THE EXPORTS OF SOME CROPS FROM USA. A PANEL DATA APPROACH

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Abstract

The main objective of this paper is to determine the impact of crop productivity and price index on some crops exports (feed grains, food grains, food grains, oil crops, vegetables and fruits- cross-sections) in USA during 2000-2013. Due to the short data set available for USA, a panel data approach is chosen. There are significant differences between US states regarding the plant exports. The crop exports have increased in USA with 184.31% in 2013 compared to 2000. California is the biggest crop exporter from USA, plant exports increasing with almost 170% in 2013 with respect to 2000. The differences across crops influence the crops' exports. The estimated random-effects models showed that the prices had a higher impact than productivity on the crop exports. Moreover, the panel VAR model gave more details. In the first period, 59.51% of the variation in crops' exports is due to changes in export, while 37.92% of the variation in exports is due to changes in prices. The influence of prices on exports increases up to 5th lag. Starting with the 6th lag, the prices influence decreases slowly till a variation of 37.34% of the exports due to prices modifications. The productivity impact is quite low, the maximum being registered in the second period (3.77% of the variation in exports is due to productivity changes).

Keywords: *crop; exports; random-effects model; panel VAR model*

JEL Classification: *C14, Q12*

1. Introduction

In the context of climate changes and environmental degradation, more people are interested in the essential resources like land, water and farm inputs. The agriculture trade reflects the changes that were made in people feeding process. The trade rules of the World Trade Organization have to focus on the fining of good solutions for vulnerable aspects.

Problems like risky nature of agriculture, the exports limitations in some countries and bio-fuel policies.

The main aim of this paper is to identify some determinants of crops exports in USA. An empirical analysis is conducted to show the impact of prices and productivity on crops exports in USA econometric techniques are used to study the relationship between these variables. Indeed, there are also other factors that affect exports in USA, but this analysis takes into account only some macroeconomic variables, because of the lack of other data for USA agriculture. The database ended up to 2013, because data from 2014 are not available in official database of United States Department of agriculture. After a short literature review, the methodological background is presented. Some panel data models are estimated and the main conclusion is that prices influence the exports more than the crop productivity does.

2. Analytical background

The exchange rate and world commodity prices are standard determinants of agriculture trade in literature. In many empirical studies, like those of Shane (2008) and Huchet-Bourdon and Korinek (2011), there is appositive relationship between exports of agricultural products and the depreciation in exchange rate.

Efficient policies should be implemented to face the volatile prices and unpredictable climatic changes. In time crisis the policy makers have to take fast measures, the food price spikes from 2007/2008 and 2010/2011 being a good warning for this. Critical stock-to-use ratios from most of the grains were identified by Bobenrieth, Wright and Zeng (2013), who concluded that stocks data could become valuable to price data as vulnerability indicators to price spikes and shortages. The evaluation of climate modifications on agricultural market supposes the assessment of climate changes on land productivity. Several scenarios of climate changes were proposed by Müller and Robertson (2014) who predict a decrease of crops production with 10-38%. This potential decrease will reduce the crops exports.

In industrialized countries like USA, the government supported the agriculture through subsidies and by keeping high prices, as Benbrook (2012) showed. The means of production are modernized by the permanent flow of capital into this sector. There is a good integration of the agriculture with the other sectors of the economy. The progress in social, scientific and technological infrastructure allows an efficient adaptation to the new conditions, according to Oerke, Dehne, Schönbeck and Weber (2012). There are high natural yields in industrialized countries that increase very fast, the markets being saturated. A good agricultural policy is based on an efficient agricultural price policy. The prices level, development and relationship of the main factors of production ensure the achievement of the long-run agricultural price policy that is oriented to high productivity realization. Within the agricultural sector, a special attention has been accorded to crops for which there is a high demand inside the producing country but also from the other states. The adoption of a new technology for herbicide-resistant crops will bring important advantages like increases in yields, economic savings and an improved weed management, according to Duke (2014). These advantages will have an important impact on crops' export. In seed sector, the rights of intellectual property have become essential in the context of consistent private investment in the crop breeding research in USA. Even if the strong rights of intellectual property encourage the seed international exchange, the exports could decrease. The effect of intellectual property rights on seed exports is estimated by Galushko (2012) for USA using Heckman selection model.

USA pretends that the Yuan's undervaluation makes the USA exports to China to diminish. Moreover, the imports from China to USA increase. Therefore, the effect of Yuan undervaluation on USA trade, demand, supply and prices was analyzed by Devadoss, Hilland, Mittelhammer and Foltz (2014) that used an error correction model. The Chinese currency devaluation generated imports of USA cotton, soybeans and mil to decline and USA imports of fruit, fruit juice and beans to increase on long and short-term.

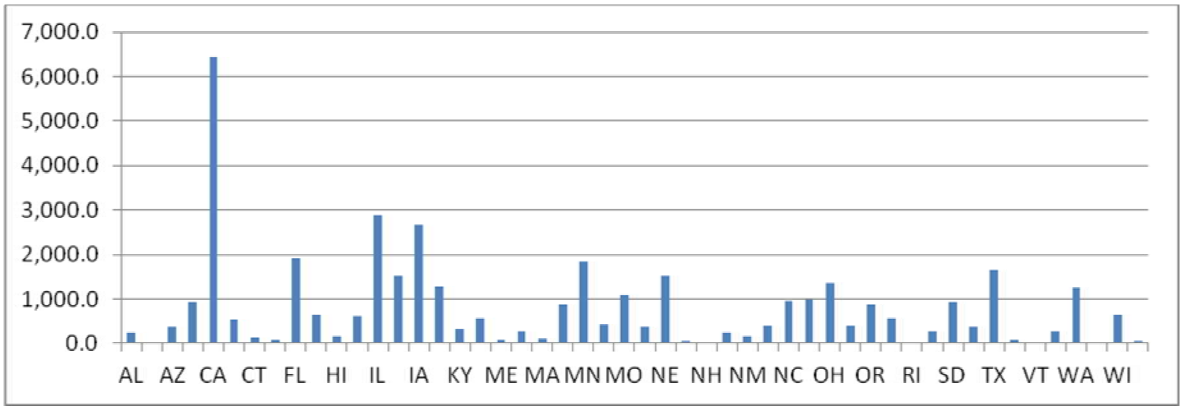
The effect of minimum salary increase on textile market in China for USA exports of cotton was analyzed by Macdonald, Pan, Hudson and Tuan (2014) that used a nonlinear quadratic and almost perfect demand system model. According to the results of simulations, the domestic consumption of textile will increase in China and the exports will decrease. Therefore, the production of textile in other countries will grow and the clothing price will increase.

In developing countries the determinants of agricultural exports are quite different compared to industrialized countries like USA. A gravity model was proposed by Hatab, Romstad and Huo (2010) to determine the main factors that affects the agricultural exports in Egypt. Transportation costs had a negative influence on exports of goods from agriculture sector. Using the Kalman filter estimates, Ivaniuk (2014) have shown that in Ukraine the increase in agriculture export is generated by the domestic agricultural production, international food prices and the output in Russia.

The crop exports have increased in USA with 184.31% in 2013 compared to 2000. As we can see from the following graph in 2000, the highest exports of crop was registered by California State, being followed by Illinois and

Iowa. The lowest export was registered in Alaska, a predictable situation because of the clime conditions in this state.

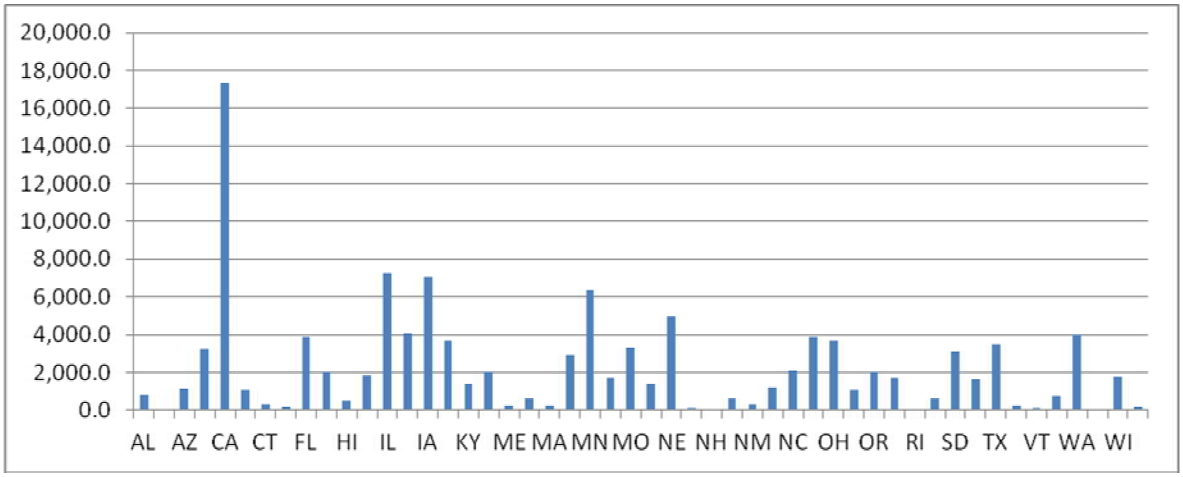
Figure 1 *The crop exports in US states in 2000*



Source: author's graph

California is the most populous state of USA and it is dependent by the success from agriculture, the climatic conditions being favorable for crops. Moreover, in this state the research in agriculture is very well developed. California's economy is dependent on trade and the technological improvements in crop production contributed to the high exports in this state. On the other hand, even if Alaska is the largest state as surface, it has many unpopulated areas. The agriculture represents a very small fraction of the Alaskan economy. The agricultural production is mainly used for consumption within the state.

Figure 2 *The crop exports in US states in 2013*



Source: author's graph

In 2013, California continued to be the biggest exporter from USA. Alaska remained the state with the lowest exports of crop production, even if the exports have grown with 98.5% in 2013 compared to 2000. On the other hand, in California the crop production exports increased with almost 170% in 2013 with respect to 2000.

3. Methodological framework

Let consider a vector of endogenous variables denoted by Y_t . The dimension is Gx1. The VAR model for this vector is:

$$Y_t = A_0(t) + A(l)Y_{t-1} + u_t, \text{ where } u_t \rightarrow iid\left(0, \sum_u \right) \quad (1)$$

$A(l)$- polynomial function in the lag operator
$A_0(t)$ includes the deterministic components
The standard finite order VAR with constant coefficient is based on Wold theorem and it supposes stationary, linearity and invertibility of the moving average form. Any vector Y_t has an infinite lag VAR representation. Therefore, in applications the assumption that the contribution of Y_{t-j} to Y_t is small for large j is made to have a finite VAR.
In panel VAR (PVAR) models, the variables remain interdependent and endogenous, but a second dimension (cross-sectional one) is added to the representation. There is a vector y_{it} that includes G variables for each unit,

where i is the index for units that might be spatial units, markets, sectors etc. (i=1,2,…,N). The representation of the panel VAR is:

$$y_{it} = A_{0i}(t) + A_i(l)Y_{t-1} + u_{it}, \text{ where}$$
$$u_t \rightarrow vector\ of\ random\ disturbances\ (Gx1\ elements) \quad (2)$$

t=1,2,…, T and i=1,2,…,N

In the case of a panel VARX model, we have:

$$y_{it} = A_{0i}(t) + A_i(l)Y_{1t-1} + F_i(l)W_t + u_{it}, \quad u_t \rightarrow iid\left(0, \sum_u \right) \quad (3)$$

$u_{it} = [u_{1t}, u_{2t}, \dots, u_{Nt}]'$

j-lag (j=1,2,…,q)

$F_{i,j}$ - matrices (dimension GxM)

W_t - vector of predetermined variables (dimension Mx1) for all units

Three important characteristic should be stated for PVAR models used in financial and macroeconomic approaches:

- Dynamic interdependencies (for all units the lags of endogenous variables enter the model for the unit *i)*;
- Static interdependencies (in general, u_{it} correlate across *i*) that imply restrictions for the shocks' covariance matrix;
- Cross sectional heterogeneity (the slope, the intercept and the shocks' variance could be unit specific).

PVAR models are often used in literature to analyze the convergence and similarities between cycles in different groups of countries. These models are also employed to build leading or coincident indicators of the economic activity or to predict different macroeconomic variables like inflation or GDP, because they consider the potential cross unit spillover effect. PVAR models are frequently utilized to build average effects and to describe the unit specific differences with respect to the average.

4. Some determinants of crops exports in USA

In this study, several types of crops have been chosen: feed grains, food grains, food grains, oil crops, vegetables and fruits. For these crops, the following variables were registered in the period from 2000 to 2013 for USA: indices of productivity, price indices and agricultural exports. The mentioned crops are the cross-dimension of panel data. A panel data approach was chosen to determine the factors that influence the agricultural exports of these crops in USA. According to unit root tests, the data are not stationary and the logarithm is applied for each data set in order to ensure the stationary character of the data. The transformed variables are denoted by L1, L2 and L3 (L1 (logarithm of productivity index), L2 (logarithm of price index) and L3 (logarithm of crop exports). More types of panel data models were proposed, but in the end two random-effects models were valid: a random-effects GLS regression and a random-effects ML regression. The individual specific effects are not correlated with the exogenous variables in the model. The use of random-effects model to explain the exports of some crops is in accordance with the expectations. Indeed, not all types of crops were considered. We select random crops, but the analysis was limited by the data existence for USA. Moreover, the differences across crops influence the crops' exports. The coefficients interpretation for random-effects model is quite tricky, because the parameters include between-unit and within-unit effects. However, the prices have a higher impact than productivity on the crop exports (Table 1). The LM test recommended the random-effects model against the OLS model.

Table no. 1 *Random-effects models for explaining crops exports*

Random-effects GLS regression				
R-sq within: 0.8822 R-sq between: 0.1832 R-sq overall: 0.6749	Coefficient	Std. error	Z	P>|z|
logarithm of productivity index	0.7422	0.2248	3.3	0.001
logarithm of price index	1.1560	0.0679	17.02	0.000
Const.	7.6132	0.0511	148.83	0.000
Random-effects ML regression				
logarithm of productivity index	0.4369	0.2059	2.12	0.034
logarithm of price index	1.2023	0.0591	20.34	0.000
Const.	7.6082	0.1080	70.43	0.000

Source: author's computations

The research continues with the estimation of a panel VAR model.

Most of the lag criteria (LR, FPE and HQ) indicated that the most suitable is a panel VAR of order 3, as we can see in Table 2.

Table no. 2 *Panel VAR lag order selection criteria*

Lag	LogL	LR	FPE	AIC	SC	HQ
0	38.47870	NA	4.15e-05	-1.576831	-1.456387	-1.531931
1	134.3800	174.7536	8.73e-07	-5.439113	-4.957336*	-5.259511
2	141.4273	11.90209	9.58e-07	-5.352326	-4.509217	-5.038023
3	163.4497	34.25701*	5.45e-07*	-5.931098	-4.726656	-5.482094*
4	169.2485	8.247174	6.47e-07	-5.788822	-4.223048	-5.205117
5	181.6544	15.98977	5.82e-07	-5.940193*	-4.013087	-5.221787

Source: author's computations

The model satisfies the stability conditions: there are no roots outside the unit circle. The polynomial roots of autoregressive process are presented in the following table (Table 3):

Table no. 3 *Roots of characteristic polynomial*

Root	Modulus
0.985765	0.985765
0.974368	0.974368
0.216718 - 0.404722i	0.459093
0.216718 + 0.404722i	0.459093
-0.121463	0.121463
0.061099	0.061099

Source: author's calculations

The panel VAR model was built for stationary data (Table 4). The new variables based on the logarithmic transformation are denoted by L1 (logarithm of productivity index), L2 (logarithm of price index) and L3 (logarithm of crop exports). The Granger causality test indicated that the exogenous variables are cause for the dependent variable (logarithm of crop exports).

Table no. 4 *The panel VAR model estimation*

	logarithm of productivity index	logarithm of price index	logarithm of crop exports
logarithm of productivity index (-1)	0.518537	-0.273898	-0.091185
logarithm of productivity index (-2)	0.056056	-0.419861	0.208268
logarithm of productivity index (-3)	-0.050226	0.553117	0.051114
logarithm of price index (-1)	0.031030	0.577907	0.032604
logarithm of price index (-2)	-0.148116	-0.037999	-0.011101
logarithm of price index (-3)	-0.090199	0.391816	-0.020305
logarithm of crop exports (-1)	-0.047381	0.510325	0.849406
logarithm of crop exports (-2)	0.194005	-0.161621	0.123526
logarithm of crop exports (-3)	-0.016015	-0.274213	0.023747
C	-0.972782	-0.524348	0.120630
R-squared	0.631428	0.876728	0.939941
Adj. R-squared	0.557713	0.852074	0.927930

Sum sq. residuals	0.260674	0.554486	0.527917
S.E. equation	0.076110	0.111004	0.108312
F-statistic	8.565862	35.56078	78.25191
Log likelihood	69.13340	48.37716	49.72750
Akaike AIC	-2.150306	-1.395533	-1.444636
Schwarz SC	-1.785336	-1.030564	-1.079667
Mean dependent	0.016353	0.223927	7.890995
S.D. dependent	0.114443	0.288613	0.403458
Determinant residual covariance (degrees of adj.)		4.91E-07	
Determinant residual covariance		2.69E-07	
Log likelihood		181.9177	
Akaike information criterion		-5.524279	
Schwarz criterion		-4.429370	

Dependent variable: L3 Granger causality test			
Excluded	Chi-sq	Degrees freedom	Prob.
logarithm of productivity index	13.47325	3	0.0037
logarithm of price index	23.92067	3	0.0000
All	34.31062	6	0.0000

Source: author's computations

The residuals are homoskedastic and independent up to a lag of 12. As we can see from Table 5, the probabilities associated to the residual tests are greater than 0.05. so, for a level of significance of 5%, the errors are not auto-correlated and they are homoskedastic, the panel VAR model in this form being valid.

Table no. 5 *VAR Residual tests*

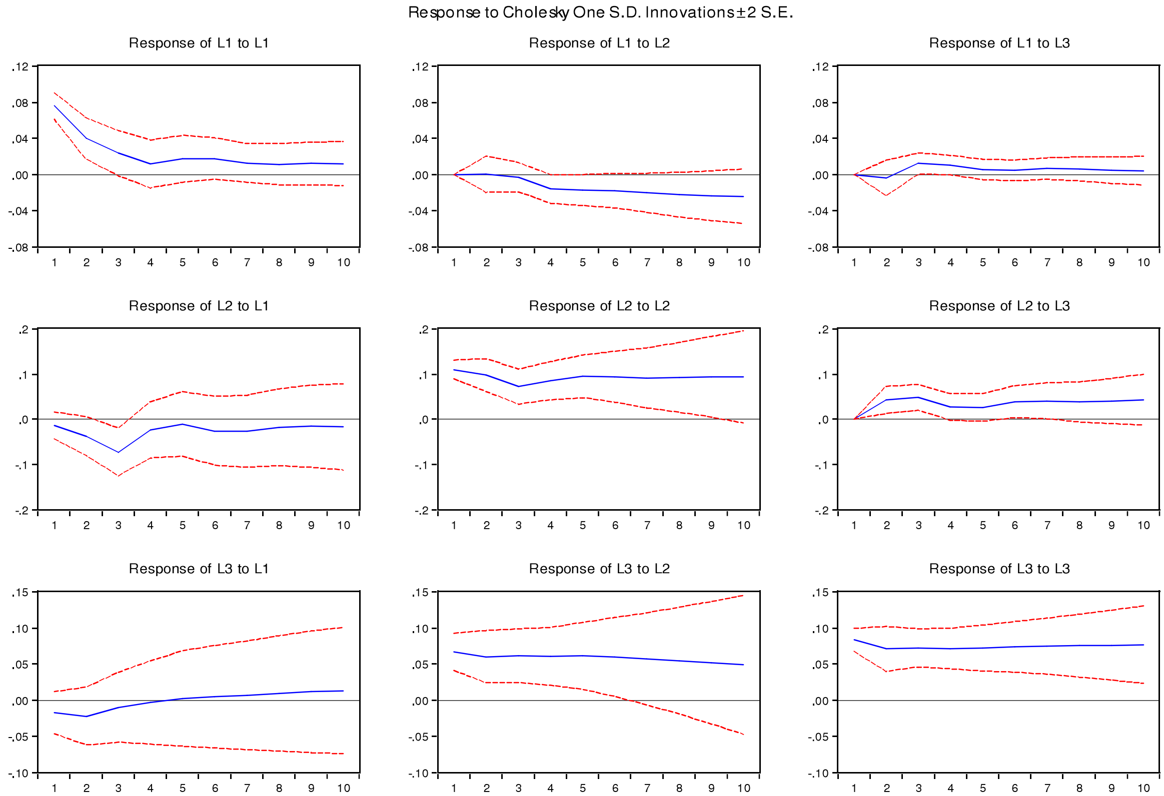
VAR Residual Serial Correlation LM Tests			VAR Residual Homoskedasticity test		
Lags	LM-Stat	Prob.	Chi-sq	Degrees	Prob.

				freedom	
1	10.61746	0.3028	117.0194	108	0.2603
2	17.59860	0.0401			
3	5.337188	0.8040			
4	11.94828	0.2162			
5	13.48270	0.1420			
6	15.85296	0.0700			
7	9.581750	0.3854			
8	8.027634	0.5314			
9	2.616985	0.9776			
10	7.934493	0.5408			
11	3.976904	0.9129			
12	6.325832	0.7069			

Source: author's computations

Starting from VAR(3) model, we analyzed the effect of a shock in one of the variable on the other one. In Figure 3, the impulse-response functions are represented.

Figure 3 *The impulse-response functions*



Source: author's graph

In the first period, 59.51% of the variation in crops' exports is due to changes in export, while 37.92% of the variation in exports is due to changes in prices. The influence of prices on exports increases up to 5th lag. Starting with the 6th lag, the prices influence decreases slowly till a variation of 37.34% of the exports due to prices modifications. The productivity impact is quite low, the maximum being registered in the second period (3.77% of the variation in exports is due to productivity changes).

Most of the variation in productivity is due to changes in this variable. Surprisingly, the impact of prices has a high influence starting with the 4th lag when the influence grows very quickly till 23.35% of variation explained by prices in the 10th lag. Starting with the 4th lag, there is a stable influence of exports around 3%, as we can see in Table 6.

Table no. 6 *Variance decomposition of the variables*

Variance Decomposition of logarithm of productivity index:				
Period	S.E.	logarithm of productivity index	logarithm of price index	logarithm of crop exports
1	0.076110	100.0000	0.000000	0.000000
2	0.086012	99.78721	0.000904	0.211886
3	0.090026	97.87762	0.116991	2.005388
4	0.092738	93.78820	3.099890	3.111911
5	0.096068	90.64023	6.127631	3.232139
6	0.099418	87.76463	9.012092	3.223274
7	0.102449	84.17147	12.39947	3.429064
8	0.105650	80.26871	16.18190	3.549388
9	0.109010	76.62868	19.85659	3.514729
10	0.112403	73.20093	23.35623	3.442843
Variance Decomposition of logarithm of price index:				
Period	S.E.	logarithm of productivity index	logarithm of price index	logarithm of crop exports
1	0.111004	1.479679	98.52032	0.000000
2	0.158411	6.330256	86.42332	7.246427
3	0.194700	18.06145	70.95088	10.98766
4	0.215545	15.92577	73.50930	10.56493
5	0.237204	13.34262	76.74955	9.907824
6	0.259561	12.12920	77.31826	10.55254
7	0.279520	11.35709	77.41451	11.22839
8	0.297545	10.37736	78.07217	11.55047
9	0.315048	9.501930	78.57050	11.92757
10	0.331929	8.827048	78.70267	12.47028
Variance Decomposition of logarithm of crop exports:				
Period	S.E.	logarithm of productivity index	logarithm of price index	logarithm of crop exports
1	0.108312	2.563191	37.91912	59.51769
2	0.144525	3.779965	38.67366	57.54637
3	0.173156	2.952223	39.49501	57.55277
4	0.196850	2.308613	40.00616	57.68523
5	0.218421	1.886517	40.35229	57.76119
6	0.238149	1.627377	40.22932	58.14330

7	0.256194	1.473086	39.75221	58.77470
8	0.272748	1.416020	39.08917	59.49481
9	0.288102	1.430840	38.28128	60.28788
10	0.302447	1.490163	37.34149	61.16834

Source: author's computations

All in all, we can state that the prices have a high impact on the selected crops' exports from USA, the productivity having a marginal influence. However, most of the variance in exports is due to the changes in this variable. Other important factors, like exchange rate might generate changes in export.

5. Conclusions

This study determines some factors that increase the crop exports in USA. In this study, several types of crops have been chosen: feed grains, food grains, food grains, oil crops, vegetables and fruits. The results of panel data approach are:

- The productivity and prices are determinant for some crops exports in USA;
- The differences between crops influence the exports;
- The influence of prices is significant higher than the productivity impact on exports;
- There are high differences between US states regarding the crop production exports determined also by extern factors like clime conditions, traditions.

In a future research it would be interesting to select more variables to develop the panel data models. A dummy variable for climate conditions that might be favorable for crop production would be necessary.

The results show the marginal contribution of productivity. Therefore, the agricultural policies in USA should more take into account the ways to increase the productivity of production factors. There are many agricultural researches regarding the use of different fertilizers to increase the production, but the orientation on quality is more important than the quantity.

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