

Localized Shocks, Job Displacement, and Wages: Evidence from Mexico

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Version 0.7
December 17, 2009

Preliminary and incomplete:
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Two recent papers highlight the growing focus on wage and employment dynamics. Bergin et al. (forthcoming) describe the importance of understanding the sources and consequences of labor market volatility. Couch and Placzek (forthcoming) represents renewed interest in understanding one particular consequence of this volatility: post-displacement wage dynamics. Bergin et al. (2009) suggest that volatility may be higher in developing countries and focus on Mexico's maquiladora sector as an example. Kaplan et al. (2005), followed by Couch et al. (2009), illustrate the importance of local labor market conditions (across both time and space) in determining post-displacement wages. The differences between the United States and Mexico are consistent with international heterogeneity that emerges from other countries, such as Kuhn (2002), Helwig (2001), Howland and Peterson (1988), and Kreichel and Pfann (2003). While the empirical results show much variation, there is little theoretic work seeking to identify the variables that may be driving heterogeneity in volatility and post-displacement experiences.

One possible variable that might help explain both the excess volatility and the variation in post-displacement wages found in the literature is a cost to workers of separating from their jobs (a "separation cost"). The analogy for this cost in the U.S. is the driving force behind the "job lock" literature (Gruber and Madrian 1994, 2002 and Bansak and Raphael 2008) that suggests that the cost to workers from leaving their jobs reduces labor market turnover by 20-40%. This kind of cost is distinct from a cost to the employer of adjusting employment (described widely as hiring and firing costs) that have been found to be empirically relevant in the U.S. and other developed countries

(Hamermesh 1989 and Hamermesh et al. 1996) but an order of magnitude smaller in Mexico (Robertson and Dutkowsky 2002). Rather than affecting employers, the employee-based costs might result from risk aversion or loss of health insurance.

The goal of this paper is to explore the possible consequences of the separation cost in Mexico. In section 1, we develop a very basic labor market model of imperfect competition and a separation cost. This model generates a number of predictions for employment and wage dynamics that we evaluate empirically in the rest of the paper. Specifically, section 2 contains a description of the matched worker-firm data used in section 3 to explore employment dynamics following Davis et al. (1996) and in section 4 to examine post-displacement wages following Jacobson, Lalonde, and Sullivan (1992a, 1992b).

1. A Model of Separation Cost, Wage and Labor Turnover

The goal of this section is to develop a very simple and rudimentary model that illustrates how workers' wages change after separating from the firm. The objective of the model is not to make a theoretic contribution per se, but rather to offer some guidance as to the possible implications a separation cost might have. The main features of the model include imperfect competition in the labor market and separation that is costly to the worker. Imperfect competition implies that workers' skills are valued by a limited number of firms in the market (although this number may be large). The separation cost is borne by the worker if the worker voluntarily separates from the firm, but is shifted to

the firm when the worker involuntarily leaves the firm due to layoffs through a payment to the worker by the firm (a severance payment).¹

1.1 The Basic Model

The model begins with the basic specification and assumptions.

1.1.1. The Workers and the Firm

We begin with the assumption that there are many firms and many workers in the labor market. The firms are subject to independent productivity shocks that affect the value of the match between the worker and the firm. As a result, firms are heterogeneous in the sense that they have different values for workers.

The marginal productivity of workers is constant in the sense that the productivity of any worker in any firm is unaffected by the number of other workers employed in that firm. Workers, then, do not compete for jobs. Instead, firms compete for workers in a “Bertrand” manner.

Although the marginal productivity of workers is not affected by the number of workers in the firm, workers differ in their productivity, which is a function of their educational level, training, and working experience. Without loss of generality, we can then focus on a representative worker. The realized marginal productivity of a representative worker at each firm is described by the vector $\mathbf{v} = (v_0, v_1, v_2, \dots, v_n)$ where v_i is the realized productivity of the worker at the firm i . The realized productivity of the

¹ The fact that the severance payments are established either by law or convention differentiates our model somewhat from the implicit contract literature (e.g. Rosen 1985) that might suggest that workers may have different post-displacement wages due to *a priori* beliefs about displacement probabilities and compensating contracts. To the extent that these severance payments are established by law or convention, they are less subject to the kinds of individual variation implied by implicit contracts. Furthermore, as Rosen (1985) points out, contracts increase employment volatility and pre-displacement wages might incorporate the right of layoff. Nevertheless, exploring our question in the scope of implicit contracts may be a fruitful area for future research.

worker at firm i is composed of two components: a general component and a firm-specific component. The general component is simply the expected value of worker's productivity, m and is equal in all firms: $E(v_i) = m \forall i$ in $(1, 2, 3, \dots, n)$. The specific component comes from independent and identically-distributed shocks represented by random variables ϵ_i , for $i = 0, \dots, n$ with mean zero, support $[-1, 1]^2$ and continuous distribution and density function $F(\cdot)$ and $f(\cdot)$. Then: $\mathbf{v} = (m + \epsilon_0, m + \epsilon_1, m + \epsilon_2, \dots, m + \epsilon_i, \dots, m + \epsilon_n)$.

To model labor market competition, we make two assumptions: (1) the productivity vector \mathbf{v} is revealed to the worker at zero cost, and (2) a firm does not know about the worker's productivity at other firms, but once this information is revealed to the firm, it can be verified at zero cost. The first assumption implies that the worker is fully aware of all the outside offers (the search cost is fixed, zero, and occurs with replacement). The second assumption implies that the firm will offer the worker a wage equal to the worker's marginal revenue product (MRP) in any period (t): $W_t = MRP_t = (m + \epsilon_i) * p_t$.

1.1.2. Timing

The model has three periods. We assume that period 1 represents equilibrium in the sense that workers are well-matched; i.e. there is no incentive for any worker to change jobs or for any firm to adjust wages. In period 1, the whole industry is stable. At the beginning of the period 2, a negative generalized price shock occurs. We initially model this shock as a fall in the product price p_t for every firm. Labor turnover takes place and labor market reaches equilibrium by the end of each period. We are interested

² The support is consistent with the reality that that variance in wages is bounded.

in wages (especially for laid-off workers) by the end of period 2. As noted above, the main analysis begins in period 1, which is in a state of equilibrium. To formally illustrate the returns to the three worker types, however, it is helpful to include period 0 (an additional period prior to period 1). At the beginning of period 0, we assume workers are randomly assigned to firms.

1.1.3. Labor Market Turnover

Labor turnover can be classified into three categories: firings, quits, and layoffs. Firings are separations that are due to poor performance or malfeasance by the worker. We assume that there are no firings. To define quits and layoffs, we turn to McLaughlin (1991). McLaughlin defines quits as separations that occur when the worker receives a higher outside offer that the firm refuses to match. Layoffs occur when the worker refuses the firm-initiated wage cut. Both quits and layoffs are efficient.

In the event of a negative shock, a firm may realize that the worker's marginal revenue product is less than the predetermined wage ($W > MRP$), motivating the firm to initiate a wage cut in order to meet the lower MRP. If the worker refuses this wage cut, then the worker is laid off.

If switching jobs is costless, the worker in firm 0 will initiate a wage raise when the worker receives an outside offer that is higher than her current wage (that is $W_0 < \text{Max} \{MRP_i\}$). Not willing to pay a wage above the worker's MRP, the firm refuses to pay the higher wage and the worker quits.

1.1.4. Separation cost

Switching jobs may not be costless. Distinct from adjustment costs to firms (Hamermesh, 1993) there may be significant relocation, learning, psychic, and other adjustment costs to workers that arise from changing jobs. As noted in the introduction, a significant “job lock” literature focuses on these separation costs in developed countries (mainly the United States) and finds that they significantly reduce mobility. We therefore assume that, from the worker’s point of view, it is costly to switch jobs. Without proper compensation workers can get “trapped”: workers would prefer not to incur the cost associated with changing jobs. Denote C as the monetized value of the separation cost that the worker experiences when separating from the firm: when a worker separates, either through a quit or a layoff, the worker experiences a cost C .³ To simplify our analysis, we define C as a certain multiple of the output price: $C_t = p_t * A$. A is the real (de-monetized) value of separation cost, which we treat as exogenous. Linking the separation cost to the output price makes the separation cost proportional to the worker's wage, which reflects the fact that higher-paid workers may incur higher separation costs.

The separation cost affects workers' behavior. Realizing the existence of the separation cost, a worker quits only when his new outside wage offer is higher than the sum of his current wage and the separation cost; $W_0 + C < \text{Max}[W_i]$. Otherwise the worker stays. In the presence of the separation cost, first-period equilibrium may be characterized by some workers who are not matched to the highest-valuing firms. That is, some workers may have a higher outside offer, but stay due to the separation cost C . They belong to the category such that, $W_0 < \text{max} [W_i] < W_0 + C$, which is inefficient in the sense that some workers are not matched to the firm that would value them the most.

³ To mitigate these costs, firms, either by custom or law, often compensate workers who separate involuntarily from firms. Firms do not offer severance payments to workers who quit, since workers voluntarily leave their jobs in the case of a quit.

1.1.5. Output Market

At time t , all firms in the industry produce homogeneous outputs and sell them at the same price p_t . The output price p is a function of the tariff level τ and the macroeconomic conditions (e.g aggregate demand), inversely indexed by u_t .⁴ Then $\mathbf{p}_t = \mathbf{p}(\tau_t, u_t)$. We assume that a higher tariff and better macroeconomic conditions increase the output price and vice versa. Then $\partial p_t / \partial \tau_t > 0$ and $\partial p_t / \partial u_t < 0$.

1.2. Effect of a General Negative Shock

We assume that there are two kinds of negative shocks that may lead to worker displacement: general shocks and firm-specific shocks. Examples of general shocks include recession, a fall in aggregate demand, or a drop in tariffs that affects the industry-specific output price. Examples of firm-specific shocks may include poor management, loss of a business partner, or an idiosyncratic response to a general shock. We analyze the general shock in sections 1.2 through 1.4 and then analyze the firm-specific shock in section 1.5.

1.2.1 Decision Rules

A negative general shock causes the output price to fall from p_1 to p_2 at the beginning of period 2, causing the worker's MRP to fall below her wage. The firms will initiate a wage cut so the adjusted wage equals the new MRP.⁵ If the worker is matched to her most productive firm in period 1, then she will accept the wage cut and stay. If the worker was prevented from efficient turnover by the separation cost in period 1, however,

⁴ For example, u_t may represent the unemployment rate, which would be a useful proxy for macroeconomic conditions.

⁵ This result matches Jacobson et al. (1992a,1992b) and others, who find falling wages prior to displacement.

then in period 2 she will refuse the wage cut, get laid off, receive the severance payment, and work for her most productive firm. Although it might not be in the firm's best interest to lay off workers because it has to pay for the separation cost, the firm is unable to identify the worker that will refuse the wage cut because the firm lacks information about the complete productivity vector \mathbf{v} .

1.2.2 Wage Effects of Displacement

To illustrate how equilibrium is reached we look back to period 0 when workers are randomly assigned to firms. This assumption is useful simply to help illustrate the initial equilibrium of the model and does not affect the results. From period 0 on, labor market turnover occurs. In order to identify the effects of displacement on wages, we first identify three groups of workers by their status in period 0: Quitters, Trapped, and Stayers. Quitters are workers for whom $p_1(m+\epsilon_0) + C < p_1(m+\epsilon_{\max})$. These workers are able to change jobs prior to the first period. Their outside offer is higher than the sum of their current wage and the separation cost, so they quit. Since we assume that period 1 starts in equilibrium, we assume these workers had already quit and moved and, therefore, start period 1 matched with their most productive firm. As a result, after the negative shock, these workers will accept the wage cut and stay.⁶

Trapped workers are those who fall into the group characterized by $p_1(m+\epsilon_0) < p_1(m+\epsilon_{\max}) < p_1(m+\epsilon_0) + C$. That is, the separation cost prevents these workers from quitting in period 1, but in period 2 they are laid off. They would have been more productive at some other firm, but the real separation cost is greater than the difference in productivity. Facing a wage cut in period 2 and compensation from the firm

⁶ In other words, the set of quitters in periods 1 and 2 is empty. Anyone who would have quit did so before period 1, leaving no quitters for the first and second periods..

for the separation cost, the worker is able to switch jobs at zero cost. He will certainly get laid off and work for his most productive firm. In other words, the trapped workers are also the workers who are laid off (displaced).

“Stayers” are workers characterized by $p_1(m+\epsilon_0) > p_1(m+\epsilon_{\max})$. That is, the worker is matched to the most productive firm in period 0. Through period 1 and period 2, he will not switch jobs. Denote the wage offer from firm 0 at time t as $W_{0t} = p_t(m+\epsilon_0)$, and the highest wage offer from other firms as $V_t = p_t(m + \epsilon_{\max})$.

The expected return to a representative worker is the sum of the expected returns in each state (stayers, trapped, and quitters) times the probability of being in each state. Denote the wages paid with W_{it} (t is the time period 0,1,2 and i represents the firm), and the three states with **a** (quitters) , **b** (trapped) , and **c** (stayers). Since we define ϵ_0 as a random variable with mean zero, probability density function $f(\cdot)$ and cumulative distribution function $F(\cdot)$, it follows for the random variable $\epsilon_{\max} = \max \{\epsilon_1, \epsilon_2, \dots, \epsilon_n\}$, the corresponding CDF and PDF are $F_n(\cdot) = F(\cdot)^n$ and $f_n(\cdot) = nf(\cdot)F(\cdot)^{n-1}$. Algebraic manipulation generates several results that provide the foundation of the model. In Appendix A, we calculate the expected returns to a representative worker in each period.

1.3. Dependence of returns on the parameters (m, A, pt, n)

1.3.1. The average marginal product, m

The parameter m represents the expected value of worker’s marginal productivity in real terms. One way to think about variation in m would be to let m capture regional differences. In this model, it simply shifts the distribution of values in vector v up or down for all $(n+1)$ firms.

Proposition 1 As the average product m increases, **i)** the return to all workers increases and the marginal benefit of a one-unit increase in m is equal to the output price per unit in that period; **ii)** the efficiency loss in period 0 does not change; **iii)** the probability of being laid off is not affected; **iv)** the return to laid-off worker increases; **v)** the probability of being better off given the worker is laid off after the shock is decreasing. This proof and proofs of all subsequent propositions are provided in Appendix B.

1.3.2. The “real value” of the separation cost A

In practice, the separation cost is taken to have a monetary value. Workers care about the real, rather than the nominal, value of this separation cost. Therefore, we perform the analysis using the real value of the separation cost, which is the nominal value of the separation cost divided by the price level.

Proposition 2 When the real separation cost A increases, **i)** the return to the worker decreases when the separation cost exists (in period 1); **ii)** the return to the worker does not change when firm 0 pays the separation cost to the worker; **iii)** the efficiency loss increases; **iv)** the probability of being laid off increases; **v)** the probability of being better off given the worker is laid off increases.

Together, parts i, ii, and iii of Proposition 2 illustrate the inefficiency introduced by the separation cost. The separation cost makes workers worse off, but the payment to the workers by the firm effectively compensates the workers for the loss. This is consistent with the widespread practice, legally mandated and otherwise, of severance payments. Nevertheless, as the cost increases, the efficiency loss increases.

Together, results iii, iv, and v of proposition 2 illustrate the inefficiency introduced by the separation cost. The presence of the separation cost reduces the worker's incentive to correct bad matches on their own: workers are less likely to quit. Furthermore, it increases the probability of layoffs, which are more likely as match quality falls, and increases the probability that workers are better off after being laid off.

1.3.3. The product prices before and after shocks: p_1 and p_2

Proposition 3.a. As the product price increases **i)** the return to the worker in respective period increases; **ii)** the efficiency loss increases in period 0; **iii)** the probability of being laid off does not change; **iv)** the return to the laid-off worker increases.

Proposition 3.b. **i)** As the pre-shock product price p_1 increases, the probability of being better off given the worker is laid off decreases; **ii)** As the post-shock product price p_2 falls (that is, the shock is more severe), the probability of being better off given the worker is laid off falls.

Part i) and ii) of Proposition 3.b are two sides of the same coin: the greater (the more negative) the price shock is, the more likely that the laid-off worker is going to be worse off. This is a very intuitive result that illustrates how the post-displacement experience depends on economic conditions.

1.3.4. The number of firms in the market, n

The amount of economic activity at one place may be characterized by the number of firms, n . In a model of imperfect labor market competition (e.g. Stevens

1994), the number of firms plays a very important role. When there is only one firm, the firm has monopsony power over wages. As the number of firms increases, so does labor market competition, and the power that any given firm has over wages falls. This competition causes wages to increase as the number of firms increases.

Proposition 4.a. As the number of firms in the industry n increases, the returns to the worker increase.

If we investigate the wage an average worker will get in the industry at place j , then it seems that the amount of economic activity (the number of firms) matters in the sense that increasing the number of firms will increase the worker's pay. If we study the laid off group, however, many things are unclear. Specifically, the direct effects (derivatives) with respect to n are difficult to sign. We can, however, determine the signs of the second derivatives: the effects of the other exogenous variables on the effect that n has on our endogenous variables.

Proposition 4.b The marginal returns on n to X and \Pr [layoff] decreases in A for n sufficiently large.

Proposition 4.c As $n \rightarrow +\infty$, **i)** For A that is greater than the range of the random variable ϵ_1 , the efficiency loss approaches some fixed positive value and the probability of being laid off approaches 1; **ii)** For A that is less than the range of the support of the random variable, the efficiency loss and the probability that the worker gets laid off

approach some fixed value depending on $F(\cdot)$ and A . Furthermore, $\frac{d}{dA} \lim_{n \rightarrow +\infty} \Pr[\text{layoff}] > 0$

and $\frac{d}{dA} \lim_{n \rightarrow +\infty} X > 0$.

Proposition 4.d There exists a $N \in \mathbb{N}$ such that $\frac{\partial \Pr[\text{layoff}]}{\partial n} < 0$ and $\frac{\partial X}{\partial n} < 0$ when $n > N$.

The intuition behind this result is that increasing the number of firms will increase the probability that the worker is well-matched initially. The main implication of this result would be seen in cross-country comparisons, as adjustment costs would likely be similar within a given country. Conditional on the same shock, countries with higher adjustment costs may be more likely to experience layoffs in areas with greater economic activity.⁷

1.1.4. One Curious Result: Higher Post-Displacement Wages

One curious result of the model is the possibility that workers may get higher wages when they are re-employed after being displaced. The worker in a particular industry at certain place is better off after the negative shock if and only if $R_2 > R_1$ because we use the wage (represented here as R) as the sole measure of the worker's welfare.⁸ The condition $R_2 > R_1$ is equivalent to

$$p_1 \left\{ (m+1) - \int_{-1}^1 F(y) F_n(y+A) dy \right\} < p_2 \left\{ (m+1) - \int_{-1}^1 F(y) F_n(y) dy \right\}$$

⁷ This may be universally true, but we later show that this certainly holds in Mexico.

⁸ There are two important points to make about this assumption. First, we fully recognize that we are not measuring utility and, therefore, we may be missing factors for which there may be compensating differentials. Second, however, most studies in this literature use the wage as at least the primary, if not the only, measure of worker well-being. In other words, our problematic use of the wage as a measure of worker well-being is consistent with the literature.

$$p_2 > p_1 \frac{(m+1) - \int_{-1}^1 F(y)F_n(y+A)dy}{(m+1) - \int_{-1}^1 F(y)F_n(y)dy}$$

$$\text{Let } \omega = \frac{(m+1) - \int_{-1}^1 F(y)F_n(y+A)dy}{(m+1) - \int_{-1}^1 F(y)F_n(y)dy} \text{ and we know that } 0 \leq \omega \leq 1.$$

We therefore know that whether or not the worker is better off or worse off depends on how bad the negative price shock is. As long as p_2 is above ωp_1 , the worker is actually going to be better off. As ω increases, the worker is more vulnerable to negative price shock. In other words, if the price shock affects all firms, and it is not too large, then the chance that the worker will be better off after moving is higher. The intuition for this is also straightforward: a worker is more likely to be able to find a firm paying higher wages if the other firms did not experience "too great" of a price shock.

Proposition 5 Let $\omega(m, A, n)$ represent the vulnerability in response to negative shocks.

Then the following conditions hold:

- i) $\frac{\partial \omega}{\partial m} > 0$, $\frac{\partial^2 \omega}{\partial m^2} < 0$, $\frac{\partial^2 \omega}{\partial m \partial A} > 0$, and
- ii) $\frac{\partial \omega}{\partial A} < 0$, $\frac{\partial^2 \omega}{\partial A \partial m} > 0$.

In places where the workers' productivity (m) is high, the workers are more vulnerable to price shocks. The intuition behind this is simply that high-wage workers have more to lose from being displaced. On the other hand, in places where the separation cost is high, the workers are less vulnerable to negative price shocks. In other

words, higher adjustment costs mitigate the risk of economic fluctuations for workers at the cost of economic efficiency.

1.5. Implications of firm-specific price shock

Davis, Haltiwanger, and Schuh (1996) show that, during both bad and good times, firms are constantly expanding and contracting. Up to this point we have assumed that a given price shock affects all firms because all firms charge the same price in the output market. If there is variation in firm-specific prices, then firms may be susceptible to firm-specific price shocks. Examples include deals that are made or fail or even very specific trade agreements that affect prices of a very limited number of firms within broadly-defined industries. In this case, the output price that firm i charges at time t can be represented as $p_{t,i} = F(\tau_t, u_t, \sigma_i)$ where σ_i is firm-specific shock that affects firm i . $p_{t,i} = \pi_t + \pi_i$ where π_t is the economy and industry wide component and π_i is the firm specific shock. We now consider a particular example in which

(i) $\Delta\pi_t = 0$ and $\Delta\pi_i < 0$ for firm 0 ; and

(ii) $\Delta\pi_j = 0$ for all other firms $j \neq i$.

In these conditions, firm 0 gets a negative firm specific shock that results in the fall of the price of its output from p_1 to p_2 , while all the other firms can still sell their product at the price p_1 . Only firm 0 will lower its worker's wages to the new level $p_2(m + \epsilon_0)$ while all the other firms pay worker at the same rate as before. Then the worker in firm 0 will stay as long as $p_2(m + \epsilon_i) > p_1(m + \epsilon_{\max})$, and they will be laid off only if $p_2(m + \epsilon_i) < p_1(m + \epsilon_{\max})$. In this case, people in condition **b** will definitely be better off

because they get paid at $p_1(m + \epsilon_{\max})$ instead of $p_2(m + \epsilon_i)$ or $p_1(m + \epsilon_i)$. People in condition c , however, will vary. Some of them will choose to be laid off while others will accept the new wage and stay. The condition for workers in group c to be laid off is $p_2(m + \epsilon_0) < p_1(m + \epsilon_{\max}) < p_1(m + \epsilon_i)$. For this sub-group, before the price falls, the worker already works for the firm where they had the highest productivity (firm 0). After the shock, they work for a firm in which they had the second highest productivity but highest marginal revenue product (productivity times price). As a result, they will be worse off than before they were laid off, and better off than if they had experienced an industry-wide shock. Therefore, wages of displaced workers will depend on the comparison group. Wages should be higher when compared to workers who stay in displacing firms than when compared with workers in non-displacing firms.

Displaced workers are better off iff

$$p_1(m + \epsilon_{\max}) < p_1(m + \epsilon_i) + C, \text{ and (ii) } p_2(m + \epsilon_i) < p_1(m + \epsilon_{\max}).$$

The probability that the worker gets laid off given the shock is firm specific:

$$\begin{aligned} \Pr[\text{layoff} \mid \text{Firm-Specific}] &= \iint_{x+A > y > \frac{p_2}{p_1}x - \frac{p_1 - p_2}{p_1}m} f(x)f_n(y)dx dy \\ &= \int_{-1}^1 f(x) \left\{ F_n(x+A) - F_n\left(\frac{p_2}{p_1}x - \frac{p_1 - p_2}{p_1}m\right) \right\} dx \end{aligned}$$

Since $\Pr[\text{layoff} \mid \text{industry-wide}] = \int_{-1}^1 f(x) \{F_n(x+A) - F_n(x)\} dx$, it follows that

$\Pr[\text{layoff} \mid \text{Firm-Specific shock}] > \Pr[\text{layoff} \mid \text{industry-wide shock}]$. As a result, the negative firm-specific price shock will create a larger scale, but less frustrating, layoff than the negative industry-wide price shock. In other words, if workers are in a region in which overall economic conditions are good, but their particular firm experiences a

negative shock, then they are much more likely to experience positive post-displacement wages.

1.6. Plant Closings

Roberts (1996) describes patterns of producer turnover, suggesting the importance of focusing on plant closings. In Sections 1.1 through 1.5, we assume that before and after the negative price shock, no firms close down. That analysis is important because it helps us to focus on the role of separation cost and general economic conditions. In reality, however, facing severe economic hardships, firms shut down. That means in period 2, the number of firms falls from n to n' . If there is no shock, the wage the worker should have been paid is

$$R' = p_1(m+1 - \int_{-1}^1 F(y)F_n(y+A)dy)$$

It follows immediately from previous steps that $\frac{\partial R'}{\partial P} > 0$, $\frac{\partial R'}{\partial A} < 0$ and $\frac{\partial R'}{\partial n} > 0$. If P , A ,

and n change simultaneously, then $dR' = \frac{\partial R'}{\partial P} dp + \frac{\partial R'}{\partial A} dA + \frac{\partial R'}{\partial n} dn$.⁹

Since $n' < n$, then $\frac{\partial R'}{\partial n} dn = \frac{\partial R'}{\partial n} (n' - n) < 0$. As a result, in bad years or severe localized

shocks (with many plant closings), workers are more likely to be worse off. This is intuitive and consistent with Jacobson et al. (1992a,b).

Another approach would be to use notation similar to that used in Section 1.2.

Facing decline in number of firms from n to n' , the worker is better off iff

⁹ Where $dA = -A$. From period 1 to period 2, separation cost is compensated by means of severance payment. So separation cost decreases from A to 0.

$p_1\{(m+1) - \int_{-1}^1 F(y)F_n(y+A)dy\} < p_2\{(m+1) - \int_{-1}^1 F(y)F_{n'}(y)dy\}$, which implies

$$p_2 > p_1 \frac{(m+1) - \int_{-1}^1 F(y)F_n(y+A)dy}{(m+1) - \int_{-1}^1 F(y)F_{n'}(y)dy}.$$

Let $\bar{\omega} = \frac{(m+1) - \int_{-1}^1 F(y)F_n(y+A)dy}{(m+1) - \int_{-1}^1 F(y)F_{n'}(y)dy}$. We know that $0 \leq \bar{\omega} \leq 1$. Then,

$$\frac{\partial \bar{\omega}}{\partial n'} = \int_{-1}^1 F(y) * \log(F(y)) * F_{n'}(y)dy * \frac{(m+1) - \int_{-1}^1 F(y)F_n(y+A)dy}{[(m+1) - \int_{-1}^1 F(y)F_{n'}(y)dy]^2} < 0.$$

As n' decreases, then $\bar{\omega}$ increases and the worker is more vulnerable to the price shocks.

This model has several predictions. First, differences in economic conditions should generate differences in post-displacement wage experiences. These differences include smaller wage losses when unemployment is low and when there are more firms competing for workers (areas of greater economic activity). In the next section, we describe the dataset that we will use to examine both the pattern of job and worker flows and post-displacement wage experiences.

2. A Job- and Worker-Flows Data Set for Mexico

This section describes the source of the data used in this paper. These administrative data allow us to link workers with firms over time and thereby allow us to decompose the sources of volatility for Mexico.

2.1 The Raw Data

The raw data come from the Mexican Social Security Institute (*Instituto Mexicano del Seguro Social*, or *IMSS*), which is the agency that manages the social-

security accounts for all private-sector tax-registered workers in Mexico. Since filing with the IMSS has been used as a criterion for formal sector participation,¹⁰ the data can be thought of as a census of formal-sector establishments in the private sector.¹¹ The IMSS uses its own 4-digit industry classification system consisting of 271 separate industries that span all economic activity in the formal sector. Unfortunately, if an employee leaves the formal (tax-registered) sector, we are unable to observe if the employee becomes unemployed or finds a job in the informal sector.

Individual records in the raw data contain an identifying number for the person, an identifying code for the establishment, the daily wage, the date when the information of this record became valid, and the date when the information stopped being valid. If the worker leaves the establishment, the old record is closed. If the worker's salary changes, the old record is closed and a new record is opened with the updated wage information but with the same identifier for the establishment. Importantly, we have both an establishment identifier and a person identifier that are consistently coded over time. Our first step was to convert this information into annual information. We chose September 30 as the date for which we would extract the relevant information each year from 1985 to 2006.

For each September 30 of the 21 years for which we have data, we selected the records that were applicable to the particular date. If a person had two apparently applicable records from the same establishment, we chose the record with the later start date. If a person had two applicable records from different establishments, we assumed the person really was working in both establishments. We only selected workers with

¹⁰ For example, see Roberts (1991) or Marcouiller, Ruiz de Castilla, and Woodruff (1997).

¹¹ See Maloney (2004) for an excellent analysis of the informal sector.

strictly positive wages. This restriction mainly excludes students from the database, many of whom are insured by the IMSS although they are not really employees.

The files mentioned above include wage and employment histories of all workers registered with the IMSS. The files also contain the age and gender for nearly all workers. We also merged in industry and location information of the establishment using separate files provided by the IMSS. The match rate was nearly 100%.

Our data represent all sectors of the Mexican economy, but, as an additional check, we also compared our 1993 average employment in manufacturing with the 1993 average total employment in the 1993 Mexican Industrial Census. One would expect the majority of employees in manufacturing to be formally registered, implying that manufacturing employment registered with the IMSS should be similar to manufacturing employment recorded in a manufacturing census. Our 1993 manufacturing employment is 2,836,277 and the 1993 Census manufacturing employment is 3,246,039, suggesting that our data cover about 87.4% of total manufacturing employment. Based on these comparisons, we believe that our data are reliable.

2.2 Methodology

We now turn to our methodology for studying job and worker flows. To facilitate comparison with the developed countries that dominate the existing literature, we use established definitions of both job flows and worker flows (e.g. Davis and Haltiwanger 1992). We begin with the methodology for our worker-flows statistics. When an establishment hires a new employee, we refer to this event as an accession. For a given year, we define the accession percentage according to the following formula

$$accper_t = 200 * \left(\frac{\sum_j acc_{j,t}}{\sum_j empl_{j,t} + \sum_j empl_{j,t-1}} \right)$$

where $acc_{j,t}$ is the number of employees in establishment j in year t who were not working in establishment j in year $t-1$, $empl_{j,t}$ is the number of employees of establishment j in year t , and $empl_{j,t-1}$ is the number of employees of establishment j in year $t-1$. Similarly we define the separation percentage as

$$sepper_t = 200 * \left(\frac{\sum_j sep_{j,t}}{\sum_j empl_{j,t} + \sum_j empl_{j,t-1}} \right),$$

where $sep_{j,t}$ is the number of employees in establishment j in year $t-1$ who were not working in establishment j in year t . It is now natural to define the net-growth percentage in employment, which is simply

$$netper_t = accper_t - sepper_t.$$

Our two statistics on worker flows, $accper_t$ and $sepper_t$ give us information of reallocations of people within and across establishments. As we mentioned in the introduction, however, it is also common to examine reallocations of jobs across establishments.¹² Job flows statistics give us information about establishment-level changes in employment without taking into consideration the identities of the employees. For example, consider an establishment in which five employees have left since the last year and were replaced by five new employees. We would say that this establishment experienced worker flows in the form of five accessions and five separations. Since total

¹² Most of the work in the literature focuses on job flows due to data constraints.

employment has not changed, however, we would say that the establishment neither created nor destroyed jobs.

More precisely, define net employment growth in establishment j and period t as

$$net_{j,t} = empl_{j,t} - empl_{j,t-1}.$$

Now denote job creation in establishment j and period t as

$$pos_{j,t} = \max(0, net_{j,t})$$

and denote job destruction in establishment j and period t as

$$neg_{j,t} = \max(0, -net_{j,t}).$$

We can now define the job-creation percentage and job-destruction percentage in period t as

$$posper_t = 200 * \left(\frac{\sum_j pos_{j,t}}{\sum_j empl_{j,t} + \sum_j empl_{j,t-1}} \right) \text{ and}$$

$$negper_t = 200 * \left(\frac{\sum_j neg_{j,t}}{\sum_j empl_{j,t} + \sum_j empl_{j,t-1}} \right)$$

respectively.

It should be clear that statistics on job flows and statistics on worker flows are related. If an establishment increases its total employment by one, at least one current employee must be new. If an establishment reduces its total employment by one, at least one employee must have left. In this sense, statistics of job flows give us a lower bound on our worker-flows statistics.

Along these lines, we will now explain our decomposition of worker flows into two components: the component explained by job flows and the “excess” component.

First, we will define the sum of worker flows

$$sumwf_t = accper_t + sepper_t$$

as our summary measure of worker flows. Similarly, we will define our summary measure of job flows as

$$sumjf_t = posper_t + negper_t.$$

As we mentioned earlier, the sum of job flows ($sumjf_t$) can be thought of as a component of worker flows ($sumwf_t$). Our definition of “excess” worker flows will simply be

$$excwf_t = sumwf_t - sumjf_t.$$

In words, excess worker flows are the worker flows not accounted for by job flows.

One common practice in the literature on job flows is to separate jobs created by births (establishments that had zero employment in the previous year) from jobs created by expansions (establishments that had positive employment in the previous year and expanded). Similarly, it is common to distinguish jobs destroyed by deaths (establishments whose employment fell to zero) from jobs destroyed by contractions (establishments that reduced employment but continue to employ at least one employee). Our data are particularly well suited for studying births and deaths because we observe all establishments, no matter how small they are. We do not, for example, only observe establishments only when they cross some employment-size threshold.

It is also common to decompose the sum of job creation and destruction ($sumjf_t$) into an aggregate component, an industry component, and an idiosyncratic component.

In our data, however, we find that the industry-level changes in employment at any level

of aggregation explain a small fraction of gross employment flows. Therefore, we do not present these results here. Instead, they are available from the authors upon request.

3. Job and Worker Flow Results

3.1 Labor Market Characteristics and Macroeconomic Conditions

The model presented in Section 1 illustrated how an adjustment cost would affect various aspects of the labor market. The working hypothesis in this paper is that worker-side adjustment costs are significant in Mexico. One piece of evidence that is consistent with this hypothesis is the share of total separations that are voluntary. In 2000, the Bureau of Labor Statistics started the Job Earnings and Labor Turnover Survey (JOLTS). This survey tracks separations and sorts them into "voluntary" (including quits) and "involuntary" separations (such as layoffs). This terminology matches that used in the model in section 1. The average share of voluntary separations (of total separations) in the U.S. data over the 2000-2009 period was 54% (with 40% of separations being involuntary). Mexican data paint a very different picture. The *Encuesta Nacional de Empleo Urbano* (National Urban Employment Survey) also asks if a separation was voluntary or involuntary. The average share of voluntary separations from that survey over the available 1987-2001 period is 20% (with 52% of separations being involuntary). In other words, Mexicans are much less likely to separate voluntarily than in the United States, which is consistent with proposition 2.

The model also suggests differences across macroeconomic conditions. We therefore employ data that cover a period of changing policy, crisis, and recovery. To provide macroeconomic context, Figures 1a, 1b, and 1c contain the Mexican

unemployment rate (for three major cities), the monthly change in the Mexican consumer price index, and the standard deviation of prices (across goods), respectively.

While these three variables describe slightly different aspects of the Mexican economy, they clearly tell similar stories. The most immediately obvious is the severe recession that occurred with the December 1994 peso crisis. Prior to the crisis, growth was relatively robust and inflation, whose annual rate reached well over 100 per cent in 1988, was coming under control. With the contraction of GDP came a sharp devaluation of the peso (shown as an increase in the peso/dollar exchange rate), a rise in unemployment, and an increase in inflation. The economy recovered until the turn of the century, when another economic slowdown becomes apparent. Unemployment rises again in 2001-2002.

Differences in unemployment across regions are consistent with the model's prediction that areas with more economic activity. Proposition 4 suggests that countries with higher adjustment costs may be more likely to experience layoffs in areas of greater economic activity. This is certainly consistent with Figure 1a. Mexico City, home to roughly 20% of Mexico's population, has historically been the primary center of economic activity. The peso crisis had a much larger effect in Mexico City than other areas of the country.

3.2 Magnitude of Job and Worker Flows in Mexico

Table 1 presents all of the statistics on worker flows and job flows discussed in the methodology section for each year 1986-2006. Table 1 is the central table of our paper and we will discuss its implications quite thoroughly. Table 1 contains twelve columns that are grouped and numbered. Several of the columns are algebraically

related. Column 1, net employment growth, is equal to the sum of columns 2 and 3. Column 1 is the difference between jobs created (column 7) and destroyed (column 10). Furthermore, the sum of accessions and separations (column 4) can be decomposed as the sum of job creation and destruction (column 11) and excess worker flows (column 12).

Job flows in Mexico on average appear to be higher than job flows in the U.S., although both job creation and job destruction are somewhat higher in Mexico. For example, using data from West Virginia, Spletzer (2000), finds an annual job-creation percentage of 15.8%, which is lower than the 20.2% average we observe in our data (column 7). On the other hand, however, Spletzer reports an annual job-destruction percentage of 14.4%, which is only slightly lower than our average of 14.9%.

Davis et al. (1996) cover the period 1973-1988. If we compare their results to our Mexican results, we again find that both job creation and job destruction are higher in Mexico. Table 2.1 from Davis et al. (1996) allows us to directly compare five statistics: job destruction, job creation, job reallocation, excess flows, and net growth percentage. The averages from Davis et al.'s Table 2.1 are shown in the last row of Table 1. In each case the Mexican flows are considerably higher than the comparable U.S. measure. In particular, excess flows in Mexico are more than twice those in the United States. Of course, it is important to mention the possibility that the difference in time period, rather than differences in the labor market structures of each country, could explain the difference.

If we restrict the sample to manufacturing establishments, we get an average job-creation percentage of 16.4%, substantially higher than the figure of 9.2% from Davis and Haltiwanger. The average figure for job destruction in Mexico is 12.8%, marginally

higher than the 11.3% from Davis and Haltiwanger (1992). Tables analogous to Table 1 calculated separately for the manufacturing and non-manufacturing sectors are available upon request.

As in Hamermesh et al. (1996) and Abowd et al. (1999), we find that a substantial share of worker flows cannot be accounted for by job flows. As described in the previous section, we can summarize worker flows by using the sum of the accession percentage and the separation percentage. The average of this statistic in our data is 71.2% (column 4). We can similarly summarize job flows by using the sum of the percent of jobs created and the percent of jobs destroyed. The average of this statistic in our data is 35.1% (column 11). Job flows therefore account for slightly less than half of total worker flows.

3.3 Regional Differences in Job and Worker Flows across Mexico

Regional differences persist in Mexico. Haltiwanger et al. (2004) link job flows and adjustment to international integration (liberalization), and Hanson (1998) links regional variation with international integration in Mexico. One way to compare regional differences in employment dynamics is to compare the ratio of job flows statistics from different regions of Mexico. Possibly the most striking contrast within Mexico is between the Border region and the rest of Mexico. For the sake of comparison, we calculated the same statistics shown in Table 1 for each of four Mexican regions: Border, North, Center, and South. Table 2 contains the ratio of four of these statistics for the Border and Center regions. The last row shows the average values taken across the years shown in the other rows.

The main message from Table 2 is that regional differences emerge in some, but not all, of the job flows statistics. While the net job percentage and the birth percentage are, on average, higher in the border region, the accession and separation percentage, on average, are nearly identical. These statistics will be explored in more detail in future versions of the paper.

3.4 Changes over time: Recession, Recovery, and Reform

The period we study encompasses several important reforms, policies, and economic events in Mexico. Mexico joined the General Agreement on Tariffs and Trade on January 1, 1986 and implemented deep tariff cuts. A peso devaluation in 1987 was followed by an economic "Solidarity Pact" that effectively reduced inflation from over 100% per year. Foreign investment laws were liberalized in 1988, 1989, and 1990 and the new laws induced a rapid inflow of foreign capital. In 1990, Mexico announced it was pursuing a free trade agreement with the United States (with Canada to join the negotiations soon thereafter). The North American Free Trade Agreement was signed in 1992 and went into effect in January 1994. The peso crashed in December 1994 and was followed by a very deep, but relatively brief, recession that was followed by a four-year recovery. We consider our results in the context of these changes.

It is interesting to note that the pace of job flows and worker flows has been increasing over time, although not in a linear fashion. From roughly 1986-1990, the pace of worker flows was accelerating. In fact, both the accession percentage and the separation percentage increased from 1988 to 1989, and again from 1989 to 1990. The pace of job flows was fairly flat over this period, which highlights the importance of observing worker flows, which are a more complete measure of reallocations than job

flows.¹³ The timing of these accelerations in worker flows is consistent with the hypothesis that inflows of foreign capital and the implementation of GATT led to an increase in worker turnover.

The economic crisis of 1995 looks like a fairly calm period in terms of worker flows. Although the net growth was -4.6% in 1995 compared with 2.0% in 1994, the separation percentage barely changed. Almost all of the change in the net-growth percentage came from a reduction in the accession percentage. Once again the results using job flows are not as stark as the results using worker flows, although the job-creation percentage did fall more than the job destruction rose from 1994 to 1995.

The period of 1997-2001 is the most active period in terms of job flows and worker flows. One way to see this is by a series of comparisons. When one compares two years with similar net percent changes in employment, one finds that both the accession rate and the separation rate are higher in the more recent year. One finds similar results for the percent of jobs created and the percent of jobs destroyed when making these comparisons.

We also note that the accession percentage, the separation percentage, the percent of jobs created, and the percent of jobs destroyed were all higher in 1997 compared to the year 1996. We observe this same increase in all of our measures of reallocation from the year 2000 to 2001. Finally we note that the sum of the accession percentage and the separation percentage attained its two highest values in the last two years of our data (2000 and 2001). The same is true for the sum of the percent of jobs created and the

¹³ It is worth noting that both the job-creation percentage and the job-destruction percentage rose from 1989 to 1990.

percent of jobs destroyed. It seems quite clear that labor reallocations have been accelerating in recent years.

Why have labor reallocations been so high in recent years? There are at least three possible explanations. The first is that NAFTA has a bigger and bigger impact each year and that the economy is adjusting to the more open trade environment. Robertson (2007) suggests that NAFTA may have induced a fundamental restructuring in the Mexican economy by bringing Mexico into the North American supply chain. While the border region may have already been integrated through the Maquiladora industry, NAFTA allowed all of Mexico to participate in Maquiladora-type production arrangements.

Another hypothesis worth considering is that the 1997 pension reform (reform of the IMSS) reduced labor-market rigidities. The 1997 reform reduced the quotas that firms and workers had to pay to become registered with the IMSS. This change was designed to encourage the formalization of the Mexican workforce by lowering the costs of formalization. While a formal analysis of these effects is beyond the scope of this paper, it is worth noting that the acceleration in worker flows apparently began in 1997, just as the reform was implemented.

A third possibility is that the frequency of price shocks hitting firms increased. Figure 1c shows the standard deviation of product prices taken across products and cities within each month in Mexico. There is a clear increase in the standard deviation over this period, which is a common result from high inflation. The model presented in section 1 shows that prices are a driving force behind wage and employment changes. To the extent that these price shocks became larger or more frequent, it may not be surprising that labor market volatility increased as well.

In any case, the result that both worker flows and job flows have been accelerating in recent years is complemented by other work as well. Castellanos, García-Verdú, and Kaplan (2004) show that the percent of workers with nominal-wage freezes has been declining dramatically in recent years, while both nominal-wage increases and nominal-wage decreases have been increasing. Budar-Mejía and García-Verdú (2003) estimate the probabilities that a worker moves from the formal sector to the informal sector and vice versa. They find that both probabilities have been increasing over time, that is, that transitions from the formal sector to the informal sector are becoming more common as are transitions from the informal sector to the formal sector. The results from the two papers above, combined with the results on worker flows and job flows in the present paper, paint a clear picture. The labor market in Mexico has become more dynamic in recent years.

4. The Effects of Displacement on Wages

Both the model and previous literature suggest that the effects of displacement on wages varies across region and time period. Kaplan et al. (1995) illustrate how post-displacement wages vary across time (using displacement samples from 1995, 1996, and 1997) and space (using four different regions in Mexico). Here extend those results by looking at two different displacement periods: 1999 and 2001. There are three reasons why we are interested in extending the results for these two periods. First, the pre-displacement periods is characterized by higher-than-average market churning, changes in regulations, and price shocks. Second, the displacement period 2001 is characterized by a U.S. recession and rising unemployment in Mexico. Third, one of the significant concerns in Mexico about trade liberalization was regional differences. Specifically, the

liberalization was believed to favor the South relative to the Border. Looking at regional differences in post-displacement wages 5-7 years after NAFTA went into effect may help explain some of those concerns.

Table 3 presents the summary statistics for the 2001 displacement sample. The “Control” group includes a random 20% sample of all workers who have been in the same non-contracting firm every period in the sample. The “Displacement” group includes workers that were in displacing firms every quarter from the beginning of the sample until the second quarter of 2001. Table 3 shows the relatively significant effects of displacement in agriculture. Manufacturing is also significantly represented in the displacement sample. Table 3 also contains a regional breakdown. The majority of the displaced workers come from the two relatively poor regions: North and South. The fewest come from Mexico’s most dynamic region: the U.S.-Mexican border states.

4.1 Methodology

To maximize comparability with studies in developed countries, we employ the methodological "gold standard" established by Jacobson et al. (1993 a,b). We first define displacement indicators D_{jit} which equals 1 if the worker separates from a displacing firm (0 otherwise) in order to compare the wages of displaced workers with all other workers. After these initial results are presented below, we redefine the displacement indicator to identify workers in each of three groups ($j = 1,2,3$). The first variable takes on the values of 1 for workers who are not in displacing firms, and zero otherwise (group A). The second takes on a value of 1 for workers in displacing firms but remain with the same firm, and zero otherwise (group B). The third variable takes on a value of one if the workers leave firms that contract more than 30% in the quarter when the separated (i.e.

are in one of the "C" samples) but remain in the sample (that is, they do not become unemployed). We begin with the following specification.

$$w_{it} = a_i + \gamma_t + \mathbf{x}_{it}\beta + \sum_j \vartheta_j D_{jt} + \sum_j \sum_i D_{ji} \gamma_i \delta_{jt} + \varepsilon_{it}. \quad (1)$$

The dependent variable is the natural log of the real wage, which is calculated by adjusting the nominal wages variable by the Mexican national consumer price index using 2002 as the base year. The a_i term captures individual-specific fixed effects that take on a value of 1 for each individual in the sample. The parameter γ_t represents time-specific effects. In each estimated equation we include a dummy variable for each quarter-year. The \mathbf{x}_{it} vector represents other time varying characteristics of workers, which includes age. We also include the indicator for the individual's displacement group status, excluding the workers not in displacing firms as a control group. We then interact the time effects with the displacement group indicators in order to compare wages in each group before and after the displacement event.

By fully interacting displacement status with the time effects (dummy variables for each quarter), we allow the time effects for displaced workers to differ from the time effects for non-displaced workers. These differential time effects are identified off of differences over time in wage changes between displaced workers and non-displaced workers.

4.2 Empirical Results

As mentioned above, we focus on two main displacement samples. Our treatment groups are workers who are displaced between the second and third quarters of 2001 and 1999 but are in the sample in every quarter. This allows us to focus on high-tenure workers.

Figure 2 contains the results for the 2001 displacement sample relative to workers who remain in the same firm (which is not a displacing firm) for every quarter in the sample (the “Control” group) and relative to workers who stay in the displacing firm (“Stayers”). Several interesting results appear. First, the variation in the pre-displacement wages is significant. This variation is unusual in most displacement-wage studies, but is consistent with the increased variance of price shocks that characterize the pre-displacement period. The second interesting characteristic is that wages effectively start to drop around 1999 and there is little evidence of a drop that takes place at the time of displacement.

The third interesting result is that displaced workers do worse relative to both the Control group and those who remain in the displacing firm. This is consistent with the Kaplan et al. (1995) results showing that workers displaced when unemployment is high or rising experience very persistent losses. In fact, Figure 2 show very little, if any, evidence that the displaced workers are on track to recover.

One might consider our restriction of being in the sample in every period to be too strict. Figure 3 shows the comparison with the Control group for displaced workers that are out of the sample at any time for up to four quarters. These workers experience smaller losses, which is consistent with the hypothesis that tenure increases post-displacement wage losses. That said, however, it is important to notice that the post-displacement wage trend is still negative.

We also consider the effects of being displaced between the second and third quarter of 1999. The reason for focusing on this period is that it is in a period of excess price volatility but relatively low unemployment. This difference allows us to possibly

generate some evidence on the difference between firm-specific shocks (from Section 1.5) and economy-wide shocks that were the main focus of the model. The high variance in prices and relatively low unemployment suggest that price shocks might be more likely to be firm-specific in 1999, possibly leading to different displacement experiences. In particular, workers may be more likely to be better off than workers that stay in the struggling firm, but may not be better off than workers who were not displaced at all.

The results are exactly consistent with this prediction. Figure 4 shows the wage effects for workers displaced between the second and third quarter of 1999 relative to both Stayers and the Control group. Workers are much better off than stayers, but worse off than the Control group. In both cases, however, workers have positive post-displacement wage trends, suggesting recovery that was not evident during the period of rising unemployment.

Our last exercise is to consider what happens to workers across regions. Figure 5 shows the post-displacement wage experience for displaced workers relative to the Control group (2001 sample) separated by region. There is a significant amount of pre-displacement variation in wages, but there is a clear pattern in post-displacement wages. Workers in the dynamic border region fare better than workers in the relatively poor “Other” region (that includes both the “North” and “South” regions described in Table 3 and in the “Central” region. This may be a bit surprising for those who believe that the 2001 recession in Mexico was driven by trade linkages with the United States, but is clearly very consistent with the beliefs of those who express concern about regional disparities within Mexico.

5. Conclusions

Using a comprehensive matched firm-worker dataset, this paper documents employment and wage dynamics within Mexico during periods of crisis and adjustment. A very basic model of imperfect competition in the labor market characterized by separation costs generates several predictions about employment dynamics and post displacement wages that find empirical support. The results seem consistent with the presence of a significant separation cost in Mexico.

One extension would be to focus on adjustment specifically due to trade liberalization, following, for example, Clark et al. (1998) and Kletzer (1998). Marcal (2001) analyzes the relevance of Trade Adjustment Assistance for U.S. workers and Mexico, like other developing countries, considers this option.

Understanding the possible role of the separation cost is potentially important for designing optimal labor market policies. One current debate centers on the optimality of unemployment insurance programs in developing countries, where such programs are rare.¹⁴ One possible hypothesis to explore in future work is the potential role that high separation costs may play the optimality of unemployment insurance and other programs designed to alleviate the problems of volatility in developing countries.

¹⁴ Heckman and Páges (2000) is an example of a contribution to this debate in Latin America. Revenga et al. (1994) focus on one program that plays a role similar to UI insurance, and Gonzaga (2003) examines similar phenomena in Brazil.

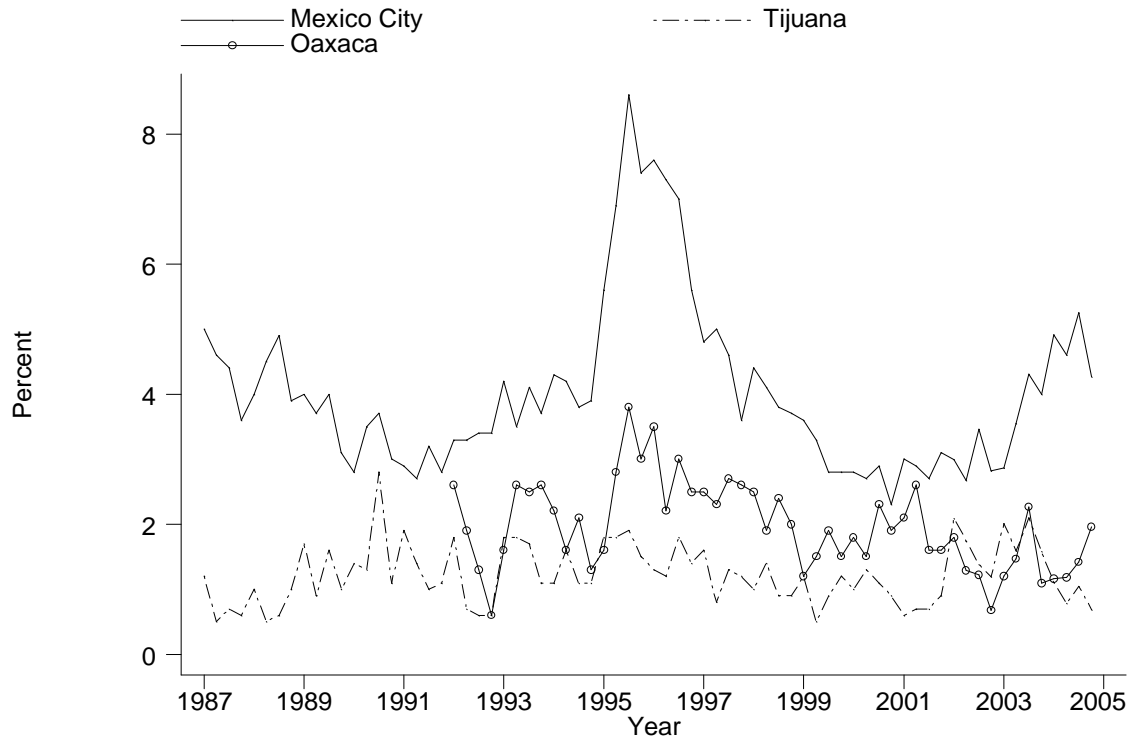
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Figure 1a: Mexican Unemployment



Notes: Open urban unemployment rates. Authors' construction using data from INEGI.

Figure 1b: Mexican Inflation

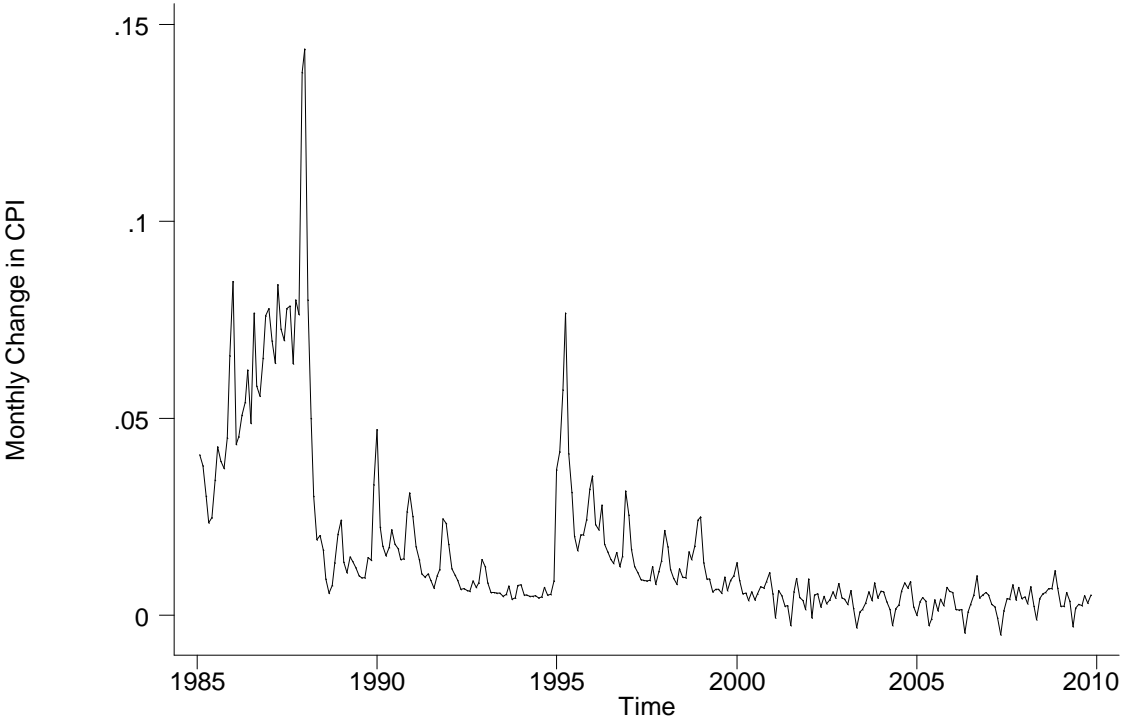
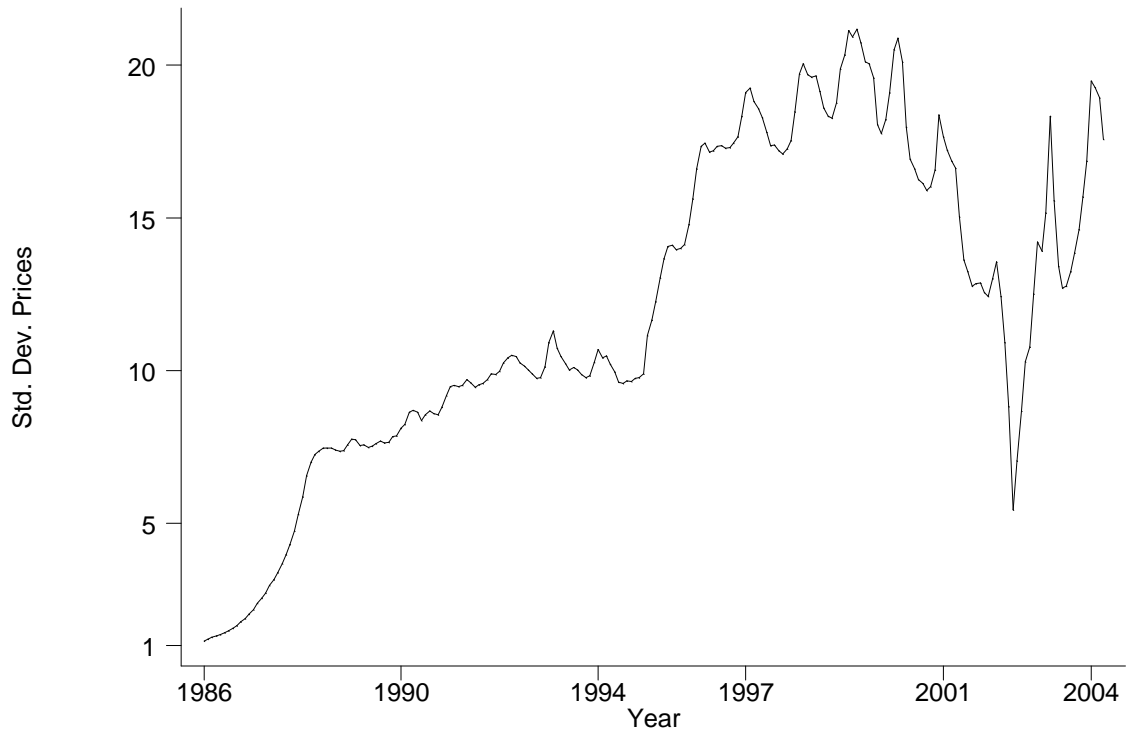
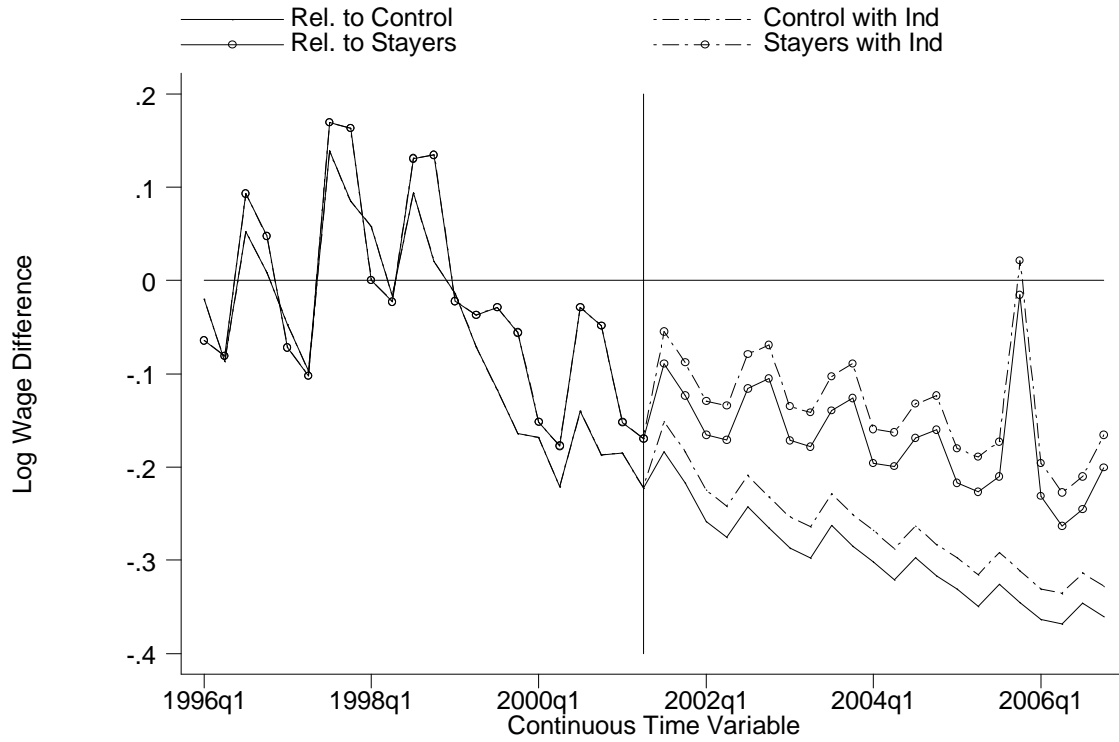


Figure 1c: Standard Deviation of Mexican Price Index



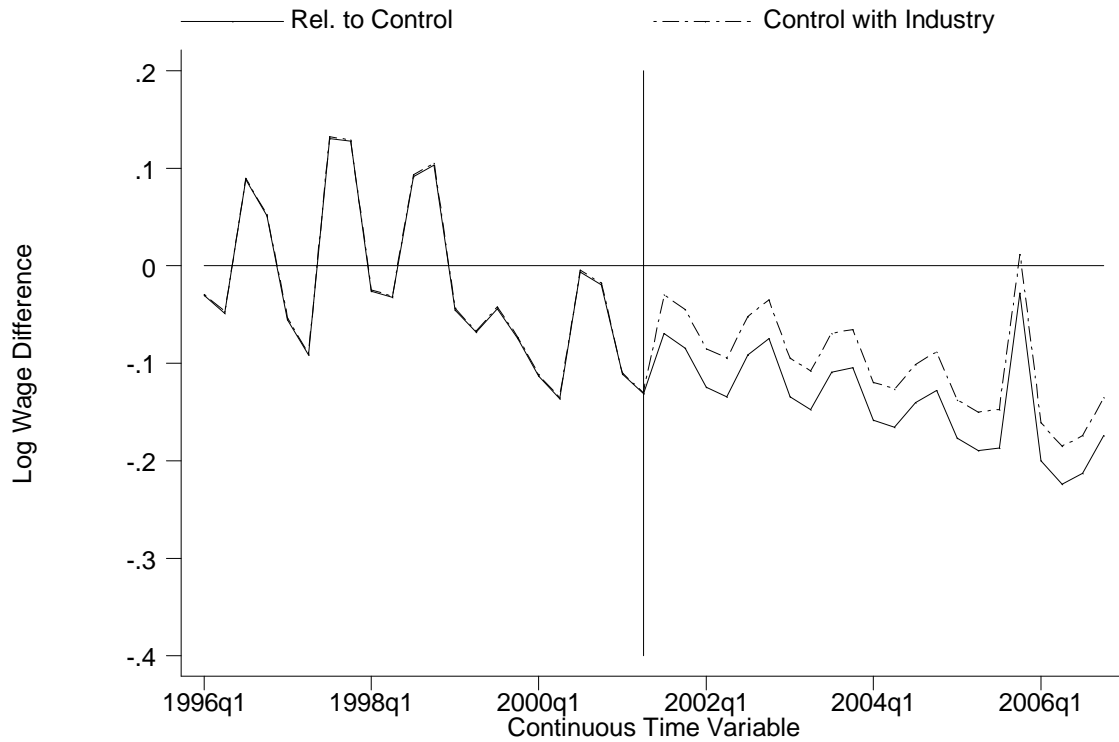
Notes: Calculated as the standard deviation of Mexican price index within each month across all Mexican products and cities. For details about the Mexican price data, see Robertson, Kumar, and Dutkowsky (2009).

Figure 2 2001 Displacement Effects



Notes: Displacement in 2001Q3. The treatment group includes workers in the displacing firm every quarter up to the quarter of displacement, and in the sample (but a different firm) in every quarter until the end of the sample. "Control" represent difference between displaced workers and a 20% random sample of workers who were in the same non-displacing firm in every quarter of the sample.

Figure 3 Displaced workers with less attachment to the formal sector



Notes: Displacement in 2001Q3. Treatment group includes workers who were in the displacing firms until the quarter of displacement and are in different firms after displacement, but may be out of the sample for up to four quarters. "Control" represent difference between displaced workers and a 20% random sample of workers who were in the same non-displacing firm in every quarter of the sample.

Figure 4: 1999 Displacement Sample

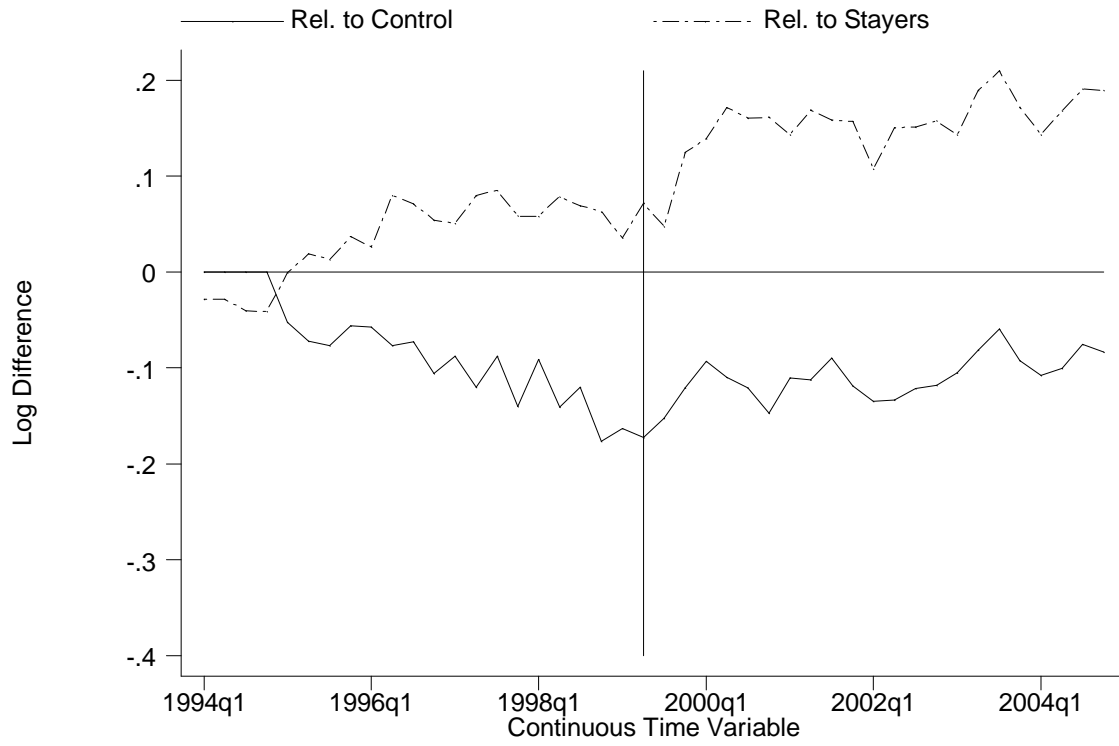


Figure 5: Regional Differences in 2001 Displacement Sample

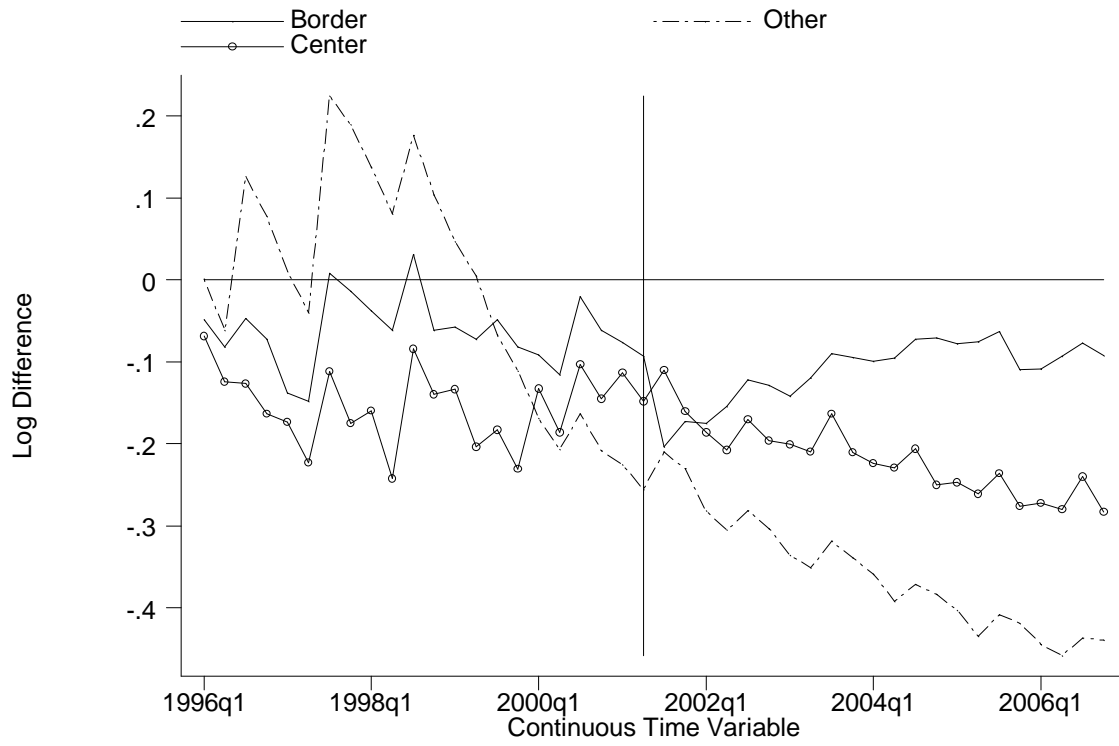


Table 1: Annual Worker Flows and Job Flows from Mexico from 1986 – 2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Year	growth perc (net)	access perc	separ perc	(2)+(3)	births	expans	job creat	deaths	contrs	job destr	job reallocation	excess flows
1986	1.4	24.6	23.2	47.8	4.5	8.5	13.0	3.3	8.3	11.6	24.6	23.2
1987	14.7	35.7	21.0	56.6	7.1	16.3	23.4	3.6	5.2	8.8	32.2	24.4
1988	19.0	39.9	20.9	60.8	7.9	18.8	26.7	3.4	4.3	7.7	34.3	26.5
1989	12.4	40.1	27.8	67.9	7.9	14.6	22.5	4.0	6.1	10.1	32.6	35.3
1990	13.2	43.2	30.0	73.2	10.1	14.5	24.6	4.9	6.5	11.4	36.0	37.2
1991	7.5	41.6	34.1	75.7	9.4	12.4	21.8	5.7	8.5	14.3	36.0	39.7
1992	2.4	39.9	37.5	77.4	8.9	11.0	19.9	6.5	11.0	17.5	37.4	39.9
1993	-1.5	36.8	38.3	75.1	8.1	9.8	17.8	7.6	11.8	19.4	37.2	37.9
1994	2.1	37.1	35.0	72.1	8.3	10.8	19.1	6.8	10.2	17.0	36.1	36.0
1995	-7.5	33.4	40.9	74.4	6.8	10.7	17.4	8.2	16.8	25.0	42.4	32.0
1996	6.9	36.6	29.7	66.3	7.8	12.3	20.1	5.6	7.6	13.2	33.3	33.0
1997	12.2	43.2	31.1	74.3	10.7	14.7	25.5	6.4	6.9	13.3	38.7	35.6
1998	7.6	41.9	34.3	76.3	9.2	13.1	22.4	5.8	9.0	14.8	37.1	39.1
1999	5.5	41.3	35.8	77.2	8.8	11.7	20.4	5.7	9.2	14.9	35.4	41.8
2000	5.6	42.2	36.5	78.7	8.4	11.9	20.3	5.5	9.2	14.7	35.0	43.6
2001	-2.0	38.4	40.4	78.8	8.3	9.7	18.1	6.6	13.4	20.0	38.1	40.7
2002	0.4	37.1	36.7	73.8	7.9	9.8	17.7	6.7	10.6	17.3	35.0	38.8
2003	-0.6	36.2	36.8	73.0	7.9	9.5	17.4	6.9	11.2	18.0	35.4	37.6
2004	2.8	37.0	34.1	71.1	7.8	10.3	18.1	6.1	9.2	15.3	33.4	37.7
2005	3.4	37.4	34.0	71.5	7.8	10.3	18.1	6.0	8.8	14.7	32.9	38.6
2006	4.6	38.6	34.0	72.6	7.9	11.0	18.9	5.6	8.7	14.3	33.2	39.4
mean	5.2	38.2	33.0	71.2	8.2	12.0	20.2	5.8	9.2	14.9	35.1	36.1
US Mean	-1.17						9.11			10.25	19.38	15.40

Notes: Source: Instituto Mexicano del Seguro Social (IMSS). The percent change denominator is the mean employment of the current and previous years. Employment measurements are taken on September 30 of every year. See text for details. Several of the columns are algebraically related. Column 1, net employment growth, is equal to the sum of columns 2 and 3. Column 1 is the difference between jobs created (column 7) and jobs destroyed (column 10). Furthermore, the sum of accessions and separations (column 4) can be decomposed as the sum of job creation and destruction (column 11) and excess worker flows (column 12). The U.S. means are from Table 2.1 from Davis et al. (1996) for 1973-1988.

**Table 2: Border/nonborder Ratios
in Selected Job Flows Statistics**

<u>Year</u>	Births (%)	Access (%)	Separ (%)	Net Growth (%)
1986	0.735	1.074	1.139	0.681
1987	0.803	0.886	1.241	0.703
1988	0.925	1.095	1.143	1.076
1989	0.847	1.074	1.142	1.021
1990	0.910	1.032	1.132	0.950
1991	0.974	1.032	1.140	0.842
1992	0.788	1.016	1.018	1.007
1993	1.364	1.026	1.039	1.198
1994	7.500	1.135	0.935	4.167
1995	0.643	1.078	0.795	0.278
1996	1.392	1.113	0.900	1.609
1997	0.938	0.993	0.984	1.003
1998	1.166	1.016	0.964	1.121
1999	1.358	1.079	0.900	1.681
2000	1.134	1.016	0.967	1.153
2001	0.958	0.837	1.073	8.058
2002	0.542	0.932	1.019	-0.981
2003	2.827	0.854	0.933	7.142
2004	1.740	0.959	0.868	1.552
2005	1.250	0.964	0.924	1.149
2006	0.759	0.947	0.909	1.071
	1.407	1.007	1.008	1.737

**Table 3: Summary Statistics for Displacement Analysis
(2001 Displacement Sample)**

<u>Broad Industry</u>	<u>Control</u>	<u>Displacement</u>	<u>Total</u>
Agriculture	32,126	105,565	137,691
Mining	30,867	400	31,267
Manufacturing	425,855	61,677	487,532
Transport	94,662	695	95,357
Construction	121,236	2,099	123,335
Utilities	259,576	23	259,599
Services	1,217,518	27,507	1,245,025
Total	2,181,840	197,966	2,379,806

<u>Region</u>	<u>Control</u>	<u>Displacement</u>	<u>Total</u>
Border	421,680	14,966	436,646
North	575,568	60,993	636,561
Central	941,520	30,770	972,290
South	243,072	91,237	334,309
Total	2,181,840	197,966	2,379,806

Notes: Border includes Baja California Norte, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas. North includes Baja California Sur, Durango, Sinaloa, Zacatecas, Veracruz (North), San Luis Potosi, Nayarit, Jalisco, Aguascalientes, Guanajuato, Queretaro, and Hidalgo. Center includes Edo. de México, Valle de México, Tlaxcala, Puebla, Morelos, and Mexico City. South includes Campeche, Colima, Chiapas, Guerrero, Michoacan, Oaxaca, Quintana Roo, Tabasco, Veracruz (South), and Yucatán.

Appendix A: Calculating Returns to Workers

:

(1) Return to the worker in period 1:

$$R_1 = E[R_1|\mathbf{a}] * \Pr[\mathbf{a}] + E[R_1|\mathbf{b}] * \Pr[\mathbf{b}] + E[R_1|\mathbf{c}] * \Pr[\mathbf{c}]$$

$$R_1 = E[V_1 - C | \mathbf{a}] * \Pr[\mathbf{a}] + E[W_{01} | \mathbf{b}] * \Pr[\mathbf{b}] + E[W_{01} | \mathbf{c}] * \Pr[\mathbf{c}]$$

$$R_1 = E[V_1 - C | a] \Pr[a] + E[W_{01} | b \cup c] \Pr[b \cup c]$$

Then, applying the appropriate distribution functions generates

Result 1:
$$R_1 = p_1(m+1) - \int_{-1}^1 p_1 F(y) F_n(y+A) dy$$

Next, we calculate the expected returns to a representative worker in period 2.

(2) Return to the worker in period 2:

$$R_2 = E[R_2|\mathbf{a}] * \Pr[\mathbf{a}] + E[R_2|\mathbf{b}] * \Pr[\mathbf{b}] + E[R_2|\mathbf{c}] * \Pr[\mathbf{c}]$$

$$R_2 = E[V_2 | \mathbf{a}] * \Pr[\mathbf{a}] + E[V_2 | \mathbf{b}] * \Pr[\mathbf{b}] + E[W_{02} | \mathbf{c}] * \Pr[\mathbf{c}]$$

$$R_2 = E[V_2 | a \cup b] \Pr[a \cup b] + E[W_{02} | c] \Pr[c]$$

Result 2:
$$R_2 = p_2(m+1) - \int_{-1}^1 p_2 F(y) F_n(y) dy$$

Since a key element of the model is the separation cost, it is helpful to calculate the expected returns to a representative worker in period 1 in the absence of a separation cost.

(3) Return to worker in period 1 if there is no separation cost:

$$I_1 = E[V_1 | \mathbf{a}] * \Pr[\mathbf{a}] + E[V_1 | \mathbf{b}] * \Pr[\mathbf{b}] + E[W_{01} | \mathbf{c}] * \Pr[\mathbf{c}]$$

$$I_1 = E[V_1 | a \cup b] \Pr[a \cup b] + E[W_{01} | c] \Pr[c]$$

Result 3:
$$I_1 = p_1(m+1) - \int_{-1}^1 p_1 F(y) F_n(y) dy$$

Results (1) and (3) can be combined to calculate the efficiency loss due to the separation cost.

(4) Efficiency loss due to the separation cost C: $X = I_1 - R_1$

Result 4:
$$X = I_1 - R_1 = \int_{-1}^1 p_1 F(x) [F_n(x+A) - F_n(x)] dx$$

This efficiency loss will play a key role in the analysis that follows. The subsequent analysis requires two additional key results. The first is the probability of being laid off.

(5) Probability of being laid off: $\Pr[\text{layoff}] = \Pr[b] = \Pr[\epsilon_0 < \epsilon_{\max} < \epsilon_0 + A]$

Result 5:
$$\Pr[\text{layoff}] = \int_{-1}^1 f(x) \{F_n(x+A) - F_n(x)\} dx$$

Result (5) can then be used to calculate the probability that a worker is better off conditional on being laid off.¹⁵

(6) Probability of being better off given the worker is laid off:

$$\Pr[\text{Better-off} | \text{Layoff}] = \frac{\Pr[\text{BetterOff} \& \text{Layoff}]}{\Pr[\text{Layoff}]} = \frac{\Pr[\text{BetterOff} | b]}{\Pr[b]}$$

Condition that worker is better off: $p_1(m + \epsilon_0) < p_2(m + \epsilon_{\max})$.

Then $\Pr[\text{Better-off} | \text{Layoff}] = \frac{\Pr[\text{Better-off} | b]}{\Pr[b]}$, which leads to

Result 6:
$$\Pr[\text{Better-off} | \text{Layoff}] = \frac{\int_{-1}^1 f(x) \{F_n(x+A) - F_n(\frac{p_1}{p_2}x + \frac{p_1 - p_2}{p_2}m)\} dx}{\int_{-1}^1 f(x) \{F_n(x+A) - F_n(x)\} dx}$$

Since we are interested in the change in wages after being laid-off, the last result calculates the return to workers who are laid off.

¹⁵ Alternatively $\Pr[\text{layoff}] = -\int_{-1}^1 F(x) \{\log F(x+A) * F_n(x+A) - \log F(x) * F_n(x)\} dx$

(7) Return to the laid-off workers:

$$E [R_2 | \text{Layoff}] = E [p_2 (m + \epsilon_{\max}) | \text{layoff}] = \frac{E[R_2 | \text{layoff}] \Pr[\text{layoff}]}{\Pr[\text{layoff}]}$$

$$E [R_2 | \text{Layoff}] = \frac{E[R_2 | b] \Pr[b]}{\Pr[b]}.$$

Result 7:
$$R[\text{layoff}] = \frac{\int_{-1}^1 p_2 (m + x) f(x) \{F_n(x+A) - F_n(x)\} dx}{\int_{-1}^1 f(x) \{F_n(x+A) - F_n(x)\} dx}$$

Results 1-7 above provide the foundation of the model. In the next section, we consider how these results vary with the key exogenous variables in the model.

Appendix B: Proofs to Propositions

Proof of Proposition 1:

$$\text{i) } \frac{\partial R_1}{\partial m} = \frac{\partial I_1}{\partial m} = p_1 > 0; \quad \frac{\partial R_2}{\partial m} = p_2 > 0;$$

$$\text{ii) } \frac{\partial X}{\partial m} = 0$$

$$\text{iii) } \frac{\partial \Pr[\textit{layoff}]}{\partial m} = 0$$

$$\text{iv) } \frac{\partial R[\textit{layoff}]}{\partial m} = \frac{\int_{-1}^1 p_2 f(x) \{F_n(x+A) - F_n(x)\} dx}{\int_{-1}^1 f(x) \{F_n(x+A) - F_n(x)\} dx} = p_2 > 0$$

$$\text{v) } \frac{\partial \Pr[\textit{betterOff} \mid \textit{layoff}]}{\partial m} = \frac{\partial}{\partial m} \frac{\int_{-1}^1 f(x) \{F_n(x+A) - F_n(\frac{p_1}{p_2}x + \frac{p_1 - p_2}{p_2}m)\} dx}{\int_{-1}^1 f(x) \{F_n(x+A) - F_n(x)\} dx}$$

$$\frac{\partial \Pr[\textit{BetterOff} \mid \textit{Layoff}]}{\partial m} = - \frac{\int_{-1}^1 \frac{p_1 - p_2}{p_2} f(x) f_n(\frac{p_1}{p_2}x + \frac{p_1 - p_2}{p_2}m) dx}{\int_{-1}^1 f(x) \{F_n(x+A) - F_n(x)\} dx} < 0 \quad \square$$

Parts ii and iii of this proposition imply that the existence of the efficiency loss (due to the separation cost) is not affected by the level of m . In Part iv the returns to the laid off worker are higher simply because they are more productive. That is, their wages are higher before and after the shock than less-productive workers. Given that result, Part v, which states that the probability of being better off after the shock is falling in m , seems to be counter-intuitive. The difference is the frame of reference. Part iv compares more productive workers to less productive workers. Part v compares more productive workers before the shock to the same workers after the shock. In part v, the higher m is, the more severe the damage $(p_1 - p_2)m$ the price shock will cause to the worker, reducing

the chance that they will be better off after the shock. In other words, more productive workers potentially have more to lose from being laid off.

Proof of Proposition 2:

$$i). \frac{\partial R_1}{\partial A} = -\int_{-1}^1 p_1 F(y) f_n(x+A) dy < 0$$

$$ii). \frac{\partial R_2}{\partial A} = 0; \frac{\partial I_1}{\partial A} = 0$$

$$iii). \frac{\partial X}{\partial A} = \int_{-1}^1 p_0 F(y) f_n(y+A) dy > 0$$

$$iv). \frac{\partial \Pr[\text{layoff}]}{\partial A} = \int_{-1}^1 f(x) f_n(x+A) dx > 0$$

Figure 2 is a Mathematica® generated plot $\Pr[\text{layoff}]$ against the number of firms when the separation costs are 0.5, 0.8, 1, 1.2, and 1.4 respectively, given that the random variables are uniformly distributed. We can see that as A increases, the whole probability curve shifts up.

v). Applying the quotient rule generates this result:

$$\frac{\partial \Pr[\text{BetterOff} | \text{Layoff}]}{\partial A} = \frac{\int_{-1}^1 f(x) f_n(x+A) dx * (\int_{-1}^1 f(x) \{F_n(\frac{P_1}{P_2}x + \frac{P_1 - P_2}{P_2}m) - F_n(x)\} dx}{(\int_{-1}^1 f(x) \{F_n(x+A) - F_n(x)\} dx)^2} > 0$$

□

Proof of Proposition 3a.

$$i) \frac{\partial R_1}{\partial p_1} = (m+1) - \int_{-1}^1 \{F(y)F_n(x+A)\} dy > 0$$

$$\frac{\partial R_2}{\partial p_2} = (m+1) - \int_{-1}^1 F(y)F_n(y) dy > 0$$

$$\frac{\partial I_1}{\partial p_1} = (m+1) - \int_{-1}^1 F(y)F_n(y)dy > 0$$

$$\text{ii). } \frac{\partial(I_1 - R_1)}{\partial p_1} = \int_{-1}^1 F(y)[F_n(x+A) - F_n(y)]dy > 0$$

$$\text{iii). } \frac{\partial \Pr[\text{layoff}]}{\partial p_1} = \frac{\partial \Pr[\text{layoff}]}{\partial p_2} = 0$$

$$\text{iv). } \frac{\partial R[\text{layoff}]}{\partial p_2} = \frac{\int_{-1}^1 (m+x)f(x)\{F_n(x+A) - F_n(x)\}dx}{\int_{-1}^1 f(x)\{F_n(x+A) - F_n(x)\}dx} > 0$$

Proof of Proposition 3b.

$$\text{i). } \frac{\partial \Pr[\text{BetterOff} \mid \text{Layoff}]}{\partial p_1} = \frac{\partial}{\partial p_1} \left(\frac{\int_{-1}^1 f(x)\{F_n(x+A) - F_n(\frac{x+m}{p_2} p_1 - m)\}dx}{\int_{-1}^1 f(x)\{F_n(x+A) - F_n(x)\}dx} \right)$$

$$\frac{\partial \Pr[\text{BetterOff} \mid \text{Layoff}]}{\partial p_1} = \frac{-\int_{-1}^1 \frac{x+m}{p_2} f(x)f_n(\frac{x+m}{p_2} p_1 - m)dx}{\int_{-1}^1 f(x)\{F_n(x+A) - F_n(x)\}dx} < 0$$

$$\text{ii). } \frac{\partial \Pr[\text{BetterOff} \mid \text{Layoff}]}{\partial p_2} = \frac{\partial}{\partial p_2} \left(\frac{\int_{-1}^1 f(x)\{F_n(x+A) - F_n(\frac{p_1}{p_2} x + \frac{p_1 - p_2}{p_2} m)\}dx}{\int_{-1}^1 f(x)\{F_n(x+A) - F_n(x)\}dx} \right)$$

$$\frac{\partial \Pr[\text{BetterOff} \mid \text{Layoff}]}{\partial p_2} = \frac{\int_{-1}^1 f(x) \left[-\frac{p_1(x+m)}{p_2^2} \right] * \left[-f_n\left(\frac{p_1}{p_2}(x+m) - m\right) \right] dx}{\int_{-1}^1 f(x)\{F_n(x+A) - F_n(x)\}dx}$$

$$= \frac{\int_{-1}^1 f(x) \frac{p_1(x+m)}{p_2^2} * f_n\left(\frac{p_1}{p_2}(x+m) - m\right) dx}{\int_{-1}^1 f(x)\{F_n(x+A) - F_n(x)\}dx} > 0$$

The higher the post-shock price, the more likely that the worker will be better off after being laid off. It is important to remember at this point that these product prices apply to

all firms. A "bad" shock that affects all firms increases the likelihood that workers will be worse off, which is reminiscent of the JLS study of Pennsylvania during a recession.

□

Proof of proposition 4a

$$\frac{\partial R_1}{\partial n} = -\int_{-1}^1 p_1 \log[F(x+A)] * F(y) F_n(x+A) dy > 0$$

$$\frac{\partial I_1}{\partial n} = -\int_{-1}^1 p_0 \log[F(y)] * F(y) F_n(y) dy > 0$$

$$\frac{\partial R_2}{\partial n} = -\int_{-1}^1 p_1 \log[F(y)] * F(y) F_n(y) dy > 0$$

□

Proof of proposition 4b

$$\frac{\partial X}{\partial n} = \int_{-1}^1 p_1 F(x) [\log[F(x+A)] F_n(x+A) - \log[F(x)] F_n(x)] dx$$

$$\frac{\partial \Pr[\text{layoff}]}{\partial n} = \int_{-1}^1 f(x) \{ \log[F(x+A)] F_n(x+A) - \log[F(x)] F_n(x) \} dx^{16}$$

$\frac{\partial X}{\partial n}$ and $\frac{\partial \Pr[\text{layoff}]}{\partial n}$ are of the similar form:

$$G(A, n) = \int_{-1}^1 M \{ \log[F(x+A)] F_n(x+A) - \log[F(x)] F_n(x) \} dx \text{ where } M > 0$$

$$\frac{\partial}{\partial A} G(A, N) = \frac{\partial}{\partial A} \int_{-1}^1 M \{ \log[F(x+A)] F_n(x+A) - \log[F(x)] F_n(x) \} dx$$

$$\frac{\partial}{\partial A} G(A, N) = \int_{-1}^1 M f(x+A) F(x+A)^{n-1} \cdot (1 + n \log[F(x+A)]) dx$$

It follows that there exists an integer \mathbf{N} such that $\frac{\partial^2(X)}{\partial n \partial A} < 0$ and $\frac{\partial^2 \Pr[\text{layoff}]}{\partial n \partial A} < 0$ for

all $n > \mathbf{N}$ (see **Proposition 4.d**).

¹⁶Alternatively, $\frac{\partial \Pr[\text{layoff}]}{\partial n} = -\int_{-1}^1 F(x) \{ \log^2 F(x+A) * F_n(x+A) - \log^2 F(x) * F_n(x) \} dx$.

Proof of Proposition 4c

i) If $A > 2$, then $\text{Min}\{x + A\} > 1$, $x+A>1$ for all x in $[-1,1]$, implying that $F_n(x+A) = 1$.

We also know that $\lim_{n \rightarrow +\infty} F_n(x) = \begin{cases} 0 & x < 1 \\ 1 & x = 1 \end{cases}$

$$\begin{aligned} \lim_{n \rightarrow +\infty} X &= \lim_{n \rightarrow +\infty} \int_{-1}^1 p_1 F(x) [F_n(x+A) - F_n(x)] dx \\ &= \lim_{n \rightarrow +\infty} \int_{-1}^1 p_1 F(x) (1 - F_n(x)) dx \\ &= \lim_{\substack{n \rightarrow +\infty \\ \varepsilon \rightarrow 0^+}} \left(\int_{-1}^{1-\varepsilon} p_1 F(x) (1 - F_n(x)) dx + \int_{1-\varepsilon}^1 p_1 F(x) (1 - F_n(x)) dx \right) \\ &= \int_{-1}^{1-\varepsilon} p_1 F(x) dx + \int_{1-\varepsilon}^1 p_1 F(x) (1 - 1) dx \\ &= \int_{-1}^1 p_1 F(x) dx \end{aligned}$$

$$\begin{aligned} \lim_{n \rightarrow +\infty} \text{Pr}[\text{layoff}] &= \lim_{n \rightarrow +\infty} \int_{-1}^1 f(x) \{F_n(x+A) - F_n(x)\} dx \\ &= \lim_{\substack{n \rightarrow +\infty \\ \varepsilon \rightarrow 0^+}} \int_{-1}^{1-\varepsilon} f(x) [1 - F_n(x)] dx + \lim_{\substack{n \rightarrow +\infty \\ \varepsilon \rightarrow 0^+}} \int_{1-\varepsilon}^1 f(x) [1 - F_n(x)] dx \\ &= \int_{-1}^1 f(x) * [1 - 0] dx = 1 \end{aligned}$$

To illustrate this result, Figure 3a plots $\text{Pr}[\text{layoff}]$ against the number of outside offers with $A = 2.5$, given the random variable is normal distributed with mean 0 and standard deviation 0.5. As n increases, the probability of being laid off increases.

ii) If $0 < A < 2$, then $\lim_{n \rightarrow +\infty} F_n(x+A) = 0$ for $x < 1 - A$ & $\lim_{n \rightarrow +\infty} F_n(x) = 0$

$$\begin{aligned} \lim_{n \rightarrow +\infty} X &= \lim_{n \rightarrow +\infty} \int_{-1}^1 p_1 F(x) [F_n(x+A) - F_n(x)] dx \\ &= \lim_{n \rightarrow +\infty} \left[\int_{-1}^{1-A} p_1 F(x) [F_n(x+A) - F_n(x)] dx + \int_{1-A}^1 p_1 F(x) [F_n(x+A) - F_n(x)] dx \right] \\ &= 0 + \int_{1-A}^1 p_1 F(x) [1 - \lim_{n \rightarrow +\infty} F_n(x)] dx \\ &= \int_{1-A}^1 p_1 F(x) dx \end{aligned}$$

$$\frac{d}{dA} \lim_{n \rightarrow +\infty} X = \frac{d}{dA} \int_{1-A}^1 p_1 F(x) dx > 0$$

$$\begin{aligned}
\lim_{n \rightarrow +\infty} \Pr[\text{layoff}] &= \lim_{n \rightarrow +\infty} \left[\int_{-1}^{1-A} f(x) \{F_n(x+A) - F_n(x)\} dx + \int_{1-A}^1 f(x) \{F_n(x+A) - F_n(x)\} dx \right] \\
&= \int_{-1}^{1-A} f(x) \{0 - 0\} dx + \lim_{n \rightarrow +\infty} \int_{1-A}^1 f(x) \{1 - F_n(x)\} dx \\
&= \int_{1-A}^1 f(x) dx = F(1) - F(1-A) = 1 - F(1-A)
\end{aligned}$$

Furthermore, $\frac{d}{dA} \{1 - F(1-A)\} = f(1-A) > 0$

To illustrate this result, Figure 3b contains a plot of Pr [layoff] against the number of outside offers with $A = 0.7$, given that the random variable is normally distributed with mean 0 and standard deviation 0.3.

Proof of Proposition 5

i).
$$\frac{\partial \omega}{\partial m} = \frac{[(m+1) - \int_{-1}^1 F(y)F_n(y)dy] - [(m+1) - \int_{-1}^1 F(y)F_n(y+A)dy]}{[(m+1) - \int_{-1}^1 F(y)F_n(y)dy]^2}$$

$$\frac{\partial \omega}{\partial m} = \frac{\int_{-1}^1 F(y)[F_n(y+A) - F_n(y)]dy}{[(m+1) - \int_{-1}^1 F(y)F_n(y)dy]^2} > 0$$

$$\frac{\partial^2 \omega}{\partial m^2} = -\frac{2 \int_{-1}^1 F(y)[F_n(y+A) - F_n(y)]dy}{[(m+1) - \int_{-1}^1 F(y)F_n(y)dy]^3} < 0$$

ii).
$$\frac{\partial \omega}{\partial A} = \frac{-\int_{-1}^1 F(y)f_n(y+A)dy}{(m+1) - \int_{-1}^1 F(y)F_n(y)dy} < 0$$

$$\frac{\partial^2 \omega}{\partial m \partial A} > 0 \text{ (Obvious.)}$$