). Projections for the rapeseed market remain uncertain because of the uncertainty in the biodiesel market; however, under the baseline approach, the results show a 15% increase in production in Croatia and a 3% production increase in the EU. Sunflower seeds are a culture that is predominantly grown in the southern member states, so it is not surprising that production growth by 2030 is stronger in the EU-13 (18%) than in the EU-15 (9%). Croatia is in the top three countries in sunflower seed yield in the world, as the average yield of 2.52 t/ha in Croatia is 53.96% higher than the average yield of other EU member states (Zmaić *et al*., 2014). Modelling results suggest that with a further increase in yields, Croatian sunflower seed production may increase by 51% up to 2030. Unfortunately, there are no aggregated EU results for soybean, therefore, the comparison of market trends in Croatia and the EU is not possible. As for the prospect of the soybean market in Croatia, a production growth of up to 53% is expected, as a result of the increase in the sown area by 2030. The reason for this can be found in the prices of key crop markets. On average, during the pre-accession period and the period after the accession, the prices of grains (except barley) dropped by approximately 15% below the EU-28 average producer prices, while the prices of oilseeds remained closer to the EU-28 average producer prices, especially for soybean and rapeseed.

Table 4. Outlok of crop market development in the EU and Croatia up to 2030

	2010	2016	2030	Diff. '10-'16	Diff. '16-'30	2010	2016	2030	Diff. '10-'16	Diff. '16-'30
			Soft wheat					Rapeseed		
Production (1000 t)										
EU-15	95848.3	98341.0	108362.8	3%	10%	14175.9	12466.9	12844.9	-12%	3%
EU-13	32021.6	45291.9	52496.8	41%	16%	6434.6	7634.8	7838.7	19%	3%
Croatia	674.7	957.6	1029.85	42%	8%	33.1	113.0	130.32	241%	15%
Yield (t/ha)										
EU-15	6.6	6.8	7.2	3%	6%	3.4	3.2	3.8	-8%	19%
EU-13	3.7	4.7	5.4	27%	15%	2.2	2.9	3.0	35%	3%
Croatia	4.0	5.7	6.4	43%	12%	2.0	3.1	3.5	55%	13%
Net trade (1000 t)										
EU-15	140.9	1092.1	2700.4	675%	147%	-5064.4	-7439.3	-5784.8	-47%	22%
EU-13	12406.2	25101.3	30615.6	102%	22%	2503.8	2962.9	3463.8	18%	17%
Croatia	294.5	576.7	640.56	96%	11%	5.2	44.1	47.8	748%	8%
			Corn					Sunflower seed		
Production (1000 t)										
EU-15	35837.6	31855.3	36767.4	-11%	15%	2931.6	2405.1	2611.0	-18%	9%
EU-13	24109.0	29223.3	36420.4	21%	25%	4041.2	6060.1	7129.1	50%	18%
Croatia	2067.80	2154.5	2576.0	4%	20%	61.8	110.6	166.6	79%	51%
Yield (t/ha)										
EU-15	9.2	9.4	10.5	1%	12%	1.8	1.6	1.7	-13%	11%
EU-13	5.4	5.7	6.8	5%	20%	1.9	2.3	2.5	24%	6%
Croatia	7.0	8.5	10.3	21%	21%	2.3	2.7	3.5	17%	30%
Net trade (1000 t)										
EU-15	-15990.6	-24469.9	-28346.9	-53%	-16%	-1551.1	-2832.5	-2969.6	-83%	-5%
EU-13	8748.1	11582.1	16388.5	32%	41%	1740.5	2528.3	2856.5	45%	13%
Croatia	119.1	424.2	1103.5	256%	160%	27.1	34.4	79.3	27%	131%
			Barley					Soy		
Production (1000 t)										
EU-15	43351.3	48464.8	51283.8	12%	6%					
EU-13	9762.6	11691.0	13515.3	20%	16%					
Croatia	172.4	263.2	264.15	53%	0%	153.6	244.1	374.6	59%	53%
Yield (t/ha)										
EU-15	4.7	5.1	5.4	8%	5%					
EU-13	3.2	4.1	4.9	30%	18%					
Croatia	3.3	4.7	5.2	42%	11%	2.7	3.1	3.5	15%	13%
Net trade (1000 t)										
EU-15	3183.7	8676.3	8534.0	173%	-2%					
EU-13	-112.1	554.9	2227.0	595%	301%					
Croatia	-8.2	0.4	5.0	105%	1155%	50.8	153.9	211.9	203%	38%

Source: Elaborated by authors according to AGMEMOD v8.0 model results

Livestock results

The simulation results for livestock production in the EU indicate different meat production patterns between the EU-15 and EU-13 (Table 5). Meat production in the EU-15 is generally expected to stagnate, showing a decline in beef and veal (-5%) and pork (-2%) production, and a slight increase in poultry (2%) and lamb and mutton (5%) production by 2030, while EU-13 results indicate a steep decline in beef and veal (-21%) production and a slight increase in pork production (5%). On the other hand, poultry and lamb and

Table 5. Outlook of the livestock market development in the EU and Croatia up to 2030

	2010	2016	2030	Diff. '10-'16	Diff. '16-'30	2010	2016	2030	Diff. '10-'16	Diff. '16-'30
	Beef & veal					**Pork**				
Production (1000 t)										
EU-15	7208.1	6858.0	6539.0	-5%	-5%	19339.0	20142.4	19782.3	4%	-2%
EU-13	908.4	1021.8	803.6	12%	-21%	3564.0	3612.7	3790.0	1%	5%
Croatia	62.9	44.8	35.2	-29%	-21%	147.6	111.4	140.5	-25%	26%
Net trade (1000 t)										
EU-15	-423.7	-507.0	-441.0	-20%	13%	2761.9	3926.2	3561.9	42%	-9%
EU-13	355.8	446.3	295.5	-25%	34%	-946.1	-1122.7	-858.8	-19%	24%
Croatia	-2.7	-8.4	-27.9	-211%	-232%	-51.8	-93.8	-78.2	-81%	17%
	Poultry					**Lamb & mutton**				
Production (1000 t)										
EU-15	9521.4	10686.5	10881.0	12%	2%	831.2	803.7	843.7	-3%	5%
EU-13	2609.4	3797.2	4472.8	46%	18%	117.5	128.1	152.9	9%	19%
Croatia	60.2	64.0	88.1	6%	38%	6.7	5.5	6.8	-18%	24%
Net trade (1000 t)										
EU-15	99.4	-391.2	-818.0	-494%	-109%	-245.9	-176.3	-230.4	28%	-31%
EU-13	259.8	1010.2	1560.7	289%	54%	27.7	44.2	63.8	60%	44%
Croatia	-13.5	-14.6	-7.3	-8%	50%	0.06	0.06	0.1	-8%	82%
	Cow's milk					**Cheese**				
Production (1000 t)										
EU-15	122127.8	134016.7	150214.0	10%	12%	8064.2	8494.5	9703.3	5%	14%
EU-13	24706.9	26895.2	31273.5	9%	16%	1279.6	1533.8	2002.5	20%	31%
Croatia	799.9	691	555.7	-14%	-20%	29.1	36.1	41.4	24%	15%
Yield (t/ha)										
EU-15	7.0	7.3	8.2	5%	12%					
EU-13	4.9	5.6	7.2	15%	29%					
Croatia	3.8	4.6	6.1	20%	34%					
Net trade (1000 t)										
EU-15						556.5	669.4	1062.0	20%	59%
EU-13						30.5	2.5	60.8	-92%	2335%
Croatia						-9.9	-18.5	-12.7	-87%	31%

Source: Elaborated by authors according to AGMEMOD v8.0 model results

mutton production in the EU-13 is expected to increase by approximately 20% by the end of the simulated period. Production patterns in the dairy sector are similar in old and new member states, which is not the case for Croatia. The dairy sector is expected to grow in milk and cheese production in the EU, even though the numbers of dairy cows are stagnating or declining slightly. In the EU-15 and EU-13, the growth of milk production is owed to an increase in milk yields. However, there will still be a substantial gap in milk yields between the EU-15 and EU-13.

The development of negative trends in beef and veal production will continue in Croatia. A decline in production up to 21% is expected, which is identical to the simulated results of the EU-13. The new member states will retain their net exporters' status, while Croatia will have to import more beef, since the demand for beef is expected to increase with the rise of income by 2030. Croatian pork, lamb, sheep and poultry markets are, on average, expected to increase in production volumes by 25% or more, but these results can be interpreted to show that these markets are recovering somewhat from the structural breaks caused by the economic crisis and the EU accession. Croatia will not be self-sufficient in the production of pork and poultry any time soon and will remain their net importer.

The Croatian dairy sector has been in stagnation for more than a decade, and the negative trends were deep-

ened by the economic crisis and the accession to the EU single market. Because of the long-term weak competitiveness of the sector, the number of milk suppliers, the number of dairy cows and the quantity of delivered milk have decreased since 2005 by more than 50%. The dairy sector is not expected to recover soon, and the simulation results indicate a further decline in the numbers of dairy cows and volume of milk production, unlike in the EU. The Croatian cheese market is expected to continue its moderate production growth pattern, but it is not expected that Croatia will meet the self-sufficiency levels of cheese production by the end of the simulated period.

Discussion

The historical data of key markets is presented in order to analyse the impact of the accession on the Croatian crop and livestock sectors. The initial decline in the output of agricultural production was observed after Croatia acceded to the EU. After a few years of adjustment, the agricultural output began to recover from its initial decline. The main reasons for changes in key Croatian agricultural markets are price developments and technological progress simulated by yield growth. Due to approximately equal levels of policy support prior to EU accession, the introduction of CAP policy instruments did not have a very significant effect on the results for the key Croatian agricultural markets. However, because of the extension of decoupled measures, its role is significant in terms of production structure changes, the increase of crop production and the stagnation of livestock production. Similar trends were observed in the rest of the new member states after their accession to the EU (Csaki & Jambor, 2009). We expect that the trends in agricultural production and trade after Croatia's accession to the EU will bear close resemblance to the patterns in the new member states (EU-13). A pattern of higher crop production growth and stagnation of livestock production is expected, as a result of changes in price relations and policy instruments, as well as a comparatively advantageous position of crop production versus livestock after the accession.

The reason for higher crop production growth patterns is that the new members states are catching up to the old member states in productivity levels per hectare, and not because of an increase in sown areas. According to historical data and the AGMEMOD results, the sown area in in the EU has not changed significantly the last few years, and it is not expected to change by 2030 (Salamon *et al*., 2019). However, historical data show that, on average, Croatia had higher crop yields than the EU-13 prior to EU accession. The increase in yields shows similar values, especially in the simulated period (2016-2030).

Market experts agreed with the model simulations related to productivity growth. However, they pointed out that an increase in oilseeds-sown areas is not likely, mainly because they expect a stronger decrease in the rapeseed-sown areas because of the instability and insecurity of the biofuel market, where rapeseed is mostly used. Furthermore, market experts do not expect an increase in sunflower-sown areas, because Croatia has only one crushing factory, and when its capacity fills, the rest is exported; but since sunflower seed is a voluminous good, it is more expensive to export. The differences in prognosis and model simulations occur due to the limitation of the model and the impossibility to fit all the complex factors that occur in the agricultural markets in its projected variables

Meat production patterns in the EU-15 are expected to continue stagnating or even decline in production volume by 2030. This can be explained by changing consumer preferences in the direction of limiting meat intake (vegans, vegetarians and flexitarians) and citizens' attitudes toward animal husbandry (Salamon *et al*., 2017). In addition, higher production costs are observed in the livestock sector in the EU-15; in the poultry sector, for example, the production costs of broilers and slaughtering are cheaper in the EU-13 (Van Horne, 2017). Compared to the general production trends in the EU, the Croatian outlook on meat production shares similar production patterns observed in the EU-13. Pork, poultry, lamb and mutton sectors in Croatia are expected to recover, while dairy and beef sectors will continue to decline until the end of the simulated period. The decline in the number of cows and calves, which is due to unattractive and uncompetitive domestic cattle production (Grgić *et al*., 2016), is the reason for the negative trends in Croatian beef and veal production. The production of pork in Croatia began to recover in 2016 (Kralik *et al*., 2017), and positive developments are expected until 2030. Similar results can be observed in the positive production trends in the lamb, sheep and poultry markets (Kranjac *et al*., 2019) in Croatia, which will follow the expected positive trends in the new member states.

The dairy sector is expected to have positive effects from increasing milk yields (Zrakić *et al*., 2015), which could go up by 34% (Table 5) by 2030, since Croatia entered the EU with modest milk yield figures. According to data of the Ministry of Agriculture (2018), there were 12,639 milk producers in 2013 that delivered 504 million kg of milk to dairies, which is an average of approximately 40,000 kg of milk per producer. In 2016, there were 8,371 milk producers that delivered 490

million kg of milk, which is an average of approximately 59,000 kg of milk per producer (Ministry of Agriculture, 2018). The reason for the strong milk yield increase is that small, inefficient and uncompetitive farms are exiting the dairy sector, while larger, more efficient dairy farms take over milk production, as can be seen from the fact that, in three years, the average delivered quantity of milk per producer increased by 48%. However, this increase in milk yields is too small to compensate for the decline in the number of dairy cows; therefore, it is expected that production will decline by 20% up to 2030.

The prognosis of market experts confirmed simulated positive trends in Croatian poultry, pork and lamb and mutton sectors. They agreed with the simulated decline in beef and milk production and state that Croatia has many natural potentials; sufficient domestic plant production at relatively low prices for fodder, lower labour costs than in most EU member states, and the availability of funding from rural development funds. However, one of the market experts remained conservative in his prognosis on the Croatian livestock sector, indicating that the expected recovery will not mean a stronger growth of the overall livestock production volume. The reason for this is that, prior to the EU accession, many livestock sectors were highly uncompetitive with a need for high capital investments, especially in the beef and dairy sector, as well as a lack of labour force due to the rural population's immigration to Western European countries and the inefficient drawing of funds from rural development funds. Market experts noted that the anticipated changes of CAP instruments after 2020 would have a strong impact on the development of the livestock sector in Croatia, and that production focused measures would be of more importance in the development of livestock production.

The structural changes and trends related to stronger growth patterns of crop production compared to livestock production, which were found in the historical data analysis of Croatia and the EU-13, were confirmed by the outlook simulations and experts' opinions. The positive trends of the crop market are a result of the higher expected growth in yields. Many more similarities in future market developments between Croatia and the new member states have been found by comparing the Croatian simulation trends with EU-15 and EU-13 agricultural markets. Similarly, in the forthcoming period, the growth of livestock production in Croatia is expected to be sluggish, which is similar to what happened in other CEEC after their accession to the EU.

In general, compared to other research, our results are more similar to Witzke *et al*. (2009) and Phillipidis *et al*. (2015); the former was carried out with the CAPSIM (PE) model, showing overall positive effects of the accession on the agricultural sector, particularly on crop markets and livestock markets, with the exception of the pork market, whereas the latter was carried out through the MAGNET (CGE) model, which showed positive effects on grains and oilseeds markets, stagnation in the pork market, and a negative effect of the accession on red meat and milk markets, which corresponds with our results more. But the levels of details describing the effects of the accession on a particular commodity are much higher in this research, which was carried out with a PE model, while the CGE model results used in other study were highly aggregated and more focused on the impact of agri-food sector changes on Croatia's overall economy. The research of Boulanger *et al*. (2013) reports that after accession to the EU, the value of production decreases for almost all major branches (-5.4% in aggregated values for the agri-food sector), without reporting which particular commodity markets decrease in production volume. Lejour *et al*. (2009) used a similar (CGE) approach and reported similar findings.

In this research, we used a partial equilibrium approach and the AGMEMOD modelling tool to simulate an outlook for key Croatian agricultural markets up to 2030. The Croatian model has been derived from, maintained and updated on the base of country-specific knowledge on market and policy instruments and the common country model template using standard AGMEMOD modelling procedures (Bartova & M'barek, 2008; Chantreuil *et al*., 2012). This *bottom-up* approach gives a unique advantage over other models, since they are maintained within either one or a small number of institutions. The model allows for the implementation of specific national policies to be linked to a particular product, thus reflecting detailed representations of relationships between policy instruments and agricultural commodity supply and demand in a particular member state. Despite AGMEMOD's positive sides, there are drawbacks in its modelling approach. The model is market-focused and incapable of incorporating new types of agricultural supports introduced in the last two decades of the EU common agricultural policy reforms, such as rural development measures and agri-environmental and climate policy instruments. In addition, the AGMEMOD tool does not include the stochastic dimension in its projected variables. Volatile changes are frequent and normally occur in agricultural markets (structural breaks, market shocks, sudden drops in prices); therefore, the model needs to be further improved by implementing a stochastic simulation approach and incorporating income-, environment-and climate change-related targets of policies, which remains an important challenge for model builders in the

future. The experience of building the Croatian model in AGMEMOD also opens the discussion about limits related to data quality for modelling. The data gathered by the national Bureau of Statistics can often be distorted and inaccurate, which affects the modelling results.

Furthermore, new CAP policy instruments in will be implemented in the EU after 2020, which will inevitably change the conditions on agricultural markets. The new CAP will have much more flexibility for member states, which will be able to choose their own direction and focus on specific policy measures through the national strategic CAP plans. The most anticipated changes for the future of the CAP are the convergence of direct payments, a stronger focus on environmental and climate policy support schemes and strengthening certain policy elements, such as risk management, knowledge transfer, generational renewal and specific territorial support (EC, 2018). Therefore, agricultural sector analyses in the future will have to be carried out with a broader range of quantitative tools with different approaches, which will include CGE, PE and farm-level model approaches.

Our analysis of historical data on the Croatian agricultural sector (2010-2016) shows an initial decline in the output of agricultural production and changes in the production structure (stagnation of livestock production and increase in crop production). The positive effects of EU integration took place after a few years of adjustment, mainly driven by prices on the single market, and to a lesser extent by the introduction of CAP instruments. Since approximately equal levels of policy support existed in the agricultural sector prior to EU accession, the introduction of CAP instruments only had a modest impact on the main Croatian agricultural markets, but it did affect the production structure in favour of crop production due to the switch to decoupled measures. The impact of EU accession on the Croatian agricultural sector shows many similarities with prior research on the impacts of EU accession on the agricultural sectors of other CEE countries (changes in production structure and in several cases initial decline in production output; Csaki & Jambor, 2009). Croatia's case can especially be related to neighbouring CEE countries (Hungary and Slovenia), where producer prices were also close to EU levels prior to accession.

Simulations of future market developments comparing Croatian simulation trends with EU-15 and EU-13 agricultural market outlooks up to 2030 indicate many similarities between Croatia and other new member states. Simulation results and expert opinions confirm a slow recovery of livestock production, while strong growth patterns of crop production are expected in Croatia, which resembles the other CEEC's post-accession situation.

The combination of two approaches used in this paper, *i.e.* comparison of historical data with previous research and PE agricultural market modelling, provides a comprehensive overview of the impacts of EU integration on a new member state's main agricultural markets. As future EU enlargement envigases integration of Western Balkan countries and Croatia is the only country from this region to have acceded so far, we believe that using similar approaches in future research could provide insight into what can be expected from further EU enlargements in the Western Balkans.

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