“Green-bricks: An empirical approach of shocks in soybean prices to residential building in Rosario, Argentina”.

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Abstract

Shocks in commodity prices affect developing countries at a macro and micro level. The aim of this paper is to study the impact of international soybean prices into the construction activity in Rosario, epicenter of the most fertile area in Argentina, a major soybean producer. VAR methodology is used and accounts for a positive effect in the period 1994-2015, being larger in residential permits.

1. Introduction

The motivation of this paper is essentially to study the impact of commodity prices at a micro and local level, specifically the soybean into the real estate activity in the port city of Rosario. We adopt the VAR methodology and the impulse response function in order to measure that effect.

On the contrary, the common of the literature has focused on the macro level. The commodity rising prices in the last decade and its volatility have been studied from different sides: Dutch disease, impact on private investment or exporting behavior. For example, Koitsiwe y Adachi (2015) studied the Australia mining boom using the VAR methodology and Pedersen (2015) did something similar with the impact of different types of shocks to the copper market into the Chilean economy1.

As far as I know, few investigations try to glimpse the effect on a specific sector at a local level. For instance, Grimes and Hyland (2013) use the VAR methodology and study the effect of commodity prices variations on urban and rural outcomes, such as national housing and farm prices in New Zealand. They find that a raise in commodity prices leads to a permanent increase in housing investment and house prices. In addition, Shi and Tang (2013) investigate the relationship between commodity prices and house prices in two commodity dependent economies (Australia and New Zealand). In different stages, they try to estimate if the impact on local housing prices is direct, or via national or regional variables (better public financial status, higher commodity prices could lead to inflation and followed by a tougher monetary policy raising interest rates).

Parallel to the “boom” in the soybean price, it is the important expansion in construction in Rosario. According to the Municipality of Rosario, the urban area grew 5.2% in 2003-

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1 Other examples: Dehn (2000) studies commodity shocks and its uncertainty to private investment in developing countries using panel data. Muñoz (2013) uses a panel data to inquiry the impact of commodity prices on debt spread in emerging countries, taking into account the concentration on exports. He finds a negative relationship, which is larger as the exports are more concentrated. Céspedes and Velasco (2012) provide empirical evidence that commodity price shocks have an important impact on economic output and investment dynamics in a small and open economy, tending to be larger in economies with a less developed financial sector. Nordin et al. (2014) study the impact of three relevant Malaysian commodity prices and some macro variables on the Malaysian Stock Index, finding some cointegrating relationships.
Lapelle et al. (2011) argued that the post-devaluation scenario and the distrust in the financial sector post financial crisis in 2001-2002, were the main reasons of the take off the construction sector. Many trusts were created and orientated to the construction of new buildings in Rosario, and the activity flourished up to 2008, when a new urban code was pronounced in March and the conflict between the National Government and the rural sector became tougher because of the creation of mobile system for export taxes. Moreover, the international financial crisis shocked the commodities markets turning them more volatile. The soybean price fell 30% in the last quarter of 2008 in comparison with the third one, and export taxes for soybean were at 35%. The double feature of being an economic and a financial investment, funneled the agrarian surplus into the construction activity. In addition to this view, Bebzeug and Garegnani (2012) using an Equilibrium Correction model found empirical evidence for Argentina that Real State is housing and financial investment as well.

The importance of this crop for the region is indubitable: 80% of the Argentinian soybean oil is produced in the Rosario region, more than 60% of the crop is produced in the core area -the most fertile land in Argentina, locally known as “zona núcleo”- where Rosario is the commercial and logistic epicenter. The common view in Rosario was that money had moved from the rural area to the construction activity. The theoretical reason as mentioned above is clear: the surplus -generated by devaluation and better prices- was redirected to Real State in a context where the memory of banking crisis in 2002 was still fresh. We want to explore that reasoning in data, analyzing the connection between soybean Gulf prices and construction activity in Rosario. As we do not have micro data, we estimate the effect of exogenous movements in soybean prices of Gulf of Mexico -as a proxy of profits- for different measures of construction activity.

We adopt VAR methodology in order to measure how shocks to soybean prices affect residential construction in Rosario. We test for stationarity and the presence of structural breaks, which are plausible as the series cover almost twelve years. The presence of structural change is not naive, since it could be affecting the results of other tests (i.e. unit root tests or cointegration tests). Because some of the unit root tests are not conclusive, and the presence of structural breaks is detected by Bai and Perron test, different models are estimated according to different assumptions. Taking into account these different scenarios, a positive change in soybean price –permanent or not- leads to a positive effect in residential buildings. Moreover, robustness checks are performed and results remain. Finally, according to the forecast error variance decomposition, although exogenous shocks in prices are probably not the main cause of the movements in building activity, the power of explanation increases in time.

The paper follows with Section 2 that provides descriptive statistics and tests performed to check stationarity. Section 3 describes briefly the methodology; section 4 states the main results; Section 5 includes robustness checks, and finally Section 6 concludes.

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2 We are not taking into account the Metropolitan Area (Funes, Roldán, Pérez, Granadero Baigorria) which its growth rate has been higher. Unfortunately, that data is not available.

3 The Resolution 125/2008 from the Ministry of Economy declared a mobile export tax that according to soybean prices in March rose to 43%. The conflict lasted from March to July.

4 Although Bus and Nicolini (2010) calculated that in Argentina the elasticity for rent for the soybean depends firstly on yield, then on international FOB price and lastly on costs, it is difficult to convert annual yields into quarterly data without some arbitraries assumptions.
2. Data

a) Descriptive statistics

The main data used is quarterly from 1994 to 2015 and includes: FOB Gulf soybean price in dollars, the authorized area for construction in Rosario in m$^2$, the authorized area for new residential buildings in Rosario in m$^2$, a national index of economic activity (EMAE), real interest rate and an index of building costs in dollars. Table 1 shows the main descriptive statistics, and data appendix contains details of each series. All variables are later transformed in logarithms, except real interest rate. Identifiable seasonality is tested using X-12 ARIMA program.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential permits in Rosario (m$^2$)</td>
<td>1994q1-2015q4</td>
<td>88</td>
<td>28,223.9</td>
<td>14,960.9</td>
<td>7,715.7</td>
<td>68,518.0</td>
</tr>
<tr>
<td>Building permits in Rosario (m$^2$)</td>
<td>1994q1-2015q4</td>
<td>88</td>
<td>52,452.4</td>
<td>21,931.5</td>
<td>17,246.7</td>
<td>124,992.3</td>
</tr>
<tr>
<td>Gulf soybean price (US$)</td>
<td>1994q1-2015q4</td>
<td>88</td>
<td>328.4</td>
<td>129.1</td>
<td>129.1</td>
<td>653.0</td>
</tr>
<tr>
<td>EMAE (base 1993=100)</td>
<td>1994q1-2013q4</td>
<td>80</td>
<td>137.6</td>
<td>34.1</td>
<td>98.8</td>
<td>209.1</td>
</tr>
<tr>
<td>Real Interest (%)</td>
<td>1999q1-2015q4</td>
<td>69</td>
<td>-1.6</td>
<td>11.1</td>
<td>-16.9</td>
<td>45.2</td>
</tr>
<tr>
<td>Building cost Index in dollars</td>
<td>1994q1-2015q3</td>
<td>87</td>
<td>94.22</td>
<td>25.44</td>
<td>36.02</td>
<td>137.91</td>
</tr>
</tbody>
</table>

Note: there is not enough statistical evidence to affirm or deny seasonality in building permits. We decided to adjust it and include it.

Table 2 Linear correlation coefficients

<table>
<thead>
<tr>
<th>Correlation with actual soybean price</th>
<th>Correlation with soybean price t-1</th>
<th>Correlation with soybean price t+1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building permits</td>
<td>Residential permits</td>
<td>Building permits</td>
</tr>
<tr>
<td>Full sample</td>
<td>0.5676</td>
<td>0.6439</td>
</tr>
<tr>
<td>1994-2007q4</td>
<td>0.5472</td>
<td>0.6344</td>
</tr>
<tr>
<td>2008-2015</td>
<td>0.0468</td>
<td>0.0683</td>
</tr>
<tr>
<td>Building permits</td>
<td>Residential permits</td>
<td>Building permits</td>
</tr>
<tr>
<td>Full sample</td>
<td>0.5625</td>
<td>0.6348</td>
</tr>
<tr>
<td>1994-2007q4</td>
<td>0.5738</td>
<td>0.6284</td>
</tr>
<tr>
<td>2008-2015</td>
<td>0.0084</td>
<td>0.0749</td>
</tr>
<tr>
<td>Building permits</td>
<td>Residential permits</td>
<td>Building permits</td>
</tr>
<tr>
<td>Full sample</td>
<td>0.5728</td>
<td>0.6585</td>
</tr>
<tr>
<td>1994-2007q4</td>
<td>0.5452</td>
<td>0.6354</td>
</tr>
<tr>
<td>2008-2015</td>
<td>-0.0516</td>
<td>0.0615</td>
</tr>
</tbody>
</table>

Note: all variables are in logarithms.

Taking a glimpse at Figure 1, we can see a mild correlation between international prices and building permits. They seem to share the same pattern from 1998 to 2008, discontinues up to 2010, and then they share volatility in a kind of steady state or mild downward trend. These observations are confirmed with the linear correlation coefficients shown in Table 2. The residential permits series is slightly more correlated with soybean prices than building permits\(^5\), which is reasonable since building permits includes another types of construction such as educational, commercial and health buildings.

\(^5\) Building permits has an outlier in 2000q3. In that time an important commercial mall was authorized.
b) Unit root tests and structural change tests

It is essential to work with stationary series and remove any trend. As Enders (2004) stated, the classical method for eliminating stochastic trend is differencing, and for removing stationary trend is detrending. Problems arise when differencing is applied to a trend stationary series (a noninvertible unit root process into the MA component is introduced), and detrending a stochastic trend does not remove it. However, this problem can be tested performing a unit root test to the residuals of the detrended series.

In Table 3, different unit root tests are resumed. The Augmented Dickey-Fuller Test gives no statistical evidence of stationarity process except for both construction series and interest rates. However, observing the figures in the Appendix, caution is advisable as we can be in the presence of at least one structural break. In the presence of a structural change, the misspecified test could lead to a wrong conclusion. Enders (2004) says: “(...) the Dickey Fuller test is biased toward accepting the null hypothesis of a unit root even though the series is stationary within each of the sub periods”. Consequently, we performed a modified version of the ADF test robust to the presence of one structural change in level, trend or both: Zivot and Andrews (1992).

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In this context, results are different, and the real exchange rate index could be trend stationary with a structural break, as well as building costs. On the contrary, the permission areas would no longer be stationary.

The third unit root test performed is a modified Dickey-Fuller where the series are transformed by a generalized least-squares regression proposed by Elliot, Rothenberg and Stock (1996). This test has more power than the traditional ADF. Here, both null hypothesis mean that series are random walk, but the alternatives are: stationary in mean or trend stationary. Rosario’s permissions would be mean stationary, while real interest rates would be trend stationary.

Finally, the last unit root test used is the Phillips and Perron (1988) that uses Newey-West standard errors, which are robust to serial autocorrelation. In this case, building permits seem to be stationary as well as interest rates.

All in all, it is difficult to come to a conclusion. “A trend stationary process can arbitrarily well approximate a unit root process. If the stochastic portion of the trend stationary process has sufficient variance, it will not be possible to distinguish between the unit root and trend stationary hypothesis” (Enders 2004, p. 209). Furthermore, many macroeconomic variables are not characterized by unit root processes and they are trend stationary processes joined with structural breaks, instead. (Enders 2004, p.

Table 3 Summary of unit root tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF Unit root tests</th>
<th>Zivot and Andrews</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level (constant)</td>
<td>Level (constant and trend)</td>
</tr>
<tr>
<td>In soybean price</td>
<td>-1.295</td>
<td>-2.015</td>
</tr>
<tr>
<td>In Building permits (SA)</td>
<td>-3.495***</td>
<td>-3.92***</td>
</tr>
<tr>
<td>In Residential permits</td>
<td>-2.843*</td>
<td>-3.35*</td>
</tr>
<tr>
<td>In Emae</td>
<td>1.296</td>
<td>-0.927</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>-3.313**</td>
<td>-4.629***</td>
</tr>
<tr>
<td>Building costs in dollars</td>
<td>-0.943*</td>
<td>-1.259</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>DFGLS</th>
<th>Perron</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean stationary</td>
<td>Trend Stationary</td>
</tr>
<tr>
<td>In soybean price</td>
<td>-1.032</td>
<td>-1.611</td>
</tr>
<tr>
<td>In Building permits (SA)</td>
<td>-2.033*</td>
<td>-2.62</td>
</tr>
<tr>
<td>In Residential permits</td>
<td>-1.119</td>
<td>-1.89</td>
</tr>
<tr>
<td>In Emae</td>
<td>0.456</td>
<td>-1.581</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>-1.788</td>
<td>-3.032*</td>
</tr>
<tr>
<td>In Building costs in dollars</td>
<td>-1.744</td>
<td>-1.872</td>
</tr>
</tbody>
</table>

Note: The optimal lag chosen is taking into account Ng and Perron (1995) sequential method. * denotes rejecting the null hypothesis at the 0.10 level, ** at 0.05 level and *** at 0.01 level.
In order to detect unknown dates of structural breaks, we follow Bai and Perron (1998) and Bai (1997). The proceeding is firstly testing the presence of structural change in the whole sample, and only if a structural break is found, follow testing in the two sub-samples. Table 4 shows many possible structural breaks in a linear framework, using this procedure.

In conclusion, there is no certainty whether there is a unit root process or not, especially in building and residential permits series. Moreover, the presence of structural breaks is making things more confused. Therefore, we follow a sceptic approach estimating different models since we could be in the existence of:

a) Unit root process and series are not stationary.

b) Stationary series or trend stationary series.

c) Stationary series with many structural breaks.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Structural breaks</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>In soybean price</td>
<td>2007q2; 2010q3; 2014q3; 1994q2; 1995q3; 1998q3; 2007q2; 2012q2; 2014q3</td>
<td>The dates in bold mean the first unknown date detected by Bai methodology.</td>
</tr>
<tr>
<td>In Building permits (Seasonally adjusted)</td>
<td>1994q4; 1996q1; 1998q1; 2004q1; 1995q3; 1997q2; 1998q1; 2001q2; 2003q3; 2009q2</td>
<td></td>
</tr>
<tr>
<td>In Residential</td>
<td>1998q1; 2004q1; 2009q3; 1994q3; 1996q2; 1998q1; 2003q3; 2008q4; 2010q2; 2013q4; 2014q4</td>
<td></td>
</tr>
<tr>
<td>In Emae</td>
<td>1995q1; 1996q2; 2004q3; 2006q3; 2010q1; 2011q1; 2012q4; 1995q1; 1997q2; 2001q3; 2008q3; 2010q4; 2013q1</td>
<td></td>
</tr>
<tr>
<td>Real interest rate</td>
<td>1999q2; 2000q3; 2001q2; 2002q3; 2009q4; 2014q4; 1999q4; 2001q1; 2001q4; 2002q3</td>
<td></td>
</tr>
<tr>
<td>In Building costs in current dollars</td>
<td>1994q4; 1996q2; 2001q4; 2010q1; 2011q2; 1995q4; 2001q4; 2008q3; 2013q4; 2014q3</td>
<td></td>
</tr>
</tbody>
</table>

3. **Methodology**

In order to see the effect of shocks of soybean prices on construction activity in Rosario, we estimate the orthogonal impulse response function from a vector autoregression model. Following Hamilton (1994) a reduced and restricted VAR form is

\[ y_t = \beta Y_{t-1} + \epsilon_t \]

where \( y \) is the \((k \times 1)\) vector of endogenous variables, \( \beta \) \((k \times (p+1))\) matrix of coefficients where \( p \) is the maximum lag, and \( Y_{t-1} \) is a \((k \times (p+1))\) matrix containing the lagged values of the variables in \( y \) as well as the constant term, and \( \epsilon_t \) is a serially
uncorrelated error term where \( E(\epsilon_t, \epsilon_{t'}) = \Omega \) para \( t = \tau \), and zero otherwise. \( \Omega \) is the contemporaneous covariance matrix.

The structural VAR takes the form

\[
A y_t \equiv B y_{t-1} + u_t
\]

Where \( A \) is a matrix of contemporaneous relationship, \( \beta = A^{-1}B \), \( u_t \) are the structural shocks, and \( E(u_t, u_{t'}) = D \) para \( t = \tau \), and zero otherwise, where \( D \) is a diagonal matrix. Identification of shocks to international soybean prices is achieved by assuming a lower triangular form for \( A \) (when the soybean price is ordered first in the vector \( y \)), and by imposing also a block-exogenous structure in \( B \) by which the price of soybeans can only be affected by its own lagged values, but not by lagged values of the other variables.

It is restricted because we impose that Gulf soybean price is not affected by the rest variables of the system, as the key assumption is the exogenous characteristic of Gulf soybean price, since Argentina is a small economy.

As we stated in the previous section, the presence of a unit root in unclear. Consequently, we follow a pragmatic approach. On the one hand, if these series contain truly a unit root process, a VAR in differences will be suitable or they will be potentially cointegrated and a VEC is performed. On the other hand, if both are stationary, a VAR in levels will be adequate. Finally, the presence of many structural breaks make advisable to filter the series (this means removing the break) and estimate a VAR with their residuals\(^7\). In sum, four models will be estimated: a Vector Error Correction Model, a VAR in levels, a VAR in differences with the original series, and a VAR with the filtered series.

We begin our analysis using a bivariate model with the variables of interest: residential permits and Gulf soybean price. Then we perform different robustness checks. First, we change the variable of interest and we use building permits. Second, we introduce one covariate in different specifications. We do not introduce more controls simultaneously as we have few observations and the number of parameters to be estimated would be enlarged and degrees of freedom would be lost.

The covariates are: a national index of activity to capture income variations, building costs in dollars and real interest rate (tries to capture other financial investment opportunities). Although yield is essential for the farmer’s income -and consequently for his investment opportunities-, it is not needed as we are not trying to estimate or forecast residential permits and because of our exogenous assumption of Gulf soybean price\(^8\).

In all cases we follow the Hannah-Quinn information criteria for the number of lags in each model and confidence intervals are calculated using bootstrapped standard errors with 500 replications. All models are estimated using STATA except VEC models, which are estimated using JMulti. The confidence intervals of these models are estimated using Hall procedure, since it has more desirable characteristics than the

\(^7\) In behalf of being simple, it has been taken into account only one structural change following Bai and Perron (1998). Linear or polynomial models were estimated as it is shown in Appendix. All filtered series are stationary.

\(^8\) In addition, as yields are annual, many methodological concerns arise trying to convert it quarterly, apart from losing observations.
alternative Efron, which has an implicit asymptotic unbiasedness assumption (Luktepohl, 2005).

Although almost all Johansen tests for cointegration performed give statistical evidence of a cointegrating vector, these tests are not shown since they could be biased because of the presence of structural changes.

4. **Empirical results. Bivariate model**

Specifying a VEC model of zero lags and restricting some coefficients because of the assumption of soybean price exogenity, the effect is significative. A permanent change in soybean price (10.5%) entails a permanent change in residential building permits, which reaches the same impact almost at the end of second year, and finally converges to a permanent change of 11.3% in the fourth year.

Returning to data and looking at figure 1 we can see a structural change in soybean prices which could be interpreted as a permanent change. In fact, according to Bai methodology applied, the first breaking point in levels was the second term of 2007. Prices seems to be a step higher.

On the other hand, residential and building permits show a breaking point in 2004, three years before the oilseed price did. Despite the fact that this seems to be contradictory with results, this might not be necessarily true since the chronological sequence does not imply causality, and the exogeneity assumption is reasonable as there is no effect of the Real Estate market of Rosario to world market of soy. Moreover, it could be hypothesized that changes in prices could have been perceived as permanent by economic agents even before Bai methodology predicts. In fact, by the second term of 2004 prices were 50% higher than second term of 2003 and 78% higher than average prices of the previous five years.

So far, the idea of a permanent change in prices leading to permanent changes in residential permits though possible, it can be improved by another hypothesis which seems to have more foundation. Again, economic agent's perceptions are the clue. If changes in prices had been perceived as transitory, people would have invested that extraordinary rent. This unexpected increase in income couples with a recovering economy, low costs in dollars, and distrust in the financial sector were a perfect mixture to invest in bricks.

This second thesis is represented in the VAR model in levels. In this case, a 10.5% shock in prices slowly goes down as the series has long memory. This entails an enduring effect on residential permits reaching a maximum of 7% seven quarters later and then fades out slowly. The time path is reasonable for two reasons.

First, it follows quite well the soy cycle: it takes a whole season knowing the economic result plus the investment made for the second one. Also, another way to see it is that includes the soy season knowing the profits, and then six months where the investor plan where to put the money. As an example, in the case of Rosario, many trusts were

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9 In fact, performing the Granger causality test, residential permits Granger cause soybean prices. The fallacy of inducing that something is the cause of its effect because it happened before, Samuelson in his introductory book of economics calls it in latin "post hoc ergo propter hoc": "after this, therefore because of this"
created as a financial mechanism to construct buildings and that takes time, and that trusts were funded with the extraordinary profits after the soybean campaign.

Second, looking at the slope of the impulse response function we observe the effect of time on it. The passage of time has more impact during the first year, which usually goes along with the time horizon of an investor who will not have the money immobilized for more time. Also, for a producer who has not covered from price risk, when the impulse occurs matters: a shock price during the harvest period has more influence than recently after the sowing.

Regarding the persistence of the effect exhibited in the VAR in levels model, the mathematical explanation is linked to the fact that the soybean price itself takes time to go back to its original price. However, we should explore some possible economic reasons of this persistent effect over residential permits.

Persistent higher prices—though decaying—leads to more construction if profits remains high and/or is still an adequate investment opportunity. The extraordinary rent is difficult to maintain for the producer, and the “rent seeking behavior” of the suppliers will turn up. A more demand of seeds, fertilizers, pesticides will probably increase its prices. Moreover, the value of land also rises and therefore the lease of fields grows in paralell. For our analysis it does not matter how the extraordinary rent is distributed, meanwhile this extraordinary rent keeps in the Region and does not disperse. According to the low supply elasticity of land, the landowners will, sooner or later, benefit of the extraordinary profits. To sum up, whether profits remains in the producer or in landowners, the money is anyway available to invest in bricks.

The second reason is to maintain itself as an opportunity of investment. As we have commented in the introduction, Lapelle (2011) explains that Real Estate has a higher investment yield than investing in stock exchange or in deposits in the bank, at least for the period 2003-2010. So, the persistence could be attributed to the characteristics of the Real Estate market of Rosario.

In the rest of the specifications models, the impulse response functions though positive, are not statistically significative. The VAR in differences model is explaining that changes in growth rate prices does not affect changes in growth rate in residential surface. In other words, growth rates are not as important as price level does.

Finally, the proportion of forecast error of residential permits accounted by soybean prices increases with time and is larger in the VEC model. In the short run, it is probably not the main cause of residential permits’ behavior.

**Figure 2**

Notes: Forecast error variance decomposition of the VAR in levels and VEC. Confidence intervals are not shown.
5. **Robustness checks.**

In the previous section, we estimated four different bivariate models due to the misgiving of the unit root tests performed, caused by the presence of structural breaks and few observations. Now, to make it comparable, we keep those specifications and introduce some robustness checks. First, we replace our output variable by a similar one: building permits. Although strictly speaking it is not a robustness check, it is informative to see how a similar variable behaves. Then, different control variables are introduced into the model one at a time in order to not losing degrees of freedom as the number of parameters to be estimated enlarges. Despite almost all cointegration tests performed gives evidence of one cointegration rank, we do not show them as they would probably be influenced by structural changes of the series used as controls.

Regarding building permits, neither the VAR in levels representation, nor the VAR in differences nor the model with filtered series give statistical evidence of an impact of

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**Notes:**
- a. 95% CI bootstrapped standard errors with 500 replications in all models, except VEC.
- b. The restricted VEC models contain one constraint that reflects the weak exogeneity of soybean prices (alpha=0) in the error correction term. Its VAR representation is a VAR(1). Estimation procedure: two stage. First: Johansen approach. Second: EGLS. 95% Hall percentile bootstrap confidence intervals based on 500 bootstrap replications.
changes in soybean prices on building permits. Nevertheless, the VEC specification suggests that a permanent change of 10.5% in soybean prices accomplishes a permanent change in building permits of 7.5%, which is statistically significative. This punctual estimation is less than the one obtained with residential permits. This result is reasonable, taking into account that building permits includes commercial, educational and other types of construction, which are also influenced by other variables.

The reason of introducing EMAE as a proxy variable of income tries to account for the relationship between income and investing in real state. At a macro and micro level, relationship could come from both sides, and the VAR methodology is adequate in terms of letting that bi-variate relationship flows. The more money a family has, the more investment can be done in apartments. Also, the other way round could be true: the more investment done, the more income a family will have.

Using EMAE as a proxy variable of income, the significance of the results does not change in comparison with our bivariate model benchmark. However, the effect is larger in the VAR in levels reaching 11.5%, and in VEC 25%.

The next covariate analyzed is real interest rate. The purpose is to introduce a sort of opportunity cost of investment. Also, the lower the interest is, the cheaper is to borrow money in real terms and investment in capital goods is therefore encouraged. The orthogonalized impulse response function is significative in the VAR in levels model only in five quarters. The effect reaches 7% and then goes down. Unfortunately, the sample has fewer observations than the bivariate model, ranging from 1999 to 2015. Although not strictly comparable in terms of the size of the effect, the significance is still reached even with fewer observations.

Finally, the aim of introducing building costs in dollars is a way of seeing how affordable for a producer is to invest in bricks. As the producer exports in dollars, the revenues´ purchase power is related to the exchange rate and the cost of a bundle of goods needed to construct. In the VEC specification the OIRF reaches 15% in the twentieth quarter. In the VAR in levels almost reaches 10% being significative in some periods. Again, results are similar to our benchmark.

**Figure 4 Building permits**

Notes: a- The restricted VEC models contain one constraint that reflects the weak exogeneity of soybean prices (alpha=0) in the
Notes: 95% CI bootstrapped standard errors based on 500 replications.
a. VEC(1) Estimation procedure: two stage. First: Johansen approach. Second: EGLS. 95% Hall percentile bootstrap confidence intervals based on 500 bootstrap replications. Soybean coefficients have been restricted to zero. b. The VAR in levels is a VAR(2). c. VAR in diff (1). d. The EMAE series is filtered by a polynomial trend and a structural change. Figure could be seen in Appendix. The series are stationary. A VAR(1) is estimated.

Figure 5 EMAE as control

Notes: 95% CI bootstrapped standard errors based on 500 replications.
a. VEC(0) Estimation procedure: two stage. First: Johansen approach. Second: EGLS. 95% Hall percentile bootstrap confidence intervals based on 500 bootstrap replications. Soybean coefficient is restricted to zero. b. The VAR in levels is a VAR(2). c. VAR in diff (1). d. The EMAE series is filtered by a polynomial trend and a structural change. Figure could be seen in Appendix. The series are stationary. A VAR(1) is estimated.

Figure 6 Real interest as control
6. Conclusions

In this paper, the plausible effect of soybean prices into the building activity of Rosario is studied using VAR methodology and the exogenity of the oilseed price is assumed. Differents unit root tests are performed into the series in order to see its stationarity. Due to the presence of structural changes, results are not conclusive and differents bivariate models are presented based on different assumptions of the true characteristic of the serie. Once the bivariate model is estimated as a benchmark, different robustness checks are performed based on the same models used for the bivariate case. Although a positive effect is found, the FEVD gives account of a probable small explanatory power.

It is difficult to come to a final and undoubted conclusion as results are mixed. On the one hand, VEC specifications could be giving evidence of how a permanent change in soybean prices affects positively residential permits permanently. On the other hand, perhaps this change is considered as transitory, its effect lasts in disappearing, and we are close to a random walk process, which is difficult to verify as we stated in the unit root tests section.
Although the structural change identified in residential permits is before the one in soybean prices, this is a methodological identification made ex-post. We do not know the real perceptions of economic agents at that time, but we do know is that by the second term (the harvest period in Argentina) of 2004 prices were 50% higher than second term of 2003 and were 78% higher than average prices of the previous five years. According to the permanent income theory, if the shock of income was perceived as transitory, savings would have increased, and this savings could have increased in the form of investment in bricks. Despite the fact prices fell down in 2005, the rent gained in the previous campaign enabled to spill it over the construction sector. Moreover, there were other economic reasons that helped that boom: a recovering economy, low building costs in dollars and a collapsed financial system.

To sum up, data are acquainting for a plausible positive effect, and in some VAR models that effect is significative after a year or two, which is reasonable. Also, this positive effect is in concordance with the results obtained by Grimes and Hyland (2013) in New Zealand. Another reasonable result, is that the response in residential permits is larger than building permits, a variable that includes other types of construction (i.e. education or health buildings).

Although it could be redundant, no model in the VAR in differences specification gives evidence of an effect, meaning that changes in the growth rate of soybean prices do not affect residential permits.

Further research should be taken in order to shed more light on the relationship between the surplus in the agrarian sector and construction activity, reflected here between soybean prices and construction in Rosario. Another methodologies could be used, such as panel data using building permits of different cities, or threshold VAR models in order to inquire if there is a minimum price from which an effect could be detected.

Finally, some policy concerns arise at the end of this paper. For instance, for fostering the building activity, is it better to give soft loans -such as the Pro.Cre.Ar- or just remove export taxes and leave the private sector invest in construction? Unfortunately, this question is out of scope of this paper, but it is a first step that goes in that direction.
References

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DATA APPENDIX

Building permits: it includes the authorized covered area in m² for all types of buildings: residential, commercial, and others. In addition, it includes new buildings and extensions. Source: Municipality of Rosario.

Residential permits: it is a subset of building permits and includes only new residential buildings. Source: Municipality of Rosario.

EMAE (base 1993=100 seasonally adjusted): index of national economic activity. Source: INDEC. A word of caution: In 2016, the new National Government declared “statistical emergence” which means that many indicators must be revised backwards. In the case of EMAE, the new data available and official is base 1993 up to 2013q4, and base 2004 from that year up to the present. We decided to use the first series.

Nominal interest rate BADLAR: The Buenos Aires Deposits of Large Rate (BADLAR) is calculated by the Central Bank taking into account a sample of banks in Capital Federal and Gran Buenos Aires. Includes deposits from 30 to 35 days of more than one million Argentinian pesos. Source: Central Bank of Argentina

Real interest rate: It is the BADLAR rate deflated by a composed price index. It begins with the National Price Index and the uses a mixture of San Luis and Capital Federal consumer prices indexes. This procedure is recommended by the new INDEC until new figures are calculated.

Building costs in dollars: It is the Construction Cost Index divided the official exchange rate in Argentina. The series tries to reflect the cost of building in current dollars. Source: own elaboration based on INDEC and Central Bank of Argentina.
Appendix I: Figures

- Authorized Covered Area for Rosario (1994-2015)

- Index of economic activity

- Building costs in dollars

- FOB Gulf Soybean real price (2010)

- Interest rates

- EMAE index (base 1993=100) seasonally adjusted
Appendix II: Structural changes

Structural change in residential permits

Structural change in building permits

Structural change in soybean price

Structural change in lnemae

Structural change in real interest rate

Structural change in building costs in dollars