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Agro-Manufactured Export Prices, Wages and Unemployment

Guido Porto

The World Bank
Development Research Group
Trade Team
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Abstract

This paper estimates the impacts of world agricultural trade liberalization on wages, employment and unemployment in Argentina, a country with positive net agricultural exports and high unemployment rates. In the estimation of these wage and unemployment responses, the empirical model allows for individual labor supply responses and for adjustment costs in labor demand. The findings show that a 10 percent increase in the price of agricultural exports would cause an increase in the Argentine employment probability of 1.36 percentage points, matched by a decline in the unemployment probability of 0.75 percentage points and an increase in labor market participation of 0.61 percentage points. Further, the unemployment rate would decline by 1.23 percentage points (by almost 10 percent). Expected wages would increase by 10.3 percent, an effect that is mostly driven by higher employment probabilities. This indicates that the bulk of the impacts of trade reforms originates in household responses in the presence of adjustment costs, and that failure to account for them may lead to significant biases in the welfare evaluation of trade policy.

Agro-Manufactured Export Prices, Wages and Unemployment*

Guido G. Porto[†]
Development Research Group
The World Bank

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[†]Correspondence: Guido Porto, MailStop MC3-303, The World Bank, 1818 H Street, Washington DC 20433. email: gporto@worldbank.org

1 Introduction

Agricultural policies in developed countries, such as tariff protection, non-tariff barriers, export subsidies, and income support policies, are likely to have significant effects on poverty in the developing world. In low-income countries, for example, agricultural policies that affect the international prices of major cash crops will have impacts on income, crop choices, and consumption. In contrast, middle-income countries with a more developed industrial sector will most likely be affected through labor markets via prices in the agro-industrial sector. More concretely, changes in agro-manufactured export prices will induce a reallocation of factors of production, changes in relative factor demands, and changes in relative factor prices (wages). If there are frictions in the economy and wages are not fully flexible, there may be changes in unemployment as well: employed workers may lose their jobs, unemployed workers may become employed, and inactive workers may enter the workforce. These changes in the employment status of individual workers may comprise discrete changes in labor income and thus in household welfare.

There is a vast literature that has studied farm responses to trade in low-income countries.[1] There is also a vast literature that has looked at labor markets and wages.[2] Fewer papers, however, have investigated the link between trade and labor market responses with adjustment costs, endogenous labor supply, and unemployment.[3] While most research on this topic has focused on developed countries, my main objective here is to provide evidence on labor market adjustment to trade shocks in middle-income developing countries.[4] I explore the case of Argentina, a country well-endowed in natural resources and with a comparative advantage in agro-manufacturing—the major export sector. In addition, the unemployment

rate in Argentina during the last decade was always greater than 10 percent, making this experience a great case study to investigate the impacts of agro-manufactured exports in the presence of adjustment costs in labor markets.

I set up a maximum likelihood model of trade, wages and unemployment. Based on their market and reservation wages, workers decide whether to be active (i.e., to participate in the labor market) or inactive. Firms make job offers to active workers; workers who receive an offer are employed and those who do not become unemployed. Thus, there are three regression functions in my model: a wage equation, a reservation wage equation, and a job offer equation.

I capture the role of trade with the international price of agro-manufactured exports and I make both wages and job offers a function of these prices. To estimate the model, I combine labor force data on wages, employment, and unemployment at an individual level with export and import price data at an aggregate level. The method takes advantage of the time variability in prices and the time variability of household surveys to identify the parameters of the model. Similar methods have been utilized by Deaton (1997), Goldberg and Tracy (2003), Porto (2006), Ravallion (1990), and Wolak (1996).

The maximum likelihood model estimates parameters that measure how market wages, reservation wages, and job offers react to a change in the prices of agro-manufactured exports. These parameter estimates can be used to predict the probability of actively participating in the labor market, the probability of getting a job offer, and the probability of employment and unemployment. In addition, the estimated regression function for wages can be used to predict expected wages. Armed with these estimates, I investigate the impacts of higher

export prices of agro-industrial products, possibly due to episodes of trade liberalization in the developed world.

My results indicate that Argentina would significantly benefit from higher prices of agro-manufactured exports. These higher prices would trigger job openings, raise employment probabilities and raise wages. By increasing the market wage relative to the reservation wage, labor market participation would increase as well. In the end, following a 10 percent increase in the price of agro-manufactured exports, I estimate an increase in the employment probability of 1.36 percentage points, on average. The unemployment rate would decline by 1.23 percentage points, which is roughly equivalent to 10 percent of the Argentine unemployment rate in 1998. Expected wages would increase by 10.39 percent due to higher market wages, on the one hand, and higher employment probabilities, on the other. A key finding is that the increase in employment opportunities accounts for more than 70 percent of the increase in expected wages. These results thus highlight the importance of allowing for labor market adjustments to trade reforms in empirical work and suggest that failure to account for these adjustment effects will bias the estimates of the welfare impacts of trade policy.[5]

The rest of the paper is organized as follows. In section 2, I describe and estimate the empirical model, and I discuss the results. In section 3, I investigate the impacts of higher prices of agro-manufactured exports on wages, employment and unemployment in Argentina. Finally, section 4 concludes.

2   A Model of Trade, Wages and Unemployment

International trade cannot by itself be the cause of unemployment, which instead arises when there are frictions in the economy. Models of unemployment typically include minimum wages, efficiency wages, search costs and matching, and credit and liquidity constraints. Theoretical models of trade and unemployment with minimum wages include Brecher (1974) and Davis (1996). Albert and Meckl (2001) study trade in the presence of efficiency-wage unemployment. Davidson, Martin and Matusz (1999) explore instead trade and search-generated unemployment. Finally, Leamer (1980) and Baldwin, Mutti, and Richardson (1980) introduce models of unemployment generated during the transition that follows a trade reform when there are costs of adjustment.

In all these scenarios, trade can interact with the inherent frictions in the economy to exacerbate the incidence of trade costs or to boost the gains from trade. For example, when new export opportunities arise, unemployed individuals may become employed in the export sector, thus significantly benefiting from trade. In contrast, frictions may prevent the absorption of job losses in the import competing sectors in the face of stronger competition from abroad. If there are labor supply responses, additional effects will arise in equilibrium because the conditions in international markets can affect total labor supply and equilibrium unemployment.

Figure 1 provides an overview of the mechanisms. The graph depicts a simple two-sector (a and m) specific factor model (land and capital, for instance). Labor is mobile across sectors. The length of the box measures the total labor supply, and the downward sloping curves represent labor demand (the value of its marginal productivity): Vp_a is the labor

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demand in the export sector (say, agro-manufactures) and Vp_m, the labor demand in the m sector. Because of the frictions mentioned above, the equilibrium wage $\overline{w}$ is above the competitive wage so that the labor market does not clear completely and there is unemployment, $U = L(p_a, p_m) - L_a - L_m$.[6]

In Figure 1, the impacts of trade can be assessed by considering an increase in the price of agro-manufactured exports, p_a. Although I do not model the price changes explicitly, export prices for Argentine products like dairy, oils and fats, mills products and beef—goods that form the bulk of manufactured exports of the country—may increase due to trade liberalization in developed countries. These countries intervene in world markets with an extensive set of tariffs, non-tariff barriers, and subsidies and it is feasible to think that the elimination of (some of) these barriers will bring about increases in export prices. The increase in p_a raises labor demand in the agro-industrial sector. This is captured by an outward shift in the demand curve to Vp'_a. In addition, there may be a change in the market wage, say to $\overline{w}'$. Finally, there may a change in total labor supply, say to L'. The impacts of a higher p_a on unemployment is thus ambiguous. The initial shift in labor demand tends to reduce unemployment, but higher wages cause firms to move backwards along the labor demand curves, thus reducing employment. Finally, higher wages lead to more participation and higher unemployment (ceteris paribus).

In the remainder of this section, I develop an empirical model of trade, unemployment and labor supply that captures these features. My goal is to estimate the model using Argentine household survey data. I do not attempt to identify any of the theoretical models of trade and unemployment. Rather, I am interested in exploring the impacts of higher

export prices of agro-manufacture exports when labor markets in developing countries are not fully flexible. In other words, this paper is an attempt at measuring the potential benefits (and costs) of enhanced export opportunities in a context without full wage adjustment.

My empirical model is conceptually simple. Firms maximize profits and demand labor. Workers maximize utility and supply labor. As explained above, unemployment is assumed to be generated by some frictions present in the economy.

I discuss labor demand first. In a typical general equilibrium model of trade, labor markets are linked to trade through the relative prices of exports and imports. This is the Stolper-Samuelson result (in a 2×2 model) or some of its variants for multidimensional models (Dixit and Norman, 1980). For a small open economy, prices are determined in world markets and are thus taken as given. Given export (and import) prices, firms choose factors of production optimally. This leads to a set of labor demand functions for different types of labor, that is workers with different schooling (particularly unskilled, semi-skilled, skilled). For my purposes, the important fact is that these labor demand functions depend on the level of the prices of traded goods. As a result, faced with higher export prices, agro-manufacturing firms will increase the demand for labor of varying skills. In a model with flexible prices, this increase in labor demand will cause an increase in wages for different skills (and thus in the implicit returns to schooling).

The derivation of labor supply follows from standard processes of utility maximization. To allow for labor market participation and labor supply responses, I assume that each worker has a reservation wage. Each individual compares his market wage (given his characteristics like age and, fundamentally for my purposes, his schooling) with the reservation wage to

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enter the labor force. This defines whether a worker belongs to the active workforce or becomes inactive instead.

To model unemployment effects, I build on the idea developed in Blundell, Ham, and Meghir (1987) and assume that, due to search and costly matching—and since there is an unemployment pool in the economy—the hiring process takes place through a job offer mechanism. To hire a worker, firms scrutinize the labor market and make job offers to selected active workers at the market wage (which may be different for different selected workers). Active workers need a job offer by one of the firms to become employed. If a worker receives a job offer, the vacancy is filled. Whether a worker who is in the active labor force becomes employed or unemployed depend critically on these job offers. In the end, the effects of trade protection and export prices on employment and unemployment depend on the relative response of wages, employment offers and labor supply.

2.1   The Empirical Model

The simple model sketched above can be estimated with three regression functions: a wage equation, a reservation wage equation, and a job offer equation. The wage equation defines market wages, which are a function of trade policies as well as of domestic variables and individual characteristics. The reservation wage depends, too, on individual characteristics and on the characteristics of the worker's family. The job offer equation depends on trade variables as well as on workers' characteristics that may attract firms. This feature accommodates cases where, for example, skilled individuals earn higher wages and are more likely to receive job offers.

I assume that trade has an effect on all three regression functions. It is intuitive to allow the job offer mechanism to depend on trade (via export prices) since new export opportunities open up new jobs. Further, wages will be affected by trade shocks through the induced changes in labor demand and supply, as in the Stolper-Samuelson logic. Finally, reservation wages may depend on export prices through general equilibrium effects outside the labor market (via changes in household behavior), through expected effects on the length of unemployment or growth rates, or through government transfers tied to customs revenues. Although the estimation of these reservation wage effects is not essential for my purposes, allowing for them makes the final model more flexible and significantly simplifies the maximization of the likelihood function (see below).

Since I model the effects of trade on the domestic economy through international export and import prices (particularly of agro-manufactures), my strategy requires using prices of exports and imports as explanatory variables in the regressions. Similar models have been used by Deaton (1997), to estimate demand elasticities, Goldberg and Tracy (2003), to study exchange rates and wages, Porto (2006), to examine trade and inequality, and Wolak (1996), to look at deregulation in the telecommunication industry. Details follow.

The wage equation is given by

$$w_i = \mathbf{x}_i'\boldsymbol{\beta} + u_i$$

(1)
$$= \widetilde{\mathbf{x}}_i'\widetilde{\boldsymbol{\beta}} + \boldsymbol{\beta}_w'\mathbf{ed}_i \ln p_{ai} + u_i,$$

where w_i is the log of the (monthly) wage earned by individual i and p_a is the international price of agro-manufactured exports. The error term u is assumed to be a normally distributed

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random variable with variance σ_u^2 so that $u \sim N(0, \sigma_u^2)$.

Since I am interested in capturing wage price-elasticities that differ by labor skills, I interact prices with educational dummies, which are represented by the vector $\mathbf{ed}_i$. Three labor categories are considered: unskilled (primary education), semi-skilled (secondary education) and skilled labor (college education). The wage price elasticities are denoted by the three-element vector $\boldsymbol{\beta}_w$. In the estimation, I include prices interacted with the three educational dummies; an equivalent procedure would be to include prices separately and add two interactions with the skill dummies. Introducing the three interactions provides direct estimates of the wage-price elasticities and it is thus more convenient.

I add a comprehensive set of controls in (1). Wages depend on a vector $\widetilde{\mathbf{x}}_i$ which includes individual characteristics like age, (and age squared), gender and marital status, as well as on a separate set of educational dummies that accounts for differences in returns to schooling not related to the trade shocks. To control for technical change and other preference and profit shifters, I follow Roberts and Tybout (1997) and introduce a trend in (1). I interact the trend with the educational dummies so as to capture differential technological change by skill intensity, too.

These trends also capture other macroeconomic factors that may have affected wages. During the period under study, Argentina adopted a currency board in 1991 that led to a huge crisis in 2001. While in the estimation I only use data from 1992 to 1999, so that the crisis period is excluded from the estimation, there is concern that some of the macroeconomic tensions that gave rise to the crisis were present even before 2001. To further control for these factors, and on top of the aggregate trends, I include an index price of both import

and non-agricultural export prices, interacted with the educational dummies too. This price index serves two purposes: to account for the role of relative prices and to control for macro-factors.

The second piece of the model is an equation that describes the log reservation wage w_i^r

$$(2) \qquad w_i^r = \mathbf{z}_i' \boldsymbol{\alpha} + v_i;$$

w_i^r is a function of individual and aggregate variables, $\mathbf{z}_i$, with parameter vector $\boldsymbol{\alpha}$. I include the sex of the individual, the marital status, the education level (as above), an interaction between the gender dummy and the marital status indicator, the number of members in the household, the non-labor income of the household, education dummies interacted with the prices of agro-manufactured exports, education dummies interacted with the price of imports and non-agricultural exports, regional dummies, and trends interacted with educational dummies. Reservation wages may depend on prices because of general equilibrium effects that affect household behavior, the expected length of unemployment or the general perception of growth in the economy. This can affect the level of wages at which an individual may decide to work. Also, prices may affect the level of public transfers, such as unemployment benefits, that affect reservation wages (in developing countries, a significant fraction of public resources comes from taxes on international transactions). The error term is normally distributed with zero mean and variance σ_v^2, $v \sim N(0, \sigma_v^2)$.

In some models of selection in agriculture the errors are, for simplicity, assumed to be independent (Key, Sadoulet and de Janvry, 2000). In other models, like Bellemare and

Barrett (2006), errors are instead allowed to be correlated. In my model, I follow this latter approach and do not impose independence between the error of the wage regression and the error of the reservation wage. This interdependence between errors complicates the likelihood, but describes a more realistic empirical model. The covariance between the errors v and u is denoted by σ_{uv}^2.

The reservation wage equation is introduced to model the labor market participation of the individual. Every period, individual i chooses to enter the work force if his market wage is greater than the reservation wage. The probability that $w_i > w_i^r$ is given by

$$
\begin{aligned}
P_{wi} &= P(y_i^* > 0) \\
&= P_w(\mathbf{x}_i, \mathbf{z}_i; \boldsymbol{\beta}, \boldsymbol{\alpha}) \\
(3) \qquad &= P\left(\widetilde{u}_i < \mathbf{q}_i'\boldsymbol{\delta}\right),
\end{aligned}
$$

where $y_i^* = w_i - w_i^r$, $\mathbf{q}_i'\boldsymbol{\delta} = \mathbf{x}_i'\boldsymbol{\beta} - \mathbf{z}_i'\boldsymbol{\alpha}$, and $\widetilde{u}_i = u_i - v_i$. Notice that $V(\widetilde{u}_i) = \sigma_{\widetilde{u}}^2 = \sigma_u^2 + \sigma_v^2 - 2\sigma_{uv}^2$, and that $\operatorname{cov}(u_i, \widetilde{u}_i) = \sigma_{\widetilde{u}u}^2 = \sigma_u^2 - \sigma_{uv}^2$. It follows that u_i and $\widetilde{u}_i$ have a bivariate normal distribution with correlation parameter $\rho = \sigma_{\widetilde{u}u}/\sigma_{\widetilde{u}}\sigma_u$. The complement probability, $1 - P_{wi}$, determines the probability of being inactive (not willing to participate in the market).

The last equation of the model describes the job offer probability function. As opposed to standard labor supply models, which assume that an individual can find employment at his market wage with certainty, I allow for the possibility that someone who wants to work is unable to find a job by requiring that an active worker receive a job offer to become

employed. This addition allows for richer effects of trade by boosting job offers. The job offer function is

(4)
$$o_i^* = \mathbf{m}_i'\boldsymbol{\gamma} + \varepsilon_i$$

$$= \widetilde{\mathbf{m}}_i'\widetilde{\boldsymbol{\gamma}} + \boldsymbol{\beta}_o'\mathbf{ed}_i \ln p_{ai} + \varepsilon_i.$$

Thus, individual i gets a job offer ($o_i = 1$) if $o_i^* = \mathbf{m}_i'\boldsymbol{\gamma} + \boldsymbol{\varepsilon}_i > 0$, whereas he does not ($o_i = 0$) if $\mathbf{m}_i'\boldsymbol{\gamma} + \varepsilon_i < 0$. In fact, if the error term ε_i is drawn from a symmetric distribution with zero mean, the probability of getting a job offer is

(5)
$$P_{oi} = P_o(\mathbf{m}_i; \boldsymbol{\gamma}) = P(\varepsilon_i < \mathbf{m}_i'\boldsymbol{\gamma}).$$

In the vector $\mathbf{m}_i$ (the individual determinants of receiving an offer), I introduce aggregate labor demand variables that can be associated with trade policies. As in the wage equation, this can be done by including the prices of agro-manufactured exports interacted with the education dummies ($\mathbf{ed}_i \ln p_{ai}$), as regressors. The response of job offers to price changes is given by the vector $\boldsymbol{\beta}_o$ (for different educational attainments). To control for relative prices and other macroeconomic factors, the regression includes import and non-agricultural export prices and trends interacted with the educational dummies, too. Other controls in $\mathbf{m}$ are regional dummies. These variables capture the role of local labor markets and national employment trends in determining the chance of getting a job offer. For example, regional dummies would capture the effects of regional unemployment rates, an indication of the conditions of regional labor markets. Individual controls, such as age, age squared, gender,

marital status, education, are introduced as well.

The error term ε_i is distributed $N(0,1)$. Since the job offer function leads to a dichotomous variable o_i, the scale of this part of the model (the variance of ε_i) cannot be identified. Following Blundell, Ham and Meghir (1987), ε_i is assumed to be independent of u_i and v_i, the errors in equations (1) and (2).

Those individuals who want to work (i.e., those with $w_i > w_i^r$) must receive a job offer to be employed. Hence, the probability of being employed, P_{ei}, is

$$(6) \qquad P_{ei} = P_w(\mathbf{x}_i, \mathbf{z}_i; \boldsymbol{\beta}, \boldsymbol{\alpha}) P_o(\mathbf{m}_i; \boldsymbol{\gamma});$$

the probability of being unemployed, P_{ui}, is

$$(7) \qquad P_{ui} = P_w(\mathbf{x}_i, \mathbf{z}_i; \boldsymbol{\beta}, \boldsymbol{\alpha}) \left[1 - P_o(\mathbf{m}_i; \boldsymbol{\gamma}) \right].$$

The present model is a more complicated version of the standard selection model of Gronau (1974) and Heckman (1974). To estimate it, I write the model as a modified Tobit 2 model (Amemiya, 1985). The likelihood is

$$(8) \qquad L = \prod_i P(y_i^* < 0) \prod_i P(y_i^* > 0) P(o_i^* < 0) \prod_i P(y_i^* > 0) P(o_i^* > 0) f(w_i | y_i^* > 0),$$

where $f(\cdot)$ is the normal density function of the wage w_i.[7] The first and second factors in (8) capture the probabilities of being inactive and unemployed, respectively. The last factor is the probability of observing wage w_i, conditional on being employed; this

requires a positive net wage for worker i and a job offer. Notice that $f(w_i|y_i^* > 0) = \int_0^\infty f(w_i, y_i^*)dy_i^*/P(y_i^* > 0)$, and that $f(w_i, y_i^*) = f(w_i)f(y_i^*|w_i)$. This probability is, thus, equal to $P(o_i^* > 0)\int_0^\infty f(y_i^*|w_i)dy_i^*$. Using the fact that $y_i^*|w_i$ is normally distributed (Amemiya, 1985), the log likelihood can be written as

$$
\begin{aligned}
\ln L &= \sum_i \ln\left[1 - \Phi\left(\mathbf{q}_i'\frac{\boldsymbol{\delta}}{\sigma_{\widetilde{u}}}\right)\right] + \sum_i \ln \Phi\left(\mathbf{q}_i'\frac{\boldsymbol{\delta}}{\sigma_{\widetilde{u}}}\right)[1 - \Phi(\mathbf{m}_i'\boldsymbol{\gamma})] \\
&\quad + \sum_i \ln \Phi(\mathbf{m}_i'\boldsymbol{\gamma})\frac{1}{\sigma_u}\phi\left(\frac{\mathbf{w}_i - \mathbf{x}_i'\boldsymbol{\beta}}{\sigma_u}\right)\Phi\left(\mathbf{q}_i'\frac{\boldsymbol{\delta}}{\sigma_{\widetilde{u}}} + \rho\frac{1}{\sigma_u}(\mathbf{w}_i - \mathbf{x}_i'\boldsymbol{\beta})\frac{1}{(1-\rho)^{1/2}}\right),
\end{aligned}
$$

(9)

where $\Phi(\cdot)$ is the cumulative distribution of the standard normal.

2.2 The Data

I use two sources of information: household surveys and price indexes. Data on export prices of agro-manufactures are taken from the Statistical Institute in Argentina (INDEC). Data on individual characteristics and labor markets are taken from the Argentine Encuesta Permanente de Hogares, EPH (permanent household survey). The EPHs are household surveys that gather information on wages, employment status, income (not expenditures), sector of employment, and other individual and household characteristics (age, gender, number of household members, demographic composition, etc.). The EPH is a repeated cross-section and the data are collected twice per year, in May and October.[8] In this paper, I use data from 1992 to 1999, a total of sixteen EPH surveys.

Since over 85 percent of the Argentine population lives in urban areas, the EPHs are urban surveys. In consequence, my focus is on urban employment and unemployment

and I omit any analysis of farm employment and rural labor markets. Moreover, and partly for this reason, I restrict the analysis to the impact of changes in the prices of agro-manufactures exports, leaving aside the impacts of changes in the export prices of agricultural commodities.[9]

Table 1 reports the main trends in three variables of interest: the employment status of the individual, monthly wages, and the level of the price of agro-industrial exports. In the Table, I report data on all workers in all sectors.[10] The sample is restricted to include all "employed" workers, leaving aside the self-employed. Sample sizes of employed, unemployed and inactive individuals of working age are reported as well.

The average wage of unskilled workers (primary education) increased until 1995 and declined afterwards to reach, in 1999, a level comparable to that in 1992. The wages of semi-skilled workers (secondary education) increased until 1996, and then stabilized. In 1999, average wages declined, but were still higher than in 1992. The wages of skilled workers (college education) fluctuated more: they increased until 1995, declined in 1996, and then recovered again until 1998. In 1999, wages are higher than in 1992, indicating positive growth during the period.

The Argentine Statistical Institute provides data on the international prices of Argentine exports of agro-manufactured goods, which include dairy product, beef, oils and fats, and food-processing goods. These export prices show an increasing trend (with fluctuations) from 1992 to 1997, and a decline in more recent years.[11]

In the EPH survey, there are three employment categories: employed, unemployed and inactive. The employment categories are defined on a weekly basis—this type of reporting is

standard to measure aggregate unemployment in the economy as well as the size of the active labor force. An employed individual is one who wants to work (his market wage is higher than his reservation wage in the model) and receives a job offer. An unemployed person wants to work but does not receive an offer. Finally, inactive individuals do not want to work (their reservation wage is higher than their market wage). In the analysis, I include all employed workers (in all sector), all unemployed individuals, and all inactive individuals aged 18-65. Student and retirees are excluded, as well as those self-employed. Notice that there may be more than one adult in the sample from a given household. In the model, however, I assumed that the decisions of each agent are taken individually (conditional on the behavior of other members of the household especially in determining the reservation wage). Allowing for interdependence of intra-household decisions could be an interesting extension of this model. However, since 65 percent of households report one working member (and 80 percent report one or two working members) the assumption of independence is unlikely to affect my main conclusions.

Table 1 shows the fraction of the labor force (defined as working age population) in each category. Starting from 1992, the proportion of employed individuals increased in 1993, dropped thereafter until 1996, and slightly recovered afterwards. The proportion of inactive individuals remained roughly constant throughout the period. The proportion of unemployed workers, on the other hand, steadily increased until May 1996, declined until May 1999 and increased a little in October 1999. Notice that this is the share of the population that is unemployed. It is not the unemployment rate, which is defined as the ratio of the number of unemployed individuals to the total number of employed and unemployed people (excluding

the inactive).

2.3   Results

The model is estimated with maximum likelihood methods. Although the likelihood function in (9) is complicated, it satisfies all the properties of a Tobit 2 Model (Amemiya, 1985). Therefore, convergence in the maximization algorithm is straightforward (but time consuming). In fact, the estimation of the model can be performed with the Stata Corporation built-in (ml) maximizer routine (Gould, Pitblado and Sribney, 2003).[12]

The results of the estimation of the model in (1), (2) and (4) are reported in Table 2. The columns show the estimated coefficients of the wage equation $(\widehat{\boldsymbol{\beta}})$, of the labor market participation (net wage) equation $(\widehat{\boldsymbol{\delta}} = \widehat{\boldsymbol{\beta}} - \widehat{\boldsymbol{\alpha}})$, and of the job offer equation $(\widehat{\boldsymbol{\gamma}})$. Since I am regressing individual outcomes on aggregate variables (like prices), the standard errors are corrected for clustering (Kloek, 1981). These are reported in squared brackets below each coefficient.

I find that an increase in the prices of agro-manufactured exports raises wages in Argentina. The responses are positive and statistically significant for all types of labor, but not very large: from a value of 0.5 for unskilled labor, to 0.52 for semi-skilled labor, and to 0.57 for skilled labor. This means that a one percent increase in the price of agro-industrial exports (due to, for example, lower protection of agricultural markets in the North) would cause Argentine wages to increase by 0.5-0.57 percent. Notice that the model measures general equilibrium effects, so that the change in the price of agro-goods may have an impact on the wages earned in different sectors through intersectoral labor reallocation and spillover

effects. A similar issue, albeit in a different context, is raised by Dyer, Boucher, and Taylor (2006). They model supply responses of subsistence households that are indirectly linked to market prices through spillovers in factor markets for labor or land. They find strong evidence in support of spillovers from market to subsistence. In Porto (2007), I present for robustness results from a model with tradable sectors only (so that spillovers are assumed not to be transmitted to the non-tradable sector). In this case, I find that the wage elasticities are similar to those reported in the text but that the job-offer elasticities (see below) are somewhat larger.

Wages respond in a sensible way to the other controls. They are positively associated with age, at a decreasing rate, while males and married individuals earn higher wages. Trends and educational dummies behave as expected: whereas there is a declining trend in the wages of unskilled workers, there is growth in semi-skilled wages and faster growth in skilled wages. Recall that these interactions of education dummies and time trends are included to capture technical change (probably skill-biased) and other supply and demand shifters (such as factor endowments). Finally, wages respond negatively to the index price of imports and non-agricultural exports.

An interesting implication of these results is that technical change may have been more important than export prices in shaping the recent trends in the skill premium in Argentina. The wage regression shows that, while higher export prices raise wages, they do that uniformly across skill categories. However, the overall trends (interacted with the skill dummies) are indeed different across those skill categories and part of these effects are due to technical change (although notice that these trends capture macroeconomic factors as well).

The second column of the table reports the estimated coefficients of the net wage equation, the difference between the market wage and the reservation wage.[13] I find that the export price of agro-industrial goods is positively associated with net wages for unskilled and semi-skilled workers; this means that higher export prices lead to higher net wages and higher probabilities of participation for these individuals. These results reveal that labor supply would respond positively to trade shocks in Argentina, particularly for unskilled and semi-skilled workers.

More experienced workers have higher net wages (or, lower relative reservation wages) and thus show higher labor market participation. The same is true with males. Moreover, a married male has a higher net wage, while a married woman has a lower net wage. This makes women and married women more likely to be inactive (i.e., to have a lower labor market participation rate). Interestingly, males with large families tend to be more active, willing to work. Finally, the reservation wage is higher (and therefore the participation in the labor market becomes lower) as non-labor income increases.

The last column of Table 2 reports the estimated coefficients of the job offer equation. An increase in the price of agro-manufactured goods boosts job offers in Argentina. These responses are positive and significant for all educational levels: for unskilled and semi-skilled workers, the coefficient is 0.59 and for skilled workers, it is 0.88. The differences in the coefficients are hardly significant at usual confidence levels. The implications of this result in terms of the probability of employment and unemployment in Argentina are discussed in section 3.

The additional controls behave as expected. More experienced workers, as measured by

age, are more likely to receive a job offer. Most importantly, the coefficients of the trends (interacted with the educational dummies) reveal that there is a tendency to observe a decline in job offers during the period. These declines tend to be largest among unskilled workers, intermediate for semi-skilled workers, and smallest among skilled workers.

The following scale parameters are estimated: $\widehat{\sigma}_u^2 = 0.62$ and $\widehat{\rho} = -0.15$. Since the scale of $\widetilde{u}$ cannot be identified, I set $\sigma_{\widetilde{u}}^2 = 1$ without loss of generality. It follows that $\widehat{\sigma}_{\widetilde{u}u}^2 = 0.014$, $\sigma_{uv}^2 = 0.606$, and $\sigma_v^2 = 1.592$.

It is important to notice that the estimates reported here are specific to the Argentine experience. On the one hand, there are features of the economy that are specific to Argentina, such as factor endowment, or technology and factor intensity use in import and export sectors. On the other hand, the macroeconomic context, as explained above, was very peculiar. Further, results depend to some extent on the conditions and frictions that generate unemployment. Hence, a different set of initial conditions may lead to measurements of different parameters and price elasticities.

3 The Impacts

In this section, I use the estimated coefficients of the previous section to explore the effects of higher agro-manufactured export prices, possibly due to trade reforms in the developed world, on wages, employment and unemployment in Argentina. Notice that my analysis is purposefully narrow in that I focus only on the impacts of export prices of agro-industrial goods rather than on general equilibrium price effects. This is because my objective in this paper is to develop methods to measure the potential impacts of trade reforms (via export

prices) in the presence of imperfections in labor market adjustment. I claim that this type of analysis is necessary to provide a much detailed description of how the population will be affected by trade liberalization in world markets.

To estimate policy impacts, I adopt a two-step methodology as in Chen and Ravallion (2004), Edmonds and Pavcnik (2005), Deaton (1997), and Porto (2006), among others. This methodology requires the combination of the estimated parameters of section 2 with a (policy-induced) price change of agro-manufactured exports. To illustrate how the model works, in what follows I adopt a generic increase in the export prices of agro-manufactures of Argentina of 10 percent.

Although I do not model this price change in my analysis, it is useful to think about scenarios that could potentially generate it. One such scenario is agricultural trade liberalization in developed countries (perhaps following the WTO Doha Development Agenda). As it is well known, agricultural protection in world markets is widespread and includes different policy mechanisms, such as ad-valorem tariffs, specific tariffs, non-tariff barriers, antidumping threats, technical barriers, quality standards, export subsidies, and production subsidies.[14] A glance at the level of protection faced by Argentine exports is given by Messerlin (2001). He estimates the tariff rates levied by the European Union on agriculture: Cereals get an average MFN tariff of 14 percent, Meat, of 11.2 percent, and Dairy Products, of 9.7 percent; the average ad-valorem tariff on Food Products is 19.5 percent. Non-tariff barriers are important as well: from 5 percent in Cereals and in Food Products, to 64.8 percent in Meat, 100.3 percent in Dairy, and 125 percent in Sugar. The overall rate of protection, the sum of the MFN tariffs and the tariff equivalent of the non-tariff barriers,

is impressive: Sugar gets a 125 percent protection, Dairy, 110 percent, Meat, 76 percent, and Cereals, 19 percent. Food Products get a 24.5 percent tariff equivalent. The average overall border protection of agricultural goods is estimated at 27.6 percent. Hence, assuming that the elimination of some of these barriers will cause an increase in the international prices of agro-manufactured products seems quite reasonable.

However, assessing the magnitude of the price increase is less obvious. Notice that estimating the pass-through of trade policies to prices is outside the scope of this project. There is a huge literature that has tried to do this, with mixed success and results. There are essentially two approaches that can be used to estimate these price changes: econometric studies and Computable General Equilibrium models (CGE). For the case of agricultural protection on world prices, Beghin et al. (2002) use CGE models to estimate an increase in prices of 15.4 percent, while Hoekman et al. (2004) use econometric models to find an increase of 7.5 percent. In a comprehensive study of the implications of the Doha Round, Hertel and Winters (2006) deploy an improved CGE model (that combines a global model with several national models) and find an average increase in agricultural prices of roughly 11 percent. Accordingly, the 10 percent price increase that I use is somewhat in the middle of the price change estimates in Beghin et al. (2002) and Hoekman et al. (2004) and in line with those in Hertel and Winters (2006).

The advantage of focusing on the impacts of one price change is simplicity in the way the methodology works and clarity in the forces behind the results. This type of comparative static results with respect to a major export price is a feature shared by many other papers in the literature like Deaton (1989) and Edmonds and Pavcnik (2005). However, notice that

I am not carrying out any trade policy evaluation. On the one hand, the price changes used in this study cannot be necessarily attributed to a specific trade reform (like Doha). On the other hand, some of the general equilibrium effects will be lost. For example, a reform like Doha would not only affect agro-industry prices but also the equilibrium prices of non-agricultural exports and imports. In a comprehensive evaluation of this policy, those general equilibrium effects are unavoidable. Here, I instead adopt this narrower approach to make the point that labor market adjustment, and its interaction with trade reforms, can matter a lot in such an evaluation.

3.1 Employment and Unemployment

I begin by looking at the impacts on employment and unemployment probabilities. The aggregate probability of being employed can be written as

$$(10) \qquad P_e = \int P_e(\mathbf{x}_i, \mathbf{z}_i, \mathbf{m}_i; \boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\gamma}) dG(\mathbf{x}_i, \mathbf{z}_i, \mathbf{m}_i),$$

where $G(\cdot)$ is the distribution function of individual attributes $\mathbf{x}_i$, $\mathbf{z}_i$ and $\mathbf{m}_i$. Similarly, the aggregate probability of being unemployed is

$$(11) \qquad P_u = \int P_u(\mathbf{x}_i, \mathbf{z}_i, \mathbf{m}_i; \boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\gamma}) dG(\mathbf{x}_i, \mathbf{z}_i, \mathbf{m}_i).$$

The probability of being unemployed is not the same as the unemployment rate, which is

defined instead as the proportion of unemployed individuals out of the total active population

$$(12) \qquad U_{rate} = \frac{P_u}{P_u + P_e}.$$

Differentiating (10) and (11) with respect to $\ln p_{ai}$, I get

$$(13) \qquad \frac{\partial P_e}{\partial \ln p_a} = \int \frac{\partial}{\partial \ln p_{ai}} P_e(\mathbf{x}_i, \mathbf{z}_i, \mathbf{m}_i; \boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\gamma}) dG(\mathbf{x}_i, \mathbf{z}_i, \mathbf{m}_i),$$

$$(14) \qquad \frac{\partial P_u}{\partial \ln p_a} = \int \frac{\partial}{\partial \ln p_{ai}} P_u(\mathbf{x}_i, \mathbf{z}_i, \mathbf{m}_i; \boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\gamma}) dG(\mathbf{x}_i, \mathbf{z}_i, \mathbf{m}_i).$$

The change in the aggregate probability of being employed, equation (13), can be recovered

as the average change in the individual probabilities of employment P_{ei}. Similarly, the change

in the aggregate probability of being unemployed (equation (14)) is the average of individual

changes in P_{ui}.

To derive these individual quantities, differentiate (6) with respect to $\ln p_{ai}$ to get

$$
\begin{aligned}
\frac{\partial P_{ei}}{\partial \ln p_{ai}} &= \frac{\partial P_{wi}}{\partial \ln p_{ai}} P_o + \frac{\partial P_{oi}}{\partial \ln p_{ai}} P_w \\
(15) \qquad &= f(\mathbf{q}_i' \boldsymbol{\delta}) \frac{\partial \mathbf{q}_i' \boldsymbol{\delta}}{\partial \ln p_{ai}} P_{oi} + P_{wi} f(\mathbf{m}_i' \boldsymbol{\gamma}) \frac{\partial \mathbf{m}_i' \boldsymbol{\gamma}}{\partial \ln p_{ai}}.
\end{aligned}
$$

The effects of trade policies that affect the international prices of agro-manufactured

Argentine exports on employment comprise two channels: a *participation effect*,

$(f(\mathbf{q}_i'\boldsymbol{\delta})(\partial \mathbf{q}_i'\boldsymbol{\delta}/\partial \ln p_{ai})P_o)$, and a *job offer effect*, $(P_w f(\mathbf{m}_i'\boldsymbol{\gamma})(\partial \mathbf{m}_i'\boldsymbol{\gamma}/\partial \ln p_{ai}))$. The

participation effect arises because trade policy affects the market wage and the reservation

wage. Based on the estimates in section 2, lower trade protection in world markets raises the net wage (the difference between the market wage and the reservation wage) thereby inducing a larger number of workers to participate in the labor market. For a given probability of getting an offer, P_{oi}, this raises P_{ei} (that is, conditional on getting an offer, a higher participation in the labor market increases the employment rate). The *job offer effect* arises because the expansion of the agro-manufacturing sector induces firms to hire more workers and make more job offers. Since both the participation and the job offer effects are positive, lower agricultural protection increases the probability of being employed.

Using (7), the change in P_{ui} caused by a change in $\ln p_{ai}$ is

$$
\begin{aligned}
\frac{\partial P_{ui}}{\partial \ln p_{ai}} &= \frac{\partial P_{wi}}{\partial \ln p_{ai}}(1 - P_{oi}) - \frac{\partial P_{oi}}{\partial \ln p_{ai}}P_{wi} \\
(16) \qquad &= f(\mathbf{q}_i'\boldsymbol{\delta})\frac{\partial \mathbf{q}_i'\boldsymbol{\delta}}{\partial \ln p_{ai}}(1 - P_{oi}) - P_{wi}f(\mathbf{m}_i'\boldsymbol{\gamma})\frac{\partial \mathbf{m}_i'\boldsymbol{\gamma}}{\partial \ln p_{ai}}.
\end{aligned}
$$

As before, there is a participation and a job offer effect. On the one hand, the fact that higher export prices raise the employment participation of the Argentine workforce implies an increase in unemployment, conditional on the probability of *not* receiving an offer, $1 - P_{oi}$. On the other hand, the increase in labor demand increases the probability of getting an offer, unemployment declining as a result (this is the negative of the job offer effect in equation (15)). The net effect depends on which of these two forces dominate.

The change in the probability of being inactive, P_{Ii}, is given by

$$
\begin{aligned}
\frac{\partial P_{Ii}}{\partial \ln p_{ai}} &= -\frac{\partial P_{wi}}{\partial \ln p_{ai}} \\
(17) \qquad &= -f(\mathbf{q}_i'\boldsymbol{\delta})\frac{\partial \mathbf{q}_i'\boldsymbol{\delta}}{\partial \ln p_{ai}},
\end{aligned}
$$

which is negative. Higher export prices raise the net wage and cause a decline in the probability of being inactive (that is, increases labor market participation). Notice that since $P_{ei} + P_{ui} + P_{Ii} = 1$,

$$(18) \qquad \frac{\partial P_{ei}}{\partial \ln p_{ai}} = -\left(\frac{\partial P_{ui}}{\partial \ln p_{ai}} + \frac{\partial P_{Ii}}{\partial \ln p_{ai}} \right).$$

To estimate equations (15), (16) and (17), I need the coefficients reported in section 2 and the generic changes in agro-manufactured exports of 10 percent.

In Table 3, I report the estimated changes in employment probabilities. The leftmost panel displays the effects on the probability of being employed (disentangling the participation effect and the job offer effect). The central panel shows the effects on the probability of being unemployed (disentangling the two effects as before) and the rightmost panel reports the effects on the probability of being inactive.

The numbers within square brackets in Table 3 represent the standard errors of the changes in the probabilities. I estimate the variance-covariance matrix with bootstrap methods, as follows. Stacking the vector of coefficients $\boldsymbol{\delta}$, $\boldsymbol{\beta}$, and $\boldsymbol{\gamma}$, I construct a vector $\boldsymbol{\theta}$ such that $\sqrt{n}(\widehat{\boldsymbol{\theta}} - \boldsymbol{\theta}) \longrightarrow^d N(\mathbf{0}, \mathbf{V}_\theta)$. Estimation of the model delivers the estimated vector $\widehat{\boldsymbol{\theta}}$ and the estimated asymptotic variance, $\widehat{\mathbf{V}}_\theta \longrightarrow^p \mathbf{V}_\theta$. To estimate the standard errors, I take draws $\widetilde{\boldsymbol{\theta}}$ from the multinormal empirical distribution $N(\widehat{\boldsymbol{\theta}}, \widehat{\mathbf{V}}_\theta)$, and I reevaluate (15), (16) and (17). Repeating this procedure 50 times, I obtain a bootstrap sample of the average changes in probabilities that can be used to estimate their standard errors.

The main finding of the paper is that higher agro-manufactured export prices (induced,

for example, by lower trade protection in the North) increase employment in Argentina by 1.36 percentage points. The participation effect accounts for 0.52 points (38 percent) and the job offer effect accounts for the remaining 0.84 percentage points (62 percent of the total employment effect). Employment increases because the elimination of the trade protection on agro-manufacturing in the developed world would boost the Argentine economy as the agro-industry expands (the job offer effect) and absorbs a larger number of a growing active workforce (the participation effect).

The counterpart of this increase in the probability of employment is a decline in P_u (the probability of being unemployed) by 0.75 percentage points, and a decline in P_I (the probability of being inactive) by 0.61 percentage points. Since the increase in agro-manufactured export prices raises net wages (market wages net of reservation wages), a larger number of the working age individuals decide to enter the workforce. I estimate this effect to be equal to 0.61 percentage points, of which 0.52 (percentage points) manage to get a job offer and become employed and the remaining 0.09 percentage points do not get an offer and thus become unemployed. From the pool of pre-price change unemployed workers, 0.84 percentage points finally get an offer and become employed. In the end, the probability of being unemployed declines by 0.75 $(0.84 - 0.09)$ percentage points because the number of those previously unemployed that get a job is greater than the number of previously inactive individuals that become unemployed.

As already mentioned, the unemployment rate differs from the probability of being unemployed (as defined in (7)) because the unemployment rate is the probability of being unemployed conditional on being active (i.e., willing to participate in the labor market). The

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unemployment rate in (12) was estimated at 13.32 percent using data for October 1998. The impact of agro-manufacturing trade liberalization in developed countries can be estimated as

$$(19) \qquad \frac{\partial U_{rate}}{\partial \ln p_a} = \frac{1}{(P_u + P_{e})^2} \left[\frac{\partial P_u}{\partial \ln p_a} P_e - \frac{\partial P_e}{\partial \ln p_a} P_u \right].$$

The last column of Table 3 shows that a 10 percent increase in the price of agro-manufactured exports would cause the unemployment rate to decline by 1.23 percentage points, i.e., from approximately 13.32 to 12.09 percent. This is a substantial change: higher export prices would bring the unemployment rate down by roughly 10 percent.

To relate this type of trade reform with poverty, I look at the employment-unemployment effects separately for the poor and the non-poor. In the second and third rows of Table 3, I report that the impacts tend to be rather similar for these two groups. For instance, the probability of becoming employed increases by 1.45 percentage points for the poor and by 1.34 percentage points for the non-poor. Interestingly, the probability of being unemployed declines by more for the non-poor (-0.78 percentage points) than for the poor (-0.74 points), but the change in the probability of participating in the labor market increases more for the poor (0.67) than for the non-poor (0.60). This is because the majority of inactive individuals before the price change is actually poor. Notice, however, that all these differences are hardly significant (from a statistical viewpoint). The same pattern can be discerned across quintiles of household per equivalent adult income. The changes in the probability of being employed are relatively similar across quintiles: from 1.46 percent in the first quintile, to 1.17 percent

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in the fifth quintile. Notice that both the participation effect and the job offer effect tends to be higher for the lowest quintiles. The probability of being unemployed declines with income, by 0.78 points in the first quintile to 0.68 points in the last quintile. In addition, the change in the probability of being inactive declines with the quintile, by 0.67 percentage points in the first quintile to 0.49 percentage points in the fifth quintile. These differences are not statistically significant.

3.2 Expected Wages

The expected wage responds to agricultural protection through changes in the market wage and through changes in the probability of being employed, unemployed or inactive. Let p_{ai}^0 be the price level of agricultural exports in the presence of agricultural protection in developed countries; the expected wage is

$$(20) \qquad E[w|p_a^0] = E[w|e = 1, p_a^0]P_e\left(p_a^0\right).$$

The marginal effect of a change in prices on the expected wage of individual i is

$$(21) \qquad \frac{\partial E(w_i|p_{ai}^0)}{\partial \ln p_{ai}} = E(w_i|e_i = 1, p_{ai}^0)\frac{\partial P_{ei}\left(p_{ai}^0\right)}{\partial \ln p_{ai}} + \frac{\partial E(w_i|e_i = 1, p_{ai}^0)}{\partial \ln p_{ai}}P_{ei}(p_{ai}^0),$$

where $e_i = 1$ if individual i is employed. These marginal effects can be estimated with

$$(22) \qquad \frac{\partial \widehat{E}(w_i|p_{ai}^0)}{\partial \ln p_{ai}} = \widehat{E}(w_i|e_i = 1, p_{ai}^0)\frac{\partial \widehat{P}_{ei}\left(p_{ai}^0\right)}{\partial \ln p_{ai}} + \widehat{\boldsymbol{\beta}}'_w\mathbf{ed}_i\widehat{P}_{ei}(p_{ai}^0),$$

where a hat over a variable stands for its estimated value (from the estimates of the regression function and of the probabilities in the MLE). Changes in expected wages can arise because of two factors. For a given expected market wage, realized expected wages can increase due to a higher probability of being employed; this is the employment probability effect. Given the probability of being employed, $P_e(p_{ai})$, lower trade protection and higher agro-manufactured export prices would increase the realized expected wages because of the increase in market wages; this is the wage effect.

The aggregate expected wage can be estimated by integrating (averaging) over individuals. In Table 4, I report the change in expected wages and its decomposition in the employment probability effect and the wage effect. Standard errors computed with bootstrap methods are reported within squared brackets. On average, Argentine wages increase almost one to one with prices: a 10 percent increase in export prices raises expected wages by 10.39 percent. Interestingly, these impacts do not vary significantly across population groups (poor versus the non-poor), or across quintiles of per equivalent adult income.

A key result of this paper is that most of the increase in expected wages (7.45 percentage points) can be attributed to the increase in the probability of becoming employed. This is, in effect, an increase in the wage of those who were unemployed and become employed due to trade. Only the remaining 2.94 percentage points originate in higher wages, conditional on being employed (i.e., an increase in the wage of those workers who are already employed). This result implies that to truly capture how household welfare reacts to trade in developing countries, the estimation of first order effects are generally not enough and that second order effects (like employment responses) are essential.

4 Conclusions

This paper has studied the impacts of agro-manufacturing export prices on wages, employment and unemployment in Argentina. In principle, lower protection of agricultural world markets would lead to higher prices of agro-manufactured exports and to an expansion of the agro-industry sector. This, in turn, would lead to higher wages, more job openings, and lower unemployment. It follows that changes in export prices (possibly due to trade reforms in world markets) affect workers directly, through higher wages, and indirectly, through more job offers and labor supply decisions. A major claim of this paper is that the bulk of the impacts of trade reforms on the welfare of the population will take place through quantity adjustments in labor markets. This implies that the focus on wage adjustment only, as in most of the trade and wages literature, will provide a biased picture of the benefits and costs of trade liberalization. This paper has tried to fill a gap in which the impacts of trade may be blurred by the existence of imperfections in labor markets, rigidities, and adjustment costs.

I have found that a 10 percent increase in the price of Argentine agro-manufactured exports would bring about an increase of 1.36 percentage points in the probability of being employed. This change would be accounted for by an increase of 0.61 percentage points in the probability of labor market participation, and a decline in the probability of unemployment of 0.75 percentage points. The unemployment rate would decline by almost 10 percent or by 1.23 percentage points.

Expected market wages would increase almost one to one with export prices. More than 70 percent of this change would be brought about by a higher probability of getting a job. This result confirms that the gains from trade are not only revealed by higher market wages,

but also by lower unemployment, thus highlighting the importance of unemployment and labor supply responses in empirical work on trade policies. Based on this evidence, I conclude that the first order approximations often used in the trade literature will fail to capture an important fraction of the total impacts. In fact, the estimation of labor market responses is necessarily a critical component of any serious welfare evaluation of trade reforms.

Notes

[1] A few key examples are Deaton (1989), who analyzes the first order effects of export taxes on rice in Thailand, Goetz (1992), who set up a selectivity model of food marketing in Senegal, and Key, Sadoulet, and de Janvry (2000), who explore supply responses in the presence of transaction costs in Mexico.

[2] See Goldberg and Pavcnik (2007) for an overview.

[3] There is a view that argues that trade does not affect unemployment, because unemployment is determined by the natural rate of unemployment (NAIRU). Even if international trade does not affect the NAIRU, trade may have strong short run effects on unemployment that are worth investigating.

[4] Some examples of quantitative analysis of trade reforms with adjustment costs in industrial countries are Magee (1972), Baldwin, Mutti and Richardson (1980), de Melo and Tarr (1990), Takacks and Winters (1991). A good example of how relevant these costs are in developing countries is McMillan, Welch and Rodrik (2003).

[5] Dyer, Boucher and Taylor (2006) reach similar conclusions in their analysis of farm responses to market price changes. They show that market prices can have " ... strong impacts even on subsistence farmers when ..." spillovers through factor markets are taken into consideration.

[6]In the simplest setting compatible with Figure 1, $\overline{w}$ is the minimum wage; but search costs or efficiency wages can easily be incorporated in similar graphs.

[7]Notice that the independence between ε and u or $\widetilde{u}$ has been used in deriving the likelihood.

[8]There is a panel component from 1998 that I do not use in my analysis.

[9]Primary products are likely to have smaller spillovers than agro-manufactures. First, the primary sector in Argentina, although important in terms of exports, is much smaller in terms of the generation of employment and wage income. Second, primary products feed into the agro-industry sector and thus increases in export commodity prices can also generate negative spillover effects.

[10]See Porto (2007) for a model of the tradable sector only.

[11]Although not reported in Table 1, the regression model includes an index price of both non-agricultural export and import prices as well.

[12]For details on the code, see Porto (2007). The maximization of the likelihood becomes much more complicated if I do not allow prices to affect the reservation wage directly. In this case, a restriction on the coefficients $\boldsymbol{\gamma}$ should be added to the likelihood function. (Concretely, the restriction imposes the price coefficients in the wage equation to be the same as in the labor participation equation). This significantly complicates the maximization algorithm.

[13]To interpret the coefficients in the second column, notice that they represent the difference $\boldsymbol{\beta} - \boldsymbol{\alpha}$. If a regressor j (such as prices) is in both equations, then the reported coefficient is $\beta_j - \alpha_j$. Instead, if the regressor is only in the reservation wage equation, then the coefficient represents $-\alpha_j$. Notice that all the regressors in the wage equation $\mathbf{x}$ are in $\mathbf{z}$.

[14]These trade barriers constitute an approximation to agricultural trade costs, as in Anderson and van Wincoop (2004). There is a large literature that measures and analyzes the protection of world agricultural markets. There is, for instance, a series of studies carried out by the Institute of International Economics

that includes Hufbauer and Elliot (1994) for the US and Messerlin (2001) for the EU.

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Figure 1
Trade, Wages, and Unemployment
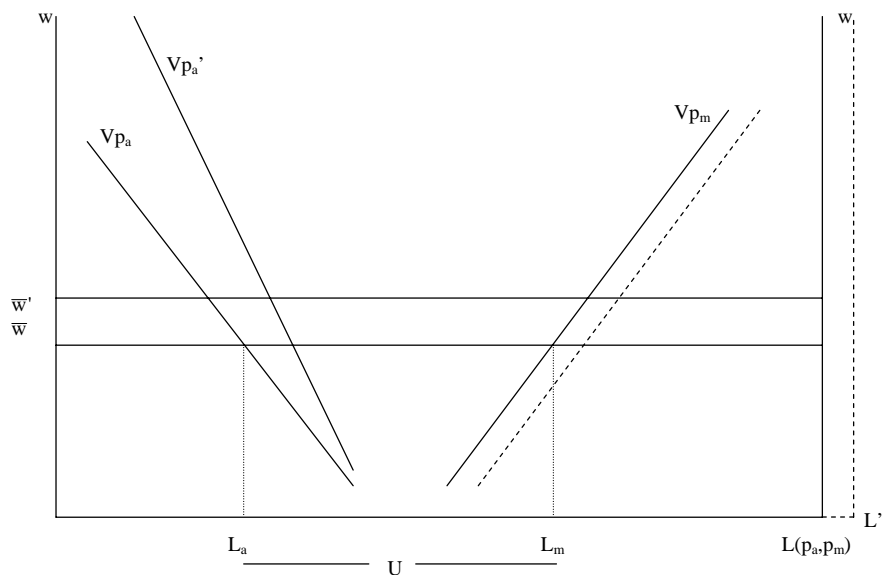
Note: The graph depicts the equilibrium of a specific factor model. The market wage is assumed to be above market clearing ($\overline{w}$) so that unemployment arises in the model. The figure depicts the mechanisms triggered by an increase in the price of agro-manufactured export p_a.

Table 1

Summary Statistics: Wages, Price, and Employment Status

Argentina: 1992 -1999

	Wages (in logs)			Export Prices	Employment Status			Unempl.	Sample
	(1)	(2)	(3)	agro-manuf.	(5)	(6)	(7)	Rate	Size
1992 (May)	5.86	6.04	6.38	4.5778	56.22	39.53	4.25	7.03	17879
1992 (Oct)	5.87	6.14	6.50	4.5880	58.25	37.72	4.03	6.47	19003
1993 (May)	5.95	6.21	6.59	4.5941	58.91	34.95	6.14	9.44	20797
1993 (Oct)	5.98	6.27	6.64	4.6357	57.96	36.27	5.78	9.06	20770
1994 (May)	5.94	6.25	6.65	4.6357	58.26	35.73	6.01	9.35	26083
1994 (Oct)	5.95	6.27	6.69	4.6191	56.95	35.88	7.17	11.19	26203
1995 (May)	5.96	6.26	6.73	4.6347	56.21	32.58	11.21	16.63	24782
1995 (Oct)	5.90	6.25	6.70	4.6357	55.57	34.47	9.96	15.19	28619
1996 (May)	5.88	6.25	6.66	4.6501	54.72	35.22	10.06	15.53	30285
1996 (Oct)	5.85	6.21	6.66	4.7005	55.14	34.26	10.59	16.12	27552
1997 (May)	5.84	6.24	6.68	4.6663	57.23	33.55	9.22	13.88	31513
1997 (Oct)	5.83	6.22	6.70	4.7068	58.39	33.57	8.04	12.10	31695
1998 (May)	5.87	6.23	6.74	4.6463	59.31	32.94	7.75	11.55	29613
1998 (Oct)	5.84	6.24	6.75	4.6062	59.55	33.29	7.16	10.73	28093
1999 (May)	5.74	6.15	6.66	4.4785	54.67	37.97	7.37	11.87	21646
1999 (Oct)	5.77	6.17	6.67	4.3833	58.03	33.31	8.66	12.99	25066

Note: the data come from the EPH, Permanent Household Survey. For a given year, EPH gathers data on May and October. Columns (1) to (3) report the average (log) wages by education category, unskilled (1), semi-skilled (2), and skilled (3). Column (4) displays the international price of agro-manufacturing exports. Column (5) shows the proportion of the population that is employed, column (6), the proportion of the population that is inactive, and column (7), the proportion that is unemployed (as defined in the text). The unemployment rate is defined as the probability of being unemployed conditional of being active.

Table 2
Estimated Coefficients

	Wage Equation	Labor Market Participation Equation	Job Offer Equation
Agricultural Export Prices			
Unskilled Labor	0.50	0.26	0.59
	[0.04]	[0.10]	[0.12]
SemiSkilled Labor	0.52	0.27	0.59
	[0.04]	[0.12]	[0.14]
Skilled Labor	0.57	0.15	0.88
	[0.06]	[0.20]	[0.20]
age	0.05	0.22	0.12
	[0.001]	[0.002]	[0.002]
age squared	−0.001	−0.003	−0.001
	[0.00002]	[0.00002]	[0.00003]
male	0.25	0.40	-
	[0.006]	[0.012]	
married	0.16	−0.93	-
	[0.002]	[0.0089]	
male * married	-	1.69	-
		[0.017]	
# members * male	-	0.004	-
		[0.0016]	
non-wage income	-	−0.001	-
		[0.0001]	
trend * Unskilled Dummy	−0.002	0.001	−0.008
	[0.0004]	[0.001]	[0.0014]
trend * SemiSkilled Dummy	0.004	−0.004	−0.008
	[0.0005]	[0.002]	[0.0017]
trend * Skilled Dummy	0.013	0.004	−0.007
	[0.0009]	[0.003]	[0.0026]
Price Index * Unskilled Dummy	−0.72	—0.62	−3.23
	[0.08]	[0.22]	[0.26]
Price Index * SemiSkilled Dummy	−0.67	−0.60	−3.21
	[0.08]	[0.23]	[0.28]
Price Index * Skilled Dummy	−0.65	−0.28	−3.43
	[0.09]	[0.28]	[0.31]
constant	5.71	−1.72	11.25
	[0.24]	[0.68]	[0.821]
Regional Dummies	yes	yes	yes

Note: estimated coefficient from the MLE model. Standard errors (cluster corrected) within brackets. The model estimates a wage regression (first column), a net wage equation (market wage net of reservation wages, second column) and a job offer equation (last column).

Table 3
Changes in Probabilities
Employment, Unemployment, and Inactive

	Employment			Unemployment			Inactive	Unemp. Rate
	Part. effect	Job offer effect	Total effect	Part. effect	Job offer effect	Total effect		
Whole Sample	0.52	0.84	1.36	0.09	−0.84	−0.75	−0.61	−1.23
	[0.157]	[0.127]	[0.232]	[0.028]	[0.127]	[0.121]	[0.185]	[0.18]
Poor	0.57	0.89	1.45	0.11	−0.89	−0.78	−0.67	-
	[0.176]	[0.145]	[0.260]	[0.033]	[0.145]	[0.139]	[0.209]	
NonPoor	0.51	0.83	1.34	0.09	−0.83	−0.74	−0.60	-
	[0.154]	[0.123]	[0.227]	[0.027]	[0.123]	[0.118]	[0.181]	
1st Quintile	0.57	0.89	1.46	0.11	−0.89	−0.78	−0.67	-
	[0.175]	[0.147]	[0.261]	[0.033]	[0.147]	[0.140]	[0.209]	
2nd Quintile	0.54	0.83	1.41	0.10	-0.83	-0.77	-0.64	-
	[0.166]	[0.143]	[0.250]	[0.030]	[0.143]	[0.137]	[0.197]	
3rd Quintile	0.55	0.86	1.41	0.10	-0.86	-0.76	-0.65	-
	[0.167]	[0.135]	[0.245]	[0.030]	[0.135]	[0.129]	[0.197]	
4th Quintile	0.53	0.83	1.36	0.09	-0.83	-0.74	-0.62	-
	[0.160]	[0.123]	[0.233]	[0.027]	[0.123]	[0.117]	[0.188]	
5th Quintile	0.43	0.74	1.17	0.06	-0.74	-0.68	-0.49	-
	[0.148]	[0.109]	[0.216]	[0.021]	[0.109]	[0.103]	[0.118]	

Note: the table shows the estimated changes in probabilities of different employment status induced by an agricultural trade liberalization in the North. The Participation Effect is the increase in the probability of labor market participation induced by higher market wages. The Job Offer Effect is the increase in job offers brought about by higher agricultural prices. The impact on the probability of employment is equal to the changes in the probabilities of unemployment and of Inactive. Standard Errors of the changes in these probabilities are reported within squared brackets.
The 'Poor' is the set of households with a (per equivalent adult) income below the poverty line. The quintiles refer to household per equivalent adult income as well.

Table 4

Changes in Expected Wages

	Employment Probability effect	Wage effect	Total effect Whole Sample
Whole Sample	7.45	2.94	10.39
	[1.30]	[0.15]	[1.32]
Poor	7.53	2.55	10.08
	[1.42]	[0.14]	[1.42]
NonPoor	7.43	3.04	10.47
	[1.29]	[0.16]	[1.31]
1st Quintile	7.51	2.56	10.07
	[1.41]	[0.14]	[1.42]
2nd Quintile	7.62	2.80	10.42
	[1.39]	[0.16]	[1.39]
3rd Quintile	7.66	2.85	10.51
	[1.37]	[0.16]	[1.38]
4th Quintile	7.54	3.02	10.56
	[1.33]	[0.16]	[1.35]
5th Quintile	6.92	3.50	10.42
	[1.28]	[0.22]	[1.31]

Note: the table shows the estimated change in the expected labor income of Argentine households. The Employment Probability Effect is the change in the expected wages arising from a higher probability of getting a job. The Wage Effect is the change in expected labor income due to a higher induced wage. Standard Errors (estimated with bootstrap methods) are reported within squared brackets.
The 'Poor' is the set of households with a (per equivalent adult) income below the poverty line. The quintiles refer to household per equivalent adult income as well.