

Preliminary

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Trade Policy, Income Risk and Welfare*

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Abstract

This paper studies empirically the relationship between trade policy and *individual* income risk and uses the empirical estimates of this relationship to assess the welfare costs of changes in trade policy. The empirical analysis proceeds in two steps. First, longitudinal data on income of Mexican workers are used to estimate individual income risk in various manufacturing sectors. Second, the variation in income risk and trade barriers – both over time and across sectors – is used to arrive at estimates of the relationship between trade policy and individual income risk. Given the estimate of this relationship, a simple dynamic general equilibrium model with incomplete markets is used to calculate the associated welfare effects of changes in trade policy.

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I. Introduction

The recent years have seen an increased integration of countries into the world economy through trade and capital market liberalization. This has led to a parallel surge of interest in the academic and policy literature on the implications of increased “openness” of countries to cross-border trade in goods and factors.¹ The economic benefits and costs of openness are now being actively debated: While many economists have pointed to the gain in allocational efficiency that results from free international exchange, others have pointed out potential downsides, arguing that openness may lead to an increase in income inequality and, separately, income risk (income volatility). Although there is by now a large empirical literature analyzing the impact of trade openness on wage *levels* and the distribution of income,² an empirical analysis of the effect of trade openness on *individual* income volatility has so far been lacking. This paper aims to conduct such an empirical investigation of the impact of trade policy on individual income risk, and to use the empirical results to assess the welfare effect of trade policy.

The theoretical literature has suggested various channels through which openness might affect individual income volatility.³ One potential channel, with central standing in this discussion, works through the impact that openness could have on the nature and extent of competition in product markets. For instance, in imperfectly competitive settings, lower tariff barriers imply that import-competing industries face greater competition from a larger and more varied number of international competitors, leaving them a more tenuous

¹For a general discussion of the debate, see for instance, Rodrik (1997), Irwin (2002), Bhagwati (2002) and Bhagwati and Srinivasan (2001).

²In addition to the early papers of Lawrence and Slaughter (1993) and Borjas, Freeman and Katz (1992), contributions in this literature include Richardson (1995), Leamer (1996), Feenstra and Hanson (1999), Hanson and Harrison (1999) and Harrigan (2000) among many others. See also the recent survey treatments provided by Slaughter (2001a), Feenstra and Hanson (2002) and Hanson, Knetter, Leamer, Levinsohn and Slaughter (2002).

³See Rodrik (1997 & 1998) for detailed and highly accessible discussions.

grip on their own market. Goods demand and the derived labor demand function become more elastic, and any shock to goods demand or labor productivity translates into larger variation in wages and employment – income risk increases.⁴ Even with perfect competition, greater openness likely induces a more specialized production structure in individual countries, leading again to stronger variation in wages and employment in response to the same demand and supply shocks.⁵ This suggests that greater openness could lead to an increase in income volatility. On the other hand, the world economy is likely to be less volatile than the economy of any single country – since supply and demand shocks in a given country could be offset by shocks in the opposite direction in others – leading to more stable prices worldwide than in any single autarkic economy. This suggests that greater openness should instead lead to reduced variance in individual incomes. Thus, theoretically, the openness-volatility relationship is ambiguous, that is, the theoretical literature does not offer a strong prior on the sign or magnitude of this relationship.

In this paper, we study *empirically* the relationship between trade openness and income risk using the following approach. First, for each year and each industry (sector), we estimate individual income risk defined as the variance of unpredictable changes in individual income. In this first step, we are careful to distinguish between transitory and permanent shocks to income since the two types of shocks have very different welfare implications. More specifically, a substantial body of work has shown that agents can self-insure against transitory income shocks by using their own savings, which implies that the effect of such shocks on consumption and welfare are relatively small.⁶ Permanent income shocks, in contrast, affect consumption almost one for one, and have therefore very large welfare con-

⁴For a more detailed discussion of this argument, see Rodrik (1997). For recent attempts to investigate the issue empirically, see Slaughter (2001b) and Krishna, Mitra and Chinoy (2001).

⁵On the issue of trade policy in the context of uncertain world prices, see the papers by Eaton and Grossman (1985) and Helpman and Razin (1980), among others.

⁶See, for example, Blundell, Pistaferri and Preston (2002) for recent empirical work, Aiyagari (1994) and Krusell and Smith (1998) for computational work and Levine and Zame (2001) for a theoretical argument.

sequences.⁷ Second, we use these estimates of individual income risk and industry-level data on trade openness to conduct an empirical investigation of the relationship between individual income risk and openness. More specifically, we regress (the estimates of) individual income risk on trade policy measures, and control for changes in macroeconomic conditions and industry specific effects by including time and industry dummies. In other words, we identify the relationship between income risk and openness by exploiting the difference across industries with respect to changes in income risk and trade policy over time.⁸

To study the link between trade policy and individual income volatility empirically, it is necessary to have longitudinal information on incomes at a disaggregated level (individual or household)⁹ in countries that have undergone discernable (and ideally substantial) changes in their external regime. Unfortunately, countries that maintain detailed longitudinal records on individual incomes have rarely undertaken major trade reforms and countries that have undertaken extensive trade policy reforms have rarely collected data on individuals of requisite scope and quality. Thus, a multi-country study examining the questions of interest to us is infeasible and we focus instead on the only country, to our knowledge, that satisfies both criteria: Mexico. Specifically, as we discuss in significant detail later in the paper, we use a unique data source - quarterly Mexican household income surveys that survey workers of a variety of skill and experience levels with comprehensive coverage of all sectors of the economy. The survey data run from the mid-1980s until now - a time period in which the Mexican economy experienced substantial changes in trade

⁷See, for example, Blundell, Pistaferri and Preston (2002) for recent empirical work, Krebs (2001) for a computational analysis, and Constantinides and Duffie (1996) and Krebs (2000) for theoretical arguments supporting this view.

⁸In section III we discuss alternate specifications which exploit to a greater extent the *within*-industry variation in trade policy over time. Macroeconomic factors are then controlled for by their direct inclusion on the right hand side of the regression equation (rather than through the use of time dummies).

⁹It should be clear that our need for longitudinal data follows from our desire to study how trade policy impacts the magnitude and frequency of individual income shocks (changes). This is a quite distinct task from that of measuring the impact of trade policy on the distribution of income levels.

policy.¹⁰ To get to the openness-volatility link, our research strategy is a simple one: We obtain suitable measures of volatility in individual incomes (taking care to distinguish between temporary and permanent shocks to income) and then exploit the variation in trade policy in our data to obtain estimates of the correlation between income volatility and openness (after conditioning suitably for a wide variety of other determinants of income volatility such as general macroeconomic conditions).¹¹

An important component of our analysis deals with the welfare consequences of changes in individual income risk that are brought about by changes in trade policy. If insurance markets and other institutional arrangements for sharing individual income risk are missing (incomplete markets), then changes in income risk (volatility) will alter consumption volatility and therefore workers' welfare. To find out how income risk is linked to consumption volatility and welfare, we use a dynamic general equilibrium model with incomplete markets in which the consumption/saving choice of workers in the presence of idiosyncratic income risk is explicitly modeled. As is well known, general versions of such models are difficult to solve, and most work in the literature has therefore been computationally intensive (Aiyagari (1994), den Haan (1996) and Krusell and Smith (1998)). In contrast, we rely upon a version of the incomplete-markets model recently developed and analyzed by Constantinides and Duffie (1996) and Krebs (2000) that is highly tractable, but still rich enough to allow for a tight link between the econometric framework and the theoretical model. The welfare expressions that we derive theoretically are then used to translate changes in individual income risk into welfare changes.

¹⁰In an early wave of trade reforms, tariffs were cut from an average of about 40 percent to about 15 percent between 1987 and 1989. See Figure I.

¹¹As will become clear from our discussion, our analytical framework is flexible enough to permit separate analyses for workers of different income, skill or experience categories. This is to say that we will be able to examine, for instance, whether low-skill workers suffer from greater (or lesser) increases in income risk due to trade liberalization than do high-skill workers.

In sum, this paper attempts to study empirically the impact of trade openness on individual income risk using trade policy data and longitudinal data on individual incomes. A dynamic general equilibrium model with incomplete markets serves as the basis for translating any estimates of changes in income risk due to trade policy into estimates of welfare changes. It is worth emphasizing that the empirical study we conduct here is the first of its kind. While several scholars have commented upon the potential importance of the link between openness and income risk, and while some attempts have been made to estimate the relationship between openness and *aggregate* volatility,¹² none has studied this issue in the manner or detail that we have done here.

The rest of the paper proceeds as follows. Section II describes the estimation procedure and data that we use to estimate individual income risk. Section III discusses the empirical methodology we use in a second stage to get to estimates of the relationship between income risk and trade policy. Section IV describes the theoretical framework that will be used to translate changes in income risk into changes in welfare. Section V presents our results.

II. Income Risk

The first stage of our analysis concerns the estimation of individual income risk, where income risk is defined as the variance of unpredictable changes in individual income. In this first stage, we will distinguish between transitory and permanent shocks to income. As discussed in the introduction, from a welfare point of view this separation is essential since self-insurance through saving works well for transitory income shocks, but not for permanent ones. For this and other reasons (to be discussed in detail below), we eventually focus on permanent shocks and their relation to openness.

¹²See, for example, Rodrik (1998). For a related but distinct line of research emphasizing economic integration and (aggregate) risk-sharing between nations and states within a nation, see Sorensen, Yosha et al. (1996 & 1998).

II.1. Data

In Mexico, the National Urban Employment Survey (ENEU) conducts extensive *quarterly* household interviews in the 16 major metropolitan areas and is available from the mid-1980s until now (the most recent year for which data is available is the year 2000). The sample is selected to be geographically and socio-economically representative. The survey questionnaire is extensive in scope and covers all standard elements such as participation in the labor market, wages, hours worked, etc. The treatment of sample design, collection and data cleaning is careful.¹³ The ENEU is structured so as to track a fifth of each sample across a five quarter period. To construct the panels, workers were matched by position in an identified household, level of education, age and sex to ensure against generating spurious transitions. Using just the first variables to concatenate and following changes in sex across the panel led to mismatching (or misreporting) of under .5 percent. Taken together, we have 44 complete panels of 5 periods (i.e., quarters) each, spanning a total of 12 years (48 quarters). The number of individuals surveyed in any given calendar year is approximately 10,000.

II.2. Specification of Income Process

As in previous empirical work, we assume that the log of labor income of individual i employed in industry j in period t , y_{ijt} , is given by:

$$y_{ijt} = \alpha_{jt} + \beta_{jt} \cdot x_{ijt} + u_{ijt} . \quad (1)$$

In (1) α_{jt} and β_{jt} denote coefficients, x_{ijt} is a vector of observable characteristics (such as age and education), and u_{it} is the stochastic component of earnings. We assume that the stochastic term is the sum of two (unobserved) components, a permanent component ω_{ijt}

¹³The actual surveys and documentation of methodology are available on request.

and a transitory component η_{ijt} :

$$u_{ijt} = \omega_{ijt} + \eta_{ijt} . \quad (2)$$

Permanent shocks to income are fully persistent in the sense that the permanent component follows a random walk:

$$\omega_{ij,t+1} = \omega_{ijt} + \epsilon_{ij,t+1} , \quad (3)$$

where the innovation terms, ϵ_{ijt} , are normally distributed random variables with zero mean. We further assume that they are identically distributed across individuals and independently distributed over time, but permit the variance to depend on time and industry: $\epsilon_{ijt} \sim N(0, \sigma_{\epsilon jt}^2)$. Transitory shocks have no persistence, that is, the random variables η_{ijt} are independently distributed over time. We further assume that they are normally distributed with zero mean. Clearly, η_{ijt} captures both temporary income shocks and measurement error. As before, we assume that individuals are ex-ante identical in the sense that the variance of η_{ijt} is independent of i , but allow for time and industry dependence: $\eta_{ijt} \sim N(0, \sigma_{\eta jt}^2)$.

Our specification for the labor income process is in accordance with the empirical work on US labor income risk. For example, Carroll and Samwick (1997) and Gourinchas and Parker (2002) use exactly our specification. Hubbard, Skinner and Zeldes (1994) and Storesletten, Telmer and Yaron (2001) assume that the permanent component is an AR(1) process, but estimate an autocorrelation coefficient close to one (the random walk case). Finally, some papers have allowed for a third, MA(1), component. See, for example, Hall and Mishkin (1982) and Meghir and Pistaferri (2001) and also David and Willen (2000) who allow for both an autoregressive and a moving average component. Notice also that with the exception of Meghir and Pistaferri (2001) and Storesletten et al. (2001), the previous literature has confined attention to the special case of time-independent variances (homoscedastic case). Clearly, the introduction of time-variation in the parameters $\sigma_{\epsilon jt}^2$

and $\sigma_{\eta jt}^2$ makes the estimation of these parameters more challenging.

In principle, both $\sigma_{\epsilon jt}^2$ and $\sigma_{\eta jt}^2$ represent measures of individual income risk. In this paper, we will focus on $\sigma_{\epsilon jt}$ and its relationship to trade policy. This choice is motivated by the following two considerations. First, as discussed in the introduction, transitory income shocks are unlikely to generate consumption volatility since self-insurance through own-saving is highly effective, and the welfare effects of these shocks are therefore small. Second, term $\sigma_{\eta jt}^2$ is likely to contain a large amount of measurement error, and therefore overstates the degree of transitory income risk.

II.3. Estimation of Income Process

Consider the change in (the residual of) income of individual i between period t and $t+n$:

$$\begin{aligned} \Delta u_{ij,t+n} &\doteq u_{ij,t+n} - u_{ijt} \\ &= \epsilon_{ij,t+1} + \dots + \epsilon_{ij,t+n} + \eta_{ijt} + \eta_{ij,t+n} . \end{aligned} \tag{4}$$

Thus, we have the following expression for the variance of income changes:

$$E[\Delta u_{ij,t+n}^2] = \sigma_{\epsilon j,t+1}^2 + \dots + \sigma_{\epsilon j,t+n}^2 + \sigma_{\eta jt}^2 + \sigma_{\eta j,t+n}^2 . \tag{5}$$

We use the moment restrictions (5) to estimate the parameters $\sigma_{\epsilon jt}^2$ and $\sigma_{\eta jt}^2$ using GMM, where the sample analogs to the moment conditions are formed by using the estimates of u_{ijt} obtained as residuals from Mincerian regressions of income on observable characteristics as specified in (1) – an approach also used by Meghir and Pistaferri (2001), Storesletten et al. (2001) and Gourinchas and Parker (2002).¹⁴ Notice that the restrictions are linear in the parameters $\sigma_{\epsilon jt}^2$ and $\sigma_{\eta jt}^2$, which facilitates the estimation substantially. Since, for

¹⁴Notice that Meghir and Pistaferri (2001) and Storesletten et al. (2001) exploit additional moment restrictions that follow from the autocovariance function of income changes.

each time period, there are two parameters to be estimated and one moment condition corresponding to *each* time interval into the future, there are, in general, many more moment conditions than there are parameters.¹⁵ Thus, the system is overidentified, and we can use the overidentifying restrictions to test the model specification.

Some intuition for the way in which our approach separates transitory from permanent income shocks can be obtained from the following simple example. Suppose that risk is time-invariant, $\sigma_{\epsilon jt}^2 = \sigma_{\epsilon j}^2$ and $\sigma_{\eta jt}^2 = \sigma_{\eta j}^2$, an assumption that has been made by most of the previous empirical literature on income risk. In this case, the moment restrictions (5) become the following:

$$E[\Delta u_{ij,t+n}^2] = 2\sigma_{\eta j}^2 + n\sigma_{\epsilon j}^2. \quad (6)$$

Thus, the variance of observed n -period income changes is a linear function of n , where the slope coefficient is equal to $\sigma_{\epsilon j}^2$. The insight that the random walk component in income implies a linearly increasing income dispersion over time is the basis of the estimation method used by several authors. For example, Carroll and Samwick (1997) estimate σ_{ϵ}^2 by performing OLS regressions of the left-hand-side of (6) on n . While the preceding example, with time-invariant parameters, serves to illustrate the intuition underlying the estimation procedure, we should note that our approach is more general in the sense that it allows for arbitrary time variation in income risk parameters and uses GMM instead of OLS.

III. Trade Policy and Income Risk

The procedure outlined in the previous section provides us with estimates of individual income risk, $\sigma_{\epsilon jt}^2$, for each industry (i. e., manufacturing sector) j and time period t . These time-varying, industry-specific estimates in conjunction with observations on trade policy,

¹⁵This is to say that for Mexico, where individuals drop out of the sample after 5 quarters and where we have data spanning a total of 48 quarters, the number of parameters to be estimated is $2^*(48)$ and the number of moment conditions is approximately $4^*(48)$.

τ_{jt} , allow us to estimate the relationship between income risk, $\sigma_{\epsilon_{jt}}^2$, and openness, τ_{jt} . For example, if we assume linearity, but allow for industry fixed-effects and aggregate time effects, then we have the following:

$$\sigma_{\epsilon_{jt}}^2 = \alpha_0 + \alpha_j + \alpha_t + \alpha_\tau \tau_{jt} + \nu_{jt} . \quad (7)$$

In (7) the coefficients α_j capture the industry fixed-effects, the α_t 's pick up aggregate trends and the coefficient α_τ measures the effect of openness on income risk. Note that we assume that the error term ν_{jt} is uncorrelated with any of the right-hand-side variables.

The inclusion of industry dummies in the specification above allows us to control for any fixed industry-specific factors that may affect the level of riskiness of income in that industry. Moreover, the inclusion of time dummies controls for any changes in macroeconomic conditions that affect the level of income risk. While this ensures that our estimation results are not driven by changes in *macroeconomic* conditions (business cycle effects and/or long-run structural changes) unrelated to trade policy, it also means that identification of the relationship between $\sigma_{\epsilon_{jt}}^2$ and τ_{jt} will have to be based on the differential rate of change in trade barriers across sectors over time (or the vector of observations on tariffs in the panel corresponding to (7) will be perfectly collinear with the time-dummy vector). This, however, does not pose problems for our estimation since trade policy data in fact do exhibit substantial cross-sectional variation.¹⁶

Specification (7) provides the starting point for our econometric analysis. An alternate specification, which we also explore, exploits to a greater extent the time variation in trade policy *within* each industry in the estimation of α_τ . This is done by dropping the time dummies but controlling for relevant macroeconomic factors affecting income risk, S_t , by directly including them on the right hand side of the estimating equation:

¹⁶For instance, in Mexico, tariffs varied between 80 and 20 percent prior to the trade reforms of 1987 and ranged between 20 and 10 percent by 1994 - implying a variation in tariff changes across sectors that is quite substantial.

$$\sigma_{\epsilon_{jt}}^2 = \alpha_0 + \alpha_j + \alpha_\tau \tau_{jt} + \beta \cdot S_t + \nu_{jt} . \quad (7')$$

Other extensions of (7) may also be studied. For example, one possible extension would be to include observed industry-level variables and allow for an interaction between them and trade policy:

$$\sigma_{\epsilon_{jt}}^2 = \alpha_0 + \alpha_j + \alpha_t + \alpha_S \cdot S_{jt} + \beta \cdot S_{jt} \cdot \tau_{jt} + \alpha_\tau \cdot \tau_{jt} + \nu_{jt} , \quad (8)$$

where S_{jt} is a vector of observable industry-level variables measuring the level of economic activity in industry j (GDP, employment, etc.).

In estimating (7,8), one concern is that the left hand side variable is estimated and not observed. This is not a substantial problem by itself, as it is well known that while “measurement error” in the dependent variable does reduce precision, it does not bias our estimates. A further concern arises, however, from the fact that the estimates of σ_{jt}^2 have differing standard errors across industries, that is, the specification we have described above will suffer from a heteroscedasticity problem. However, since the magnitudes of these standard errors are known to us (directly from the GMM estimation of income risk parameters) we can use this information to address the problem using standard weighted-least-squares (WLS) techniques.¹⁷

IV. Trade Policy and Welfare

The preceding discussion has outlined our approach to estimating the relationship between trade policy and income risk. We now turn to the analysis of the link between income risk and welfare, which is provided by a simple dynamic general equilibrium model with incomplete markets.

¹⁷For an example, see Krishna (2002).

The model is based on work by Constantinides and Duffie (1996) and Krebs (2000). It features ex ante identical, long-lived households that make consumption/saving choices in the face of uninsurable income shocks. It is a pure exchange model, and aggregate saving is therefore by definition zero. For an extension of the analysis to a production economy with positive aggregate saving, see Krebs (2001, 2002). The tractability of the model derives from the assumption that income shocks are permanent. Clearly, in the data there are both transitory and permanent income shocks, and by neglecting the transitory shocks, we are likely to underestimate the welfare effect of income risk. However, as discussed in the introduction, previous results suggest that this error is quantitatively small. Notice also that the model neglects transitions across industries (sectors), which is likely to lead to an overestimate of the welfare cost of income risk. We intend to study the quantitative importance of this effect in future work by extending the current model and allowing households to move across industries at a fixed cost.

Time is discrete and open ended. Labor income of worker i in period t is denoted by y_{it} . Notice that to streamline the analysis, we have suppressed the industry index j . Labor income is random and defined by an initial level y_{i0} and the law of motion

$$y_{i,t+1} = (1 + g_{i,t+1}) y_{it} , \quad (9)$$

where $\log(1 + g_{i,t+1}) \sim N(-.5\sigma_{t+1}^2, \sigma_{t+1}^2)$. In other words, the growth rate of labor income of individual i in period $t + 1$, $g_{i,t+1}$, is log-normally distributed with $E[g_{i,t+1}] = 0$ and $var[g_{i,t+1}] = \sigma_{t+1}^2$. Notice that for simplicity we have set per capita consumption growth to zero. We assume further that the variance of income shocks depends on the the aggregate state of the economy in period $t + 1$ (macroeconomic conditions), S_{t+1} , and the trade policy adopted in period $t + 1$, τ_{t+1} . That is, we assume $\sigma_{t+1}^2 = \sigma^2(S_{t+1}, \tau_{t+1})$. In general, S_{t+1} is a multi-dimensional vector of all relevant macroeconomic variables other than trade policy

(real GDP, inflation, etc.). We assume that the random variables $g_{i,t+1}$ are identically distributed across households and independently distributed over time.

Taking the logarithm in (9), we find

$$\log \tilde{y}_{i,t+1} = \log \tilde{y}_{it} + \log(1 + g_{i,t+1}) . \quad (10)$$

Thus, labor income follows a logarithmic random walk with heteroscedastic error term $\log(1 + g_{i,t+1})$. In other words, the labor income process (10) is identical to the permanent component of the income process (1-3): $\log y_{it} = \omega_{it}$ and $\log(1 + g_{i,t+1}) = \epsilon_{i,t+1}$. This provides the link between our empirical estimates of individual income risk and the theoretical model on which our welfare calculations are based.

Each worker begins life with no financial wealth. However, workers have the opportunity to borrow (dissave) and lend (save) at the common risk-free rate r_t . Hence, the sequential budget constraint of worker i reads

$$\begin{aligned} a_{i,t+1} &= (1 + r_t)a_{it} + y_{it} - c_{it} \\ a_{it} &\geq -D , \quad a_{i0} = 0 . \end{aligned} \quad (11)$$

Here c_{it} denotes worker i 's consumption in period t , a_{it} his asset holdings at the beginning of period t (excluding interest payment in this period) and D is the maximum amount of debt the worker may accumulate. Notice that a_{it} is negative if the worker is a borrower, and that the explicit debt constraint automatically rules out any Ponzi scheme.

Households have identical preferences that allow for a time-additive expected utility representation:

$$U(\{c_{it}\}) = E \left[\sum_{t=0}^{\infty} \beta^t u(c_{it}) \right]. \quad (12)$$

Moreover, we assume that the one-period utility function, u , is given by $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$, $\gamma \neq 1$, or $u(c) = \log c$, that is, preferences exhibit constant degree of relative risk aversion γ .

For a given process of interest rates, each worker chooses a consumption/saving plan that maximizes expected lifetime utility (12) subject to the budget constraint (11). In equilibrium, the asset market must clear:

$$\sum_i a_{it} = 0. \quad (13)$$

Notice that (13) and (11) imply goods market clearing (Walras' law). Under the assumptions made so far, there is an equilibrium in which households optimally choose not to use borrowing and lending to smooth out income fluctuations (Constantinides and Duffie (1996) and Krebs (2000)). In short, we have $c_{it} = y_{it}$. Given this characterization of equilibrium, it is straightforward to derive the welfare expressions. As a simple example, suppose that all aggregate variables are expected to be constant over time: $S_t = S$ and $\tau_t = \tau$. In this case expected lifetime utility (12) is

$$U = \frac{c_0^{1-\gamma}}{1-\gamma} \left(1 - \beta E[(1+g)^{1-\gamma}] \right)^{-1}, \quad (14)$$

where the expectation is taken over idiosyncratic shocks (over the random variable g). Notice that we dropped the indexes i and t because the expression (14) is worker- and time-independent.¹⁸

Using the assumption that $g \sim N(-.5\sigma^2(S, \tau), \sigma^2(S, \tau))$, integration over income shocks

¹⁸To save space, we only present the welfare results for $\gamma \neq 1$.

yields

$$U = \frac{c_0^{1-\gamma}}{1-\gamma} \left(1 - \beta \exp \left(.5 \left((1-\gamma)^2 - (1-\gamma) \right) \sigma^2(S, \tau) \right) \right)^{-1}. \quad (15)$$

Equation (15) shows how trade policy affects welfare through its effect on individual income volatility, σ^2 , and it is this channel which is the focus of the current paper.¹⁹ In short, we are interested in the welfare change $\frac{\partial U}{\partial \sigma^2} \frac{\partial \sigma^2}{\partial \tau}$.

To calculate the welfare change experienced by each worker when the trade policy is changed from τ to $\tau' = (1 + \Delta_\tau)\tau$, these welfare changes can be expressed in compensating variation in initial consumption, c_0 .

That is, we can ask how much each worker's initial consumption has to change in order to keep his welfare constant when trade policy has changed.²⁰ Mathematically, for any c_0 , τ and Δ_τ , we are searching for the percentage change in initial consumption, $\Delta_c = c'_0/c_0 - 1$, solving

$$U(c_0, \tau) = U((1 + \Delta_c)c_0, (1 + \Delta_\tau)\tau). \quad (16)$$

Equations (15) and (16) give us the final expression linking welfare changes (in terms of compensating variation in initial consumption) to trade policy change (from τ to τ'):

$$\Delta_c = \left(\frac{1 - \beta \exp(.5 \left((1-\gamma)^2 - (1-\gamma) \right) \sigma^2(S, \tau'))}{1 - \beta \exp(.5 \left((1-\gamma)^2 - (1-\gamma) \right) \sigma^2(S, \tau))} \right)^{\frac{1}{1-\gamma}} - 1. \quad (17)$$

Notice that expression (17) is independent of c_0 , that is, the welfare change expressed

¹⁹Trade policy might also impact welfare through its effect on aggregate consumption growth, which is set to zero in expression (13). Moreover, trade policy might have an indirect effect on σ^2 through its effect on macroeconomic conditions, S .

²⁰Notice that for the case considered here, this compensating variation is equal to the equivalent variation.

in percentage changes of consumption levels is the same for all workers. Expression (17) forms the basis for the quantitative welfare analysis of induced volatility conducted in this project. It should be clear from (17) that to evaluate the welfare cost of moving trade policy from τ to τ' , we need information about the function $\sigma^2(\cdot)$ – the estimation of which, of course, formed the core of the empirical analysis described in section III. We will also need information about the discount factor β and the coefficient of relative risk aversion, γ . Although these preference parameters are not directly observable, a large macroeconomic literature suggests values for β between .9 and .96 and values for γ between 1 and 4 (Cooley (1995) and Storesletten et al. (2001)). In conducting our welfare analysis, we perform an extensive sensitivity analysis with respect to the values of the parameters β and γ . Standard errors corresponding to the welfare estimates are obtained through simulation.²¹

V. Results

As discussed in section III, the first step in our analysis is the estimation of sectoral time-varying income risk parameters using our data on individual income changes. These income risk parameters, the variances of transitory and permanent shocks to income, were estimated under the assumption that they varied every quarter and also under the alternate assumption that they were fixed with a calendar year but varied annually.

Table I presents panel estimates of the second-stage regressions relating our (time-varying) estimates of σ_ϵ^2 to trade policy levels and trade policy changes. Macroeconomic factors

²¹To get some sense for the quantitative importance of idiosyncratic risk for welfare, let us consider a simple numerical example. Suppose that σ_ϵ^2 increases from .03 to .04. For preference parameters $\beta = .96$ and $\gamma = 2$, this implies that $\Delta_c = .11$. That is, to compensate the households for the welfare loss due to this increase in idiosyncratic risk, one has to offer them a permanent increase of mean consumption by 11 percent. In comparison, Lucas (1987) finds the welfare cost of *aggregate* fluctuations to be only 0.1 percent of consumption. The welfare effects of *idiosyncratic* risk are clearly much higher. This should serve to underscore the reasons for our focus here on individual risk.

affecting all industries are taken into account by the use of time dummies. As the results presented in Table I reveal, the relationship between the level of trade barriers and σ_ϵ^2 is statistically insignificant. Interestingly, the tariff *changes* in the two preceding years (cumulated) are significantly related to income risk and in the expected manner – large tariff reductions over the preceding two years result in greater variance in shocks to permanent income. Note that in industries with high levels of import penetration, the coefficient on trade policy changes in the preceding year is larger indicating that the same reduction in tariffs in these industries results in larger (temporary) increases in σ_ϵ^2 .

Table II presents estimates with time dummies on the right hand side of the specification replaced with particular macroeconomic variables such as the GDP growth rate and real exchange rate depreciation. The coefficient on GDP growth is negative indicating that higher GDP growth in the preceding year lowers the variance of shocks to permanent income as does the appreciation of the real exchange rate over the preceding two years.

Table III presents calculations of estimated changes in σ_ϵ for hypothetical tariff changes of ten and twenty percent so these may be compared in magnitude with the mean level of σ_ϵ in the sample. These temporary increases in σ_ϵ are substantial in magnitude. For the full sample, a ten percent tariff reduction undertaken at a particular point in time results in a temporary increase in σ_ϵ of about thirty percent for two years and a twenty percent reduction in tariffs results in temporary increase in σ_ϵ of nearly sixty percent for two years. For industries with high levels of import penetration, these numbers are even larger.

[More to be Added]

VI. Summary and Conclusions

This paper investigates the link between trade policy and individual income risk. The framework developed here for analysis of this question proceeds in three steps. In the first step, micro-level data on individual incomes is used to estimate the risk to incomes faced by individuals in various manufacturing sectors and to decompose this risk into its permanent and temporary components. In the second stage, the variation in trade policy experience of the various manufacturing sectors is used to identify the relationship between income risk and trade policy. A simple dynamic general equilibrium model with incomplete markets is used to calculate the welfare effect of trade policy using estimates of the relationship between trade policy and income risk.

Our preliminary findings using Mexican data are as follows. While income risk seems to be significantly related to trade policy *changes* in the preceding period, the level of trade openness itself does not appear to be significant. Income risk also appears to be related to exchange rate movements (not levels) and to movements in the aggregate output.

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I. Income Risk and Tariffs - Panel Estimates (Random Effects)

1987-1998

	Full Sample	High Import Penetration
Tariff Level	0.148 (0.192)	0.104 (0.236)
Change in Tariffs	-0.28 (0.128)	-0.36 (0.160)
Time Dummies	Included	Included
R2	0.03	0.045

II. Income Risk and Tariffs - Panel Estimates (Random Effects)**1987-1998**

	Full Sample	High Import Penetration
Tariff Level	0.044 (0.096)	0.048 (0.112)
Change in Tariffs	-0.152 (0.064)	-0.192 (0.092)
Depreciation in Real Exchange Rate	-0.056 (0.024)	-0.072 (0.028)
GDP Growth	-0.204 (0.044)	-0.22 (0.052)
R2	0.015	0.02

III. Impact of Trade Liberalization

Standard Deviation of shock to Permanent Income

	Full Sample	High Imp-Pen
Mean Value	0.18	0.18
10 Percent Drop in Tariffs		
Year 1	0.23	0.25
Year 2	0.23	0.25
20 Percent Drop in Tariffs		
Year 1	0.28	0.30
Year 2	0.28	0.30