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A Value Chain Approach to Measuring Distortions to Incentives and Food Policy Effects (with application to Pakistan's grain policy)

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We develop an extended Nominal Rate of Assistance (NRA) methodology to disentangle policy welfare impacts for various interest groups along the value chain (to disaggregate effects within the "producer" and "consumer" umbrellas). We apply our value chain NRA methodology to Pakistan's price and trade policy. We analyse the welfare implications for various agents in the wheat-flour value chain from 2000 to 2013, a period characterized by major global price volatility and by regular adjustments of domestic policies. We find that the wheat price policy has generally benefitted flour consumers and wheat traders at the expense of wheat farmers and to a lesser extent flour millers. Our findings illustrate that the welfare implications of policies can be quite different within the "producer" and "consumer" umbrellas, which has potentially important implications for economic and political economy analyses and for the design of policies aimed at targeting the poorest groups along value chains.

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1. Introduction

Both economic policy and political economy models often consider "producers", "consumers", and "taxpayers" as the main agents in the economy to study the welfare impacts of policies, their incentive effects, and rent (re-)distribution. It is well known that the "real economy" is much more complicated and that many more agents are affected – and also play a role in lobbying governments to introduce or remove certain policies. In agricultural and food policies "other agents" include input suppliers (such as land owners, seed and agro-chemical companies, and rural banks) on the upstream side of the value chain and traders, food processors and retail companies on the downstream side of the value chain. These agents may be differently affected by policies, depending on the nature of the policy (e.g. whether the policy is targeted to the (raw) agricultural commodity (such as price support for grain) or to a processed commodity (such as import tariffs on bread or cheese).[1] As a consequence, these different agents have sometimes joined forces ("political coalitions") with farmers or with final consumers to influence policy makers in setting public policies.

One of the reasons for simple producer-consumer models is of course its didactic use in theory, i.e. to avoid unnecessary complications in economic models to derive policy effects and identify equilibria. Another reason is empirical: the absence of detailed empirical information on policy impacts on various agents. A major contribution to empirical agricultural and food policy analysis in recent years is the World Bank project on "Distortions to Agricultural Incentives", coordinated by Kym Anderson. The project resulted in a major new dataset on measures of the effects of agricultural and food policies, and a growing number of studies using and explaining food policy distortions (e.g. Anderson, 2009; Anderson et al. 2008a; Anderson et al., 2008b; Anderson et al., 2013; Anderson and Nelgen, 2013; Olper and Swinnen, 2013; Olper et al., 2014).

[1] The distribution of rents or taxes among various agents within the producer and consumer groups depends on various factors such as concentration at various stages of the chain, supply and demand elasticities, etc. For instance, it is well known that land owners often capture part of the subsidies to farmers and that this capture depends on the nature of the subsidies, the supply elasticity of land and market imperfections (e.g. Ciaian and Swinnen, 2006; Ciaian and Swinnen, 2009; Goodwin et al., 2011; Latruffe and Le Mouël, 2009).

The project has made a major contribution to empirical analysis by vastly extending the coverage of policy indicators over time and across different countries (regions).

However, as most other projects before, the indicators produced by the project are indicators which measure how much "producers" and "consumers" are taxed or subsidized through various policies. The most important indicators are the nominal rate of assistance to agriculture (NRA), the real rate of assistance to agriculture (RRA) and the consumer tax equivalent (CTE). In these indicators "producers" and "consumers" are a combination of different agents (interest groups). Therefore one needs to interpret the numbers carefully (both from an economic and political economy perspective) to reach the correct interpretation of the impacts.

To illustrate this, consider the NRA for a product such as sugar. The NRA is measured as the ratio between the domestic price of sugar and the world market price, plus any additional taxes and/or subsidies. The NRA for sugar is thus interpreted as how much subsidies "producers" get. Inversely, it is interpreted as how much "consumers" get taxed or subsidized (the CTE is the negative NRA plus any additional direct consumer taxes or subsidies). But who are these "consumers" and "producers"? Since the NRA is measured at the level of sugar, i.e. the processed product, the "producers" include both sugar processing companies and the farmers producing sugar cane or sugar beet. Other agents, such as land owners and agribusinesses supplying inputs to the farmers, may also be affected by the government policies and the impacts on them are also captured in the NRA. This means that it is not clear from the NRA indicator how policies affect specific groups, such as farmers.

The same issue also applies to the "consumer" side. Some sugar is "consumed" directly by households, but most is sold to the food industry, which uses the sugar in various products sold to retailers and only then households consume the sugar.[2] Hence, the impact on all these groups are part of the NRA/CTE effects, but the NRA/CTE indicator does not provide specific information about each group's welfare captures impacts.

[2] For example, in early 2015 the EU's beverage and confection industries and sweetener companies lined up to lobby the EU decision-makers against the extension of the EU sugar quota. These mostly large food companies are included under the "consumer" heading in the indicators. On the other side of the lobbying campaign are farmers and sugar companies – both captured by the "producer" indicator.

In this paper we will try to disentangle some of these distortions/rents among interest groups within the "consumer" and "producer" groups. We explicitly consider the impact on several groups along the value chain. To do so, we first develop a disaggregated NRA indicator to measure these different distortions/rents along the value chain. We then apply this approach to the wheat-flour chain in Pakistan.[3] The wheat-flour value chain in Pakistan is an interesting case since (a) wheat is a very important staple food in Pakistan[4]; (b) Pakistan is a country with significant poverty and food insecurity; (c) the government intervenes heavily at various stages of the wheat-flour chain, and (d) these interventions have been criticized for being distortionary and ineffective (Dorosh and Salam, 2007a; 2008; 2009; Prikhodko and Zrilyi, 2013; World Bank, 2010). We calculate the welfare implications for various agents in the chain for the years 2000 – 2013, a period characterized by major price volatility in global wheat and flour markets and by regular adjustments of domestic policies.

2. A Value Chain Approach to Measuring Distortions and Policy Rents

The NRA measures the extent of distortions to producer and consumer price incentives generated by direct and indirect government intervention at the border and in domestic markets. We extend the methodology of Anderson (2009) and Anderson et al. (2008a, 2008b) to measure the welfare effects for different agents along the value chain. Government policies can affect the welfare of

[3] Our approach is related to the analysis of Ivanova et al. (1995) and Swinnen (1998) of rents in the wheat-flour chain in Bulgaria.

[4] Wheat is the most important agricultural crop and staple food in Pakistan, grown by 80 % of farmers (USDA, 2014). Wheat flour consumption per capita in Pakistan is one of the highest in the world, accounting for about 37 % of daily caloric consumption (Prikhodko and Zrilyi, 2013). Hence, both farmer income and food security are to a large extent associated with wheat production and consumption, in particular among the many poor. An estimated 17 to 38 % of the population is classified as poor and 56 % is considered vulnerable, i.e. being poor or likely to become poor after a shock (World Bank, 2010).

agent *i* in the value chain by changing input prices and/or output prices and/or by providing direct subsidies or taxes. The NRA to agent *i* in a vertical chain is calculated as follows:[5]

$$NRA^i = \frac{(p_o^i - p_o^{i*}) * Q_o^i + \sum_j (p_j^{i*} - p_j^i) * Q_j^i}{p_o^{i*} * Q_o^i} \quad (1)$$

where p_o^i is the actual domestic price of output *o*, p_o^{i*} is the 'undistorted' domestic output price, i.e. the price without government intervention, Q_o^i is the quantity of output sold, p_j^i is the actual domestic price of input *j*, p_j^{i*} is the 'undistorted' domestic price of input *j* and Q_j^i is the quantity of input *j* used to produce output *o*. The NRA to agent *i* can therefore be rewritten as:

$$NRA^i = \frac{p_o^i - p_o^{i*}}{p_o^{i*}} + \frac{\sum_j (p_j^{i*} - p_j^i) * Q_j^i / Q_o^i}{p_o^{i*}} \quad (2)$$

$$= NRA_O^i + NRA_I^i$$

where Q_{Ij}^i / Q_o^i represents the conversion rate from input *j* to output *o*. The NRA to output, NRA_o^i, measures the extent of distortions to output prices expressed as a percentage of the undistorted domestic output price. The NRA to input, NRA_I^i, measures the total extent of distortions to input prices for all inputs *j* used to produce output *o*, expressed as a percentage of the undistorted output price. The total NRA^i to agent *i* is the sum of both.

We now apply this approach to the wheat-flour value chain in Pakistan. Before doing the calculations we give a brief review of the policies causing distortions and rent distribution in Pakistan's wheat-flour chain.[6]

[5] This formula does not include direct subsidies/taxes since these are not relevant for our empirical case. Including these, the general formula would be $NRA^i = \frac{(p_o^i - p_o^{i*}) * Q_o^i + \sum_j (p_j^{i*} - p_j^i) * Q_j^i + z_i}{p_o^{i*} * Q_o^i}$ where z_i represents net direct subsidies to agent *i*.

[6] For more details see Dorosh and Salam (2007; 2008); International Finance Corporation (2011); Lohano, Smith, and Stockbridge (1998); Prikhodko and Zrilyi (2013), Ahmad et al. (2005), USAID (2009) and Zahid et al. (2007).

3. Government Policies and the Wheat (Flour) Value Chain in Pakistan

Figure 1 shows international and Pakistan wheat prices for the period 1994-2013. The correlation coefficient is 77 %, but Pakistan's wheat prices were less volatile than international wheat prices. This reduced volatility was the result of government interventions.

[Figure 1]

3.1. The Wheat Price Stabilization Scheme

Since the 1960s, the wheat and flour markets have been heavily regulated by the government through the Wheat Price Stabilization Scheme, which entails both domestic market interventions and trade policies.[7] The government procures wheat from farmers at the *support or procurement price* and sells procured wheat to flour millers at the *release or issue price*. Government wheat procurement at the support price is intended to increase wheat production and support farmer incomes in post-harvest price depressions. Increasing domestic wheat production has also been seen as a means of improving overall national food security by limiting the reliance on wheat (flour) imports. The distribution of wheat to flour mills at the subsidized release price, in combination with the formulation of ceiling prices for ex-mill wheat flour, are intended to ensure the availability of wheat flour at affordable prices to urban areas and to maintain price stability.

In the past, Pakistan was a wheat-deficit country with domestic production typically accounting for about 90 % of availability. The government controlled wheat trade through the Trading Corporation of Pakistan and did not allow private sector wheat imports until 2000 (Prikhodko and Zrilyi, 2013). Imports of wheat were used to supplement domestic production with the aim of stabilizing domestic supply and prices.[8]

[7] Wheat in Pakistan is mainly produced in the Punjab and Sindh province: in the period FY1992 – FY2012 (fiscal years) Punjab accounted for 76 % and Sindh for 14 % of national wheat production. The remaining 10 % is produced in Khyber Pakhtunkhwa and Balochistan. Wheat is grown primarily by small (0.5 to 5 ha) and medium-sized (5 to 10 ha) farmers. On average, about 40 % of production is retained at the farm for seed, in-kind labour payments and household food consumption. As a result, about 60 % of wheat production enters the market (Dorosh and Salam, 2008; Prikhodko and Zrilyi, 2013; Prikhodko and Zrilyi, 2013).

[8] PASSCO is a federal institute responsible for nation-wide procurement and distribution of wheat and is specifically in charge of supplying wheat to deficit zones (i.e. Balochistan and Khyber Pakhtunkhwa) and to the military forces.

The main buyers of wheat are the government and private sector wheat traders. Provincial Food Departments purchase wheat from farmers at the support price to support farmer incomes. [9] To ensure that Food Departments meet their targets, a ban may be placed on inter-provincial wheat trade and the private sector is not allowed to engage in large-scale wheat purchases and storage until government procurement has ended.[10]

Procured wheat supplemented with public wheat imports is sold to flour mills at below-market rates, i.e. the release price. Large (urban) mills tend to supplement government wheat by wheat purchases on the open market. The price of flour processed from subsidized wheat is also regulated by the government through ceiling prices to lower consumer prices. However, Dorosh and Salam (2008:76) argue that: "[a]lthough there may be a stipulated sales price of flour, there is no effective enforcement mechanism. Since wheat flour produced from government wheat is not distinguishable from wheat flour produced from market wheat, their prices are the same.".[11] Flour mills that receive subsidized wheat from the government can therefore enjoy large rents from sales of subsidized wheat flour at market prices. Lohano, Smith, and Stockbridge (1998) and Ahmad et al. (2005) argue that this policy offers considerable opportunities for rent-seeking and has resulted in a considerable excess capacity in the flour milling industry.[12]

Since the 2000s, the government has been procuring on average about 40 % of the marketable surplus, or 23 % of national production (see Figure A1, Appendix 4).

[9] The wheat crop marketing year runs from May to April the following year. Most wheat in Pakistan is harvested in March and April and sowing takes place in September-December.

[10] Exceptions are made for flour mills – the major processors of wheat – and local traders, known as Aarthis and Beoparis. Beoparis are village traders that are in direct contact with farmers and are responsible for wheat purchases at the farmgate. Aarthis are commission agents that deal in large quantities of wheat and contract Beoparis to assemble these quantities. Wheat purchased at the farm by Beoparis is packed and delivered to the Aarthis, who sell the assembled quantities on the wholesale market to flour millers or stockists. Most small and medium-sized farmers sell their produce to wheat traders; self-marketing is only a marginal phenomenon.

[11] See also International Finance Corporation (2011) and Prikhodko and Zrilyi (2013).

[12] In a reaction to the food crisis the government also sells wheat flour at subsidized prices 10 to 20 % lower than market prices to consumers through the Utility Stores Corporation system (USC) but in reality the impact of this program seems marginal (Khan and Akhtar Ali Shah, 2011; World Bank, 2010). The geographical coverage is limited, there is no targeting and the amount allowed per family is only 5 kg/month compared to an average per capita wheat

3.2. Policies and Trade in the 2000s

Trade policies shifted back and forth in the 2000s. After a bumper harvest in 2000 (see Figure A1, Appendix 4) the government started to subsidize public and private exports of wheat.[13] As a result, Pakistan became a net wheat exporter in the early 2000s.[14] However, in 2003 the government imposed an export ban on wheat and wheat flour (although informal wheat (flour) exports continued) (Persaud, 2013).[15] In October 2005 the government liberalized private sector imports and removed the tariff on wheat imports (Dorosh and Salam, 2008). In April 2007 the government lifted the export ban on wheat (flour) that had been in place since 2003, but was not well enforced, and permitted 500 thousand tonnes of private sector wheat exports (Dorosh, 2008; Persaud, 2010).

However, as international wheat prices surged, the government reinstated the export ban for wheat and wheat flour a month later (in May 2007) and started importing large quantities of wheat.[16] Despite this intervention and a 2007 record harvest, domestic wheat prices rose about 71 %. Yet, Figure 1 shows that the domestic price rise was not nearly as great as the surge in international prices in 2007/08. The gap between state controlled prices in Pakistan and international wheat prices created incentives for the private sector to informally export wheat (flour) to Afghanistan. It is estimated that about 1.5 to 2 million tonnes of wheat flour were illegally

consumption of around 10.5 kg per person per month . FAO et al. (2008) also indicate that Utility Stores face problems of queues, long waiting hours and unreliable supply.

[13] Afghanistan is the main destination of wheat flour exports from Pakistan. In the period 2003-2013 over 90 % of Pakistan wheat flour exports flowed to Afghanistan (UN, 2014).[13] Pakistan is also the dominant supplier of wheat to Afghanistan, covering on average 65 % of Afghanistan's import requirements (USDA, 2012a).

[14] When referring to net imports and exports, we take into account both wheat and wheat flour trade. Wheat flour imports and exports are converted to wheat equivalents using an extraction factor of 0.77. This rate is calculated by taking a simple average of the extraction rate of Atta (82 %) and Maida (72 %) flour (Tayyab, 2013; USDA, 2012b). Wheat flour imports mostly involve humanitarian aid and food aid (Prikhodko, 2013).

[15] Informal wheat exports refer to wheat exports by private agents that do not pass through official channels.

[16] The reintroduction of the export ban in May 2007 did not apply to exports to Afghanistan. In early 2008, however, the government extended the export ban to Afghanistan (Persaud, 2010).

exported to Afghanistan during the food price shock in spite of the official export ban, pushing up domestic prices (USDA, 2014b; World Bank, 2010).

Another possible explanation for rising domestic prices is widespread hoarding behaviour of grain, as the private sector expected the government to increase the wheat support price (Tayyab, 2013; World Bank, 2010). In fact, the support price did increase by 62 % between July 2007 and July 2009.[17]

Pakistan was hit by severe floods in 2010 and 2011, but in both years the floods had little impact on wheat production as the wheat crop was already harvested (USDA, 2011). In fact, the 2010 harvest was only 3 % lower than the record harvest of 2009 and the 2011 harvest reached a record level of 25 million tons.

Despite international wheat prices rising again in mid-2010, the wheat (flour) export ban was lifted in December 2010 and exports reached a record level in 2010/11 at 1.7 million tonnes of wheat and 1.2 million tonnes of wheat flour. In the next two years, wheat and particularly flour exports remained large. As a result, Pakistan again became a net wheat (flour) exporter in these years.

3.3. Summary

Extensive government interventions in wheat markets and trade caused domestic markets and prices to diverge from international markets and prices, but the extent (and even the nature) of the price difference varied significantly over the two decades.[18] In fact, in recent years Pakistani prices and international wheat prices were relatively close, and the volatility of domestic prices through the past decade was much lower than world market prices. Pieters and Swinnen (2014) conclude that Pakistan's wheat policies have performed "relatively well" compared to other countries if one takes into account price stability as an explicit government objective. Of course, such policy interventions may still have important redistribution effects. In the next section we use the value chain NRA disaggregation to measure who benefitted from these interventions.

[17] In 2008/09, the government imported even larger quantities of wheat (3.1 million tons) to offset a disappointing 2008 harvest and high support prices resulted in a bountiful 2009 wheat harvest. Nevertheless, domestic prices further increased as net domestic wheat availability declined due to massive government procurement and modest releases.

[18] Table A1 in Appendix 4 provides a summary of wheat policies and markets in Pakistan in the past decades.

4. NRAs along the Value Chain

Using the general formula (2), we calculate the NRA at the level of (a) wheat farmers, (b) wheat traders, (c) wheat flour millers, and (d) wheat flour consumers.

The NRA to the wheat sector captures the cumulative rate of assistance to farmers (NRA^f) and wheat traders (NRA^t), or the nominal rate of assistance to wheat NRA^w.

$$NRA^w = NRA^f + NRA^t \tag{3}$$

where

$$NRA^f = NRA_O^f + NRA_I^f \tag{4}$$

$$NRA^t = NRA_O^t + NRA_I^t \tag{5}$$

$$NRA_O^f = \frac{p_o^f - p_o^{f*}}{p_o^{f*}} \tag{6}$$

$$NRA_I^f = \frac{\sum_j \left(p_j^{f*} - p_j^f\right) * Q_j^f / Q_o^f}{p_o^{f*}} \tag{7}$$

$$NRA_O^t = \frac{p_o^t - p_o^{t*}}{p_o^{t*}} \tag{8}$$

$$NRA_I^t = \frac{\sum_j \left(p_j^{t*} - p_j^t\right) * Q_j^t / Q_o^t}{p_o^{t*}} \tag{9}$$

This implies that

$$NRA^w = \frac{p_o^f - p_o^{f*}}{p_o^{f*}} + \frac{\sum_j \left(p_j^{f*} - p_j^f\right) * Q_j^f / Q_o^f}{p_o^{f*}} + \frac{p_o^t - p_o^{t*}}{p_o^{t*}} + \frac{\sum_j \left(p_j^{t*} - p_j^t\right) * Q_j^t / Q_o^t}{p_o^{t*}} \tag{10}$$

For wheat traders, both input and output are wheat and hence $Q_o^t = Q_j^t$. The formula to calculate wheat trader input NRA_I^t then becomes:

$$NRA_I^t = \frac{(p_I^{t*} - p_I^t)}{p_o^{t*}} \tag{11}$$

Given that the output price received by farmers equals the input price paid by wheat traders, or $p_o^f = p_I^t$ and $p_o^{f*} = p_I^{t*}$, equation (12) can be written as:

$$NRA^w = \frac{p_o^f - p_o^{f*}}{p_o^{f*}} + \frac{\sum_j \left(p_j^{f*} - p_j^f\right) * Q_j^f / Q_o^f}{p_o^{f*}} + \frac{p_o^t - p_o^{t*}}{p_o^{t*}} + \frac{p_o^{f*} - p_o^f}{p_o^{t*}} \tag{12}$$

4.1. NRA to wheat farmer input (NRA_I^f)

The second term in equation (12) captures the NRA to farm input NRA_I^f. Earlier World Bank estimates (Anderson and Nelgen, 2013) assumed that the NRA to farm input for wheat was zero from 2006 to 2010 (see Table A2, Appendix 4). However, the implicit subsidy to urea and DAP was likely non-trivial after 2005, in particular during the international food price shock.[19] We account for this implicit subsidy by calculating the NRA to urea and DAP fertilizer for 2000-2013 and adding it to the NRA to farmer output.[20] Our calculated NRA to fertilizer approaches the World Bank estimates of the NRA to farm input reasonably well for the years in which the World Bank estimates are non-zero.[21]

4.2. NRA to wheat trader output (NRA_O^t)

The third term in equation (12) captures the NRA to wheat trader output NRA_O^t. The government procures on average about 40 % of marketed wheat nation-wide and may supplement procured wheat with public wheat imports. The government sells wheat to flour millers at the release price, which is on average lower than the wholesale price of wheat (see Figure A3, Appendix 4). We use the price of wheat at the Lahore wholesale market as an indicator for p_o^t.

[19] According to a recent IFPRI policy report (Salam, 2012): "… the cost of domestically produced urea has been less than the imported price due to the subsidized gas supply to the fertilizer industry. Since both imported and local fertilizers are sold at the same rate, the government has to subsidize the imported urea, the import of which has recently been confined in the public sector to the Trading Corporation of Pakistan. […] Accordingly, there has been an implicit element of subsidy in the sales price and use of these fertilizers [urea and DAP] throughout the reference period." Moreover, a report by the World Bank (2010) similarly states that in the 2007/08 fiscal year " [f]ertilizer subsidies (mainly on di-ammonium phosphate or DAP) also became an increasingly large fiscal burden because of increased world market prices". The use of urea and DAP accounted for about 93 % of total fertilizer cost and 22 % of total farmer production costs per acre in the last two wheat crop years (author's calculations based on API data).

[20] Although the NRA to fertilizer does not take into account government assistance to other important inputs such as water, Dorosh and Salam (2007) argue that it captures the major distortion to non-factor agricultural input prices in Pakistan. Details on the calculation of the NRA to farmer input are provided in Appendix 1.

[21] For 2000-2005, the average difference is equal to 0.2 percentage points, or about 7.5 % of the World Bank average NRA to farm input for 2000-2005.

For the undistorted wholesale price of wheat p_o^{t*} one should use the border price measured at the Lahore wholesale market. Dorosh and Salam (2007) argue that in many years domestic wheat prices in Pakistan would likely lie between import and export parity prices in the absence of government interventions. Hence, the conventional approach of using import (export) parity prices as border prices for wheat will understate (overstate) the nominal rate of assistance in certain years. They use estimated autarky (no trade) prices as the border price when the autarky price is below import parity. We follow the methodology of Dorosh and Salam (2007), except that import and export parity prices were calculated using Lahore as the reference market rather than Karachi.[22] We also follow their methodology in calculating autarky prices based on the Dorosh-Salam dataset (extended with recent data).[23]

4.3. NRA to wheat farmer output (NRA_o^f) and wheat trader input (NRA_I^t)

We use the border price for wheat measured at the farmgate in Lahore as an indicator of the undistorted farmgate price for wheat p_o^{f*}. Import parity, export parity and autarky prices measured at the farmgate are equal to the import parity, export parity and autarky price measured at the Lahore wholesale market minus marketing costs from the farmgate to the Lahore wholesale market. Wheat trader input distortions, NRA_I^t, are the counterpart of wheat farmer output distortions.

The price that traders pay to farmers, i.e. the farmgate price, is the measure for p_o^f (= p_I^t). However, data on farmgate prices are not available for Pakistan. We have therefore calculated an indicator for farmgate prices under two assumptions. In the first approach, we assume that wheat traders pay farmers the support price set by the government. Kurosaki (1996), cited in Ahmad et al. (2005), for example concludes, after examining the spatial and intertemporal price relations of grains in the Punjab province, that in the case of wheat the farmgate price is explained mostly by the support price. Another interpretation of this assumption is that the support price is the price

[22] The import parity price for wheat measured at the wholesale market in Lahore equals the C&F Karachi price plus import costs and marketing costs from Karachi to the wholesale market in Lahore. The export parity price for wheat at the wholesale market in Lahore equals the FOB Karachi price minus export costs and marketing costs from Lahore to Karachi. The calculation of border prices for wheat is described in more detail in Appendix 2.

[23] Table A3 in Appendix 4 shows the border price (import parity, export parity or autarky price) used for each year (for all agents in the value chain).

received by farmers when selling wheat to the government during the procurement season. Note that in this case fluctuations of the wholesale price of wheat are passed on entirely to wheat traders and do not affect farmers.

In the second approach we assume that wheat traders pay farmers the wholesale price of wheat at Lahore minus marketing costs from the farmgate to the wholesale market in Lahore. In this case, the trader marketing margin is assumed to be fixed and fluctuations of the wholesale wheat price are passed on entirely to farmers.[24]

Figure 2 shows that the real wholesale price (minus marketing costs) fluctuates according to the wheat season: wholesale prices generally fall in the months following the wheat harvest and increase towards the winter.

[Figure 2]

In most of the 1990s, 2004-2006 and 2008, the wholesale price minus marketing costs exceeded the support price throughout the year, including in the months following the harvest. Hence, in these years farmers would be better off receiving the wholesale price minus marketing costs throughout the year, as they would be capturing the rents of higher wholesale prices. In other years, the wholesale price minus marketing costs falls below the support price during post-harvest months. Hence, in these years farmers would be better off receiving the support price in post-harvest months.

4.4. NRA to flour mills (NRA^m)

When calculating the NRA to flour mills, we assume that wheat grain is their only input[25]:

$$NRA^m = \frac{p_o^m - p_o^{m*}}{p_o^{m*}} + \frac{(p_I^{m*} - p_I^m) * Q_I^m / Q_o^m}{p_o^{m*}} \qquad (13)$$

[24] Data used for the calculation of the NRA to wheat farmers and wheat traders are presented in Tables A3 and A4 in Appendix 4.

[25] Wheat purchases account for approximately 90 % of production costs of flour milling (see Prikhodko and Rybchynsky (2009) and author's calculations based on data from International Finance Corporation (2011)). We therefore abstract from possible government assistance to other inputs such as electricity, fuel or water.

$$= \; NRA_O^m + NRA_I^m$$

where p_o^m is the price of wheat flour received by flour millers, p_o^{m*} is the undistorted price of wheat flour received by flour millers, p_I^m is the price of wheat paid to traders (or the government) and p_I^{m*} is the undistorted price of wheat paid to traders. Q_o^m is the quantity of wheat flour sold and Q_I^m the quantity of wheat purchased by flour millers. Hence, Q_I^m/Q_o^m is the conversion rate of wheat to wheat flour.

We use the border price for wheat at the wholesale market in Lahore as an indicator for the undistorted wholesale wheat price p_I^{m*} and a weighted average of the release price and the price of wheat on the wholesale market in Lahore as an indicator for p_I^m. The weights are equal to the annual share of government releases and marketed wheat in the total domestic wheat supply (marketed wheat produce plus net government injections). We set the extraction rate of wheat flour milling (Q_I^m/Q_o^m) to 82 %.26

The indicator for the undistorted price of wheat flour p_o^{m*} is the border price for wheat flour. Appendix 3 describes the methodology used to calculate import and export parity prices and autarky prices for wheat flour, using Lahore as the reference market. For the import parity price, two sets of prices are calculated. The first assumes that Pakistan would import wheat flour from Kazakhstan, while the second assumes that Pakistan would import wheat flour from the EU or Black Sea region.

Kazakhstan is one of the largest exporters of wheat flour globally and the main supplier of wheat flour in Central and South Asia. For instance, Kazakhstan is the major competitor of Pakistan in the Afghan wheat flour market, generally supplying 20 % of Afghan wheat flour imports mostly to the north of Afghanistan. If Kazakh wheat flour exports reach Afghanistan, we assume that they could reach Pakistan as well if Pakistan would start importing wheat flour commercially. As Kazakhstan is also one of the most competitive wheat flour producers, the first set of border prices assumes that Pakistan would import wheat flour from Kazakhstan.

However, wheat flour exports from Kazakhstan to Pakistan would be transported over land across a far distance, substantially increasing the calculated cost of wheat flour imports from

[26] This is the extraction rate for Atta flour (82 %). Throughout the analysis we use domestic prices for Atta flour, which is the main type of flour consumed in Pakistan (USDA, 2012b).

Kazakhstan. In the past, humanitarian and food aid in the form of wheat flour imports into Pakistan came mostly from the European Union and Black Sea region. A calculation of the price of wheat flour imports from this area showed that Pakistan could in fact import wheat flour at a lower cost from the EU and Black Sea region compared to Kazakhstan, due to the large differences in ocean freight costs and land freight costs.[27] For this reason, we have calculated an alternative set of border prices which assumes that Pakistan would import wheat flour from the European Union and Black Sea region, rather than from Kazakhstan.

Here we only report results for the NRA to flour millers and flour consumers using EU/Black Sea import parity prices, as we have deemed this scenario the most plausible. In any case, the choice of import parity prices is only relevant in years where the border price is the import parity price; for export parity and autarky prices only one set of prices is used in the calculations (see Appendix 3 for more details and alternative assumptions).

The government of Pakistan directly intervenes in the wholesale market for wheat flour by setting ceiling prices for sales of flour milled from government wheat. However, as was discussed in section 3.1, flour milled from government wheat cannot be distinguished from flour milled from open market wheat. As a result these ceiling prices are not enforced (Dorosh and Salam, 2008). We therefore assume that all wheat flour is sold at the market price and use the wholesale price of wheat flour in Lahore as an indicator for p_o^m.[28]

4.5. NRA to flour consumers (NRA^c)

The NRA to wheat flour consumers is calculated as follows:

$$NRA^c = \frac{(p_I^{c*} - p_I^c)}{p_I^{c*}} \qquad (14)$$

[27] The cost of wheat flour imports was calculated as the international wheat flour reference price (see Appendix 3) plus average transportation costs from the Kazakh border to Lahore for the first set of prices, and plus average transportation costs from the European Union-Black Sea region to Lahore for the second set of border prices.

[28]Monthly data for the wholesale price of wheat flour was only available from FY2009 onwards. We have therefore used annual wholesale prices of wheat flour for the period FY2001-FY2008.

where p_I is the domestic price of wheat flour paid by consumers and p_I^* is the undistorted wheat flour price paid by consumers. [29] We use the border price of wheat flour at the retail market in Lahore as an indicator for p_I^*. This border price should be calculated by adding marketing costs of retailers to the border price of flour measured at the wholesale market. As information on retailer marketing costs was lacking, we have estimated an upper and lower boundary of the actual border price at the retail market. The upper boundary border price is calculated under the assumption that retailer marketing costs are equal to the price margin between the wholesale price and retail price of wheat flour, i.e. that retailer marketing margins are zero. The lower boundary border price is calculated under the assumption that retailer marketing costs are zero, i.e. that retailer marketing margins are equal to the price margin. The actual border price measured at the retail market will lie in between these boundaries, and the actual NRA to flour consumers will probably be in between the resulting upper boundary and lower boundary NRA.[30]

The government directly intervenes in the retail market for wheat flour through the Utility Stores Corporation, which sells wheat flour at subsidized prices to consumers. However, the effectiveness of the Utility Stores system is not clear. Moreover, data series on subsidized prices or the share of wheat flour sold through Utility Stores were not available. We therefore use the price of wheat flour at the retail market in Lahore as an indicator for the domestic price p_I.

[29] The consumer tax equivalent (CTE) of Anderson et al. (2008a) captures the effect of distortions on price incentives of final consumers expressed as a percentage of the undistorted consumer price. The CTE can be calculated as follows:

$$CTE = \frac{(p_I - p_I^*) * Q_I}{p_I^* * Q_I}$$

where input I represents the commodity purchased for consumption, p_I is the actual domestic consumer price, p_I^* is the undistorted domestic consumer price and Q_I equals the quantity consumed. The NRA for the final consumer relates as follows to the consumer tax equivalent (CTE) of Anderson et al. (2008a):

$$CTE = -NRA^c = -NRA_I^c$$

for i = c for the final consumer for whom $Q_o^c = 0$ and thus $NRA_O = 0$.

[30] Data used for the calculation of the NRA to flour millers and flour consumers are presented in Tables A5 and A6 in Appendix 4.

However, our disregarding of the consumer subsidy provided by the Utility Stores will lead us to overestimate consumer taxation or underestimate consumer subsidization. A quick, back-of-the-envelope calculation suggests that the additional NRA to consumers from the Utility Store sales in recent years may be around 3 to 8 %.

5. Results

The results are summarized in Figures 3 to 7 and Table 1. Table 1 presents the average NRA for different agents along the value chain across 2000 – 2013 and for 3 sub-periods: 2000-2004, 2005-2008 and 2009-2013.

[Table 1]

5.1. "Producers": Wheat farmers and wheat traders

Figure 3 and Table 1 present the NRA to "producers", i.e. the NRA to the wheat sector, which equals the sum of the NRAs to wheat farmers and wheat traders. The NRA to wheat farmers and wheat traders are given for both farmgate price indicators (support price and wholesale price minus trader marketing costs). Figure 4 presents the NRA to wheat farmers and wheat traders for alternative farmgate price indicators. Figure 5 shows the NRA to wheat traders disaggregated into the total NRA and the NRA to trader input and output.

[Figure 3]

[Figure 4]

[Figure 5]

The average NRA to the wheat sector for 2000-2013 equals - 9 %, indicating that the wheat sector as a whole is on average taxed. In fact, throughout the period the NRA to wheat is positive only in 2005/06 and in 2010/11 at 18 % and 11 %.

Wheat sector taxation was - 20 % in the sub-period 2000-2004. The NRA reaches a minimum in 2007/08 at - 25 % during the international food price shock, when the wheat sector as a whole is taxed most heavily. In more recent years, taxation has fallen significantly: in the sub-period 2009-2013 it is at its lowest level at - 2 %. In 2011/12 and 2012/13 the NRA is close to zero.

5.1.1. Wheat traders

The distribution of the NRA between wheat traders and farmers depends strongly on the assumption on the best indicator of the farmgate price, i.e. to what extent the trader's margin changes with changing wholesale prices.

In the extreme case that the traders' margin is fixed, i.e. traders pay farmers the wholesale price minus marketing costs, there is very little policy impact on the traders. In other words, fluctuations in wheat prices do not affect the NRA to traders. The difference between the domestic input and output price for wheat traders is assumed equal to marketing costs from the farmgate to Lahore, which is equal to the difference between the border price at the farmgate and at the wholesale market. Hence, the NRAs to wheat trader input and output cancel each other out, producing an NRA equal to zero.

However, if traders pay farmers the support price, they capture the rents created by fluctuations of their sales price, i.e. the wheat price on the wholesale market. The NRA to traders is then positive or zero throughout the period and slightly below zero in 2011/12 and 2012/13. In this case, the net subsidy to wheat traders for the period 2000-2013 is 6 %, with subsidization being highest in the sub-period 2005-2008 at 10 % and lowest in 2009-2013 at 4 %. The overall net subsidization of wheat traders is a result of two opposing policy effects. Traders are generally taxed on output by policies reducing their sales price, but benefit from policies lowering the price they pay to farmers and the second effect is strongest.

Traders are taxed on their output side as the price they receive for wheat sales would be higher in case the government would not intervene to adjust domestic supply. At the same time, traders are subsidized on the input side as the support price they pay to farmers is lower than the price they would pay in the absence of government interventions.[31] Our calculations indicate that

[31] In 2005/06 and 2010/11 the general situation is reversed: traders are taxed on input and subsidized on output. For 2005/06, this is explained by the fact that the border price (autarky price) was lower than domestic wheat prices and in fact close to export parity due to a bountiful harvest in 2005 (see Figure A4 in Appendix 4). For 2010/11, the

the subsidy to inputs exceeds the tax on output, and the result is a net subsidization of wheat traders for most of the 2000s.

Interestingly, if traders had to pay farmers the support price, this net subsidy effect would have been the highest at the point when overall taxation of the wheat sector was strongest. In 2007/08, at the height of the international food price shock, the government responded to rising prices by imposing an export ban and supplementing domestic production with large-scale imports at below-market rates. The government thereby prevented domestic prices from rising to the same extent as international prices. The result was a large gap between the export parity price and domestic prices and a considerable taxation of wheat trader output. Even though domestic wholesale prices did not follow international prices, they did increase, and the rents would have been captured entirely by wheat traders as a subsidy on their inputs (when paying the support price to farmers). This subsidy exceeded the tax on their output and resulted in a net subsidization of 13 % in 2007/08 and a period maximum of 17 % in 2008/09.

From 2009/10 onwards, the NRA to wheat traders moves close to zero as the gap between domestic prices and border prices decreases. That is, traders are paying and receiving a price that is very close to the hypothetical price in a no-distortions scenario. In 2009/10, domestic prices had risen to high levels and were close to import parity. In late 2010, the export ban on wheat (flour) was lifted and as domestic prices were below export parity, large wheat (flour) exports ensued. In the following years, liberalized wheat trade likely contributed to keeping domestic prices near export parity. In 2011/12 and 2012/13, the NRA to wheat traders is slightly negative because the subsidy to inputs falls close to zero.

5.1.2. Wheat farmers

Obviously, since wheat traders and wheat farmers effectively share the effects on the wheat sector as a whole, the assumption on the farmgate price has the opposite implications for wheat farmers. With fixed trader margins, the NRA to wheat farmers is equal to the NRA to "producers" (i.e. the wheat sector as a whole), as the NRA to traders is zero. If trader margins fluctuate in response to changing prices (i.e. farmers receive the support price) the impacts on the farmers will be more

explanation is the switch from import parity in 2009/10 to export parity in 2010/11 and the fact that export parity was below domestic prices until 2011.

negative than for the wheat sector, as the benefits of higher wholesale prices are captured by traders instead of the farmers.

Our calculations indicate that wheat farmers were generally taxed by government policies in 2000-2013, regardless of the indicator used for the farmgate price.[32] When farmers receive the wholesale price minus marketing costs and thus fully capture wholesale wheat price fluctuations, the tax is on average 9 % for the whole period. When farmers effectively receive the support price instead, the average tax increases to 15 % for 2000-2013.

The NRA to farmers fluctuates considerably across years. The extent of taxation is largest in 2007/08, during the spike in international wheat prices, with the NRA between - 24 % (wholesale price indicator) and - 37 % (support price indicator).33 The large increase in the tax on farmers during the food price shock was driven by the strong increase of the border price above domestic wheat prices. As the government prevented domestic prices from rising by imposing a ban on wheat (flour) exports and releasing large quantities of subsidized wheat on the market, farmers were receiving a substantially lower price than what they would have received in a no-distortions scenario.

In spite of the peak in farmer taxation during the food price spike, average farmer taxation is highest in the sub-period before the food price crisis: the average NRA was - 20 % to - 25 % in 2000-2004, compared to - 7 to - 18 % in 2005-2008. Average farmer taxation was lowest in recent years: in the sub-period 2009-2013 it was between - 2 % to - 6 %.

The shift from large farmer taxation in the 2000s to NRAs close to zero in 2012-2013 can be explained by the same factors as the shift in the NRA to traders. As domestic support and wholesale prices fluctuated around the export parity price, the NRA increased to close to zero. The

[32] In 2005/06 and 2010/11 farmers were exceptionally subsidized. The explanation is analogous to the explanation provided for trader NRAs in these years (cf. supra). For instance, the large positive NRA in 2010/11 is explained by a switch of the border price from import to export parity in May 2010, and the fact that the export parity price was far below domestic wheat prices until late 2010-early 2011 (see Figure A2 in Appendix 4).

[33] In general, the tax on farmers is larger for the support price indicator, as the support price is on average lower than the wholesale price minus marketing costs. However, in 2011/2012 and 2012/13 the NRAs are nearly equal in size for both indicators. The support price was increased to such an extent since 2007/08 that the average gap between the two farmgate price indicators has become small in recent years, reducing the difference between the corresponding NRAs (see Figure A2 in Appendix 4).

convergence of domestic and export parity prices of wheat can be explained by the fact that (1) the export parity price had increased to a higher average level following the international price rises in mid-2010 and mid-2012, approaching high domestic wheat flour prices; (2) the government allowed private sector wheat (flour) exports in late 2010 and (3) Pakistan became a net wheat exporter from 2010/11 onwards. The resulting market forces likely pushed domestic prices towards export parity in 2011-2013.

5.1.3. Seasonality of wheat prices

So far we have ignored the seasonality of wheat prices. Although the support price is lower than the wholesale price indicator on average, it is frequently higher in the months immediately following the harvest (see Figure 2). Hence, in various years farmers are better off selling to the government in the months following the harvest. According to Dorosh and Salam (2008), a large part of total marketed wheat is sold by farmers within four months of the wheat harvest. To see the impact of this on the results, one can look at the monthly NRA's for the post-harvest months. Even if one assumes that *all* wheat is sold in the post-harvest months (April-August), the average tax on farmers over the period 2000-2013 is 10 % compared to 9 % to 15 % if one takes the annual average.[34] Hence the impact of the seasonality on the farm taxation is limited.

5.2. "Consumers": Flour mills and flour consumers

Figure 3 and Table 1 show the NRA to "consumers" as a whole. The average NRA to "consumers" is calculated as the sum of the NRA to flour mills and the average NRA to flour consumers (the average of the NRAs for lower and upper bound border prices). Figure 6 and Table 1 present the NRA to flour mills and flour consumers. The NRA to flour consumers is reported for both the

[34] Only in 2010/11 are farmers subsidized when looking at post-harvest months. The average tax on farmers is the same (NRA = -10 %) for 2000-2013 regardless of the support price or wholesale price indicator used. This is because the average support price indicator for post-harvest months in 2000-2013 is equal to the average post-harvest wholesale price indicator (about 14 Rs/kg). In the sub-period 2000-2004, the average post-harvest support price is slightly higher and consequently farmer taxation slightly lower compared to the wholesale price indicator, while in the sub-period 2005-2008 the reverse holds: the average post-harvest support price is lower than the average post-harvest wholesale price indicator (9.94 versus 10.42 Rs/kg). On average, these differences cancel each other out. Detailed results are available on request.

upper and lower bound border prices. Figure 7 shows the NRA to miller input (wheat) and output (flour).

[Figure 6]

[Figure 7]

The average NRA to "consumers" is 5 % for 2000-2013, indicating that consumers as a whole are on average subsidized across the entire period. Average subsidization is highest in the subperiods 2000-2004 and 2005-2008 at 7 %. However, in recent years subsidization of consumers as a whole declines, with average subsidization lowest in 2009-2013 at 1 %. The NRA to "consumers" can be broken down into the NRA to flour mills and the NRA to companies and households that purchase wheat flour, i.e. flour consumers.

5.2.1. Flour mills

Regardless of the type of import parity price used (Kazakhstan or EU/Black Sea import parities), flour mills are generally taxed by existing government policies in 2000-2013. However, the size of taxation is limited: the average NRA over the period 2000-2013 is - 4 %. Taxation was highest in the sub-period 2000-2004 at 9 %. In the sub-period 2005-2008 the average NRA becomes slightly positive at 1 %. In recent years flour millers are again taxed: the average NRA falls back to – 4 % in the sub-period 2009-2013. This overall taxation is driven by the fact that the tax on flour output on average exceeds the subsidy on wheat input.

Flour mills are taxed on flour output throughout the period.[35] This taxation is explained by the fact that domestic wholesale flour prices are substantially lower than flour border prices (see Figure A3, Appendix 4). On the input side, the NRA to flour millers is positive throughout the period (except for 2005/06 and 2010/11). This subsidy to wheat input is driven by two prices: the price of wheat on the wholesale market and the government release price.[36] The wheat border price

[35] Except in 2005/06, due to the fact that the autarky price dropped after a bountiful 2006 harvest and was lower than the domestic wheat flour price (see Figure A5 in Appendix 4).

[36] This subsidy is the counterpart of the taxation of wheat trader output.

is higher than both prices, and the millers get extra rents from the fact that the release price is lower than the wheat price on the wholesale market.[37]

In some years, this 'double' subsidy to wheat input is sufficiently large so as to compensate the tax on flour output, resulting in a net subsidization of flour millers. However, in most years the gap between domestic flour prices and flour border prices (output) is larger than the gap between domestic wheat prices and wheat border prices (input), resulting in a (limited) net taxation of flour millers.

At the height of the food price crisis in 2007/08, the subsidy to wheat input peaked at 23 %, as the gap between export parity and domestic wheat prices increased sharply. Nevertheless, flour millers were taxed in this year, as the increase of the flour export parity price over domestic flour prices was even greater.

In recent years, the subsidy to wheat input has declined due to the convergence of domestic wheat prices and the wheat export parity price. As flour millers continued to be taxed on flour output, the net result was taxation. The extent of taxation was, however, lower compared to the early 2000s, as the gap between domestic flour prices and flour border prices narrowed.

5.2.2. Flour consumers

Flour consumers (i.e. companies and households purchasing wheat flour) are generally subsidized by existing policies. The average NRA to flour consumers over 2000-2013 is in the order of 5 % to 13 %, depending on the assumptions about border prices. Subsidization is highest in the sub-period 2000-2004 regardless of the border price, with an average NRA of 12 % to 21 %. In the following sub-periods, average subsidization is substantially lower with an average NRA in the order of 1 to 9 %.

The subsidization of flour consumers is explained by the fact that retail flour prices are generally below flour border prices. Domestic retail flour prices are kept below border prices

[37] The average spread between the release price and the wheat price on the wholesale market over the period 2000-2013 is 1.13 Rupees per kilogram. At an average of 5.2 million tons of wheat released each year, flour mill savings on wheat input in 2000-2013 amounted to an average of 6.3 billion Rupees per year. These cost savings in wheat input are presumably captured by flour mills in the form of increased profits, since wheat is generally sold at the price of flour on the wholesale market rather than the government stipulated sales price (cf. section 3).

through government wheat releases and trade restrictions. At the height of the international food price spike in 2007/08, the government reinforced these policies with large-scale public wheat imports and an (incompletely enforced) export ban on wheat and flour to all markets. Domestic retail flour prices were kept in check, resulting in a particularly large gap between domestic and border prices and a substantial jump in the subsidy to flour consumers, which more than doubled to 22 % - 27 % in 2007/08.

In recent years, the subsidy to flour consumers has declined: the NRA remains near or below 10 % for both border prices. This decline is again explained by the convergence of domestic retail flour prices and the flour export parity price.

As mentioned before, the subsidy to flour consumers through the Utility Stores is not captured by the NRAs, but it is unlikely that this subsidy will change the main conclusions here.

5.3. Summary of welfare effects along the value chain

Wheat farmers

Regardless of the indicator for farmgate prices, we find that farmers are taxed by government policies in nearly all years. The magnitude of taxation depends on assumptions about the farmgate price. Assuming that the farmgate price equals the support price of wheat set by the government, average farmer taxation in 2000-2013 is 15 %. Assuming that the farmgate price equals the wholesale price of wheat minus trader marketing costs, farmer taxation is on average 9 %. During the food price spike in 2007/08, the tax on wheat farmers increases strongly to the order of 24 % to 37 %. Farmers were not able to profit from rising international wheat prices because domestic wheat prices were kept low by a wheat (flour) export ban and large-scale government wheat releases to the domestic market. However, in later years the gap between domestic prices and international prices declined, with domestic wheat prices fluctuating around export parity after 2010. As a result, in recent years farmer taxation is substantially lower, with the NRA close to zero in the last two years.

Wheat traders

Not surprisingly, the impact depends on the farmgate price indicator. If the farmgate price equals the wholesale price of wheat minus trader marketing costs, the NRA to wheat traders is zero in all periods, as the positive NRA to trader input cancels out the negative NRA to trader output.

If the farmgate price equals the support price, wheat traders are generally subsidized by existing government policies: the average subsidy for 2000-2013 is 6 %. During the international food price spike, subsidization increases as traders were able to capture much of the gains of higher domestic prices. As a result, average trader subsidization is highest in the sub-period 2005-2008 at 10 %. This result indicates that the combination of wheat price spikes and the support price policy are benefitting wheat traders, and not farmers, when traders pay farmers the support price. In recent years, average subsidization of wheat traders declines. This result corresponds to the decrease of wheat farmer taxation and is caused by the fact that domestic wheat prices fluctuated around export parity since late 2010.

Flour millers

Flour millers are generally taxed by existing wheat policies, but the effect is relatively small. Average taxation for the entire 2000-2013 period is 4 %, but the NRA varies across sub-periods, with modest net subsidization occurring in several years. At the height of the food price spike in 2007/08, the tax on flour increased sharply as the export parity exceeded domestic wholesale flour prices by far. Even though flour millers were substantially subsidized on wheat inputs (with domestic wheat prices below export parity) the subsidy was not sufficient to compensate the large tax on output. As a result, the tax on flour millers was 6 % during the 2007/08 price spike. In recent years, the tax on flour continues to exceed the subsidy on wheat input, resulting in modest net taxation of flour millers.

Flour consumers

The NRA to flour consumers is calculated using two alternative sets of border prices, based on two extreme scenario's. The first scenario assumes that marketing costs of wheat flour retailers are equal to the price margin between wholesale and retail flour prices (i.e. their marketing margin is zero). The resulting border prices are the upper bound on actual border prices measured at the retail

market. The second scenario assumes that retailer marketing costs are zero (i.e. the retailer marketing margin is equal to the price margin) and the resulting border prices are the lower bound on actual border prices measured at the retail market. The actual NRA to flour consumers will probably be in between the NRAs calculated using the upper bound and lower bound border prices.[38]

We find that flour consumers are on average subsidized by government policies in 2000-2013 in the order of 5 % to 13 % depending on the assumptions about border prices. However, the NRA to flour consumers fluctuates considerably across the period due to large fluctuations of the export parity price of wheat flour. Consumer subsidization peaks at the height of the food price spike in 2007/08 at 22 % to 27 %, as domestic consumer prices were kept low by the export ban on wheat (flour) and large-scale public wheat imports and releases. Consumer subsidization was particularly high in the early 2000s, as domestic retail flour prices were substantially lower than border prices; in 2000-2004, the average subsidy was between 12 % and 21 %. In recent years, the NRA to flour consumers somewhat stabilizes. On average consumers continue to be subsidized in 2009-2013, but the subsidy remains below 10 %.

6. Conclusions

The concept of "producers" and "consumers" in economic analysis is a combination of different agents (interest groups) along the value chain. In this paper, we have disaggregated distortions/rents to the "consumer" and "producer" groups into rents to various actors within these groups. We have first presented a modified NRA indicator, which allows to measure the impact of policies on several groups along the value chain.

We have applied this value chain approach to measuring distortions and rent distribution in the specific case of the wheat-flour chain in Pakistan. We disaggregated the "producer" group into wheat farmers and wheat traders and the "consumer" group into flour milling companies and households and companies purchasing wheat flour (flour consumers).

[38] Our estimates do not include the subsidy to flour consumers through the sales of wheat flour at below-market rates in Utility Stores, which implies that we are underestimating flour consumer subsidization, possibly by 3 % to 8 % in recent years (according to a quick, back-of-the-envelope calculation).

Our analysis shows that interpreting the aggregate NRAs to "producers" and "consumers" as policy impacts on farmers and on final consumers (households) leads to biased conclusions, but the bias is relatively limited. The tax on farmers is higher than the producer NRA indicates because wheat traders benefit from the policy system. The average tax on "producers" for 2000-2013 is 9 %, but taxation varies significantly over time: from 20 % in 2000-2004 to 2 % in the 2009-2013 period. There are no good data on farm-level prices, so we considered the two extreme possibilities, i.e. that the farmgate price equals (i) the support price paid by the government or (ii) the wholesale wheat price minus trader marketing costs. Traders were subsidized on average between 0 % and 6 % in 2000-2013, and the effects were larger in the early period (between 0 % and 8 % in 2000-2008) when farm taxation was highest, compared to recent years (between 0 % and 4 % in 2009-2013). As a result, wheat policy-induced taxes on farms were between 9 % and 15 % on average over the entire 2000-2013 period, with the highest taxes in 2000-2008 (between 13 % to 21 %), and the lowest in recent years (between 2 % to 6 % in 2009-2013).

On the consumption side, the benefits for final consumers (households) are larger than the consumer NRA indicates because the system implies a tax on flour mills. "Consumers" are generally subsidized in 2000-2013 by government policies, but the NRA is small: the average NRA for 2000-2013 equals 5 %. This subsidization of "consumers" also declines in recent years, although the decline is less pronounced compared to the "producer" tax. The average subsidy to "consumers" was 7 % in 2000-2008 and falls to 1 % in 2009-2013. Depending on assumptions on wheat flour import prices (and sources), average flour miller taxation was between 4 % and 8 % from 2000 to 2013 (and relatively constant over the period). Flour consumers were subsidized on average between 5 % and 13 % from 2000-2013, with the highest subsidies in 2000-2008 (between 7 % and 15 %), falling to between 1 % to 9 % in 2009-2013.

In summary, our value chain NRA analysis indicates that the wheat price policy in Pakistan has generally benefitted flour consumers and wheat traders at the expense of farmers (and to a lesser extent flour millers) in 2000-2013, but the effects are relatively small. During the 2007/08 food price shock, government interventions such as the export ban prevented farmers from profiting from the spike in international wheat prices and led to a large increase in farmer taxation. Domestic prices were prevented from following the international price surge, resulting in an increase in flour consumer subsidization. In recent years, government interventions were scaled down again, which is reflected in reduced rent effects for all agents along the value chain. From late 2010 onwards,

the convergence of domestic wheat (flour) prices and export parity prices reduced consumer and trader subsidization and farmer taxation to close to zero.

The results of our disaggregated NRA calculations for different agents along the value chain paint a more nuanced picture of the welfare effects of government wheat policies, and illustrate how the distribution of aggregate distortions/rents within "producer" and "consumer" groups is affected by the interaction between government policies and domestic and international prices. Not surprisingly, the empirical difficulties encountered by measuring the standard (producer and consumer) NRAs are more important when trying to disentangle them along different agents in the value chain. However, despite these difficulties it is an important exercise if one wants to design policies that target the poorest groups along the value chains, realizing that the "producer" and "consumer" umbrellas typically include both richer and poorer groups of society.

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Tables and Figures

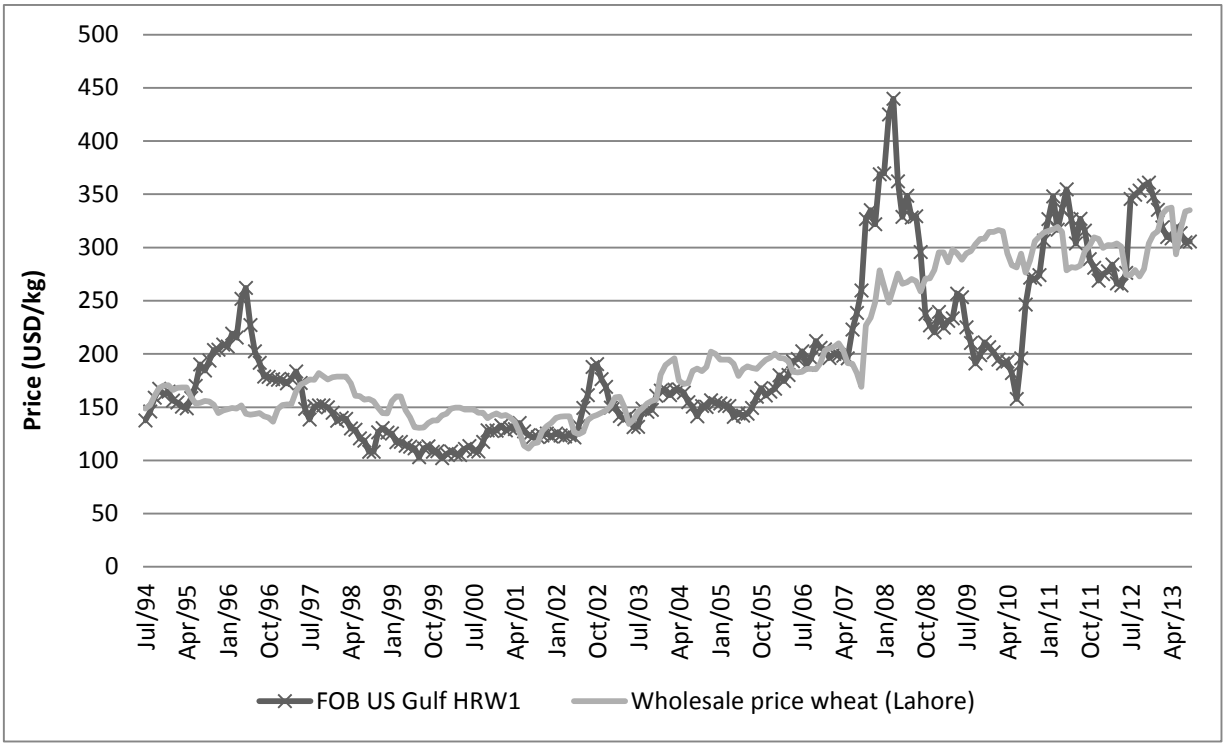
Table 1: Average NRA (%) for different agents along the value chain

Agent		2000-2013	2000-2004	2005-2008	2009-2013
NRA to "producers" (wheat sector)		- 9.2%	- 20.0%	- 7.5%	- 1.9%
Wheat farmers	Sales at support price [a]	- 15.2%	- 24.8%	- 17.8%	- 5.6%
	Sales at wholesale price – costs [b]	- 8.9%	- 19.7%	- 7.1%	- 1.7%
Wheat traders	Sales at support price [a]	6.0%	4.8%	10.2%	3.7%
	Sales at wholesale price – costs [b]	0.0%	0.0%	0.0%	0.0%
NRA to "consumers"		4.7%	7.0%	6.9%	1.0%
Flour millers		- 4.2%	- 9.4%	1.2%	- 4.3%
Flour consumers	Upper bound border price [c]	12.8%	21.2%	8.8%	9.3%
	Lower bound border price [d]	4.8%	11.6%	2.5%	1.2%

Source: Author's calculations. Notes: NRAs are calculated across wheat crop marketing years. Hence, the year 2000 starts on May 1st, 2000, and the year 2013 ends on April 30th, 2013. The NRAs for flour millers and flour consumers are calculated using EU/Black Sea import parity prices. The NRA to "consumers" is calculated as the sum of the NRA to flour millers and the average NRA to flour consumers.

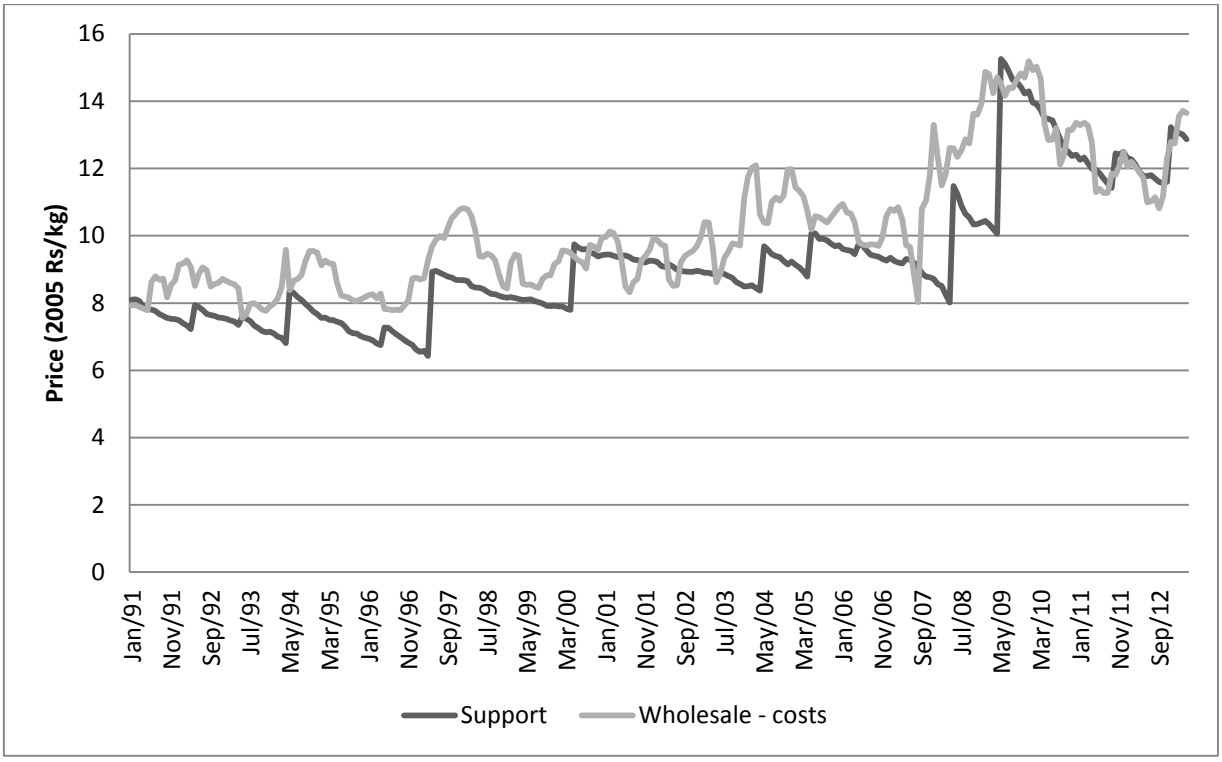
a: We assume that traders pay farmers the support price, and fluctuations in the wholesale price of wheat are captured entirely by traders (see section 4.2.1).
b: We assume that traders pay farmers the wholesale price of wheat minus trader marketing costs, and fluctuations in the wholesale price are passed on entirely to farmers (see section 4.2.1).
c: We assume that marketing costs of retailers are equal to the price margin between the wholesale price of wheat flour and the retail price of wheat flour. This assumption produces an upper bound for wheat flour border prices at the retail market and for the resulting NRAs to flour consumers (see section 4.4.1).
d: We assume that marketing costs of retailers are zero (see section 4.4.1). This assumption produces a lower bound for wheat flour border prices at the retail market and for the resulting NRAs to flour consumers (see section 4.4.1).

Figure 1: International and Pakistan wheat prices for 1994-2013.



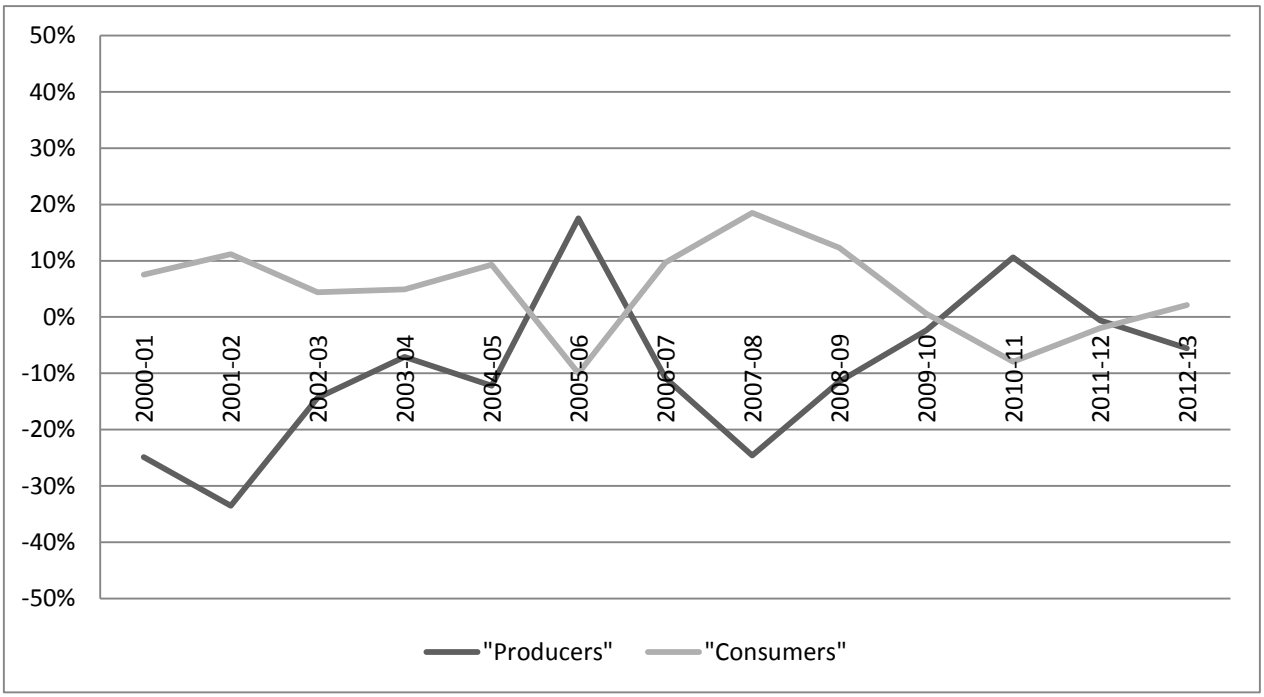
Source: International wheat price (FOB US Gulf HRW1) from World Bank. Wholesale price of wheat at Lahore from Dorosh-Salam dataset and Punjab Institute for Agricultural Marketing.

Figure 2: Real support price and wholesale price minus trader marketing costs for 1991-2013.



Source: Support price and Lahore wholesale wheat price from Dorosh-Salam dataset and Punjab Institute for Agricultural Marketing. Trader marketing costs calculated using data from (International Finance Corporation, 2011) and API and extended using the monthly Pakistan CPI.
Notes: Real prices are calculated by deflating nominal prices using the monthly Pakistan CPI (base year 2005).

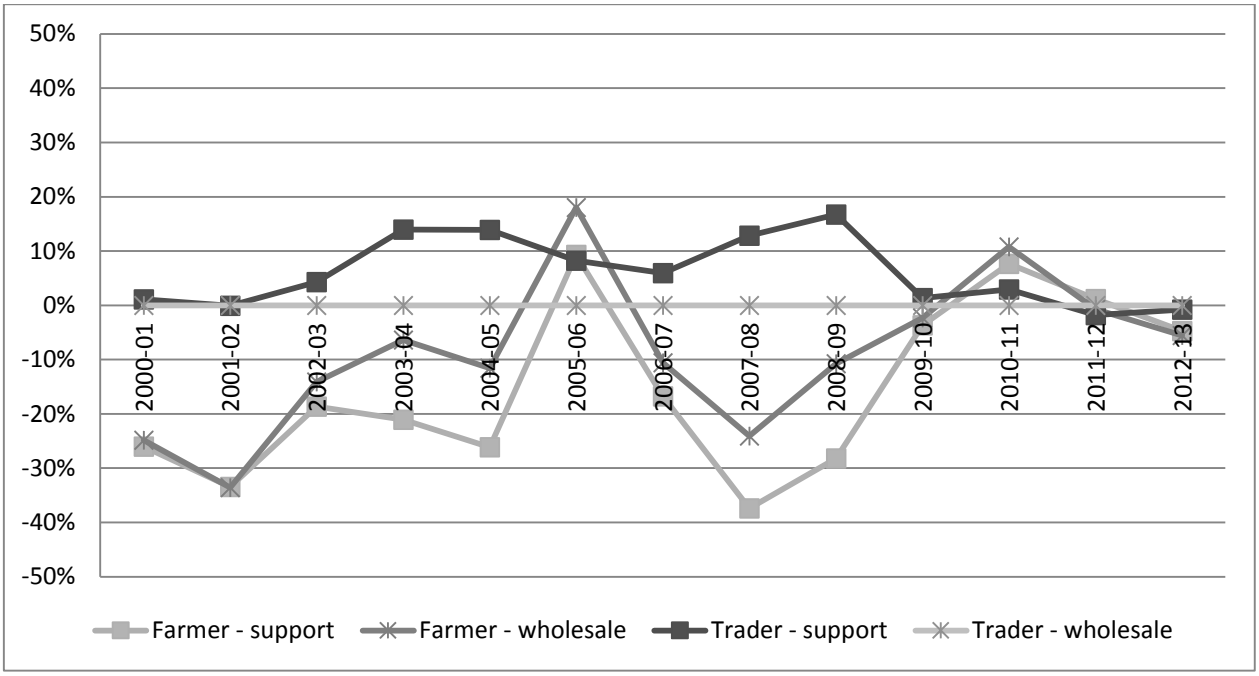
Figure 3: NRA (%) to "producers" and "consumers" for 2000-2013.



Source: Author's calculations.

Notes: The NRA to "producers" (wheat sector) is equal to the sum of the NRAs to wheat farmers and wheat traders. The NRA to "consumers" is equal to the sum of the NRA to flour millers and the average NRA to flour consumers (across NRAs for upper and lower bound border prices). The NRAs for flour millers and flour consumers are calculated using EU/Black Sea import parity prices.

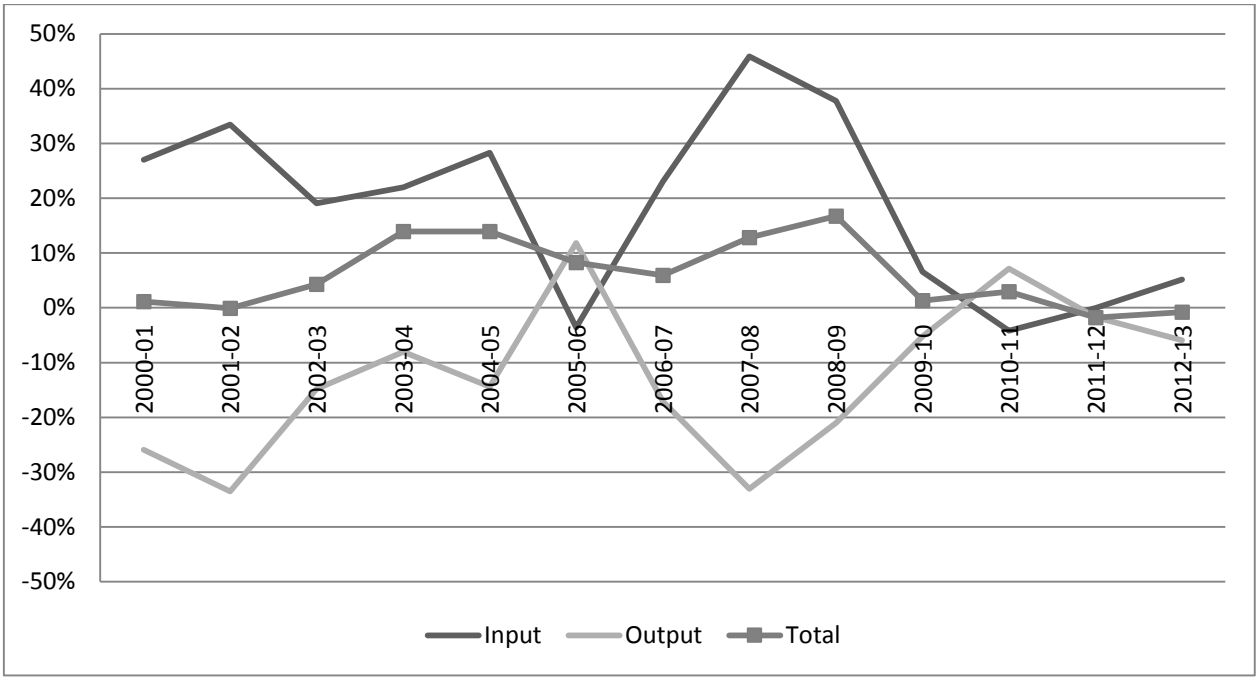
Figure 4: NRA to wheat farmers and wheat traders for alternative farmgate price indicators for 2000-2013.



Source: Author's calculations.

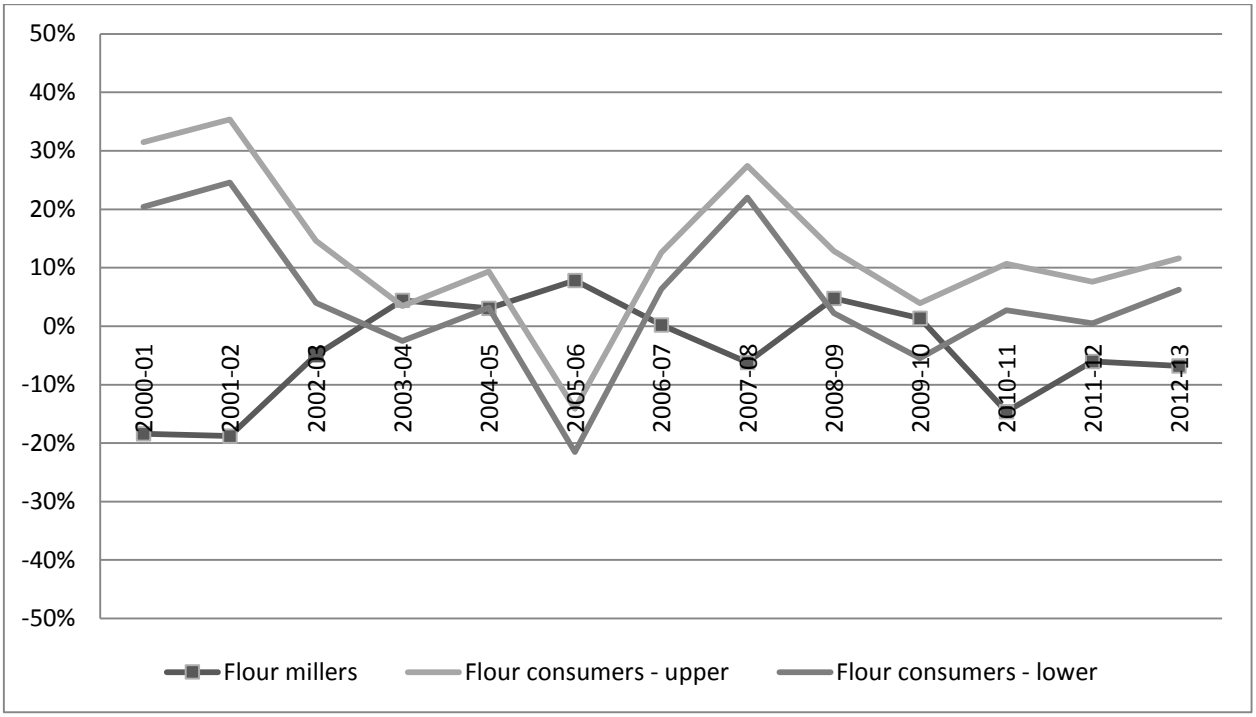
Notes: 'Support' indicates that farmgate prices are assumed equal to the support price; 'wholesale' indicates that farmgate prices are assumed equal to the wholesale wheat price minus marketing costs from the farmgate to the wholesale market in Lahore.

Figure 5: Disaggregated NRA to wheat traders (input, output, total) using the support price indicator for 2000-2013.



Source: Author's calculations.

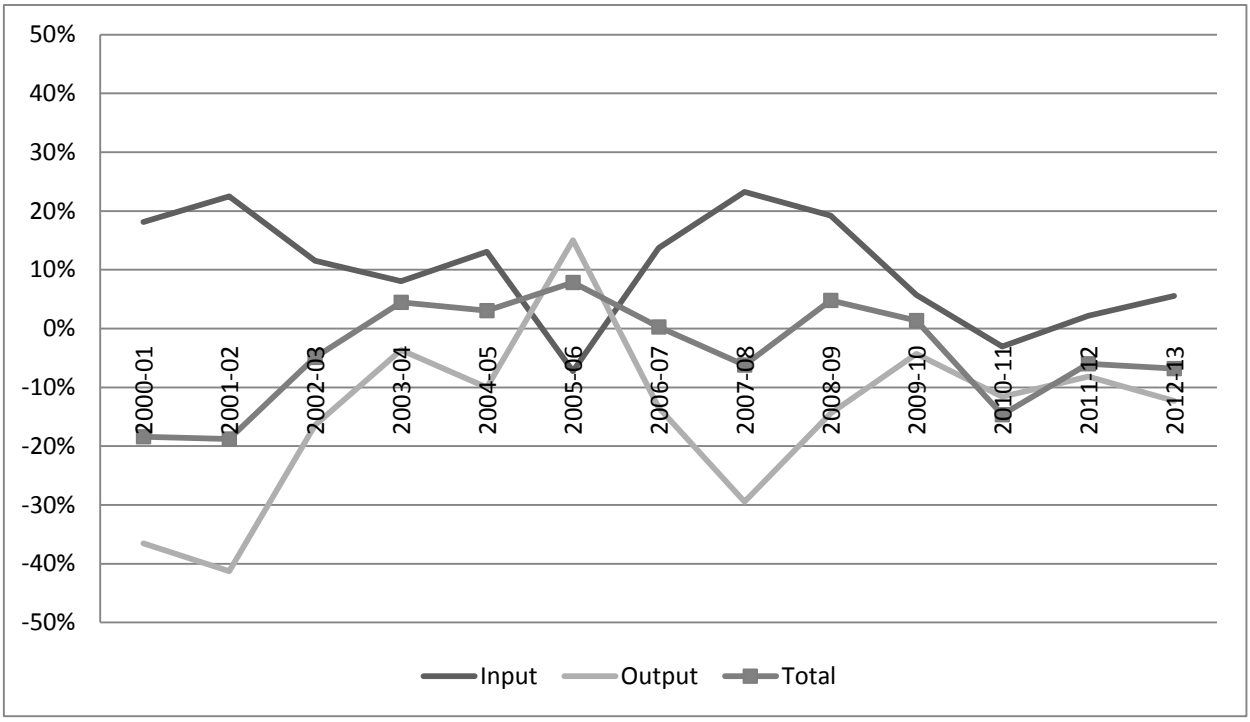
Figure 6: NRA (%) to flour millers and flour consumers (for upper and lower bound border prices) for 2000-2013.



Source: Author's calculations.

Notes: 'Lower' and 'upper' indicate that lower bound, respectively upper bound border prices were used to calculate the NRA to flour consumers. The NRAs for flour millers and flour consumers are calculated using EU/Black Sea import parity prices.

Figure 7: Disaggregated NRA to flour millers (input, output, total) for 2000-2013.



Source: Author's calculations.

Notes: The NRAs for flour millers are calculated using EU/Black Sea import parity prices.

Appendix 1: Methodology for calculating NRA to farmer input

Annual NRAs to input are calculated using annual averages of border prices and domestic prices. Monthly NRAs are calculated using monthly import parity prices and annual domestic prices due to the unavailability of monthly domestic fertilizer prices.

The international reference prices for DAP (diammonium phosphate) and urea were taken from the World Bank. For DAP the price is the FOB US Gulf price; for urea the price is the FOB Black Sea price (primarily Yuzhnyy). World market prices were calculated by adding international ocean freight rates from the US Gulf to Karachi to the international DAP price and freight rates from the Black Sea to Karachi (estimated at 85 % of US Gulf freight rates) to the international urea price. The import parity price at Lahore is then equal to the world market price times the nominal exchange rate (Pak Rs/USD) plus import marketing costs from Karachi to Lahore. We abstract from any quality adjustments.

The conversion rates of DAP and urea (Q_j^f / Q_o^f) are equal to the number of kilograms of fertilizer used to produce one kilogram of wheat. These rates were calculated using the use of fertilizer per hectare for wheat production for 2011/12 and 2012/13 from the Agriculture Policy Institute and annual yield data for wheat taken from the Pakistan Economic Survey 2012-13. We assume that the use of fertilizer per hectare was constant over the period 2000-2013. Annual fertilizer prices are averages for Pakistan and were taken from the Pakistan Economic Survey 2012-13.

Appendix 2: Methodology for calculating import and export parity prices for wheat

For the calculation of the import and export parity prices of wheat, we have followed Dorosh and Valdés (1990) and Dorosh and Salam (2007).

The import parity price for wheat

The CIF price at the border in Karachi equals the international price of wheat (US FOB Gulf HRW2) plus international freight costs from the US Gulf to Karachi times the nominal exchange rate (Pak Rs/USD). The import parity price at the wholesale market in Lahore equals the CIF price at the border in Karachi (adjusted for a quality difference of 5 %) plus import and domestic marketing costs from Karachi to the wholesale market in Lahore. The import parity price at the farmgate equals the import parity at the wholesale market minus marketing costs from the farmgate to the wholesale market in Lahore.

The export parity price for wheat at the farmgate

The FOB price at the border of Karachi equals the international price of wheat (US FOB Gulf HRW2) plus international freight costs from Karachi to the Middle East/South Asia times the nominal exchange rate (Pak Rs/USD). The export parity price at the wholesale market in Lahore equals the FOB price at the border in Karachi minus export and domestic marketing costs from Karachi to the wholesale market in Lahore. The export parity price at the farmgate in Lahore equals the export parity price at the wholesale market minus marketing costs from the farmgate to the wholesale market in Lahore.

The monthly international wheat price for US Gulf HRW2 was taken from the FAO commodity price database and the official nominal exchange rate was taken from the IMF International Finance Statistics. Import and export marketing costs include insurance, landing and handling costs, commissions for the Trading Corporation Pakistan (TCP), interest costs and other miscellaneous expenses. Marketing costs before 2005/06 were taken from the Dorosh and Salam (2007) dataset; marketing costs for the years after were taken from the Agricultural Policy Institute (API). International freight rates from the US Gulf to Karachi were taken from the Dorosh-Salam dataset for 2000-2006 and from IGC for 2007-2013. International freight rates from Karachi to the Middle East/South Asia were estimated to be 75 % of freight rates from the US Gulf to Karachi.

Appendix 3: Methodology for calculating border prices for wheat flour

Autarky prices

Autarky prices are calculated by adding marketing and processing costs of flour milling in Pakistan to the autarky wholesale wheat price in Lahore. Marketing and processing costs for 2010/11 were taken from (International Finance Corporation, 2011) and extended using the monthly CPI. Marketing costs include transportation, handling and service fees to traders.

Import and export parity prices

The calculation of import and export parity prices for wheat flour is not straightforward. Contrary to wheat grain, wheat flour is not a widely-traded commodity with a clearly identified international reference price. We have therefore calculated an import parity price for two scenario's. In the first scenario, we assume that Pakistan would import wheat flour from Kazakhstan under free trade. Kazakhstan has recently become one of the global leaders in wheat flour exports and the main supplier of wheat flour to the Central and South Asia region. As Kazakhstan has historically been the main supplier of wheat flour to the north of Afghanistan (Persaud, 2013), wheat flour from Kazakhstan should be able to reach Pakistan as well. In this scenario, the import parity price of wheat flour at Lahore is equal to the Kazakhstan wheat flour FOB price (times the Pakistan Rs./USD nominal exchange rate) plus marketing costs from Kazakhstan to Lahore, adjusted for a quality difference of 5 %.

The second scenario assumes that Pakistan would import wheat flour from the EU or Black Sea region under free trade. Wheat flour imported from the EU/Black Sea region would likely be less costly for Pakistan than importing wheat flour from Kazakhstan due to significant land freight costs for the latter. In addition, since 2003 a large share of wheat flour imports (although mainly in the form of humanitarian aid or food aid) has come from the EU-27, Turkey or Ukraine. For the EU/Black Sea region, we use the FOB export price of Turkey, the second global leader in wheat flour exports, as the international reference price. The import parity price at Lahore is then equal to the Turkey wheat flour FOB price plus international ocean freight costs from the EU/Black Sea region to South Asia (times the nominal exchange rate) plus marketing costs from Karachi to Lahore, adjusted for a quality difference of 5 %.

According to UN Comtrade statistics, in 2003-2013 over 90 % of wheat flour exports from Pakistan have flowed to Afghanistan (with the exception of 2011 where the share is 75 %, see Section 2). We therefore assume that under free trade Pakistan would continue to export wheat flour mostly to Afghanistan and that the export parity price is mainly determined by demand in Afghanistan (see also (World Bank, 2010). As Kazakhstan is the leading wheat flour exporter in the region and the main competitor of Pakistan flour exports in Afghanistan, we take the FOB wheat flour price of Kazakhstan as the international reference price. The export parity price of wheat flour at Lahore is then equal to the Kazakhstan FOB wheat flour price plus freight rates from Kazakhstan to the Pakistan-Afghanistan border minus transport and marketing costs from Lahore to the border (Peshawar).

The unit value FOB wheat flour price for Turkey and Kazakhstan is calculated using annual UN Comtrade wheat flour trade statistics for the years 2000-2003 and monthly GTIS wheat flour trade data for the years 2004-2013. International ocean freight rates from the EU/Black Sea region to South Asia is estimated to be 85 % of US Gulf – Karachi freight rates, which are taken from the Dorosh-Salam dataset for 2000-2006 and from IGC Grain Market Reports for 2007 onwards. Annual marketing costs from the Kazakhstan border to Kabul were taken from official statistics for 2011 and extended using the annual Kazakhstan CPI (base year 2005). Marketing costs from Kabul to the Afghanistan-Pakistan border (Peshawar) were calculated from estimates for 2002 in (Chabot and Dorosh, 2007) and for 2012 in (Food Security Response Analysis Support Team Afghanistan (RASTA), 2014). Both series were extended using the monthly Pakistan CPI. Marketing costs from Lahore to the Afghanistan-Pakistan border (Peshawar) were calculated from estimates for 2012 in (RASTA, 2014) and extended using the monthly Pakistan CPI.

Appendix 4: Additional tables and Figures

Table A1: Overview of wheat policies and the wheat market in Pakistan since the 1990s.

Period	Description	Production ('000 MT)	Procurement ('000 MT)	Distribution ('000 MT)	Net Imports ('000 MT)	Net availability per capita (kg/capita)	Real wholesale price wheat (2005 Rs/kg)
1988/89 - 1999/00	Liberalized retail sales; Large-scale public imports lower market prices	15 845	3 681	5 671	2 369	132	9.05
2000/01 - 2006/07	Reduced public imports and net availability; domestic prices rise; exports to Afghanistan	19 986	4 572	4 391	-376	114	10.63
2007/08 - 2008/09	Very high world prices; domestic prices rise; exports banned; large public imports	22 127	4 170	6 052	315	118	12.96
2009/10	International prices fall; domestic prices at import parity, but little trade	24 033	9 231	5 985	147	106	15.31
2010/11 - 2012/13	Moderate rise in world prices; domestic prices at export parity; net exports	23 999	6 219	6 348	-1 463	116	12.96

Source: Author's calculations. Production, procurement and distribution data from Pakistan Economic Survey. Trade data from Pakistan Bureau of Statistics, FAO and the UN Comtrade database (for 2011/12 and 2012/13). Lahore wholesale wheat prices from Dorosh-Salam dataset and Punjab Institute for Agricultural Marketing.

Notes: Production, procurement and distribution data are supplied for fiscal years. Production in the previous year is used to calculate net availability in the current year.

Table A2: World Bank estimates of NRA, NRA to output and NRA to input for wheat in Pakistan, 2000-2010.

Year	NRA	NRA to output	NRA to input
2000	0.093	0.073	0.020
2001	-0.146	-0.178	0.032
2002	-0.266	-0.287	0.021
2003	-0.290	-0.302	0.012
2004	-0.132	-0.150	0.018
2005	-0.095	-0.124	0.029
2006	-0.315	-0.315	0.000
2007	-0.484	-0.484	0.000
2008	-0.634	-0.634	0.000
2009	-0.017	-0.017	0.000
2010	-0.028	-0.028	0.000

Source: World Bank Updated Distortions to Agricultural Incentives database (Anderson and Nelgen, 2013).

Table A3: Calculation of NRA to wheat farmers (prices in Rs/kg)

Marketing Year	Border price	Support price	Wholesale wheat - trader costs	Import parity farmgate	Export parity farmgate	Autarky price farmgate	NRA support	NRA wholesale	NRA input
2000/01	Import	7.50	7.62	10.45	5.87	4.76	-0.26	-0.25	0.02
2001/02	Import	7.50	7.49	11.50	6.74	6.74	-0.33	-0.34	0.01
2002/03	Autarky	7.50	7.92	12.85	8.03	9.38	-0.19	-0.14	0.01
2003/04	Autarky	7.50	8.93	12.48	7.52	9.76	-0.21	-0.06	0.02
2004/05	Autarky	8.75	10.55	12.64	7.55	12.42	-0.26	-0.12	0.03
2005/06	Autarky	10.00	10.84	13.33	8.18	9.63	0.09	0.18	0.05
2006/07	Autarky	10.38	11.22	17.53	11.83	13.64	-0.17	-0.11	0.07
2007/08	Export	10.63	13.33	28.61	20.31	16.75	-0.37	-0.24	0.10
2008/09	Autarky	15.63	20.12	28.62	20.21	25.77	-0.28	-0.11	0.11
2009/10	Import	23.75	24.10	25.51	17.03	15.64	-0.04	-0.02	0.03
2010/11	Export	23.75	24.46	31.57	22.74	23.52	0.08	0.11	0.03
2011/12	Export	25.21	24.74	34.39	25.20	23.80	0.01	-0.01	0.01
2012/13	Export	27.81	27.57	39.39	29.39	31.21	-0.05	-0.06	0.01

Source: Author's calculations. Wholesale price wheat at Lahore from Dorosh-Salam dataset and Punjab Institute for Agricultural Marketing. Notes: Appendix 2 provides details on the calculation of import and export parity prices for wheat. Autarky prices supplied by P. Dorosh.

Table A4: Calculation of NRA to wheat traders (prices in Rs/kg)

Marketing year	NRA input support	NRA input wholesale	Wholesale wheat Lahore	Import parity wheat Lahore	Export parity wheat Lahore	Autarky price wheat Lahore	NRA output	NRA support	NRA wholesale
2000/01	0.27	0.26	8.08	10.90	6.33	5.22	-0.26	0.01	0.00
2001/02	0.33	0.34	7.95	11.97	7.21	7.21	-0.34	0.00	0.00
2002/03	0.19	0.15	8.40	13.33	8.51	9.86	-0.15	0.04	0.00
2003/04	0.22	0.08	9.43	12.98	8.02	10.26	-0.08	0.14	0.00
2004/05	0.28	0.14	11.10	13.18	8.09	12.96	-0.14	0.14	0.00
2005/06	-0.04	-0.12	11.42	13.91	8.76	10.21	0.12	0.08	0.00
2006/07	0.23	0.17	11.75	18.06	12.36	14.17	-0.17	0.06	0.00
2007/08	0.46	0.33	14.13	29.41	21.10	17.54	-0.33	0.13	0.00
2008/09	0.38	0.21	21.21	29.71	21.30	26.86	-0.21	0.17	0.00
2009/10	0.05	0.05	25.32	26.73	18.25	16.87	-0.05	0.01	0.00
2010/11	-0.04	-0.07	25.77	32.89	24.06	24.83	0.07	0.03	0.00
2011/12	0.00	0.02	26.07	35.73	26.53	25.13	-0.02	-0.02	0.00
2012/13	0.05	0.06	28.93	40.75	30.76	32.58	-0.06	-0.01	0.00

Source: Author's calculations. Wholesale price wheat at Lahore from Dorosh-Salam dataset and Punjab Institute for Agricultural Marketing. Notes: Appendix 2 provides details on the calculation of import and export parity prices for wheat. Autarky prices supplied by P. Dorosh.

Table A5: Calculation of NRA to flour millers for EU import parity prices (prices in Rs/kg)

Marketing Year	Release price	Wholesale price flour Lahore	Import parity flour Lahore (EU)	Export parity flour Lahore	Autarky price flour Lahore	NRA input (EU)	NRA output (EU)	NRA (EU)
2000/01	7.75	8.64	13.62	10.76	6.86	0.18	-0.37	-0.18
2001/02	8.00	8.57	14.59	11.52	8.89	0.22	-0.41	-0.19
2002/03	8.00	9.69	17.02	12.44	11.60	0.12	-0.16	-0.05
2003/04	8.36	11.62	16.58	17.16	12.06	0.08	-0.04	0.04
2004/05	9.64	13.44	17.55	13.47	14.93	0.13	-0.10	0.03
2005/06	10.78	14.20	16.49	12.86	12.34	-0.07	0.15	0.08
2006/07	10.96	14.24	20.67	14.37	16.46	0.14	-0.13	0.00
2007/08	13.18	18.28	32.41	25.91	20.06	0.23	-0.29	-0.06
2008/09	17.82	25.61	41.01	38.77	29.93	0.19	-0.14	0.05
2009/10	23.68	31.44	32.86	26.36	20.30	0.06	-0.04	0.01
2010/11	24.69	28.80	40.04	32.58	28.57	-0.03	-0.12	-0.15
2011/12	24.95	31.41	44.45	34.20	29.05	0.02	-0.08	-0.06
2012/13	27.08	34.58	51.01	39.44	36.82	0.06	-0.12	-0.07

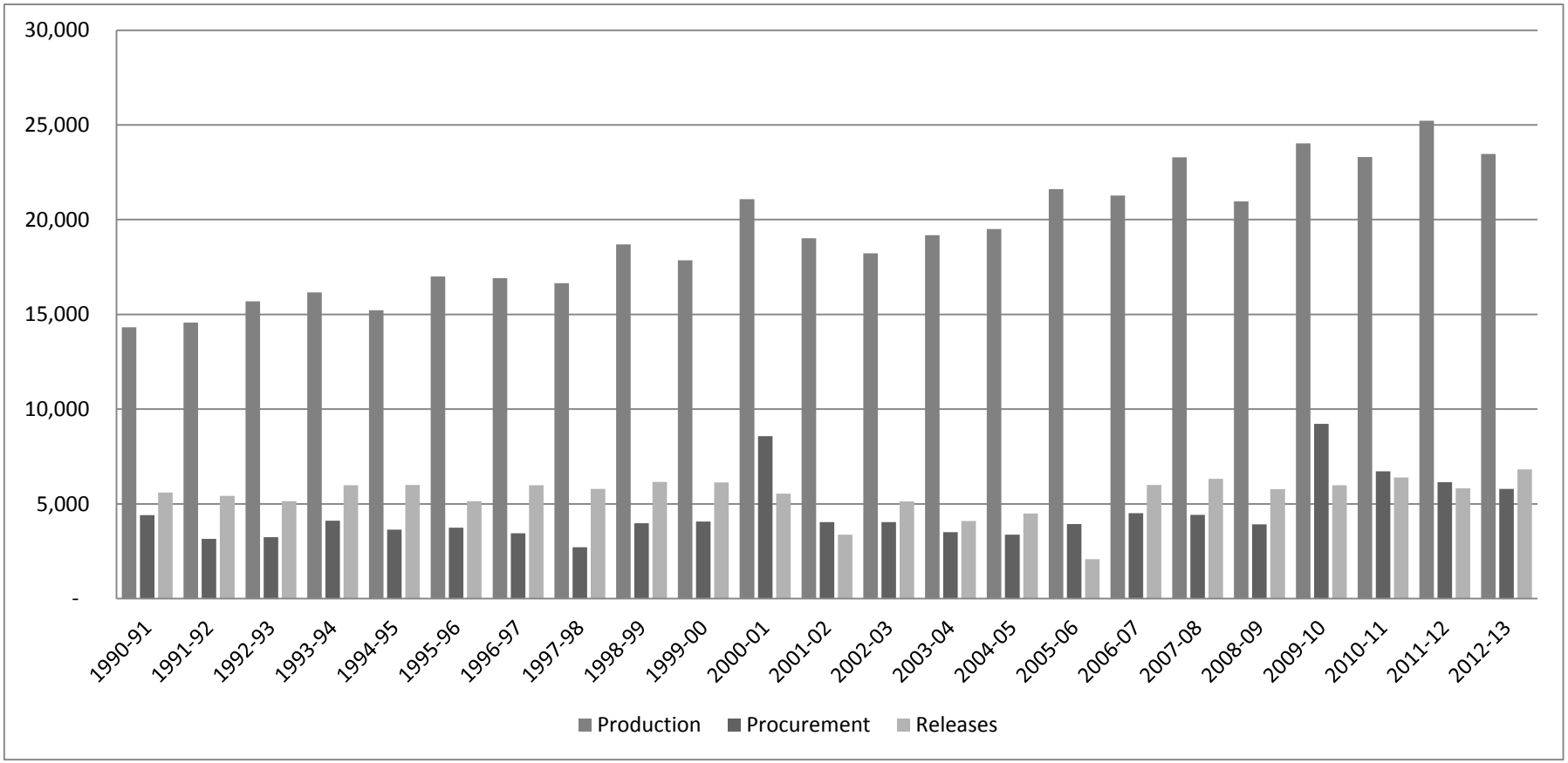
Source: Author's calculations. Release price from Dorosh-Salam dataset. Wholesale price wheat flour at Lahore from Pakistan Bureau of Statistics.
Notes: Appendix 3 provides details on the calculation of wheat flour border prices. The wholesale wheat flour price is for wheat flour of superior quality.

Table A6: Calculation of NRA to flour consumers for EU import parity prices (prices in Rs/kg)

Marketing Year	Retail price wheat flour	Upper import parity flour (EU)	Upper export parity flour	Upper autarky price flour	Lower import parity flour (EU)	Lower export parity flour	Lower Autarky price flour	NRA Upper	NRA Lower
2000/01	10.83	15.81	12.95	9.05	13.62	10.76	6.86	0.31	0.20
2001/02	11.00	17.02	13.95	11.33	14.59	11.52	8.89	0.35	0.25
2002/03	11.14	18.47	13.88	13.05	17.02	12.44	11.60	0.15	0.04
2003/04	12.36	17.32	17.90	12.80	16.58	17.16	12.06	0.03	-0.03
2004/05	14.46	18.57	14.49	15.95	17.55	13.47	14.93	0.09	0.03
2005/06	15.00	17.30	13.67	13.14	16.49	12.86	12.34	-0.14	-0.22
2006/07	15.42	21.84	15.55	17.63	20.67	14.37	16.46	0.13	0.06
2007/08	20.21	34.35	27.85	22.00	32.41	25.91	20.06	0.27	0.22
2008/09	29.26	44.66	42.41	33.57	41.01	38.77	29.93	0.13	0.02
2009/10	34.67	36.09	29.58	23.53	32.86	26.36	20.30	0.04	-0.05
2010/11	31.68	42.92	35.46	31.45	40.04	32.58	28.57	0.11	0.03
2011/12	34.04	47.08	36.84	31.69	44.45	34.20	29.05	0.08	0.00
2012/13	36.98	53.40	41.83	39.22	51.01	39.44	36.82	0.12	0.06

Source: Author's calculations. Retail wheat flour price at Lahore from Pakistan Bureau of Statistics.
Notes: The wheat flour retail price is the price for wheat flour of superior quality.

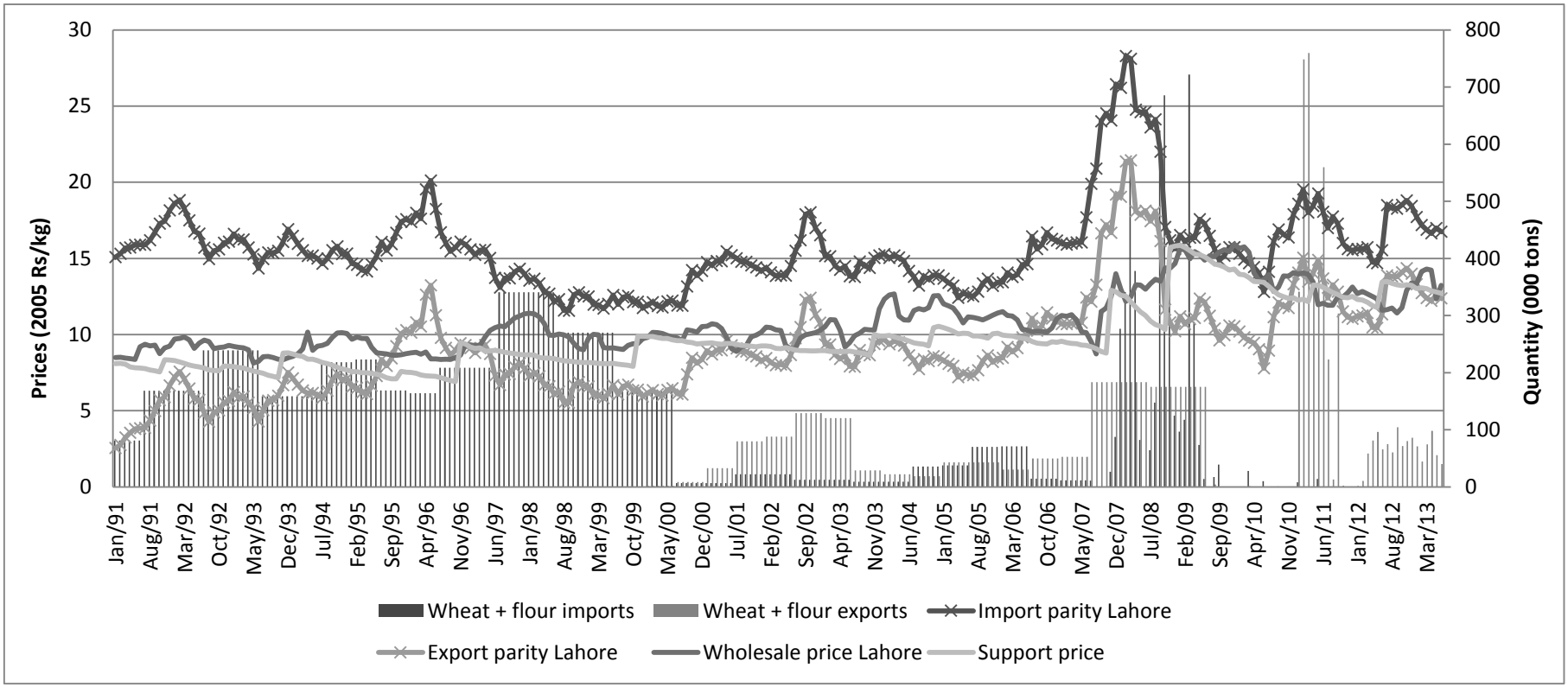
Figure A1: Production, government procurement and government releases of wheat in Pakistan for 1990-2013.



Source: Pakistan Economic Survey.

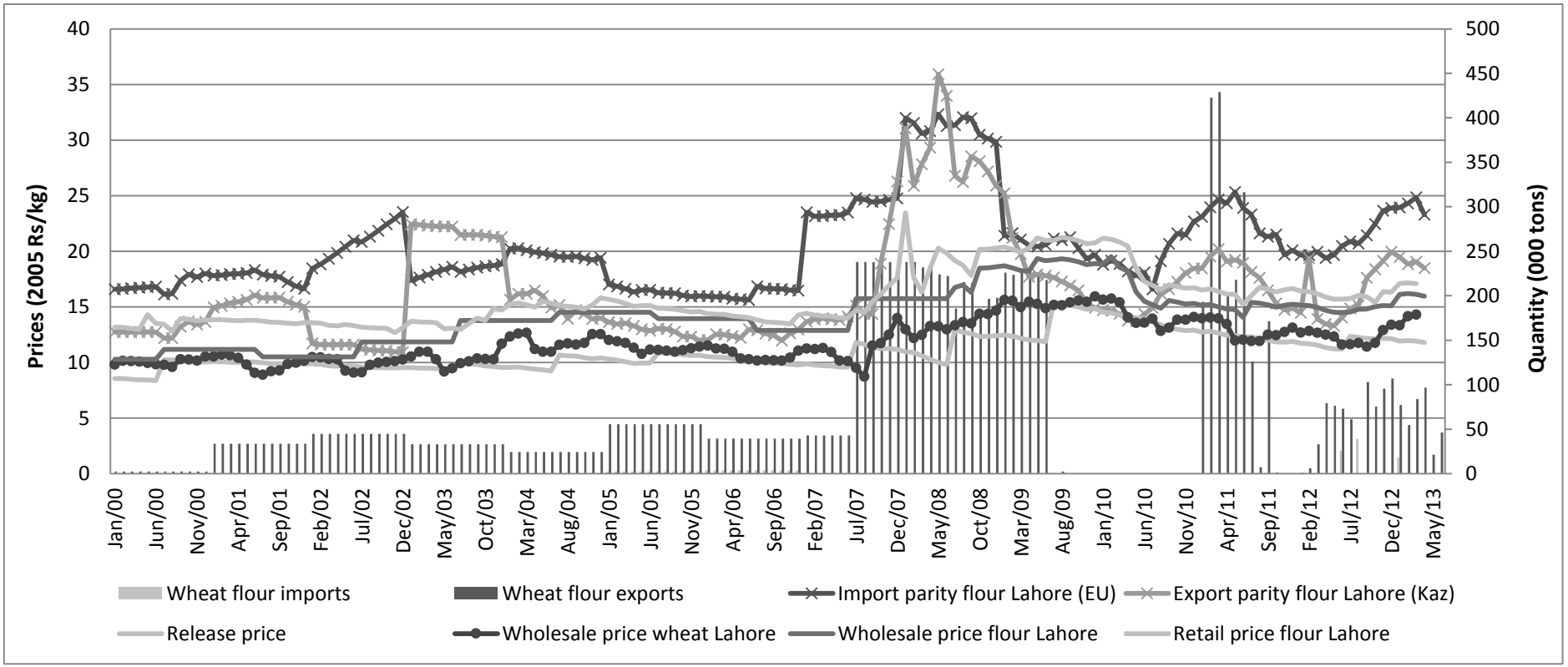
Notes: The Pakistan Economic Survey supplies production, procurement and release data by fiscal year. Hence, the figure shows data for FY1991-FY2013.

Figure A2: Real wheat border prices, domestic wheat prices and wheat (flour) trade for Pakistan for 1991-2013.



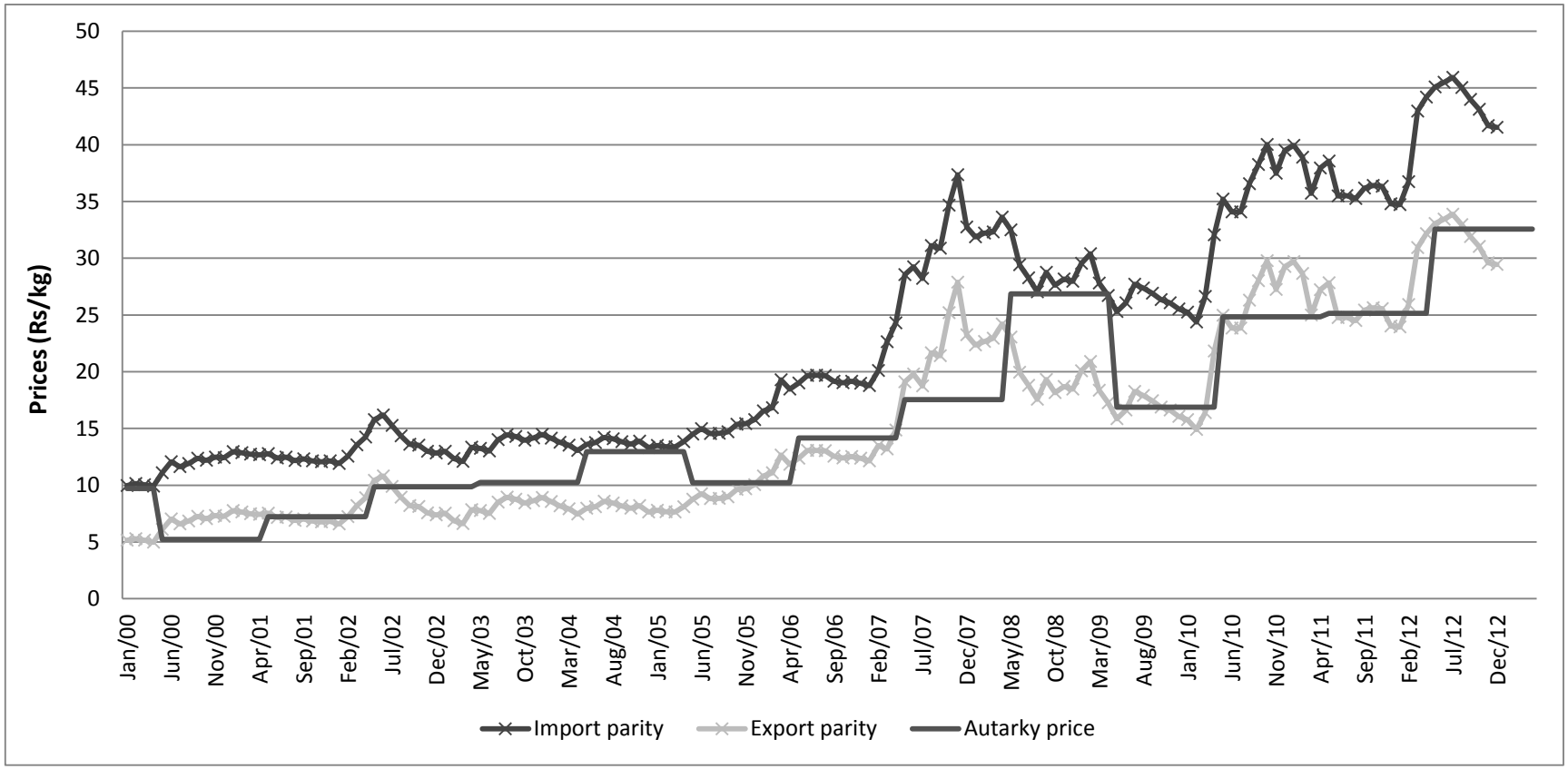
Source: Import and export parity prices for wheat from author's calculations (see Appendix 2 for details). Trade data from Pakistan Bureau of Statistics, FAO and the UN Comtrade database (for 2011/12 and 2012/13). Support price and Lahore wholesale wheat prices from Dorosh-Salam dataset and Punjab Institute for Agricultural Marketing.
Notes: Import and export parity prices shown here are measured at the wholesale market in Lahore and are calculated using the FOB price for US Gulf HRW1 wheat. The import and export parity prices used for the calculation of the NRAs are based on the FOB price for US Gulf HRW2 wheat, which is most comparable to Pakistan wheat. The reason for showing HRW1 border prices in this Figure is the unavailability of US Gulf HRW2 wheat prices before January 1998. Wheat flour trade quantities are converted to wheat equivalents using a conversion factor of 0.77. Real prices are calculated by deflating nominal prices using the monthly Pakistan CPI (base year 2005).

Figure A3: Real wheat flour border prices, domestic wheat (flour) prices and wheat flour trade for 2000-2013.



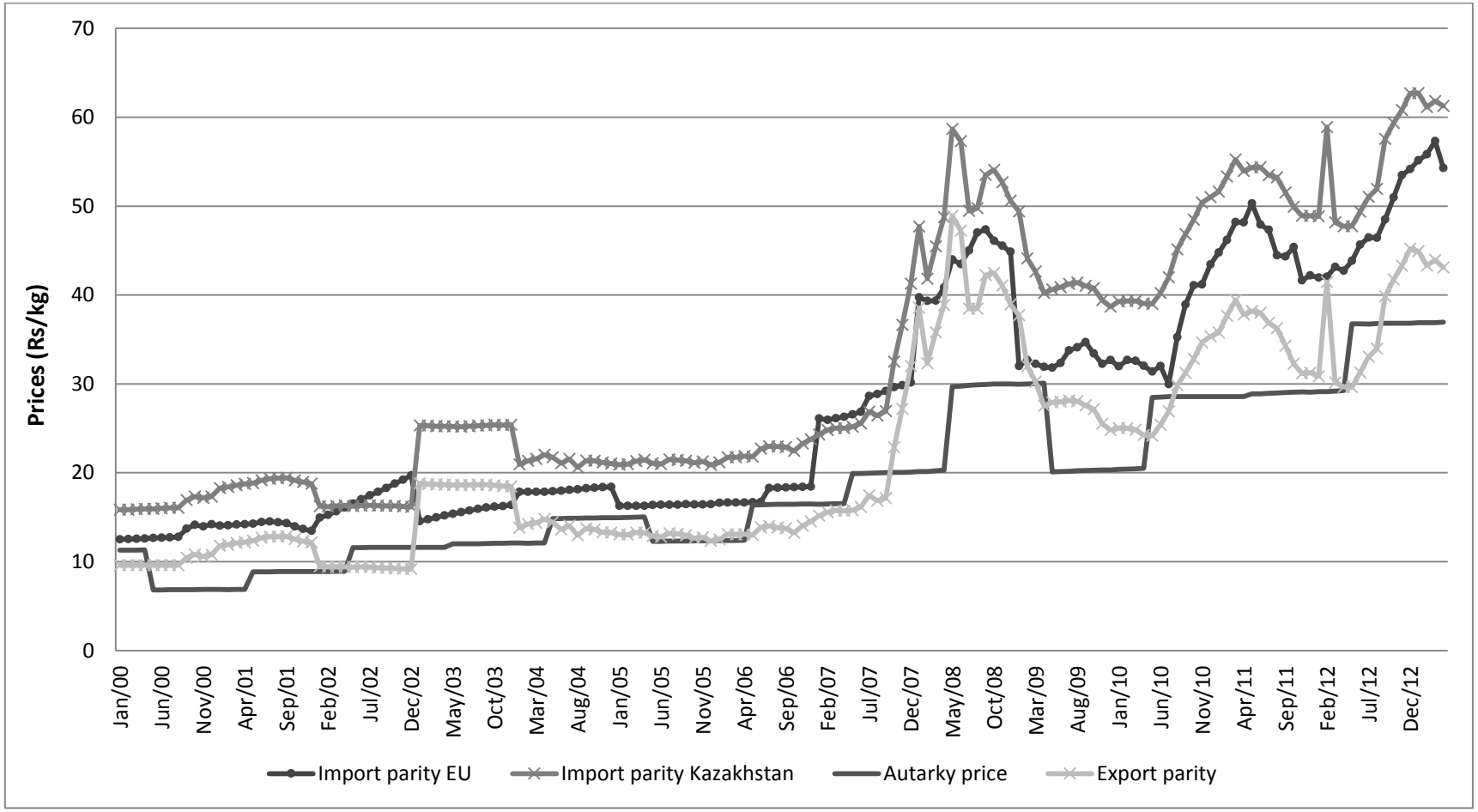
Source: Import and export parity prices for wheat flour from author's calculations (see Appendix 3 for details). Trade data from annual FAO data until 2011 and monthly data from Pakistan Bureau of Statistics for 2011-2013. Domestic prices from Dorosh-Salam dataset, Pakistan Bureau of Statistics and Punjab Institute for Agricultural Marketing.
Notes: Wheat flour prices are prices for Atta flour of superior quality. The wholesale price of wheat flour shows annual data before July 2008 (deflated by the annual CPI) and monthly data afterwards (deflated by the monthly CPI). Import parity prices are calculated assuming wheat flour imports from the EU. Import and export parity prices are measured at the wholesale market in Lahore and are used for the calculation of the NRA to flour millers. These border prices are equivalent to the lower bound parity prices used for the calculation of the NRA to flour consumers. Real prices are calculated by deflating nominal prices using the monthly Pakistan CPI (base year 2005).

Figure A4: Import parity, export parity and autarky prices for wheat for 2000-2013.



Source Author's calculations. Appendix 2 provides details on the calculation of import and export parity prices. Autarky prices were supplied by P. Dorosh.

Figure A5: Import parity, export parity and autarky prices for wheat flour for 2000-2013.



Source: Author's calculations. Appendix 3 provides details calculation of wheat flour border prices.
Notes: Wheat flour border prices and autarky prices are measured at the wholesale market in Lahore. These border prices correspond to the lower bound border prices at the retail market used for calculations of the NRA to flour consumers.