10 YEARS OF VALUE ADDED IN THE ARGENTINE WHEAT VALUE CHAIN

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Abstract
Argentine is considered one of the main players in the wheat world market. With more than 15 million tons of yearly production and an average of 10 million tons exported over the last 10 years the country is the 11th producer in the world and the 5th exporter of this cereal. Few efforts have been made to measure the economic impact and the complex interrelationships among the links of the wheat value chain and the objective of this article is to fill that gap. We constructed an internally consistent model that identifies the input-output relationship among 13 individual links. The model seeks to measure the value added of the Wheat Value Chain by building up from the value added of 13 component parts: seeds industry, agrochemical industry, fertilizer industry, farming subcontractors network, primary production, technical & administrative services, return to land, transportation, storage service, ports, wheat milling, bakery industry and government. An effort has been made to estimate the Value Added in each step of the process with a methodology consistent with the National Accounting System. We seek to estimate the Total Value added, its internal distribution as well as its evolution during the last decade, identifying the main factor explaining the inter-annual variation of the chain VA. Sensibility analyses was also performed on the model, shocking exogenous parameters and testing how the nature of the shock has different impacts on the chain and on each link.

KEYWORDS: Wheat value chain, input output model, Argentine agro industry

Introduction

Argentina is considered one of the main players in the wheat world market. With more than 15 million tons of yearly production and an average of 10 million tons exported over the last 10 years the country is the 11th producer in the world and the 5th exporter of this cereal. More than a hundred years of wheat production has encourage the development of a complex value chain with the interaction of thousands of agents in a unique structural configuration.

A ton of wheat coming out of a farm is the combination of natural resources, agrochemicals, fertilizers, seeds, machinery services, entrepreneurship and professional agronomical knowledge among others. Financial resources flow fluently and technology spreads through a complex diffusion network. The production of a kilo of bread or pasta requires a whole industrialization process to transform the primary grain into a differentiated food derivative. The logistic required to export a ton of wheat or flour involves freight, silo services or port infrastructure that demands precise coordination.

This characteristic also shaped argentinean tastes and habits: according to the Food and Agricultural Organization (FAO) wheat staples represent almost 35% of Argentinean caloric consumption, positioning the country as one with the highest per capita consumption figures in the world.

Few efforts have been made to measure the economic impact and the complex interrelationships among the links of this chain. The objective of this article is to fill that gap.

In order to do so we constructed an internally consistent model that identifies the input-output relationship among 13 individual links. In addition an effort has been made to estimate the Value Added in each step of the process with a methodology consistent with the National Accounting System. We seek to estimate the Total Value added of the wheat chain, its internal distribution and its evolution during the last decade.

The paper is structure as follows: Section I describes the benchmark structure of the model and the methodology applied. In section II we carry out a sensibility analysis of the model testing the differential response of each sector to a variety of shocks. Results are presented in Section III, and Section IV concludes.

Section 1: The model

Background

The model seeks to measure the value added of the Wheat Value Chain (W.V.C.) by building up from the value added of its component parts. Using this methodology, we were able not only to measure the value added of the chain as a whole but also to understand its internal distribution and the response of each link to different shocks. The model is calibrated to measure the value added generated during the decade starting with the season 1997/1998 to 2006/2007. We divided the chain in 13 sub-sectors using accounting identities for each one, with data from many sources in an internally consistent model.

The 13 sub-sectors are: seeds industry, agrochemical industry, fertilizer industry, farming subcontractors network, primary production, technical & administrative services (for primary production), return to land, transportation, storage service, ports, wheat milling, bakery industry and government.

Box 1 describes the basic accounting identities used through the paper. Total Value Added (VA) is the sum of value added in each sector plus export taxes revenue. This distinction has to be made because Gross Value of Production (GVP from now on) in many sectors is valued using FAS[1] price. As this price relates inversely with export tax rate, doing otherwise would undervalue chain VA making it incomparable with argentinean GDP. VA in each sector is the VA before taxes (VABT) minus taxes, while VABT is defined as GVP minus cost.

The methods used to estimate GVP, costs and taxes for each sector will be explained below.

[1] Free Alongside Ship, usually referred as the internal price of goods.

Box 1 Accounting identities and price valuation definitions

$VA = \sum_{s \in S} VA_s + export\_tax$	$FAS = FOB \cdot (1 - export\_tax\_rate) - ports\_price$
$VA_s = VABT_s - taxes_s$	$ports\_price = (fixed\_port + variable\_port \cdot FOB)$
$VABT_s = GVP_s - costs_s$	$storage\_price = (fixed\_stor + variable\_stor \cdot FAS)$

Three of the five price definitions used to properly value the model are also presented in Box 1 above. (1) The internal price (FAS) paid by the wheat and flour is a theoretical one built from the FOB price, subtracting from it the export taxes and the price paid for the port service. (2)Wheat and flour FOB[2] prices are January-February-March average (harvesting time) on Argentinean ports. (3) Port service prices for each ton exported is the sum of a fixed and a FOB-dependent component. This is done to allow for price variations when performing sensibility analysis on section 2. Both components were provided by sector specialists. (4) Storage price is valued the same way, but its variable part is FAS-dependent instead of FOB. The base price for each year comes from specialized magazine “Margenes Agropecuarios”. The same source was used for (5) primary production inputs prices (IP_i) and technological & administrative services costs, valued as of June of each year (seeding time).

Primary production

The country is split into 17 agronomical heterogeneous regions (Indexed as R). Each of these group agronomical homogeneous departments from a total of 224 departments (indexed as D in the model). The 2006/2007 season average department production was 65 thousand tons while the average sown area was 25 thousand hectares.

[2] Free On Board, International Price of goods

Table 1: Country regional wheat production

	Area				Production			
	1996/1997		2006/2007		1996/1997		2006/2007	
	Thous. Has	%	Thous. Has	%	Thous. Tons	%	Thous. Tons	%
Mar y Sierras	1109	10%	1031	10%	4034	14%	3751	13%
Southwest Buenos Aires	973	9%	869	8%	2591	9%	1562	6%
East Buenos Aires	30	0%	32	0%	86	0%	134	0%
North Buenos Aires	563	5%	326	3%	1597	5%	1319	5%
West Buenos Aires	363	3%	292	3%	1008	3%	1136	4%
Southeast Buenos Aires	198	2%	155	1%	595	2%	618	2%
Sandy West	354	3%	81	1%	813	3%	147	1%
Semiarid region	636	6%	322	3%	1341	5%	536	2%
	4227	74%	3107	56%	12066	82%	9202	63%
Center Santa Fe	214	2%	256	2%	252	1%	592	2%
South Santa Fe	651	6%	530	5%	1455	5%	1730	6%
North Santa Fe	37	0%	66	1%	39	0%	109	0%
	902	16%	852	15%	1746	12%	2432	17%
South Litoral	268	2%	279	3%	584	2%	889	3%
North Litoral	26	0%	110	1%	27	0%	141	0%
	295	5%	389	7%	611	4%	1031	7%
Center Region	189	2%	395	4%	249	1%	784	3%
North Cordoba	18	0%	266	3%	21	0%	361	1%
	207	4%	662	12%	270	2%	1145	8%
Argentine Northwest	59	1%	373	4%	90	0%	547	2%
Chaco Santiagueño	14	0%	156	1%	17	0%	187	1%
	72	1%	529	10%	107	1%	734	5%
Total	5702		5538		14800		14544	

Source: own elaboration with data from SAGPYA

Table 1 summarizes area and production information for each region for the first and the last season analyzed in this work. Both production and area remain fairly stable during the decade, with a difference of only 160 thousand hectares and 250 thousand tons between 1997 and 2007, but a clear change in the regional distribution of production can be seen when analyzing the figures. The decade saw, accompanying the soybeans revolution that the country lived during the period, the emergence of non-traditional areas of production in the north and center of the country, replacing the traditional Pampean core regions. Wheat is characterized by a special complementarily with soybean production. As a winter crop, wheat can be combined, with 2nd crop soybeans, allowing for a double use of the same parcel within the same season. This feature, and the widespread use of genetically modified soybeans and no tillage practices, among other specificities of Argentinean production, turn the wheat production profitable in regions that were considered marginal in the near past.

Four production identities, summarized in Box 2, will be used when estimating the model. (1) The average yield in each region by technological level will be addressed as $Y^t{}_r$ (2) the aggregate area under production in each region using each technology will be identified as $A^t{}_r$ (3) $prod_r$ will be used to identify de production in each region (simply area times yield) and (4) tot_prod will be the sum of each region production.

Box 2 production identities

$$Y^t{}_r \qquad \forall r \in R, t \in T$$

$$A^t{}_r \qquad \forall r \in R, t \in T$$

$$prod_r = \sum_{t \in T} Y^t{}_r A^t{}_r \quad \forall r \in R$$

$$tot\_prod = \sum_{r \in R} prod_r$$

We built, for each region, two production functions representing heterogeneous technological levels relating input needs with wheat production[3]. Each production function, which represents the average technology applied in each region, results in a combination of the expected needed amount of each input to produce the average yield effectively observed. Using this information, we constructed a 13 x 17 x 2 input-output matrix (IO Matrix) representing unitary physical demand per hectare of each of the 13 inputs for each of the 17 region in both technological levels. In what follows, each of the elements of this matrix will be identified as $IO^t{}_{ir}$. Table 2, draws an example for South Buenos Aires.

Table 2 input output matrix for South Buenos Aires by technological level

		South Buenos Aires	
		Average Tech	High tech
Farming Works	UTA / ha	1.55	2.1
Wheat Seeds	kg/ha	120	120
Seed treatment	50 kg	0.1625	0.1625
Glyphosate*	kg/ha	2.2	2.4
Sulfonilureas + Dicamba	l/ha	0	0.1
Graminicide	Dosis	1	1
Metsulfuron + Dicambra	l/ha	0.2	0.2
Fungicide	l/ha	0.5	0.5
Cypermetrin	l/ha	0.1	0.1
Urea	kg/ha	80	170
Diamonic Phosphate	kg/ha	60	100

Source: own elaboration

This input-output relationship was constructed using 2006/2007 data, and was kept constant for the decade. This indeed involves some strong assumptions about the input intensity in the early year of the estimation as a general tendency toward technological progress has been observed, especially in the use of fertilizers and agrochemicals. Anyway, after interviews with technical professionals we concluded that the bias might not be significant, even thought we expect to correct this in further extensions of the model.

Gross Value of production

In order to estimate the GVP of each sector, we needed to identify both quantities and prices of product and services sold. In order to do so, two methods of estimation were applied.

The first one was used to estimate de GVP of seeds industry, agrochemical industry, fertilizer

[3] We would like to thank AACREA, specially Ricardo Negri and his team, and the Agricultural Estimations team of the Bolsa de Cereales (Buenos Aires Grain Exchange) for their invaluable help in this subject.

industry, farming subcontractors network, technical & administrative services (for primary production), transportation, storage service and port services.

Knowing the distribution of hectares using each technology in each region, we could use the IO Matrix to aggregate the total requirement of inputs in each of the upstream sector. By simply multiplying this amount by the input price we obtained an estimation of total sales of seeds, fertilizers and agrochemicals. In order to check for consistency of the data, the physical input demand obtained using this procedure was then compared with information provided by industry informants[4] and official figures. Even thought the numbers obtained were not the same, their orders of magnitude were acceptable.

$$GVP_{\{seeds/\ fert/agroq\}} = \sum_{i \in sector} IP_i \cdot \left(\sum_{r \in R} \sum_{t \in T} IO^t{}_{ir} A^t{}_r \right)$$

Revenue accrued by Subcontractor network[5] was split in two sources of income: farming works and harvesting services. The first component was estimated using the same procedure applied for other upstream sector. On the other hand, harvesting services income was estimated as a share ψ_r (usually 8%) of total production in each region. Multiplying this amount of production by its FAS we obtain de total GVP of this component.

$$GVP_{\{contractors\}} = IP_{farm} \cdot \left(\sum_{r \in R} \sum_{t \in T} IO^t{}_{farm,r} A^t{}_r \right) + FAS \cdot \sum_{r \in R} \psi_r\, prod_r$$

Administration and technical services GVP is obtained by multiplying its price per hectare by the total area under production.

$$GVP_{\{adm\,\&\,tech\_serv\}} = Serv\_price \cdot \sum_{r \in R} totarea_r \cdot \rho_r$$

Region production is weighted by a parameter $0 \leq \rho_r \leq 1$. The idea of this parameter is to distribute the Administration and technical services among the various crops that may use a hectare in a single year. The methodology to determine the weight of these indirect costs for each crop is the share in total income, which is calculated as follows:

$$\rho_r = \max\{\gamma_r, 0\} + \min\{(1-\gamma_r), 1\} \left(\frac{prod_r^{wheat} \cdot FAS^{wheat}}{prod_r^{wheat} \cdot FAS^{wheat} + prod_r^{soy2nd} \cdot FAS^{soy}} \right)$$

Where $\gamma_r = \dfrac{area_r^{wheat} - area_r^{soybeand}}{area_r^{wheat}}$

Return to land is supposed to be a 35% of total production. This important assumption is

[4] Cámara de Sanidad Agropecuaria y Fertilizantes CASAFE
[5] Even thought primary producers might do the farming works or the harvesting of their crops by themselves, subcontractor GVP has been measured with the assumption that all the labor was outsourced, in order to capture the remuneration of this production factor. The same assumption was applied to the rent accrued from land factor

incorporated because of its "single rule" appeal, in order to avoid multiple ad-hoc assumptions for each region in each season. The figures calculated with this rule was fairly coincident for those regions where information was available and this methodology allowed us to obtain return to land estimations for those regions without a reliable data source.

$$GVP_{\{Rent\}} = \alpha \cdot FAS \cdot \sum_{r \in R} prod_r$$

The quantity unit used for GVP estimation for storage and port services is the tons produced and tons exported respectively. GVP is obtained by multiplying this quantity by the corresponding price, as follows:

$$GVP_{\{ports\}} = exports \cdot ports_{price}$$
$$GVP_{\{storage\}} = tot_{prod} \cdot storage_{price}$$

The GVP for the primary producers was estimated assuming a FAS price for wheat with export destination and FAS price plus 10% for wheat sold for local milling. This premium reflects the idea that the average ton of wheat demanded for local milling is of better quality than the average one exported. Freight in this model is considered a cost for producer and not a factor affecting the price they receive.

$$GVP_{\{primary\}} = exports \cdot FAS + milling \cdot FAS(1 + 10\%)$$

A second methodology was used in the case of milling and bakery industry. In this case, because we do not have a proper measure of sales, GVP is estimated through an expansion over costs. This methodology was used as estimations of inputs in both sectors were available. The procedure applied was as follows:

We disaggregated, from the MIP-97, the GVP in three components: Value Added (including tax net of subsidies), in-chain inputs (basically wheat for milling and flour for bakery and food products) and outer-chain inputs, measuring the share of each of the component. We can then estimate the share of in-chain inputs (ICI) over total costs (β) and the value added over costs (δ). The quantity of yearly wheat purchases by the milling industry is a known data, which allow us to obtain the in-chain inputs. In order to obtain an out-chain inputs (OCI) benchmark for the season 1997/1998 we expanded the ICI using the β parameter. For the following years, we simply indexed this OCI estimation with the wholesale (U$D) price index of the economy (ω_t). Thus GVP for each year is simply the sum of in-chain inputs and out-chain-inputs multiplied by the value added over costs estimated previously[6].

$$OCI_{t\{milling/bakery\}} = \frac{ICI_{1997}}{\beta}(1 + \omega_t)$$

$$GVP_{t\{milling/bakery\}} = (ICI_t + OCI_t) \cdot (1 + \delta)$$

[6] This procedure involves a very strong assumption of a constant VA over cost parameter (δ) through the whole period, which is expected to be removed in further extensions of the model. When using this assumption of constant mark-up, we instantly translate every cost change, be it a OCI or a ICI price variation, to the final price of the output and may thus not reflect the true market condition. It should be noted that the mark-up do not only involves profits, but also wages, amortizations, taxes, etc.

Transport Model

We develop a specific model for the transport sector, in order to better capture the flow of goods during the productive process. Wheat production has basically two possible uses: the milling industry for flour production or exports as grain.

The model applied to capture this flow is a two-step procedure. *The first stage* is to identify where the milling industry receives the supply of wheat from. The assumption used is that each of the mills, located in any of the 224 departments, will always buy the wheat from the closest supplier available. Having this in mind we build an algorithm that cycles through each mill letting them draw resources from the closest department, if not available it will search on the second closest one, if not available on the third and so on. Once the mill buys the wheat from a department (that may not be enough to satisfy its total wheat needs) the next mill decides. After all mills have been supplied at least once, a second round begins, where each mills search again for the closest provider. The procedure continues up to the point where all milling demand has been fulfilled. After the first stage, each producing department has an unsold amount of wheat. During *the second stage* this quantity is sent to the closest port thus maximizing income.

When ending this two-step procedure, a lot of information on transport flows is available. Wheat dispatched through each port, kilometers covered by wheat transport, average tariff paid and, most importantly, the GVP of the transport sector. We add, to the GVP measured this way, a 20km-per-ton tariff in order to transport the wheat from the farm to a local silo and an income corresponding to the exports of flour. The average tariff paid per ton of flour transported is supposed to be the same than that for wheat.

Cost per sector

Having the GVP per sector, the second value that is needed is the intermediate input cost required to produce it. For every sector with the exception of the producer, rent and administration services we used the following formula as measure of its costs.

$$Cost_{sector} = GVP_s \cdot \lambda_s$$

Where λ_s comes from the MIP-97 and is simply defined as $\frac{Cost_{sector}}{GVP_{sector}}$.

λ for seeds, fertilizers, agrochemicals, crushing, ports and storage services come from the MIP-97. Wages, interest on capital, amortizations and taxes were not considered part of the costs as they are captured in the value added.

Both land return and technological and administration services were supposed to have no production costs, being their VA estimated as GVP minus Taxes. As the cost structure for freight, farming and harvesting works was no easily identified in the MIP-97 we estimate its figures using data from “Margenes Agropecuarios” magazine.

The cost structure for producers was estimated as the sum of the GVP of seeds, fertilizers, agrochemicals, transport, return on land, silage and port services, farming and harvesting works and technological and administrative services plus a small estimate of other secondary inputs (fuel, office expenditures, etc)

$$Cost_{producer} = \sum_{s \in Sector} GVP_s$$

Finally, the cost portion of the GVP for bakery and milling was estimated using the parameter δ obtained in the previous section.

Taxation model

The tax model was constructed estimating figures for the following nine taxes or tariffs, (a) export taxes (b) social contributions (c) Sales tax (d) income tax (e) financial transactions tax (f) property tax (g) road maintenance tax (h) gasoil tax and (i) stamp tax.

Export tax revenues were estimated as a rate on the total export value, estimated as wheat and flour export quantity multiplied by FOB price. The tax rate used was 0% for seasons from 1996/1997 to 2000/2001, 10% for wheat and 0% for flour in 2001/2002 and since then 20% for wheat and 10% for flour.

Social contributions are a tax on the payroll of each sector. Due to not having a proper measure of employment and wages, we used the share contributions figures over VABT from the National Accounting System7.

Sales tax is paid over de GVP of each sector using the specific tax rate for each industry according to the Buenos Aires legislation. Since 1994 primary production is exempted of this tax with the exception of Buenos Aires Province, so the tax was applied only for the wheat produce in Buenos Aires.

Income tax is paid by every sector according to its Value Added before taxes. We again based our estimation in the National Accounting System figures in order to obtain a measure of the proper tax base. The tax base, estimated as VABT minus total payroll, pays a rate which was informed by the National Tax Bureau (AFIP) in 2007[8].

Financial transaction tax is 1% of the GVP of every sector. Rent pays a U$D 20,00 and U$D 3,3 per hectare as property tax and road maintenance tax. Subcontractors sector pays U$D 2,95 per hectare of gasoil tax. Stamps tax is paid per ton produced with the corresponding rate for every province.

Section 2: Sensibility analysis

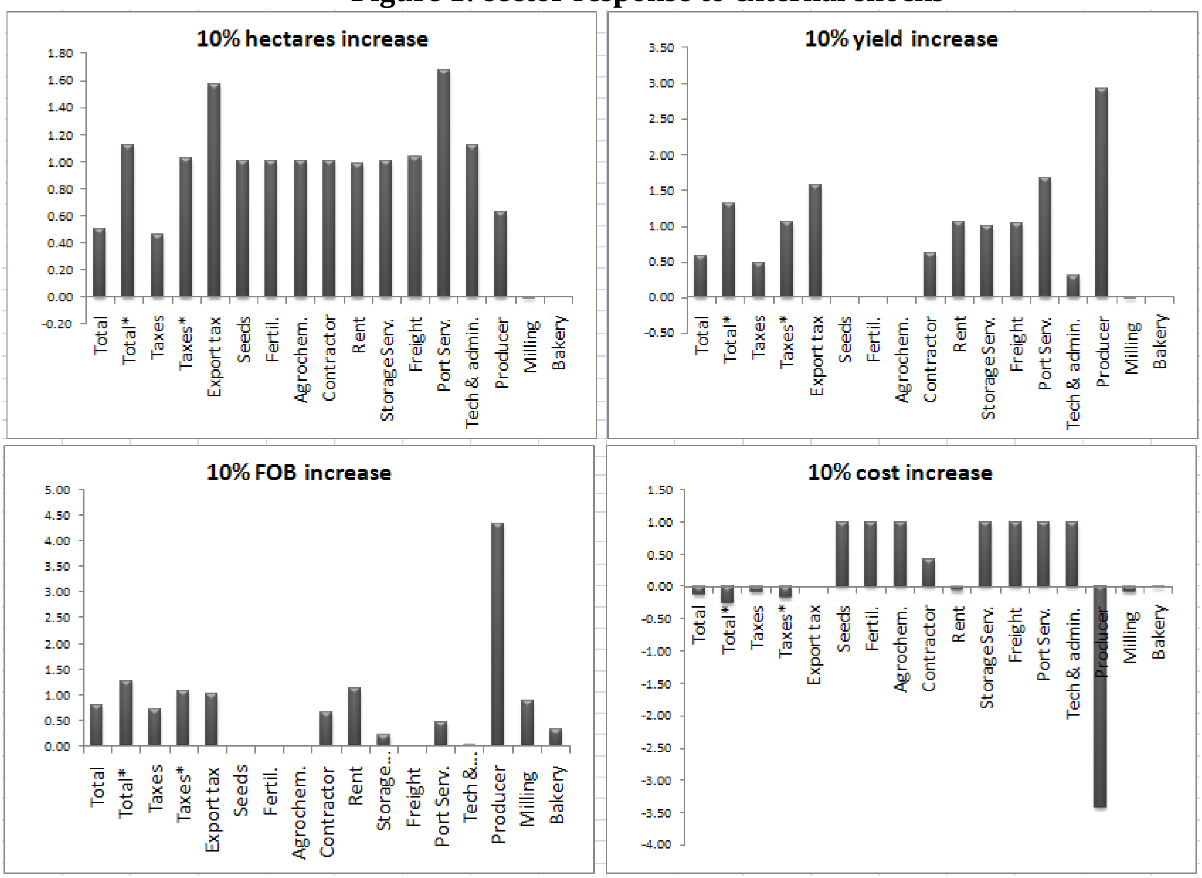
We exposed the model described in section 1 to different theoretical shocks in order to test for

[7] Dirección Nacional de Cuentas Nacionales – Cuenta de generación del ingreso e insumo de la mano de obra (http://www.mecon.gov.ar/secpro/dir_cn/ingreso.htm)

[8] Administración Federal de Ingresos Públicos – Anuario 2007 (http://www.afip.gob.ar/institucional/estudios/)

consistency and analyze the distribution of impacts among the different links of the chain. Four different shocks were simulated. (a) 10% rise in hectares planted (b) 10% rise in yields (c) 10% rise in FOB prices and (d) 10% rise in primary production costs. For each of the shocks, we define the sector elasticity as $\xi_s = \dfrac{\Delta VA_s / VA_s}{\Delta Sp / Sp}$ where Sp is the shocked parameter. The lecture of the elasticities obtained will help better understand the interrelationships working in the model. The results are presented in Figure 1. A general conclusion that will be obtained from the analysis is that the distribution of the absorption of each shock is not independent of its nature. Each figure present estimate of total VA and Taxes revenues (non-export-tax) both with and without inclusion of milling and bakery. This has been done because the high share that they represent (especially bakery) might noticeably bias the results.

Figure 1: sector response to external shocks



(a) Shock in the Area

The first shock was on the area, increasing the amount of hectares planted 10% in every region. This increase can be read both as area substitution from other field crops, as the result of varying weather conditions (droughts, floods, etc) or as the explicit incorporation of new land into production.

Area shock is characterized by its relatively homogeneous distribution. With a few exceptions, elasticity appears to be close to 1. Milling and bakery elasticity is almost zero, as the quantity and price of inputs and outputs remains fixed. This also explains why total VA elasticity, including milling and bakery, is almost 0.5. It is interesting to note how the export tax revenue and the port service VA elasticity is sensibly higher than 1, ranging from 1.6 to 1.8. This can be explained by the fact that, as internal demand remains constant, all extra production is exported. Producers VA, on the other side, do not grow as much as the new hectares in production. This is so because the primary producer is supposed to receive all the burden of cost increases. The new production requires a more than proportionate increase in transports, the new area increases the production that is not carried over sharing fixed costs with 2nd-crop soybeans and finally, as wheat with milling destination is supposed to pay a premium over export, as the new production is exported the total income is increased less than proportionate.

(b) Shock on the yield

A shock on the yield, leaving untouched the productive area, has a heterogeneous result in terms of internal distribution. It should be noticed that yields are not supposed to be technology-induced but weather induced as they do not imply a change in the producer input-output matrix. Being so, it can be seen how seed, fertilizers and agrochemicals industry VA are neutral to a yield shock. As in the previous shocks, export tax revenue and port services, have higher elasticities, as the rise (or fall) in production is use to or drawn from exports. Total VA elasticity (ex. Mill & bakery) is affected more than proportional, showing a ratio of almost 1.5. This can be explained because many costs remain fixed and an increase (reduction) in yields does not affect them. This is not the case, for example, of harvesting services costs, which grows in the same magnitude than the harvest, but if yields are higher, seeds investment do not grow and its costs are liquefied over total production income. This also explains why producer VA elasticity is almost three: as they receive de residual VA after they are heavily exposed to weather shocks.

(c) Price shocks

Price shocks are even less homogeneously distributed than area and yield shocks. It first should be noticed than only those sectors whose income or expenditures are strictly related to price are affected, and this explains why seeds, fertilizers, agrochemical, and technological and administrative services elasticity are zero[9]. Producers are clearly the most exposed to price variations, as costs other than harvesting services and return to land (that is supposed to be paid in species) are fixed. Milling and bakery VA also grow with this shock. As costs in both industries are increased it should reduce the VA, but is supposed to be full cost pass-through, keeping the ratio VA/VBP constant, so that VA in both sectors grow in absolute terms. Total VA grow more than proportionate than the price shock, for the same reasons explained in the yields shock.

(d)Cost/input prices shock

As expected, the cost shock is clearly an internal-distribution shock. The cost rise for the producer is exactly offset by a proportional increase in the income of input providers. Anyway, an interesting result can be seen in the figure. Total VA of the chain might fall if the cost/input prices increase is explained by an increase in its costs of production. In this model, this sector costs were estimated

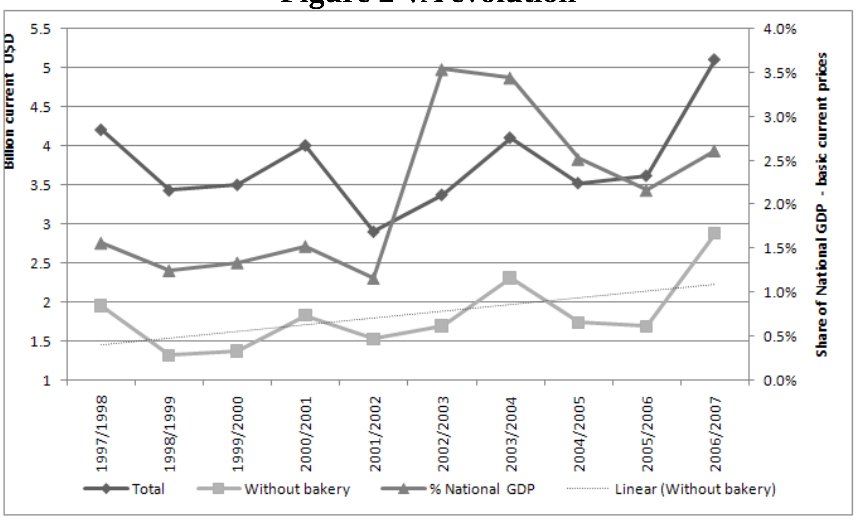
[9] It should be remembered that this is not a general equilibrium model and no second round effect are considered. It might be expected that and increase (decrease) in price, yield o area might affect the input prices even in the short run, but this effect is not modeled here. For example, leaving the supply of agrochemicals constants, increase in demand (yield, price or area induced) would possibly be followed by a rise in prices. These effects are not included here.

using the MIP-97 as a share of their income. Raising their income is also rising their costs of production, so this explain why the total VA shows a negative elasticity. A good example of this could be a rise in gas prices used to produce fertilizers. If this rise induces a proportionate fertilizers price jump, this shock should not be read as an internal distribution but as a loss of the whole chain. The internal distribution of this shock would be explained by how much of the gas price rise is passed through to the fertilizers price, what will depend on the specific characteristics of this market.

Section 3: Results.

Figure 2 shows the results of the estimation for 10 years from 1997/1998 to 2006/2007 both in current U$D billion and as a percentage of GDP. The results are also presented with and without bakery and milling.

Figure 2 VA evolution



It is clear from Figure 4 that two different dynamics can be found when analyzing the chain in U$D millions or as a percentage of GDP. On the one hand, it can be seen how the total VA of the chain ranges from U$D 3 billion on the trough of 2001/2002 to U$D 5 billion on the peak of 2006/2007, with an average of U$D 3.8 billion for the whole period. This movement is mimicked by the VA excluding milling and bakery. With a slight ascending tendency, the VA before industrialization fluctuates between U$D 1.3 billion and U$D 2.8 billion. On the other hand, the share of the W.V.C. on the GDP shows a clear structural break after 2001/2002. During the pegged exchange rate regime, the chain VA represented a share from 1.2% to 1.6% of the argentinean GDP. The ending of the convertibility regime and the strong change in the relative prices in favor of the tradable sector (W.V.C. among them) almost tripled the share of the W.V.C, with a structural change that finally stabilized around 2,4% of GDP, almost 1% above the average of the 1996/2001 period.

Table 3 describes VA, VABT and taxes results of the simulation for the 12 sector for extreme periods, 1997/1998 and 2006/2007. As was already noticed in figure 4, the VA climbs 22% from U$D 4.1 Billion to U$D 5.0. As can be seen in appendix B, this variation is not explained by yield or area but as a result of other parameter. Some interesting internal distribution effect can be seen.

First, the figures obtained by the primary producer turn positive. As was mentioned above that technology was supposed constant, so the negative result might be explained both by the lower FOB price (U$D 147 vs. U$D 216) and by a possible overvaluation of the technology applied during 1996/1997, as was explained above. Second, the non-export-tax revenue grows only 6.1% with the chain VA growing almost 22%, with a drop in the share from 34% to 29.8%. This effect is explained basically by the appearance of the export tax, whose total share climbs from 0% to 8%. Total tax revenue rise from U$D 1.4 billion to U$D 1.9, receiving 54% of the total VA increase (U$D 909). In third place, it is worth mention how the VA of the bakery and food production do not rise even with a wheat FOB increase of 46%. This is basically explained by the reduction in the U$D wholesale index, which shows a decrease of 8% between 1998 and 2007. This result is coincident with other studies on the low incidence of wheat prices on consumer wheat staples[10].

Table 3 internal distribution of value added

	1997/1998						2006/2007					
	Value Added Before Taxes		Value Added		Taxes		Value Added Before Taxes		Value Added		Taxes	
	U$D Million	Share %	U$D Million	Share %	U$D Million	% VABT	U$D Million	Share %	U$D Million	Share %	U$D Million	% VABT
Seeds	$ 132	3.2%	$ 96	2.3%	$ 35	3%	$ 92	1.8%	$ 67	1.3%	$ 25	1%
Fertil.	$ 63	1.5%	$ 38	0.9%	$ 25	2%	$ 76	1.5%	$ 46	0.9%	$ 30	2%
Agrochem.	$ 49	1.2%	$ 30	0.7%	$ 19	1%	$ 44	0.9%	$ 27	0.5%	$ 17	1%
Subcontractors	$ 237	5.7%	$ 158	3.8%	$ 78	6%	$ 238	4.7%	$ 160	3.2%	$ 78	4%
Rent	$ 647	15.6%	$ 367	8.9%	$ 280	20%	$ 768	15.2%	$ 456	9.0%	$ 312	16%
Storage Serv.	$ 63	1.5%	$ 43	1.0%	$ 20	1%	$ 34	0.7%	$ 23	0.5%	$ 11	1%
Freight	$ 182	4.4%	$ 132	3.2%	$ 51	4%	$ 167	3.3%	$ 121	2.4%	$ 47	2%
Port Serv.	$ 64	1.6%	$ 44	1.1%	$ 20	1%	$ 56	1.1%	$ 39	0.8%	$ 18	1%
Tech & admin.	$ 173	4.2%	$ 122	2.9%	$ 51	4%	$ 104	2.1%	$ 74	1.5%	$ 31	2%
Producer	$ -51	-1.2%	$ -105	-2.5%	$ 53	4%	$ 405	8.0%	$ 264	5.2%	$ 141	7%
Milling	$ 324	7.8%	$ 225	5.4%	$ 99	7%	$ 428	8.5%	$ 299	5.9%	$ 129	7%
Bakery	$ 2,254	54.5%	$ 1,577	38.1%	$ 676	48%	$ 2,231	44.2%	$ 1,565	31.0%	$ 666	35%
Sub-total	$ 4,136		$ 2,729		$ 1,407		$ 4,644		$ 3,140		$ 1,504	
Taxes			$ 1,407	34.0%			$ -	0.0%	$ 1,504	29.8%		
Export tax							$ 401	8.0%	$ 401	8.0%	$ 401	
Total	$ 4,136		$ 4,136		$ 1,407		$ 5,045		$ 5,045		$ 1,905	

Having the Total VA estimated for each year and recognizing the evolution of main parameters involved in the estimation, we proceeded to estimate how each factor explained the evolution of the VA during the period.

Five factors were recognized (a) FOB price variations (b) input cost variations (freight, seed, agrochemicals, fertilizers, port, silo and professional services) (c) export tax rate variations (0% from 1997 to 2001, 10% in 2002 and 2003 onward) (d) year on year yield variations and (e) change in hectares planted. The evolution of each parameter is presented in appendix B.

The procedure applied was as follows: for each of the factors, we redo the estimation of the VA of the chain leaving unchanged the desired parameter with the values of the previous year. The difference between the observed total VA and the VA effectively obtained can be understood as the impact of that specific parameter. The procedure was repeated for each of the 6 factors, with a total of 54 individual estimations. The difference between the sum of each individual effect can be understood as explained by a composite effect and other factor not properly captured.

The results of this procedure can be seen in Table 4. Total row show the year over year variation of

[10] Cohan L. Costa R. – "From wheat to bread: a non linear price transmission model" - Mimeo

the VA while each of the following rows describes the specific impact of each factor.

Table 4 Growth accounting

	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	Average	S.D.
Total	-35.0%	4.6%	38.7%	-15.4%	11.7%	39.1%	-26.2%	-4.5%	73.4%		
Price Effect	-20.6%	-13.9%	29.4%	-6.7%	39.9%	8.8%	-30.1%	24.8%	47.9%	8.8%	28.1%
Yield Effect	-16.7%	14.4%	2.9%	-17.5%	-12.1%	38.2%	5.6%	-7.1%	5.2%	1.4%	17.7%
Hectares Effect	-6.2%	13.0%	2.0%	9.6%	-14.2%	-3.0%	5.6%	-18.6%	13.9%	0.2%	11.6%
Cost Efect	0.3%	-0.9%	1.1%	3.1%	7.4%	-1.5%	-5.2%	-0.9%	-0.3%	0.3%	3.5%
Export Tax Effect	0.0%	0.0%	0.0%	-4.8%	-5.9%	0.0%	0.0%	0.0%	0.0%	-1.2%	2.4%
Other (composite ef.)	8.5%	-8.0%	3.4%	1.0%	-2.8%	-3.4%	-2.0%	-2.5%	7.4%	0.2%	5.4%

It is clear how the price effects is the strongest and more volatile among the factors affecting the VA of the chain, even though an average positive effect is observed during this period. It should be remembered from section 2 that price shocks impact with especial intensity on primary producers VA. Understanding the huge impacts and internal distribution of price shocks share light on the importance of the futures and capital markets for hedging and income smoothing on a highly risk exposed activity.

Yield variations appear to be the second most volatile effect affecting the chain, with a standard deviation of 17.7% for the 10 year considered. As with the FOB shocks, yields variations fall mainly over producers, but with a more distributed impact on other links of the chain, such as return to land, port services, harvesting subcontractors, silo services or export-tax subcontractor. The importance of this factor raises interesting questions about the main determinant of the yields during a season. Do they only depend on weather? Can the yield volatility be technology induced? Is there a high correlation in the yield patterns of the country? The hectares volatility is the third effect in importance to explain the VA volatility of the chain, with a standard deviation of 11.6% and an overall neutral effect during the decade. The same questions can be raised on these phenomena, which we hope to answer in future works.

Finally cost effect and export tax appear as the fourth and fifth factors, with a standard deviation of 3.5% and 2.4% respectively. In the first case, it should be remembered from Figure 1 that the effect of cost variations (input prices, exchange rate, silo and port tariffs, freight costs. etc) are basically internal to the chain and their impact on the total VA depends on how much of this shock was induced by out-of-chain price variations (i.e. petroleum prices). This apparently low 3.5% standard deviation in fact reflects very important VA redistributions among the links of the chain. The low figures observed for export tax effect are explained by the fact that only tax rate variations are captured and they only occurred twice during the period under analysis. The first tax hike in 2002 induced a fall of 4.8% in the chain VA, fall that can be read as a net transfer from the chain to the consumers, while the second variation to 20% during the same year caused an additional 5.9% drop.

Conclusion

The objective of the works was to construct an input-output model of the wheat chain value and to obtain estimation of the value added by each link of the chain. In order to do so, we analyzed the specificity of each sector and calculate a proper estimation of its value added. We performed various sensibility analyses on the model, shocking exogenous parameters and testing how the nature of the shock has different impacts on the chain and on each link. We finally estimate the value added by the chain for the decade ranging from 1997 to 2007, and capture the main factor affecting its evolution as well as the variations in its internal composition.

Many interesting result were obtained, that may trigger question for future research. The Value added by the chain ranges from U$D 3 billion on the trough of 2001/2002 to U$D 5 billion on the peak of 2006/2007, with an average of U$D 3.8 billion for the whole period. This figures represented a share from 1.2% to 1.6% of the Argentinean GDP during the convertibility regime, stabilizing around 2.4% thereafter. It was shown how the nature of a shock might affect each link differently. While, for example, area variations appears to be the most evenly distributed exogenous parameter, price shocks affect mainly primary producers

The volatility of the VA during the last decade was disaggregated recognizing its main drivers. FOB price volatility, with a standard deviation of 28.1% was identified as the main source of YoY variations, followed by yield (17.7%) and area volatility (11.6%). Costs/input prices variation where neutral in average but with an volatility of 3.5%, surprisingly high for a shock with such a low VA elasticity.

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We would like to specially thank Sandra de Girolamo (Bolsa de Cereales) for her help in collecting the required information and Estefania Puricelli (Bolsa de Cereales) for her helpful comments on the drafts of this work. Also the agricultural estimations team of the Bolsa de Cereales and Ricardo Negri from AACREA for helping constructing the producers IO matrix.

Appendix A: Total Value Added before industrialization

	1997/1998						2006/2007					
	Value Added Before Taxes		Value Added		Taxes		Value Added Before Taxes		Value Added		Taxes	
	U$D Million	Share %	U$D Million	Share %	U$D Million	% VABT	U$D Million	Share %	U$D Million	Share %	U$D Million	% VABT
Seeds	$ 132	8.5%	$ 96	6.2%	$ 35	6%	$ 92	3.9%	$ 67	2.8%	$ 25	2%
Fertil.	$ 63	4.0%	$ 38	2.4%	$ 25	4%	$ 76	3.2%	$ 46	1.9%	$ 30	3%
Agrochem.	$ 49	3.2%	$ 30	1.9%	$ 19	3%	$ 44	1.9%	$ 27	1.1%	$ 17	2%
Subcontractors	$ 237	15.2%	$ 158	10.2%	$ 78	12%	$ 238	10.1%	$ 160	6.8%	$ 78	7%
Rent	$ 647	41.5%	$ 367	23.6%	$ 280	44%	$ 768	32.5%	$ 456	19.3%	$ 312	29%
Storage Serv.	$ 63	4.0%	$ 43	2.7%	$ 20	3%	$ 34	1.4%	$ 23	1.0%	$ 11	1%
Freight	$ 182	11.7%	$ 132	8.5%	$ 51	8%	$ 167	7.1%	$ 121	5.1%	$ 47	4%
Port Serv.	$ 64	4.1%	$ 44	2.8%	$ 20	3%	$ 56	2.4%	$ 39	1.6%	$ 18	2%
Tech & admin.	$ 173	11.1%	$ 122	7.8%	$ 51	8%	$ 104	4.4%	$ 74	3.1%	$ 31	3%
Producer	$ -51	-3.3%	$ -105	-6.7%	$ 53	8%	$ 405	17.2%	$ 264	11.2%	$ 141	13%
Sub-total	$ 1,558		$ 926		$ 632		$ 1,985		$ 1,276		$ 708	
Taxes			$ 632	40.6%			$ -	0.0%	$ 708	30.0%		
Export tax							$ 376	15.9%	$ 376	15.9%	$ 376	
Total	$ 1,558		$ 1,558		$ 632		$ 2,361		$ 2,361		$ 1,085	

Appendix B: Parameters evolution

Estimation Parameters		1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007
Wheat FOB Price	U$D / Ton	$ 147	$ 127	$ 115	$ 137	$ 131	$ 167	$ 178	$ 137	$ 160	$ 216
Flour FOB price	U$D / Ton	$ 210	$ 188	$ 175	$ 175	$ 176	$ 220	$ 218	$ 156	$ 159	$ 233
Average direct cost per has.	U$D / Ha	$ 154	$ 140	$ 145	$ 145	$ 138	$ 116	$ 131	$ 139	$ 147	$ 154
Average fixed cost per has.	U$D / Ha	$ 70	$ 70	$ 70	$ 70	$ 70	$ 32	$ 35	$ 40	$ 42	$ 52
Freight Tarif (U$D)	300 km	$ 23.3	$ 23.3	$ 23.3	$ 23.3	$ 11.9	$ 13.9	$ 16.1	$ 19.0	$ 16.9	$ 20.7
Export tax rate		0%	0%	0%	0%	10%	20%	20%	20%	20%	20%
Milling	Thous. Tons	4848	4669	4660	4574	4603	4943	5014	5049	5147	5840
U$D Wholesale inflation	I.A.		-3.8%	4.0%	-2.3%	-43.3%	25.0%	7.6%	9.2%	4.9%	8.5%
Exchange rate	UD / AR	$ 1.00	$ 1.00	$ 1.00	$ 1.00	$ 3.12	$ 2.95	$ 2.94	$ 2.92	$ 3.07	$ 3.12
Production	Thous. Tons	14800	12438	14914	15465	14722	11855	14475	15673	12586	14544
Area	Thous. Has.	5702	5396	5977	6079	6560	5780	5636	5891	4971	5538
Yield	Tons/Has.	2.60	2.30	2.50	2.54	2.24	2.05	2.57	2.66	2.53	2.63

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