Trade Shocks, Firm-Level Investment Decisions, and Labor Market Responses*

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Abstract

When export opportunities arise, the gains from trade can only be materialized if the economy adjusts. In particular, in order to expand and meet new markets, firms must tune their capital stock by investing in product lines, machines and equipment. This process is costly and imperfect. Firms face convex and fixed investment costs, as well as investment irreversibility costs. These costs generate regions of firm inaction. When a trade shock occurs, some firms will be moved out of this inaction region and invest. But many other firms will remain in the inaction region, especially if the costs of adjustment are high. As a consequence, the economy reacts partially and gradually. This process, in turn, has implications for labor demand, employment and wages. To explore these issues with a dynamic model featuring a multi sector-economy with worker's mobility costs, heterogeneous firms and costly capital adjustment. We fit this model to plant-level panel data and household survey data from Argentina. We estimate the structural capital and labor adjustment cost parameters and we use them in counterfactual simulations. Under firm investment inaction in the presence of capital adjustment costs, the impacts of trade shocks can be very different from those derived from alternative models of capital mobility.

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1 Introduction

When export opportunities arise, the gains from trade can only be materialized if the economy adjusts. In particular, in order to expand and meet new markets, firms must tune their capital stock by investing in product lines, machines and equipment. This process is costly and imperfect, and, in fact, investment adjustment may be fully hindered. With labor market frictions, labor adjustment is also costly, and employment may only adjust sluggishly. The dynamic path of wages, employment, capital and investment depends on the level of factor adjustment costs and on the size of the shock. A profound trade reform or a large export shock (e.g., a significant export preference) can trigger a proportionally different response than a smaller shock. Large shocks can, in fact, make factor adjustment profitable, even it is very costly. In turn, different firms may react differently, given a shock size and a structure of adjustment costs. In particular, more productive firms may react much more than low productivity firms. If so, even if the aggregate response is limited, high-productive firms may benefit significantly more from a given trade shock. In this paper, we set out to explore this interaction between the size of the shock, firm characteristics, and capital and labor adjustment costs on the dynamic responses of the economy to trade shocks.

We formulate a dynamic structural model of trade with worker's intersectoral search and firm's capital accumulation decisions. Our framework combines the labor supply model with workers' mobility costs of Artuç, Chaudhuri and McLaren (2010) with the labor demand model with capital adjustment costs of Cooper and Haltiwanger (2006). The labor supply side is characterized by a rational expectations optimization problem of workers facing mobility costs and time-varying idiosyncratic shocks. The labor demand side is characterized by the rational expectations intertemporal profit maximization problem of firms facing costs for adjusting their capital stock and time-varying technology shocks. Firms face different types of costs of capital adjustments. There are convex costs that induce firms to smooth investment over time. There are also non-convex, fixed, costs that create occasional investment bursts instead. And there are irreversibilities of investment when installed capital can be sold at a fraction of the purchasing prices. Overall, these costs generate regions of investment (and disinvestment) inaction. When a trade shock occurs, some firms will be moved out of this inaction region and invest. The economy thus adjusts. But many other firms will remain in the inaction region, especially if the costs of adjustment are high. As a consequence, the economy reacts partially and gradually. If the trade shock is large, or if a given trade shock arrives in a setting with lower costs, then the adjustment will be fuller and quicker. Also, firms are heterogenous in productivity and more productive firms may take better advantage of the enhanced export opportunities.[1]

We fit our model to plant-level panel data and household survey data from Argentina. We use the firm-level data to identify the technology and capital adjustment costs parameters that define labor demand. We use the panel component of the household survey data to identify the labor mobility costs parameters. We recover the structural parameters that characterize the frictions faced by both workers and firms. We then combine all these estimates to characterize the stationary steady-state of the economy. Finally, we use the estimated parameters and the solution of the equilibrium to simulate counterfactual adjustments of investment, capital, labor allocations and wage distributions across sectors after a trade shock.

Our findings are as follow. A positive trade shock to the Food & Beverages sector, whose domestic price increases, triggers a gradual increase of the capital stock. Covering 75-95 percent of the transition to the new steady state takes between five and nine years. There is also a relatively sluggish response of the labor market. Real wages increase at first in Food and Beverages but decline elsewhere. Workers gradually reallocate towards the expanding sector, and wages start to decline (while real wages in all other sectors slightly recover). If the trade shock becomes larger, the economy responds more. More importantly, the aggregate capital stock becomes proportionately more responsive. This is because higher price changes make a larger proportion of firms to move out of the inaction region. It it noteworthy the proportional adjustment of real wages is instead independent of the size of the shock. This implies that larger shocks tend to benefits firms' profits proportionately more than workers' wages. In addition, ex-ante more productive firms expand more and benefit more from larger shocks than ex-ante low-tech firms. This is because the inaction region is smaller for the high-tech firms. As expected the economy adjusts much more abruptly and quickly in the absence of adjustment costs.

The paper is organized as follows. In section 2, we discuss the theoretical model of firm and worker behavior in the presence of capital adjustment costs and labor mobility costs. In section 3,

[1] It is noteworthy that the treatment of capital adjustment costs is succinct in the related trade literature. Artuç, Chaudhuri and McLaren (2010) assume fixed capital and Dix-Carneiro (2010) works out an example with arbitrary costs. In contrast, imperfect labor mobility has been extensively studied. A branch of the literature focuses on workers' moving sectoral costs (Artuç, Chaudhuri and McLaren, 2010; Artuç, 2009; and Dix-Carneiro, 2010) and workers' sector-specific experience (Coşar, 2010; Dix-Carneiro, 2010; Davidson and Matusz, 2004; Davidson and Matusz, 2006; and Davidson and Matusz, 2010). Another set of explanations focuses on firm behavior and includes firing and hiring costs (Kambourov, 2009; Dix-Carneiro, 2010) and market search frictions (Coşar, 2010; and Coşar, Guner and Tybout, 2010). All these studies conclude that large adjustment costs may lead to large unrealized gains from trade.

we discuss the data, the estimation strategy and the main results. In section 4, we compute the stationary rational expectations equilibrium of the model and we estimate the effects of trade liberalization on labor market by performing counterfactual simulations. Finally, section 5 concludes.

2 The Model

In this section, we develop the structural model that we use to explore how the economy adjusts to a trade shock in the presence of factor adjustment costs. Firms face capital adjustment costs, as in Cooper and Haltiwanger (2006), and workers face labor mobility costs, as in Artuç, Chaudhuri, and McLaren (2010).[2] The dynamic optimization problem of the firms delivers a set of supply functions for output and a set of demand functions for labor in each of the sectors, given product prices and the costs of adjusting capital. The behavior of firms is described in section 2.1. Workers maximize utility. They choose a consumption bundle, given their income and product prices, and they choose a sector of employment, given wages and the costs of mobility. Their behavior is described in section 2.2. The equilibrium of the economy is discussed in section 2.3.

2.1 Firms: Labor Demand, Investment, and Output Supply

Our model of firm behavior is based on Cooper and Haltiwanger (2006). The purpose of the model is to derive investment, labor demand, and output supply functions of different sectors in the presence of costly capital adjustment. There are J sectors in the economy; $J-1$ of these sectors are exportable or importable manufactures, and the remaining sector is a large non-manufacturing/non-tradable sector.[3] Each sector is composed of a continuum of firms.

[2] Alternatively, we could assume that firms face both capital and labor adjustment costs as in Bloom (2009), while workers can move freely across sectors. We prefer our setting for various reasons. First, note that we cannot have both labor adjustment costs on the firm side and labor mobility costs on the workers side. This is because Artuç, Chaudhuri, and McLaren (2010) is a discrete choice model, and any worker who chooses a sector must get a job in that sector. This is not guaranteed with hiring and firing costs on the firms side, for instance. In Coşar (2012), firms and workers interact through a matching process. Second, faced with a choice, we adopt Artuç, Chaudhuri, and McLaren (2010) because it has become a leading model of trade with imperfect labor mobility. This model can explain large inter-industry wage differentials and can create bilateral flows of ex-ante homogenous workers across sectors. Both features are observed in the Argentine data used to estimate the model below. Only large differences in labor hiring and firing costs across sectors could explain the same phenomenon. Our data, however, are not rich enough to identify sector-specific labor adjustment costs. Furthermore, while we can estimate the parameters of Artuç, Chaudhuri, and McLaren (2010) model, our data are not rich enough either to estimate the parameters of a matching function. Research embedding the three sources of factor adjustment costs is therefore pending.

[3] In the implementation of the model in section 3 we work with 5 manufacturing sectors and 1 non-tradable sector for a total of J=6 sectors.

In a given sector j, production technology is Cobb-Douglas:

$$(1) \quad Q^j(A_{ijt}, K_{ijt}, L_{ijt}) = A_{ijt} K_{ijt}^{\alpha_K^j} L_{ijt}^{\alpha_L^j},$$

where A_{ijt} is a Hicks-neutral productivity shock faced by firm i at time t, K_{ijt} is the capital stock and L_{ijt} is the labor input. Productivity shocks A_{ijt} follow a first-order Markov Process. Firms differ in A_{ijt}, so that the productivity shocks are a source of firm heterogeneity that trigger different investment and employment decisions. The coefficients α_K^j and α_L^j are estimable parameters, as well as the transition function for A_{ijt}, which we specify in Section 3.

Labor is a variable input that adjusts freely, whereas capital is subject to adjustment costs. Investment becomes productive with a one period lag so that capital accumulation is given by:

$$(2) \quad K_{ij,t+1} = (1 - \delta^j) K_{ijt} + I_{ijt},$$

where I_{ijt} denotes gross investment and δ^j is the capital depreciation rate.

To model capital adjustment costs, we adopt the specification in Cooper and Haltiwanger (2006), which includes three types of costs: fixed adjustment costs, quadratic adjustment costs, and partial investment irreversibilities. The cost function is

$$\begin{aligned}(3) \quad G^j(K_{ijt}, I_{ijt}) \;&=\; \gamma_1^j K_{ijt}\, 1[I_{ijt} \neq 0] + \gamma_2^j (I_{ijt}/K_{ijt})^2 K_{ijt} + \\ &\quad + p_b^j I_{ijt}\, 1[I_{ijt} > 0] + p_s^j I_{ijt}\, 1[I_{ijt} < 0],\end{aligned}$$

where $1[I_{ijt} \neq 0]$, $1[I_{ijt} > 0]$ and $1[I_{ijt} < 0]$ are indicator variables that are equal to one when investment is non-zero, strictly positive, and strictly negative, respectively. The first term captures fixed adjustment costs, which are independent of the investment level and are paid whenever investment or disinvestment take place. This component is related to non-convexities in the functional form of the cost of adjustment and capture indivisibilities in capital, increasing returns to the installation of new capital and increasing returns when restructuring the production activity. We assume that these costs are proportional to the predetermined level of capital at the firm level as indivisibilities become more relevant as a firm grows larger.[4]

[4] Fixed costs can be modeled as proportional to the level of sales at the plant-level; see for example Bloom (2009), Cooper and Haltiwanger (2006), Caballero and Engel (1999). Alternatively fixed costs can also be modeled as independent of firm size, as in Rho and Rodrigue (2012). We argue that fixed costs and irreversibilities generate investment inaction even under the more conservative specification of fixed costs that depend of firm size.

The second term in (3) captures the quadratic adjustment costs. These are variable costs that increase with the level of the investment rate. Variable costs are higher when the investment rate changes rapidly. We assume these costs are proportional to the predetermined level of capital as well. These costs are motivated by the observation in Dixit and Pindyck (1994) who argue for the existence of increasing costs in the incorporation new capital, in the reorganization of production lines and in worker's training.

Finally, the last two terms in (3) capture partial irreversibilities related to transactions costs, reselling costs, capital specificity and asymmetric information (as in the market for lemons). These costs are incorporated into the model by assuming a gap between the buying p_b^j and selling price p_s^j of capital so that $p_b^j > p_s^j$.

The presence of fixed costs and irreversibilities generates a region of inaction for the firm, as well as regions of investment and disinvestment bursts. Following a negative shock firms may hold on capital in order to avoid fixed costs and reselling losses; conversely, in periods of high profitability, firms may choose not to increase the capital stock as much, in anticipation of eventual future costs of selling that capital, or not at all, to avoid fixed costs. Quadratic adjustment costs, on the other hand, create incentives to smooth out investment over time. In the empirical section, we estimate the fixed cost parameter γ_1^j, the quadratic cost parameter γ_2^j, and the ratio of buying to selling price $\gamma_3^j = p_b^j / p_s^j$.

Regarding product markets, we assume that products are homogeneous, that firms are small, and that all manufactures are tradable. The country is small and faces exogenously given international prices p_{jt}^*. The government sets trade taxes at the rate $\tau_{jt} > 0$, in the case of imports, or $\tau_{jt} < 0$, in the case of exports. Domestic prices faced by producers are $p_{jt} = p_{jt}^*(1 + \tau_{jt})$. In the non-manufacturing sector, prices are endogenously determined in a competitive market. In each industry, we assume decreasing returns to scale ($\alpha_L^j + \alpha_K^j < 1$) due to fixed factors such as "managerial capacity," as in Friedman (1962), an assumption that is supported by the estimation results. Since firms are heterogeneous in productivity and prices are exogenous, this is important to prevent the most productive firms to completely sweep the market. We make two further simplying assumptions regarding participation. First, we do not model the decision to enter or exit the domestic market. That is, the number of firms is fixed and there are no fixed costs of production so that even the least productive firms find it profitable to produce. Second, we do not model the decision to export. Since firms face a perfectly elastic demand, the decision to export does not play any role in this model.[5]

Given the predetermined level of capital and the productivity shock, firms choose labor to maximize instantaneous profits. From the profit maximization problem we obtain firm-level labor demand and output supply. Let μ_t^j denote the cross-section joint distribution of capital and productivity (K, A) in sector j, and let the mass of firms be normalized to one. Integrating firm-level labor demand and output supply over the distribution of firms, and given the Cobb-Douglas assumption on technology, we obtain aggregate labor demand N^{dj} and aggregate output supply Y^j

$$(4) \quad N^{dj}(s_t) = \int_{(K,A)} \left[\left(\frac{\alpha_L^j p_{jt}}{w_{jt}} \right) A K^{\alpha_K^j} \right]^{1/(1-\alpha_L^j)} \mu_t^j(dK \times dA)$$

$$(5) \quad Y^j(s_t) = \int_{(K,A)} \left[\left(\frac{\alpha_L^j p_{jt}}{w_{jt}} \right)^{\alpha_L^j} A K^{\alpha_K^j} \right]^{1/(1-\alpha_L^j)} \mu_t^j(dK \times dA).$$

The state variables are the firm-level productivity shock A_{ijt} and capital stock K_{ijt} as well as a vector s_t of aggregate variables. The aggregate state variables are the prices of all tradable sectors p_t $(j = 1 \ldots J-1)$, the cross-section distributions of firms for all sectors μ_t, and the labor allocations in all sectors N_t. Wages and prices of non-tradables are determined endogenously in equilibrium and thus are not included among the state variables.

The investment decision is based on the maximization of intertemporal discounted operating profits net of capital adjustment costs. The Bellman equation is:

$$(6) \quad V^j(A_{ijt}, K_{ijt}; s_t) = \max_{I_{ijt}} \left(\pi^j(A_{ijt}, K_{ijt}; s_t) - G^j(K_{ijt}, I_{ijt}) + \beta_0 E_t V^j(A_{ij,t+1}, K_{ij,t+1}; s_{t+1}) \right)$$

where $\beta_0 \in (0,1)$ is a discount factor and π^j are maximized instantaneous profits.[6] E_t is the expectation operator conditional on information available at time t and taken over the productivity shocks and output prices.[7] We will make more specific assumptions about the stochastic processes of productivity and prices when we describe the estimation method and simulation exercises. The

[5] It is theoretically straightforward to work with a monopolistic competition model as in Melitz (2003) that incorporates market power, constant marginal costs, and firm participation decisions. However, the assumption of fixed international prices seems more realistic for a small Argentine manufacturing sector. In addition, the monopolistic competition model would require the estimation of a larger number of parameters, such as elasticities of substitution, and number of varieties, that can complicate the already complex estimation method. See Coşar (2012) and Coşar, Gunar, and Tybout (2011) for monopolistic competition models.

[6] Firm-level instantaneous profits are given by $\pi^j(A_{ijt}, K_{ijt}; s_t) = (1 - \alpha_L^j) \left[\left(\frac{\alpha_L^j}{w_{jt}} \right)^{\alpha_L^j} p_{jt} A_{ijt} K_{ijt}^{\alpha_K^j} \right]^{1/(1-\alpha_L^j)}$.

[7] The evolution of capital, labor allocations, and firm distributions, on the other hand, is endogeous.

solution to the Bellman equation leads to the following policy function:

$$(7) \quad I_{ijt} = g^j(A_{ijt}, K_{ijt}, s_t).$$

To sum up, at time t, the capital stock is predetermined. Given K, the realization of the profitability shock A, and the aggregate state variables, profit maximization delivers optimal levels of labor demand and output supply, as well as, given the costs of adjustment, the optimal level of investment. Due to the presence of fixed costs and irreversibilities firms may not react to shocks that are not high enough. Investment determines firm-level capital for next period and, together with the stochastic process of productivity, next period firm distribution. For manufacturing, since goods are tradable goods and prices are exogenously determined, firms sell all their output at those prices. Instead, prices for non-manufactures must clear the market. Wages must adjust to equate demand and supply. Equilibrium wages, labor allocations, and prices for non-tradables are further described in the next two sections.

2.2 Workers: Labor Supply and Output Demand

To characterize the behavior of workers, we follow the labor mobility cost model of Artuç, Chaudhuri, and McLaren (2010) and Artuç (2012). This is a dynamic discrete choice model in which workers choose their sector of employment based on wages, job quality, mobility costs, and idiosyncratic utility shocks. The model predicts equilibrium worker mobility, equilibrium wage differentials, and dynamic responses.[8]

The economy is populated by a continuum of homogeneous workers with measure $\bar{N}$. Workers are assumed to have Cobb-Douglas preferences defined over consumption of goods, so that they spend a constant fraction ϕ_j of their labor income in good j. All individuals are risk neutral, have rational expectations, and are employed in one of the J sectors. A worker $l \in [0, \bar{N}]$ employed in sector j at time t perceives an indirect instantaneous mean utility (optimized over consumption of goods) defined as

$$(8) \quad u_{jt} = \frac{w_{jt}}{P_t} + \eta^j$$

where w_{jt} is the sector nominal wage, P_t is a price index, and η^j is a time-invariant utility shifter,

[8] We do not deal with intra-sectoral mobility.

which could be interpreted as the quality of employment in sector j.[9] These terms are common to all workers. At the end of the period, workers have the option to move to another sector at a cost. Workers can move within manufacturing sectors and also between manufacturing and the non-tradable sector. The cost of moving from sector j to sector k is C^{jk}, with $C^{jj} = 0$ for all j.

In addition to the common mean utility and moving costs, workers have heterogeneous preferences over sectors captured by a vector ε_{lt} that is realized at the end of period t. A worker l that chooses sector j at the end of t receives the idiosyncratic benefit ε_{ljt}. Workers learn the values ε_{ljt} for all sectors j before deciding to stay in their current sector or to move. For simplicity, these shocks are independently and identically distributed across individuals, sectors and time.

The worker's problem is to maximize the expected discounted value of being in a sector, net of mobility costs, by choosing in each period the sector of employment. The state variables in the decision are the current vector of idiosyncratic shocks ε_{lt} and the aggregate state variables $s_t = (p_t, N_t, \mu_t)$. Output prices, labor allocations and firm distributions together determine equilibrium wages. The Bellman equation of a worker l in sector j who chooses sector k at the end of t is

$$(9) \qquad U^j(\varepsilon_{lt}, s_t) = \frac{w_{jt}}{P_t} + \eta_j + \max_k \left\{ \varepsilon_{lkt} - C^{jk} + \beta_1 E_t U^k(\varepsilon_{l,t+1}, s_{t+1}) \right\},$$

where β_1 is a discount factor and E_t is the expectation operator conditional on information at t and taken over idiosyncratic utility shocks and output prices.

As it is standard in discrete choice models, we assume that ε_{ljt} follows a type 1 extreme value distribution with location parameter $-\nu\gamma$ and scale parameter ν.[10] This assumption is convenient because the idiosyncratic shock ε can be integrated out analitically. The costs C^{jk}, the variance of the idiosyncratic utility shocks ν, and job quality η^j are estimable parameters.

Denote by $W^j(s_t)$ the expectation of $U^j(\varepsilon_{lt}, s_t)$ with respect to the vector ε. Thus, $W^j(s_t)$ can be interpreted as the expected value of being in sector j, conditional on s_t but before the worker

[9] The instantaneous mean utility function of a worker employed in sector j defined over goods and job quality is $\widetilde{u}^j = \frac{\Pi_{h=1}^J x_h^{\phi_h}}{\Pi_{h=1}^J \phi_h^{\phi_h}} + \eta^j$, where x_h denotes consumption of good h and $\sum_{h=1}^J \phi_j = 1$. Optimizing with respect to x we obtain the indirect utility function (8) with a price index given by $\log P = \sum_{h=1}^J \phi_h \log p_h$.

[10] The cdf is $F(\varepsilon_{ljt}) = \exp(-\exp(-\varepsilon_{ljt}/\nu - \gamma))$, with $E(\varepsilon_{ljt}) = 0$, and $Var(\varepsilon_{ljt}) = \pi^2\nu^2/6$. The parameter γ is the Euler's constant.

learns his realization of ε_{lt}. The Bellman equation can be rearranged as

$$
\begin{aligned}
(10)\quad U^j(\varepsilon_{lt}, s_t) \;&=\; \frac{w_{jt}}{P_t} + \eta_j + \beta_1 E_t W^j(s_{t+1}) + \\
&+ \max_k \left\{ \beta_1 E_t W^k(s_{t+1}) - \beta_1 E_t W^j(s_{t+1}) - C^{jk} + \varepsilon_{lkt} \right\}.
\end{aligned}
$$

The convenience of this format will become clear when we describe the estimation method. Let m_t^{jk} be the fraction of agents who switch from sector j to sector k. This is the probability of choosing k conditional on being in j. Under the extreme value distributional assumption, the conditional probability of moving from j to k takes the usual multinomial logit form

$$
(11)\quad m^{jk}(s_t) = \frac{\exp\left(\left(\beta_1 E_t W^k(s_{t+1}) - \beta_1 E_t W^j(s_{t+1}) - C^{jk}\right)\frac{1}{\nu}\right)}{\sum_{h=1}^{J} \exp\left(\left(\beta_1 E_t W^h(s_{t+1}) - \beta_1 E_t W^j(s_{t+1}) - C^{jh}\right)\frac{1}{\nu}\right)},
$$

with

$$
\begin{aligned}
(12)\quad W^j(s_t) \;&=\; \frac{w_{jt}}{P_t} + \eta_j + \beta_1 E_t W^j(s_{t+1}) + \\
&+ \nu \log \sum_{h=1}^{J} \exp\left(\left(\beta_1 E_t W^h(s_{t+1}) - \beta_1 E_t W^j(s_{t+1}) - C^{jh}\right)\frac{1}{\nu}\right).
\end{aligned}
$$

The total number of agents moving from j to k, or gross flow, is equal to $m^{jk}(s_t)N_{jt}$, where N_{jt} is the number of workers employed in sector j at time t. The transition equation governing the allocation of labor between sectors is thus given by

$$
(13)\quad N_{j,t+1} = \sum_{k \neq j} m^{kj}(s_t) N_{kt} + m^{jj}(s_t) N_{jt}.
$$

This shows that, on aggregate, the individual decisions at time t determine the labor supply to each sector j at time $t+1$. At time t, the current labor allocation is predetermined and upon shocks to labor demand the labor market adjusts only through changes in wages.

Aggregate demand for good j at prices $p_{jt} = p_{jt}^*(1+\tau_{jt})$ is

$$
(14)\quad D_{j,t+1} = \frac{\phi^j}{p_{jt}} \sum_{h=1}^{J} w_{ht} N_{ht}.
$$

2.3 Equilibrium

All markets are competitive. All tradable sectors face exogenous prices, with domestic prices equal to international prices plus trade taxes. Sectors in which supply is larger than demand are net exporters, whereas sectors in which supply is smaller than demand are net importers. Gross trade flows are not determined. Equilibrium prices for non-tradable goods must equate domestic supply to domestic demand given by equations (5) and (14).

Aggregate labor demand in each sector, given by equation (4), together with current labor allocation (13), determines wages both within manufactures and in the non-tradable sector. Then, given each firm's current profitability shock, the capital stock, and the equilibrium wage paid in the sector, firms choose investment in period t. These decisions determine the current period investment and influence the following period's $(t+1)$ firm distribution and labor demand for each sector. On the other hand, each worker observes sector wages and his idiosyncratic shock ε and decides whether to remain in his current sector or move. In the aggregate, these decisions determine the following period's labor allocation. Supply of capital is assumed to be perfectly elastic with time-invariant prices.

The previous equilibrium conditions hold for all time periods and all vectors of aggregate state variables. We are also interested in defining a stationary equilibrium, which we will use in simulation exercises to isolate the desired effects. In a stationary equilibrium, there are firm-specific productivity shocks and worker-specific utility shocks, but there are no aggregate shocks to prices of tradables and average productivity. As a consequence, while we observe fluctuations in firm-level labor demand, investment and output, and in worker-level mobility, there are no fluctuations at the aggregate level. To define a stationary equilibrium we add the condition that labor allocations, aggregate capital, output, wages, prices of non-tradables, and the distribution of firms are time-invariant.

3 Estimation

In this section, we discuss how we estimate the different components of the theoretical model, which comprise parameters related to the firms' and workers' decision problems. We estimate the parameters associated with each of these problems separately, relying on different methodologies, and using two main data sources: a panel of firms and a panel of workers. We work with 6 sectors:

"Food and Beverages", "Apparel, Leather and Textiles", "Nonmetallic Minerals", "Primary Metals and Fabricated Metal Products", "Other Manufactures", and "Services." The Services sector corresponds to non-tradable goods. We begin with firm choices in section 3.1, and we move to worker choices in section 3.2.

3.1 Firms

The estimation of the firms' problem requires panel data with detailed information on the investment decision of the firms. In particular, to fit the capital adjustment cost model, we need data on purchases of new capital as well as on sales of installed capital. We estimate the model using an Argentine manufacturing survey, the Encuesta Industrial Anual (EIA, or Annual Industrial Survey), which meets these requirements. Note that the EIA covers only the manufacturing sector.[11]

We use a balanced panel from the EIA consisting of 568 Argentine manufacturing plants for the period 1994-2001. The EIA dataset provides information on gross revenue, costs, intermediate inputs, employment, consumption of energy and fuels, inventory stock, and both gross expenditures and gross sales of capital. Information on gross capital sales is important in order to estimate the role of partial irreversibility in the capital adjustment costs structure. More details about the construction of the variables are given in Appendix A.1.

The firms' model is defined by parameters in the production function, stochastic evolution of variables, adjustment cost function, depreciation rate, and discount factor. Since the firms' problem does not have a closed form solution, we recover the main parameters of interest with a simulated method of moments estimator, as in Cooper and Haltiwanger (2006) and Bloom (2009).[12] In principle, all the parameters of the model could be estimated simultaneously by simulated method of moments, but this strategy requieres numerically searching over a large number of parameters with a computationally-intensive objective function. To reduce the computational burden and improve the reliability of the numerical search, we follow Cooper and Haltiwanger (2006) and combine different strategies to recover different parameters. In particular, we limit the simulated method of moments to the estimation of the capital adjustment cost parameters.

To begin with, we set the depreciation rate δ at 9.91 and the discount factor β_0 at 0.95, both common to all firms and all sectors.

[11]See below for the non-manufacturing sector strategy.

[12]See Ruge-Murcia (2007, 2012) for a comparative analysis of different methods to estimate dynamic stochastic general equilibrium models.

To estimate the production function parameters α_L and α_K, we use the method of Olley and Pakes (1996). Since many firms report zero investment, we use materials as a proxy (Levinsohn and Petrin, 2003). Also, since there are relatively few firms in each sector, we estimate a common set of technology parameters for all firms. Results are reported in Panel A of Table 1. The labor coefficient is 0.5892 and the capital coefficient is 0.1420, and both are statistically significant.[13] The estimates exhibit decreasing returns to scale.

The EIA surveys firms in the manufacturing sector only, and we do not have comparable data to estimate the parameters of technology for the non-tradable sector. However, it is important to include this sector in the analysis because it accounts for almost 80 percent of employment in Argentina. To do this, we calibrate, rather than estimate, the parameters of the production function. We set the values α_L, α_K, and the mean of the profitability shock (A) to minimize a quadratic loss function. In particular, for any set of parameter values for the non-traded sector, we compute the aggregate steady state level of capital as well as the predicted employment level (given the observed sectoral wages). Then, the loss function matches the predicted sectoral employment, the predicted ratio of non-manufacturing to manufacturing capital, and the predicted shares of labor and capital in revenue with their observed counterparts. Information on aggregate capital by sector and the capital share of revenue come from the National Institute of Statistics and Census of Argentina (INDEC) input-output matrix for the year 1997, while information on employment and wages come from our dataset. The calibrated parameters for the non-manufacturing sector are displayed in Panel A of Table 1. The labor coefficient is 0.3402 and the capital coefficient is 0.1153. There are also strong decreasing returns to L and K in the non-manufacturing sector.

What follows is closely based on Cooper and Haltiwanger (2006). To estimate the adjustment cost parameters we first need to specify the stochastic processes of the productivity shocks A_{ijt} and prices of tradable products p_t, since firms form rational expectations about future values of these variables prior to their investment decisions, as per Bellman equation (6). Here we make two important assumptions. The first one is a departure from the model: we let firms be myopic about how wages are determined. Even though wages are determined in equilibrium, we assume for estimation purposes that firms form expectations about future wages based on an exogenous stochastic process. This assumption is necessary in order to estimate the firms and workers structural parameters separately. The second assumption is that we summarize the stochastic process

[13]These results are comparable to those obtained by Pavcnik (2002) for Chile, for example.

of productivity, prices and wages by the stochastic process of a new variable which we refer to as "profitability," and which we denote by $\widetilde{A}_{ijt}$. Based on the Cobb-Douglas definition of indirect instantaneous profits $\pi_{ijt} = (1-\alpha_L^j)[(\alpha_L^j/w_{jt})^{\alpha_L^j} p_{jt} A_{ijt} K_{ijt}^{\alpha_K^j}]^{1/(1-\alpha_L^j)}$, we define profitability as a combination of productivity, wages and product prices given by $\widetilde{A}_{ijt} = \left[(\alpha_L^j/w_{jt})^{\alpha_L^j} p_{jt} A_{ijt}\right]^{1/(1-\alpha_L^j)}$. Any variation in trade taxes is also assumed to be part of the stochastic process for profitability. We measure profitability from data on profits, capital, and the estimates of the production function parameters, again following the definition of indirect instantaneous profits, so that measured profitability is given by $\widetilde{A}_{ijt} = \pi_{ijt}/[(1-\widehat{\alpha}_L) K_{ijt}^{\widehat{\alpha}_K/(1-\widehat{\alpha}_L)}]$.

Since the objective is to generate model-based moments and compare them with data-based moments, we need profitability shocks to recreate a non-stationary economy.[14] We thus model profitability as the interaction of an economy-wide technology shock (b_t) and a firm-level component (e_{ijt}).

$$(15) \quad \ln \widetilde{A}_{ijt} = b_t + e_{ijt}.$$

Aggregate profitability b_t follows a first order, two-state (high and low), Markov process with symmetric transition matrix. To create sufficient serial correlation, we set the diagonal elements of the transition matrix to 0.8, which is estimated by Cooper and Haltiwanger (2006) by comparing the standard deviation of the process to observed US data.

Idiosyncratic profitability follows a first order autoregressive Markov process given by:

$$(16) \quad e_{ijt} = \rho_e e_{ij,t-1} + \zeta_{ijt},$$

where $\zeta_{it} \sim N(0, \sigma_e)$ and ρ_e is the first order autocorrelation coefficient. The coefficients ρ_e and σ_e are critical for understanding key moments associated with the investment rate, such as investment bursts or investment inaction. To simplify, these parameters are also common to all sectors.

We estimate ρ_e and σ_e with an OLS regressions of deviations of profitability from its year mean.[15] Panel B of Table 1 reports an estimate of the moments for the idiosyncratic component of the profitability shock. Idiosyncratic shocks to the firm seem to be highly autocorrelated. From

[14] In contrast, we shut down aggregate shocks in the simulation exercises in order to focus on permanent changes in trade policy and the transition from one stationary equilibrium to another one.

[15] The regression takes the form $\left(\widetilde{A}_{ijt} - \frac{1}{N}\sum_{i\in j}\widetilde{A}_{ijt}\right) = \rho_e\left(\widetilde{A}_{ij,t-1} - \frac{1}{N}\sum_{i\in j}\widetilde{A}_{ij,t-1}\right) + \widetilde{\zeta}_{ijt}$, where N_j is the number of firms.

the plant-level data, ρ_e is estimated at 0.8853 for the full sample. We also estimate large variance for the innovations of the idiosyncratic shock process, with a standard deviation (σ_e) of 0.6652. We adopt these parameters for firms in the non-manufacturing sector as well.

We estimate the vector of capital adjustment cost parameters $\Gamma = (\gamma_1, \gamma_2, \gamma_3)$ by simulated method of moments (SMM). The SMM is based on minimizing the distance between empirical moments generated from observed firms, and simulated moments generated from artificial firms that behave as described in the model (McFadden, 1989; Pakes and Pollard, 1989).

For a given vector of adjustment cost parameters Γ, and given the estimates of the production function and stochastic process of profitability, we solve the Bellman equation iteratively and obtain the policy function $I^j(A_{ijt}, K_{ijt}; s_t; \Gamma)$.[16] We simulate a panel of artificial firms by taking random draws of initial capital and a series of profitability shocks.[17] From the simulated data we compute a vector of simulated moments, denoted by $\Psi^s(\Gamma)$. The simulated moments depend on the adjustment cost parameters through the policy function $I^j(.)$. Let the vector Ψ denote the empirical moments. These are analogous to the simulated moments but computed from the actual firm data. The estimator for the adjustment costs minimizes the weighted distance between the empirical and simulated moments. Formally,

$$(17) \quad \widehat{\Gamma} = \arg\min_{\Gamma} \; [\Psi - \Psi^s(\Gamma)]' W [\Psi - \Psi^s(\Gamma)]$$

where W is a weighting matrix. We use the optimal weighting matrix given by the inverse of the variance covariance matrix of $[\Psi - \Psi^s(\Gamma)]$.[18] Standard errors for the estimates are computed analytically.

Since the function $\Psi^s(\Gamma)$ is not analytically tractable, the minimization is performed using numerical techniques. We use a simulated annealing algorithm for minimizing the criterion function. This algorithm works well in a case like ours, with a discretized state space and the potential presence of local minima and discontinuities in the criterion function across the parameter space.[19]

[16] We discretize the state space of variables K, K', and $\widetilde{A}$ with a grid of $400 \times 400 \times 22$. The 22 states for profitability correspond to the 2 aggregate states and 11 idiosyncratic states which are discretized from the continuous AR(1) process in equation (16) following Tauchen and Hussey (1991). See Rust (1996) for a detailed discussion of the conditions that ensure convergence of a Value Function.

[17] We draw a Markov Chain with 1100 time period for each of 568 firms. We drop the first 100 periods from the simulated data so that the simulation is independent of the initial conditions.

[18] Lee and Ingram (1991) show that the inverse of the variance-covariance matrix of the actual moments is a consistent estimator for the optimal weighting matrix. We use 1,000 bootstrap replications on actual data to generate the variance-covariance matrix of the actual moments.

[19] For the first 1500 iterations, the updated set of parameters is based on a randomization from the best prior

The identification of the parameters and the efficiency of the SMM estimator depend crucially on the appropriate choice of moments to match, moments that must be informative about the underlying structural parameters (the informativeness principle). The literature has established that a combination of moments which describe both the cross-section and time series behavior of the investment rate works well in practice. Based on these features of the data and on the guidelines in the literature (Cooper and Haltiwanger, 2006; Bloom, 2009; Caballero and Engel, 2003; Cooper, Haltiwanger and Power, 1999), we select four fairly standard moments to match. The serial correlation of investment rates ($corr(i, i_{-1})$) and the correlation between the investment rate and the profitability shock ($corr(i, a)$) have both been shown to be very sensitive to the structure of the capital adjustment costs. To capture the fact that the investment rate distribution at the plant-level is asymmetric with a fat right tail (see Figure 1), we include the positive and negative spikes rates, ($spike^{+}$) and ($spike^{-}$), defined as the percentage of firms with investment above 20 percent and disinvestment above 5 percent.[20]

Table 1, Panel C, presents our estimates for all three forms of capital adjustment costs along with the standard errors of these estimates. We also report both the observed moments and simulated moments that we match, as well as a measure of fit for the model (the distance function, denoted by $M(\Gamma)$). Due to small sample sizes, we estimate a common set of adjustment cost parameters for all sectors.

The estimated adjustment costs imply large fixed cost, large reselling costs, and large quadratic costs. All the parameters estimated are found to be significantly different from zero. We estimate a fixed cost $\widehat{\gamma}_1 = 0.1451$. This is a substantial cost since it implies that the fixed cost of adjustment is about 14.5 percent of the average plant-level capital value. The estimated coefficient for the quadratic adjustment cost parameter ($\widehat{\gamma}_2$) equals 0.1132. Using the quadratic adjustment cost function and a steady state investment rate equal to the depreciation rate ($I/K = \delta = 0.0991$), the estimated parameter implies an adjustment cost relative to the average plant-level capital of 0.056 percent. Finally, our estimate of the transaction costs ($\widehat{\gamma}_3 = 0.9143$) implies that resale of capital goods would incur a loss of about 8.6 percent of its original purchase price.

Our estimates of capital adjustment cost parameters for Argentina can be directly compared with

guess. From iteration 1500 onwards, we add a directional component to the parameter search. We also program the algorithm so that the variance of the randomization declines with the number of iterations, allowing the SMM to refine the parameter estimates around the global best fit. We set up the estimation with different initial parameters and seeds to ensure convergence to the global minimum.

[20] Investment rates exceeds 20 percent for 14 percent of firms.

those in Cooper and Haltiwanger (2006) for the U.S. as we use the same specifications. As expected, Cooper and Haltiwanger (2006) estimate smaller fixed costs ($\gamma_1^{US} = 0.039$), smaller quadratic adjustment costs (γ_2^{US}=0.049), and smaller partial irreversibilities ($\gamma_3^{US} = 0.975$). This implies that capital is more flexible in the U.S. than in Argentina. These differences, as well as the magnitudes of the estimates, are, however, sensible and plausible.[21]

3.2 Labor Mobility Costs

The estimation of the workers' problem parameter requires panel data on sectoral wages and gross flows of workers across sectors. We estimate the model using the panel sample of the Encuesta Permanente de Hogares (EPH, Permanent Household Survey). The database contains information on individual wages, employment sector, demographic characteristics and other standard variables in labor force surveys. Part of the EPH is a panel and we can use it to track labor employment flows across sector pairs and average sector wages. The top panel of Table 2 shows average wage and employment allocations across our six sectors in the sample period, 1996-2007.

The set of labor mobility cost parameters are given by the direct mobility costs C^{jk}, a vector of sector employment quality η^j, and ν, a parameter that determines the variance of the idiosyncratic utility shocks. We impose some restrictions on C^{jk} due to data constraints. In particular, we will assume a common cost C^m within the manufacturing sectors and a cost C^{nm} for movements between manufacturing and non-manufacturing sectors. The set of estimable parameters is thus $\{C^m, C^{nm}, \nu, \eta^j\}$.

We follow a two-step procedure similar to Artuç (2012) and Artuc and McLaren (2012). In the first step, we estimate the normalized moving costs C^m/ν and C^{nm}/ν and sector fixed effects that capture expected continuation values from gross flows of workers. In the second step, these estimated expected values together with data on sector wages are plugged into a Bellman equation to construct a linear regression and estimate the parameters η^j and ν.

To see how this works, recall that the total number of workers who move from sector j to k is equal to $N_t^j m_t^{jk}$. Using the probability choice equation (11) multiplied by labor allocations, we get

[21] Bloom (2009) and Bond, Soderbom and Wu (2008) report larger values for the partial irreversibility cost, with capital reselling losses of 47 and 16.9 percent respectively. Both papers also find larger values for the quadratic adjustment cost parameter (2.056 in Bloom, 2009; 1.985 in Bond, Soderbom and Wu, 2008). In turn, the fixed costs parameter γ_1, which is estimated in terms of annual sales (instead of average capital) ranges from 0.3 percent (Bond, Soderbom and Wu, 2008) to 1.3 percent of annual sales (Bloom, 2009). Note that these results are not directly comparable to ours because of these and other differences in specification—e.g., both papers estimate additional parameters to the capital adjustment costs parameters.

the following expression for gross flows of workers

$$(18)\quad \log\left(N_t^j m_t^{jk}\right) = -\frac{C^{jk}}{\nu} + \frac{\beta_1}{\nu} E_t W_{t+1}^k - \frac{\beta_1}{\nu} E_t W_{t+1}^j + \log\left(N_t^j\right) - \\ -\frac{1}{\nu}\log\left\{\sum_{h=1}^{J} \exp\left(\beta_1 E_t W_{t+1}^h - \beta_1 E_t W_{t+1}^j - C^{jh}\right)\right\}.$$

Flows of workers ($N_t^j m_t^{jk}$) are observed in the data, whereas the expected values $E_t W_{t+1}^j$ are unknown for all j. We capture the expected values with time-varying sector effects. Using sector of destination (k) and sector of origin (j) effects, we can re-write (18) as

$$(19)\quad \log\left(N_t^j m_t^{jk}\right) = -\frac{C^{jk}}{\nu} + \lambda_t^k + \alpha_t^j.$$

where $\lambda_t^k = \frac{\beta_1}{\nu} E_t W_{t+1}^k - \Lambda_t$ is the expected value of sector of destination k, identified up to a year effect Λ_t, and α_t^j captures all terms in (18) that depend on country of origin j.[22] Mobility costs C^{jk}/ν, also unobserved, are assumed to be constant over time and can thus be captured with sector-pair dummies.

A challenge presented by equation (19) is that the logarithmic specification is problematic when the choice probabilities m_t^{jk} are small. Let m_t^{jk} be the theoretical choice probabilities, which are strictly positive, and $\widehat{m}_t^{jk}$ the estimated choice probabilities, given by the observed fraction of workers who switch from j to k. Because the estimated probabilities are computed as frequencies from a panel survey of workers, some values $\widehat{m}_t^{jk}$ can be very small or even zero, especially when the sample size of the survey is not very large and when the theoretical probabilities m_t^{jk} are small. To deal with the zeros and low-value flows, we write the model in levels as

$$(20)\quad \widehat{y}_t^{jk} = \exp\left(-\frac{C^m}{\nu}\mathrm{D}_{jk}^m - \frac{C^{nm}}{\nu}\mathrm{D}_{jk}^{nm} + \lambda_t^k + \alpha_t^j\right) + v_t^1.$$

where $\widehat{y}_t^{jk} = N_t^j \widehat{m}_t^{jk}$ are worker flows, D_{jk}^m is a dummy that indicates whether j and k are both manufacturing sectors, D_{jk}^{nm} is a dummy that indicates whether either j or k are the non-manufacturing sector, and v_t^1 in an error term. Both indicator variables are zero when $j = k$. The error term has a non-standard distribution (which could in principle be derived from the model). Because of this,

[22] In multinomial logit models the probability choice of an alternative k depends on the mean utility of k normalized with respect to a reference value, usually interpreted as the utility of an outside choice. The year effects play the role of the expected value of a reference sector, so that $\Lambda_t = \frac{\beta_1}{\nu} E_t W_{t+1}^o$. The sector of origin effect is similarly given by $\alpha_t^j = -\frac{\beta_1}{\nu} E_t W_{t+1}^j - \frac{1}{\nu}\log[\sum_h \exp\left(\beta_1 E_t W_{t+1}^h - \beta_1 E_t W_{t+1}^j - C^{jh}\right)] + \log(N_t^j) + \Lambda_t$.

and because the flows m^{jk} are created by a (dynamic) discrete choice model, we can estimate this equation with a Poisson pseudo maximum likelihood estimator (Gourieroux, Monfort and Trognon, 1984; Cameron and Trivedi, 1998). For our purposes, the Poisson pseudo ML regression provides estimates of moving costs within manufacturing C^m/ν, and in-and-out of manufacturing C^{nm}/ν, expected values λ_t^k, and the terms α_t^j.

In the second step we separately identify ν and η^j using the Bellman equation for the workers' problem. Multiplying (10) by β_1/ν and taking expectations, we get:

(21)
$$E_t\left[\frac{\beta_1}{\nu}W_{t+1}^j - \frac{\beta_1}{\nu}\left(\frac{w_{t+1}^j}{P_{t+1}} + \eta^j\right) - \frac{\beta_1}{\nu}E_{t+1}W_{t+2}^j - \frac{1}{\nu}\log\sum_k \exp\left(\beta_1 E_t W_{t+2}^k - \beta_1 E_t W_{t+2}^j - C^{jk}\right)\right] = 0.$$

Using the definition of λ_t^j and α_{t+1}^j, we get:

$$(22)\quad E_t\left[\lambda_t^j - \frac{\beta_1}{\nu}W_{t+1}^1 - \frac{\beta_1}{\nu}\left(\frac{w_{t+1}^j}{P_{t+1}} + \eta^j\right) + \beta_1\alpha_{t+1}^j + \frac{\beta_1^2}{\nu}W_{t+2}^1 - \log\left(N_{t+1}^j\right)\right] = 0.$$

Define:

$$\phi_t^j = \lambda_t^j + \beta_1\alpha_{t+1}^j - \log\left(N_{t+1}^j\right),$$

and

$$\zeta_t = \frac{\beta_1}{\nu}W_{t+1}^1 - \frac{\beta_1^2}{\nu}W_{t+2}^1,$$

We can now write (22) as a linear regression equation

$$(23)\quad \phi_t^j = \zeta_t + \frac{\beta_1}{\nu}\eta^j + \frac{\beta_1}{\nu}\frac{w_{t+1}^j}{P_{t+1}} + v_t^2,$$

where v_t^2 is an error term. In the regression equation (23), the variable ζ_t is a time fixed effect, variable $\frac{\beta_1}{\nu}\eta^j$ is a sector fixed effect, and the real wage $\frac{w_{t+1}^j}{P_{t+1}}$ is taken from the data. The estimated coefficient of real wage, $\frac{w_{t+1}^j}{P_{t+1}}$, is equal to $\frac{\beta_1}{\nu}$. The structural parameters can be estimated using IV with lag wage differences as instruments (as in Artuç, Chaudhuri, and McLaren, 2010).

The estimates of the labor mobility costs are in the bottom panel of Table 2. Our estimate of

C^m is 2.07 and of C^{nm} is 1.41. This means that, on average, a worker wishing to switch sectors within the manufacturing sector would pay a mobility cost equivalent to 2.07 times his annual wage earnings. The costs needed to switch from manufactures to non-manufactures (or vice-versa) is lower, around 1.41 times the value of the annual wage income. We also estimate a fairly high variance of the idiosyncratic costs, $\nu = 0.78$.

Our estimates are much lower than those reported in Artuç (2012), using the same specification and U.S. data. He estimates 26 values of C, ranging from 4.5 to 4.8. Artuç and McLaren (2012) also use U.S. data on sectoral and occupational mobility, and report values closer to ours, with estimates of C as low as 0.99 and as high as 1.54 (with ν=0.257). Using different regression specifications, Artuç, Chaudhuri, and McLaren (2010) estimate an average moving cost of 6.565, and a value of ν of 1.884.[23]

4 Increase in Export Opportunities

We now use the model and the estimated parameters to simulate the dynamic implications of an increase in export opportunities in the Food and Beverages sector (Sector 1). We model the shock as a permanent price increase in Sector 1. The price increase could originate either from an increase in world demand or a decrease in world supply. Either way, for a small country and homogeneous goods, the shock takes the form of an upward shift in a perfectly elastic demand. In our sectoral model, a price shock to one sector does not affect prices in all other tradable sectors, thus, our shock is not equivalent to an economy-wide macro shock.

We study the transitional dynamics of sectoral capital, employment, wages, profits, and output. We evaluate differences in short-run vis-à-vis long-run responses and also asses how these responses depend on the size of the shock (i.e., a small or a large trade shock). We are particularly interested in the interaction between price shocks and the level of the cost of adjustment of capital, as well as on the role of firm-level investment decisions.

In order to assess the impact of the increase in export opportunities we create a stationary economy and shut down all other aggregate shocks. We assume that prices of all tradable products (p_t) are constant, with the exception of the permanent price increase in Sector 1, that occurs at time $t = 1$. Consequently, we assume that productivity A_{ijt} follows the same Markov process as profitability $\widetilde{A}_{ijt}$, given by (15) and (16). We further assume that there are no aggregate productivity

[23] In these three papers, the authors impose, as we do, a value for the discount factor of 0.97.

shocks, that is, we set $b_t = 0\ \forall t$ in (15). In the initial stationary equilibrium, at time $t = 0$, firms are subject to Markov productivity shocks that create individual fluctuations in investment, employment and output, while workers are subject to utility shocks that create labor mobility. At the aggregate level, however, labor allocations, capital, output, and firm distributions are constant. At time $t = 1$ there is a permanent price increase in Sector 1 that triggers dynamic responses. After a transition period, the economy converges to a new stationary equilibrium. Shutting down other price shocks and aggregate productivity shocks allows us to isolate the effect of a trade shock to one sector.

We use the model parameters to simulate the initial stationary equilibrium, the transition period, and the new stationary equilibrium, for firms and workers. For each time period and sector, we solve the optimal decisions of firms and workers from their Bellman equations. Given that we shut down aggregate shocks, firms and workers have perfect foresight of firm distributions, labor allocations, and equilibrium wages during the transition period.[24] The trade shock is a one-time unexpected shock, but there are no other sources of uncertainty. After the economy is hit by this once-time shock, firms and workers have perfect foresight for the post-shock transition. From optimal individual decisions we compute aggregate equilibrium variables.

For a given path of the aggregate state variables (labor allocations and firm distributions), the workers' Bellman equation has a closed form solution for equilibrium-path values and can be solved analytically, whereas the firms' Bellman equation is solved iteratively. Firms and workers iterations are performed jointly in order to find the equilibrium labor allocations and wages, firm distributions, and prices of non-tradables. To solve the firms' Bellman equation we take the following approach. We discretize the firm-level state variables (A and K) and compute equilibrium-path solutions for the value and policy functions with respect to the the aggregate variables. That is, for each sector j we obtain sequences of matrices $\{V_0^j(A,K), V_1^j(A,K), \ldots, V_T^j(A,K)\}$ and $\{I_0^j(A,K), I_1^j(A,K), \ldots, I_T^j(A,K)\}$, where T is the new stationary equilibrium.[25] From these solutions and using the firm distributions μ_t^j, we obtain aggregate responses for all firms, and responses by arbitrary firm-types, for example, firm-level investment status (positive investment, negative investment, and investment inaction).

[24] We lift the assumption of firm myopic expectations about how wages are determined.

[25] We discretize A and K into 20 and 154 grid points. T is equal to 30.

4.1 Responses to Trade Shocks

To document the generic dynamic responses, we begin with the impacts of an increase in the price of Food and Beverages of 10 percent. Results are displayed in Figure 2. The general equilibrium effects in other sectors are discussed in the Appendix. The immediate implication of higher prices is an increase in profitability for firms in the sector. Firms want to expand and choose to invest. However, since capital adjustment is costly, the stock of K is gradually increased. Three fourths of the adjustment of the capital stock takes place within five years following the trade shock, and 95 percent of the transition is covered in 9 years. The capital stock increases by 6.40 percent initially (Year two), by 11.15 percent in Year 3, and by 22.87 percent in the new steady state (see column 1, Panel B, of Table 3).[26]

Real wages increase at first in Food and Beverages (but decline elsewhere), due to the immediate increase in labor demand. Firms must pay higher wages to their workers. This increase in nominal wages dominates the increase in the price index and real wages go up as a result. (In all other sector, nominal wages are initially not affected, but real wages drop due to higher prices.) As wages change, workers reallocate towards Food and Beverages. Note that, because of the idiosyncratic utility shocks, not all workers move at once or even in the same direction. The flows towards F&B, however, increase. As workers move, wages adjust again. As a result, the real wage in F&B starts to decline (and the real wages in all other sectors slightly recover). The real wage in Food and Beverages increases on impact (i.e., Year 1) by 5.74 percent, and starts declining gradually after that. In the new steady state, real wages are only 2.40 percent higher than in the initial equilibrium. See column 1, Panel B, of Table 5. This happens even though firms keep expanding capital for a few years because of the continuous inflow of workers.

Employment increases gradually, by 7.74 percent in Year 2, 11.62 percent in Year 3, and 15.75 percent in steady state (Table 6). Output follows a similar path, but the proportional increase is actually lower than the increase in both capital and employment. For instance, output increases by 4.49 percent in Year 2, by 8.10 percent in Year 3, and by 12.15 percent in the new steady state. The dampened increase in output is because the production function exhibits decreasing returns to capital and labor.

The magnitude of the responses depends on the size of the shock. In Panels A and C (column

[26] Note that investment at t becomes productive capital in $t+1$. In consequence, while there is an investment response in the first year of the shock, the capital stock remains at the steady state level for one period before adjusting.

1) of Tables 3, 5, 6, and 7, we report the impacts (on capital, wages, employment, and output, respectively) of price increases of 5 and 30 percent. As expected, the economy adjusts more when the trade shock is larger. For example, while, as we just showed, a price increase of 10 percent induces an increase in capital of 6.40 percent in Year 2 and of 22.90 percent in steady state, the responses to a price increase of 30 percent are 20.37 and 75.20 percent, respectively. This pattern suggests that, as the positive price shock becomes larger, the aggregate capital stock of the economy becomes proportionately more responsive. This is because a larger price shock makes it profitable for more firms to move out of the inaction region. This is a novel finding of our paper, which we further explore below.

Following a 30 percent price shock, real wages increase, on impact, by 16.42 percent, and then continuously decline until, in the steady state, they are only 7.07 percent higher (so that the decline after Year 1 is of about 9.35 percentage points). This means that the enhanced responsiveness of capital is not reflected in the responsiveness of real wages. It is, instead, reflected in profits. In Table 8, we report a more than proportional response of profits as the price shock becomes larger. For example, a price shock of 10 percent increases profits by 20.63 percent in Year 1 and by 23.75 percent in the new steady state. Instead, following a 30 percent price shock, profits increase by 66.10 and 76.62 percent in Year 1 and in the steady state, respectively. This has implications for the distribution of the gains from trade as the trade shock varies. As the shock becomes larger, capital expands more than proportionately, and this favors firms relatively more than workers.

For completeness, we also look at the responses of the economy to various negative price shocks (–5, –10, –20 and –30 percent, respectively). The dynamic implications of a negative price shock are similar. There is a gradual, sluggish decline in capital. Real wages drop on impact and only partially recover, thus reaching a lower level in steady state. Employment declines gradually, as does output. It is noteworthy that the responsiveness of capital, wages and employment to the size of negative shocks is actually opposite to the patterns observed for positive shocks. Aggregate capital become proportionately less responsive as the price shock becomes larger. The underlying reason is the depreciation rate. Since it is costly to adjust capital and firms want to desinvest, it is convenient to let capital depreciate in lieu of paying the adjustment costs. (See Figure 5. ADD TABLE).

4.2 The Trade Shock and Firm-Level Investment Decisions

In this section, we investigate the role of firm-inaction and capital adjustment costs. We claim there is an 'interaction' effect between the price shock and the capital adjustment cost structure. When there is a price shock, firms have incentives to invest, but the costs of adjustment may prevent this expansion. If the costs of capital adjustment are lower, the price shock can trigger a larger response. This logic applies to all firms to a different degree. Inactive firms in the presence of capital adjustment costs, even with a price shock, can be moved out of the inaction region when the same price shock comes accompanied with lower costs. We expect the contribution of these firms to be large. But firms that would invest when the price shock arrives even with the capital adjustment costs, can invest more. This can happen because, for example, it is now costless to desinvent in the face of potential future profitability shocks. These mechanisms, materialized in our model with this 'interaction' effect, can have implications for the speed of adjustment, for the overall response of the economy, and for the distribution of the gains from trade. In what follows, we explore these implications in detail.

To do all this, we simulate a counterfactual shock where the trade shock takes place in the absence of both fixed costs of investment and irreversibility costs. With $\gamma_1 = 0$ and $\gamma_3 = 1$, we thus expect a larger, smoother and quicker response of firm-level capital accumulation and of aggregate capital. Note that, to build the counterfactual experiment, we run, for a given price change, two simulations, one with both lower costs and changed prices, and another with lower costs and no price change. We do this to control for the fact that a decrease in adjustment costs necessarily brings firm responses in capital that we want to keep constant. More concretely, we study the difference between the levels of the variables in the two simulations.

We want to evaluate the effect of a change in price and a change in the cost structure, γ, on an outcome variable $y(p, \gamma)$ (capital, wages, and so on). The effect of a change in price from p to $\widetilde{p}$ is $y(\widetilde{p}, \gamma) - y(p, \gamma)$. If both p and γ change simultaneously the effect is $y(\widetilde{p}, \widetilde{\gamma}) - y(p, \gamma)$. The overall change can be decomposed as follows:

$$(24) \quad y(\widetilde{P}, \widetilde{\gamma}) - y(P, \gamma) = [y(P, \widetilde{\gamma}) - y(P, \gamma)] + \left[y(\widetilde{P}, \gamma) - y(P, \gamma)\right] + \left(\left[y(\widetilde{P}, \widetilde{\gamma}) - y(P, \widetilde{\gamma})\right] - \left[y(\widetilde{P}, \gamma) - y(P, \gamma)\right]\right)$$

The three terms in the decomposition are: i) the effect of a change in the cost structure, at the old prices; ii) the effect of a change in prices, at the old structure; iii) the additional effect of a change in prices, at the new structure. This is what we call 'interaction' and captures the additional impacts of a trade shock when the cost structure withers investment inaction.

Results for capital are reported in Table 3. As expected, the increase in capital is much larger when we shock prices and the cost structure simultaneously (see columns 1 and 2). For a 10 percent price shock, for instance, the long-run increase in capital is 37.28 percent instead of 22.87 percent. This is not surprising. The intriguing results are instead the differences observed in the three components of the decomposition. We find that the role of the cost structure is more significant in the short-run than in the long-run (column 3). For a 10 percent price shock, the combined shock causes capital to increase by 22.09 percent in Year 2, by 29.11 percent in Year 3, and by 22.87 percent in the long-run. In the short-run, the change in the cost structure explain half of the increase in K. In the long-run, it explain only 29.63 percent. The joint role of the price change and the 'interaction' effect instead becomes more relevant (columns 4 and 5). But the relative importance of these components also varies (column 6). While the pure price effect becomes more relevant in the long-run, the 'interaction' effect becomes instead less relevant. We claim this is because of the role of partial and total investment inaction. When we eliminate the fixed costs γ_1 and the irreversibility costs γ_3, investment inaction (partial or total) ceases to be an optimal response, especially in the short-run. It follows that firms invest quickly, and more strongly, in the wake of a positive price shock. This effect is a short-run effect, and it loses force as the economy adjust.

We also investigate the contribution to the overall change in the capital stock from different type of firms, depending upon the investment status in the baseline. There are firms with positive investment, firms with negative investment, and inactive firms. For each of these groups, we report results in Table 4. We observe that the three types of firms contribute more or less the same to the capital stock. This highlights the response of the inaction of all firms. Moreover, we find that inactive firms contribute the most (around 50 percent) to the interaction effects. This means that the combination of a price shock in the presence of lower "inaction" costs induces inactive firms to respond, and they do so significantly.

All These results have important implications for the distribution of the gains from trade. To look at this, we study the evolution of wages (Table 5) and profits (Table 8). In the case of real wages, we note that the interaction effect has a much larger role in the short-run than in the long-run, while for the case of profits it is the other way around. The quicker investment adjustment in the early years of the transition due to the interaction effect implies a higher real wage in Food and Beverages and a distribution of the gains from the price shock towards workers in the sector. As this effect vanishes, the gains from interaction of adjustment costs and prices shifts towards firms.

Another important finding of the paper emerges from the comparison of the differential response of capital at different price shocks. We find that the interaction effect losses relative power as the shock becomes larger. In Year 2, for example, the interaction effect accounts for 47.18 percent of the combined effect of a 5 percent price shock (pure price effect plus interaction effect). For a 30 percent shock, the interaction effect accounts for 37.19 percent of the total price effect. In the long-run, these contributions are much more similar, 11.06 percent in the case of a 5 percent price shock and 12.42 percent in the case of a 30 percent price shock.

This result is driven by the incentives to investment inaction generated by the inaction costs. Given the value of γ_1 and γ_3 in the baseline, a larger price shock induces a larger proportion of firms to respond in the short-run. To put it differently, if the price shock is small when adjustment costs are high, fewer firms will find it optimal to adjust investment immediately after the shock. In the absence of those costs, thus, the same small price change will induce a much larger response of many of those firms that choose inaction in the baseline. As the price shock grows larger, these differential responses become smaller. In the long-run (in steady state, but also after about 5 years in our simulations) most firms have already adjusted and thus the differential responses narrow. Eventually, when capital adjustment is full (to its steady state), a larger price shock elicits similar proportional responses.

5 Conclusions

This paper develops a structural dynamic equilibrium model of the labor market with workers' mobility costs, firm heterogeneity and firms' capital adjustment costs. The model features firm investment decisions at the firm level, articulating both the product and labor market. This characteristic of the model allows us to analyze the role played by capital mobility and its mobility frictions on labor market after trade liberalization. We fit our model to household survey data and plant-level panel data from Argentina in order to recover a measure of the frictions faced both by workers and firms.

To be continued...

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A Appendix

A.1 Construction of Firm-Level Dataset

We express all monetary variables in real terms. We deflated wages by the consumer price index and firm's variables using the wholesale price index. In particular, we deflated investment, capital and intermediate inputs by the general level of the index. Gross revenue, sales and profits were deflated using the four digit disaggregation of the index.

To construct the real investment series, we generate an initial measure of the real capital stock at the plant-level and then complete the series using the perpetual inventory method, $K_{f,t+1} = (1-\delta)K_{ft}+I_{ft}$, where I_{ft} is real investment, K_{ft} real capital stock, and δ is the capital depreciation rate. Real investment is defined as $I_{ft} = E_{ft} - S_{ft}$, where E_{ft} is real gross expenditures on capital equipment, and S_{ft} is real gross retirements of capital equipment.

Since our dataset does not contain information about the book value of capital, we approximate the initial capital stock of the firm as the average across years of the ratio between the amount of capital depreciation declared by the firm and the depreciation rate estimated for the industry. We deflate our measure of initial capital stock by the general level of the wholesale price index. We use sectoral depreciation rates estimated by the Bureau of Economic Analysis (BEA) of the United States (Fraumeni, 1997). Our depreciation rates include both in-use depreciation (which reflects declines in the efficiency of the asset because of aging or wear and tear) as well as retirements or discards (which reflects, for example, obsolescence).

Table 1
Structural Parameters
Production Function and Capital Adjustment Costs

A) Production Function

Parameters	labor (α_L)	capital (α_K)	
Manufacturing	0.5892***	0.1420***	
	(0.0131)	(0.0423)	
Non-Manufacturing	0.3402	0.1153	

B) Stochastic Process and Depreciation

Parameters	ρ_e	σ_e	δ
	0.8853***	0.6652***	0.0991
	(–)	(–)	–

C) Capital Adjustment Costs

Parameters	γ_1		γ_2	γ_3
	0.1451***		0.1132***	0.9143***
	(0.0403)		(0.0105)	(0.0727)
Moments	$corr(i, i_{-1})$	$corr(i, a)$	$spike^+$	$spike^-$
Observed	0.188	0.121	0.139	0.011
Simulated	0.149	0.306	0.135	0.013

Source: See text.

Table 2
Estimation of Labor Mobility Costs
Parameters and Data

	Food & Beverage	Textiles	Other Manufactures	Minerals	Metals	Services
CPI weight	0.313	0.052	0.211	0.025	0.025	0.384
Average Wages	0.82	0.84	1.09	0.78	0.86	0.96
Labor Allocation	391	222	868	92	229	10,069

Estimates of Labor Mobility Costs

Parameters	C^m	C^{nm}	ν
	2.07***	1.41***	0.78***
	(0.22)	(0.27)	(0.12)

Source: panel component of EPH (Permanent Household Survey).

Table 3
Simulation Results. Capital

	Price Shock	Price Shock + Change in Cost Structure					
		Total	=	Cost +	Price +	Interaction	Inter/ (Price+Inter)
	(1)	(2)		(3)	(4)	(5)	(6)
5% Price Shock							
Year 2	2.90	16.53		66.82	17.52	15.65	47.18
Year 3	5.22	19.96		55.33	26.16	18.52	41.45
Long Run	11.37	23.83		46.35	47.72	5.93	11.06
10% Price Shock							
Year 2	6.40	22.09		50.00	28.97	21.03	42.06
Year 3	11.15	29.11		37.95	38.29	23.76	38.29
Long Run	22.87	37.28		29.63	61.34	9.03	12.83
30% Price Shock							
Year 2	20.37	43.48		25.40	46.85	27.75	37.19
Year 3	36.95	67.20		16.44	54.99	28.58	34.20
Long Run	75.20	96.91		11.40	77.60	11.01	12.42

Notes: Simulation results.

Table 4
Capital Adjustment by Firm Type

	Positive Investment Firms	Negative Investment Firms	Inactive Firms					Compositional Term
			Total	=	Cost +	Price +	Interaction	
	(1)	(2)	(3)		(4)	(5)	(6)	(6)
5% Shock								
Year 2	12.73	12.58	17.15		4.89	1.49	7.60	60.70
Year3	12.62	11.90	15.66		4.05	1.68	7.49	62.27
Long Run	11.69	10.65	13.47		3.39	1.41	7.03	65.83
10% Shock								
Year 2	19.12	17.91	19.13		3.66	2.80	11.08	45.42
Year3	16.86	15.61	16.78		2.78	2.94	9.66	52.15
Long Run	14.52	13.35	13.97		2.17	2.65	8.17	59.14
30% Shock								
Year 2	28.27	25.76	22.79		1.86	5.25	15.78	23.07
Year3	21.46	19.74	18.79		1.20	5.96	10.23	41.41
Long Run	16.30	14.90	14.68		0.83	5.04	7.36	55.57

Notes: Simulation results.

Table 5
Simulation Results. Real Wages

	Price Shock	Price Shock + Change in Cost Structure				
		Total =	Cost +	Price +	Interaction	Inter/ (Price+Inter)
	(1)	(2)	(3)	(4)	(5)	(6)
5% Price Shock						
Year 1	2.91	8.28	62.97	35.15	1.88	5.08
Year 2	1.87	7.20	72.40	26.00	1.60	5.81
Long Run	1.24	6.48	80.46	19.10	0.43	2.21
10% Price Shock						
Year 1	5.74	11.26	46.27	51.00	2.73	5.08
Year 2	3.84	9.12	57.13	42.04	0.83	1.93
Long Run	2.40	7.71	67.61	31.14	1.25	3.85
30% Price Shock						
Year 1	16.42	22.52	23.15	72.94	3.92	5.09
Year 2	11.04	16.12	32.34	68.48	-0.82	-1.21
Long Run	7.07	12.45	41.86	56.78	1.37	2.35

Notes: Simulation results.

Table 6
Simulation Results. Employment

	Price Shock	Price Shock + Change in Cost Structure				
		Total =	Cost +	Price +	Interaction	Inter/ (Price+Inter)
	(1)	(2)	(3)	(4)	(5)	(6)
5% Price Shock						
Year 2	3.84	2.77	-43.21	138.44	4.77	3.33
Year 3	5.75	4.73	-25.34	121.50	3.84	3.06
Long Run	7.90	6.77	-17.71	116.73	0.98	0.83
10% Price Shock						
Year 2	7.74	6.68	-17.95	115.82	2.13	1.80
Year 3	11.62	10.61	-11.30	109.59	1.71	1.54
Long Run	15.75	14.77	-8.12	106.67	1.45	1.34
30% Price Shock						
Year 2	22.45	21.41	-5.60	104.88	0.72	0.68
Year 3	33.86	33.04	-3.63	102.48	1.15	1.10
Long Run	46.40	46.02	-2.60	100.82	1.78	1.73

Notes: Simulation results.

Table 7
Simulation Results. Output

	Price Shock	Price Shock + Change in Cost Structure				
		Total =	Cost +	Price +	Interaction	Inter/ (Price+Inter)
	(1)	(2)	(3)	(4)	(5)	(6)
5% Price Shock						
Year 2	2.25	6.90	64.36	32.61	3.03	8.51
Year 3	3.93	8.77	50.60	44.79	4.61	9.34
Long Run	6.18	11.01	40.32	56.18	3.50	5.86
10% Price Shock						
Year 2	4.49	9.27	47.86	48.46	3.68	7.06
Year 3	8.10	13.02	34.08	62.19	3.74	5.67
Long Run	12.15	17.53	25.32	69.33	5.35	7.16
30% Price Shock						
Year 2	12.69	17.94	24.74	70.77	4.49	5.97
Year 3	23.47	28.73	15.45	81.70	2.85	3.38
Long Run	35.37	42.49	10.45	83.24	6.31	7.05

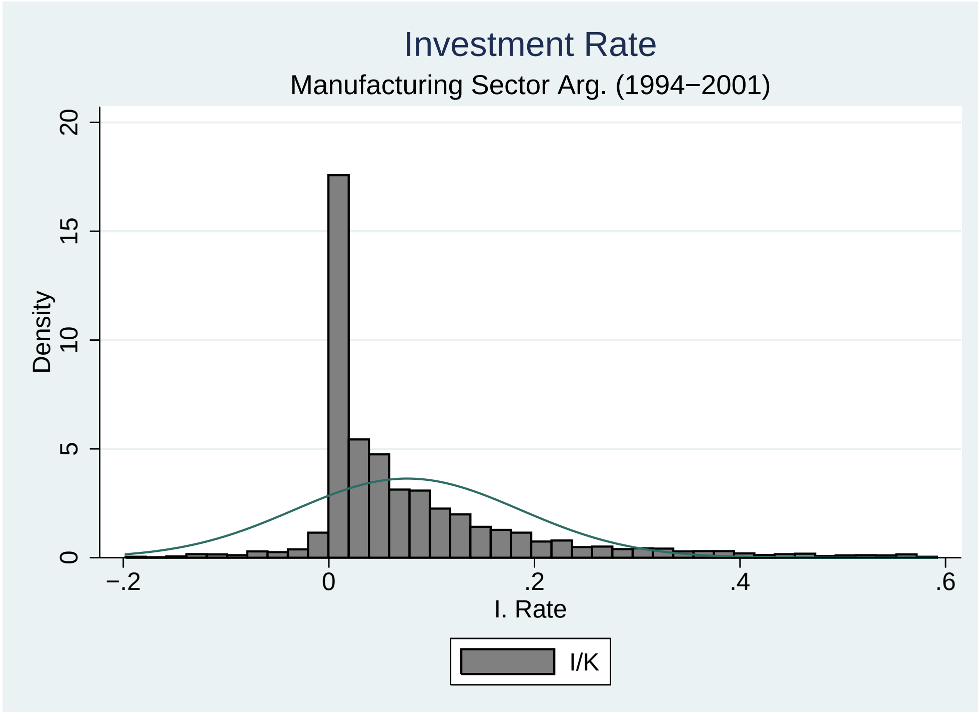
Notes: Simulation results.

Table 8
Simulation Results. Real Profits

	Price Shock	Price Shock + Change in Cost Structure				
		Total =	Cost +	Price +	Interaction	Inter/ (Price+Inter)
	(1)	(2)	(3)	(4)	(5)	(6)
5% Price Shock						
Year 1	10.02	13.97	26.81	71.76	1.43	1.96
Year 2	10.19	14.14	26.49	72.06	1.45	1.97
Long Run	11.52	15.82	23.67	72.84	3.49	4.57
10% Price Shock						
Year 1	20.63	24.65	15.19	83.70	1.11	1.31
Year 2	20.97	24.99	14.98	83.92	1.10	1.29
Long Run	23.75	28.47	13.15	83.41	3.44	3.96
30% Price Shock						
Year 1	66.10	71.33	5.25	92.68	2.07	2.19
Year 2	67.22	72.47	5.17	92.76	2.07	2.18
Long Run	76.62	84.02	4.46	91.19	4.36	4.56

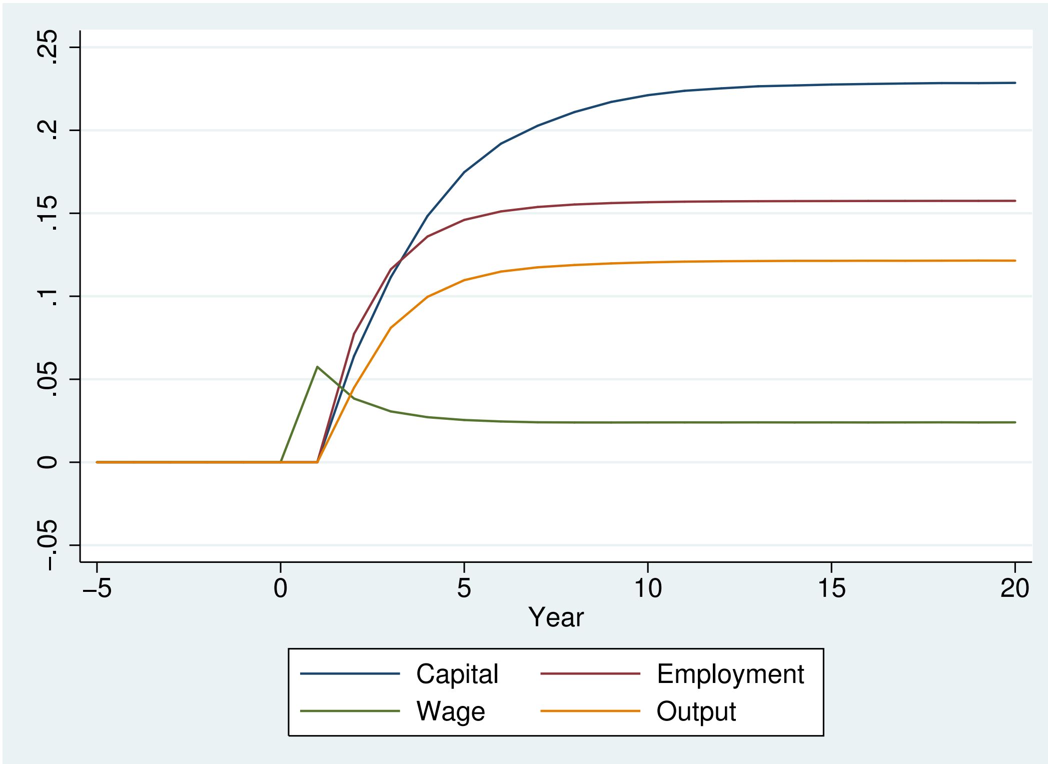
Notes: Simulation results.

Figure 1
Investment Rate Distribution



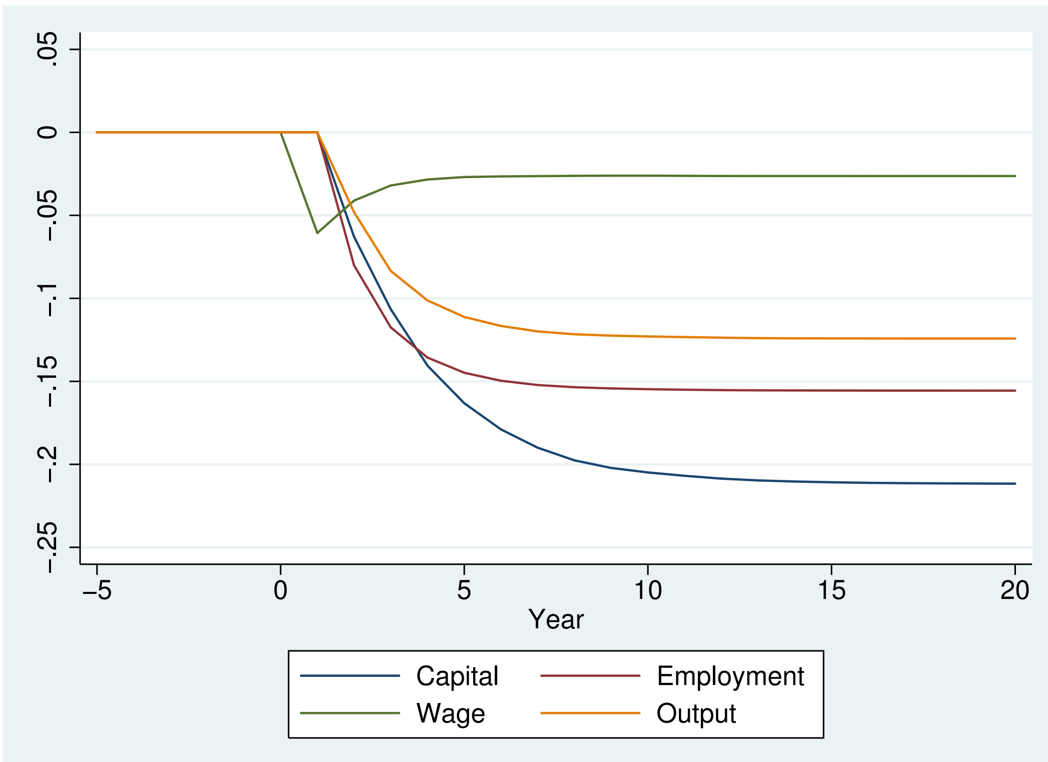
Source: ENI, Encuenta Nacional Industrial (National Industrial Survey), Argentina 1994-2001.

Figure 2
Price Increase of 10 Percent



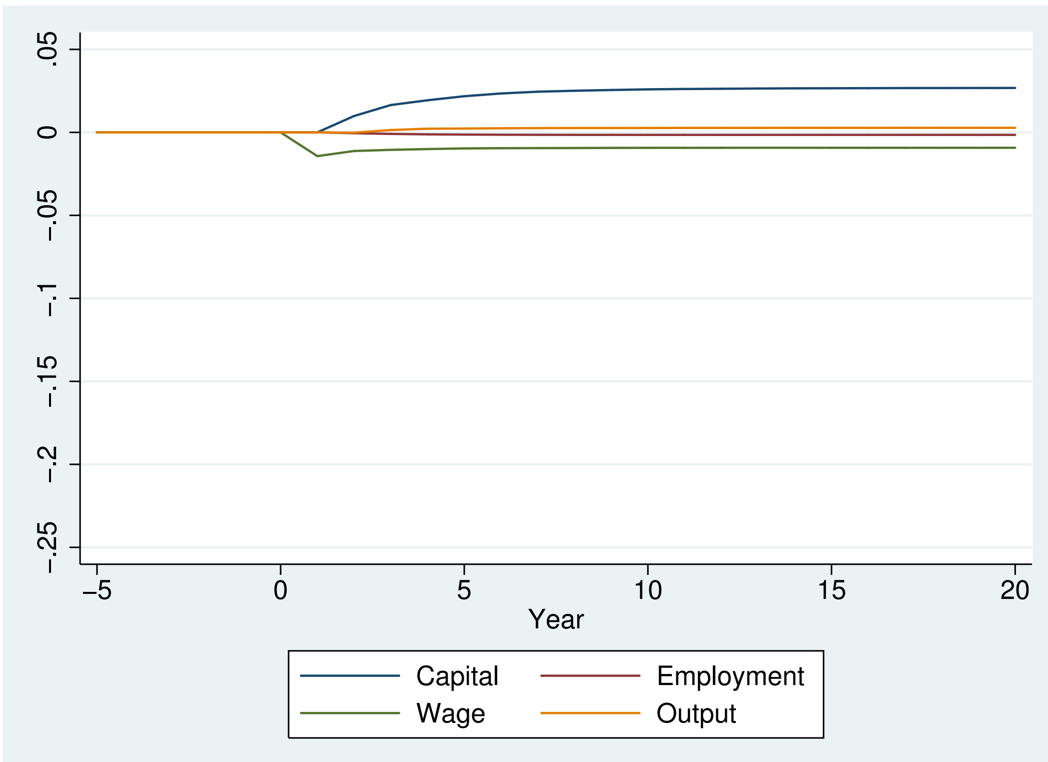
Simulation results of a 10 percent increase in price. Dynamic responses of capital, real wages, employment and output in Food & Beverages.

Figure 3
Price Increase of 10 Percent. Other Tradable Products



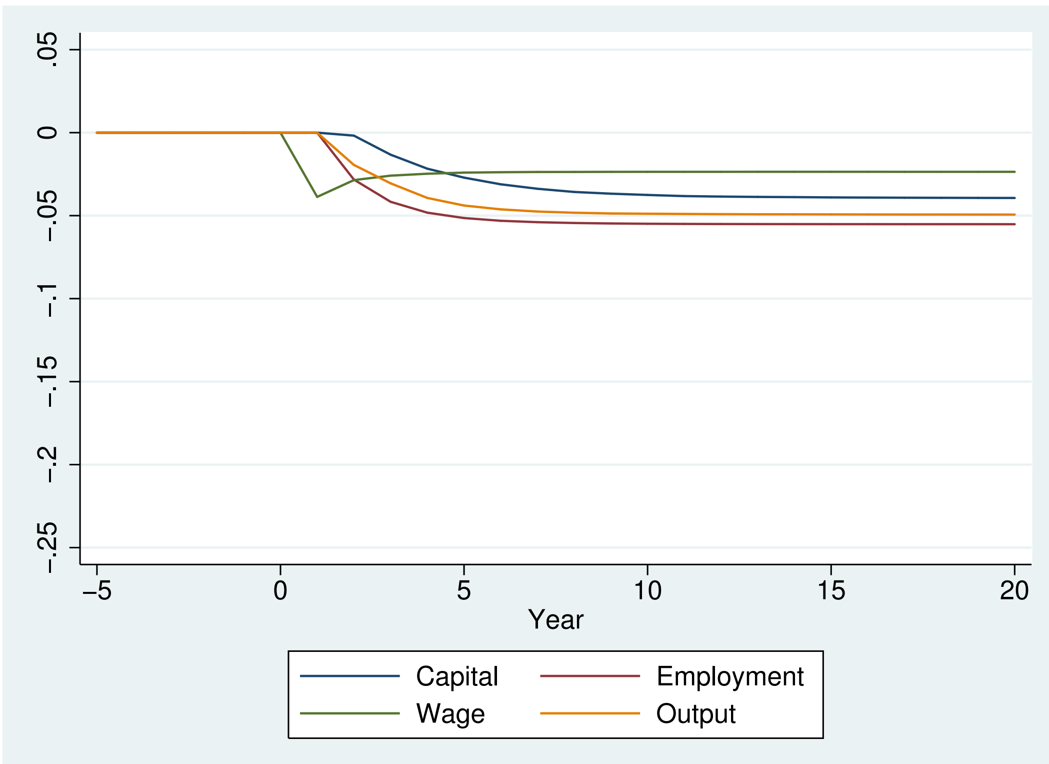
Simulation results of a 10 percent increase in price of Food & Beverages. Dynamic responses of capital, real wages, employment and output in other Tradable Sectors.

Figure 4
Price Increase of 10 Percent. Non-tradables



Simulation results of a 10 percent increase in price of Food & Beverages. Dynamic responses of capital, real wages, employment and output in the Non-Tradable Sector.

Figure 5
Price Decrease of 10 Percent



Simulation results of a 10 percent decrease in price. Dynamic responses of capital, real wages, employment and output in Food & Beverages.

Table 9
Simulation Results. General Equilibrium Effects on Other Tradables

	Wage	Employment	Capital	Output	Profits
5% Price Shock	-1.99	-1.54	-0.09	-0.96	-1.57
	-1.49	-2.35	-0.36	-1.51	-1.65
	-1.22	-3.36	-1.49	-2.50	-1.86
10% Price Shock	-3.87	-3.12	-0.18	-1.94	-3.03
	-2.86	-4.75	-1.33	-3.05	-3.19
	-2.36	-6.60	-3.94	-4.94	-3.71
30% Price Shock	-10.44	-9.22	-1.71	-5.79	-9.62
	-7.82	-13.96	-4.06	-9.30	-10.11
	-6.00	-19.40	-11.59	-14.57	-11.65
5% Price Shock + Change in Cost Structure					
	2.76	1.19	12.02	6.44	3.13
	3.31	-0.41	11.67	5.39	3.04
	3.61	-2.17	9.95	3.85	2.74
10% Price Shock + Change in Cost Structure					
	0.80	1.19	12.02	6.44	1.48
	1.87	-2.01	11.31	4.34	1.31
	2.47	-5.55	7.71	1.22	0.68
30% Price Shock + Change in Cost Structure					
	-6.08	1.19	12.02	6.44	-5.30
	-3.17	-8.17	9.71	0.26	-5.80
	-1.30	-18.69	-1.31	-9.19	-7.76

Notes: Simulation results.

Table 10
Simulation Results. General Equilibrium Effects on Non-Tradables

	Wage	Employment	Capital	Output	Profits
5% Price Shock	-0.75	-0.03	0.34	-0.01	1.47
	-0.64	-0.05	0.60	0.04	1.47
	-0.51	-0.08	1.10	0.10	1.52
10% Price Shock					
	-1.43	-0.05	0.99	-0.02	2.87
	-1.12	-0.09	1.65	0.14	2.87
	-0.93	-0.15	2.68	0.28	2.98
30% Price Shock					
	-3.63	-0.09	3.64	-0.03	9.73
	-2.45	-0.19	5.80	0.59	9.77
	-1.39	-0.36	10.15	1.07	10.29
5% Price Shock					
+ Change in Cost Structure					
	3.90	0.06	13.65	3.97	7.07
	4.04	0.03	14.64	3.96	7.07
	4.16	-0.01	15.28	4.12	7.16
10% Price Shock					
+ Change in Cost Structure					
	3.18	0.06	13.65	3.97	8.64
	3.49	0.01	15.66	3.96	8.63
	3.76	-0.09	16.94	4.28	8.82
30% Price Shock					
+ Change in Cost Structure					
	0.86	0.06	13.65	3.97	15.76
	2.03	-0.03	20.16	3.94	15.81
	3.25	-0.30	25.34	5.08	16.53

Notes: Simulation results.