Permanent and Temporary Job Flows and the Real Exchange Rate*

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June 2003

PRELIMINARY AND INCOMPLETE DRAFT

Prepared for the *Conference on Trade and Labour Perspectives on Worker Turnover*, June 26-28, 2003, Leverhulme Centre for Research on Globalisation and Economic Policy, University of Nottingham, UK.

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Jennifer Young provided excellent research assistance. Research results and conclusions expressed are those of the authors and do not necessarily indicate concurrence by the Federal Reserve Bank of Boston or the Board of Governors of the Federal Reserve System. This paper does not contain or use confidential Census Bureau data.

Abstract

Our earlier work (Klein, Schuh, and Triest 2003a, 2003b) demonstrated that real exchange rates affect labor markets by influencing rates of gross job creation and destruction, and that the effect varies by the type of real exchange rate movement. Changes in trend real exchange rates have an allocative effect, moving job creation and destruction in the same direction without affecting net employment growth. But changes in cyclical real exchange rates have an aggregate effect, moving job destruction and net employment only. This paper explores more deeply the connection between types of real exchange rate movements and their effects on labor markets via gross job flows. We decompose job creation and destruction into permanent and temporary components, and attempt to link those components to analogous movements in real exchange rates. Our econometric work uses an expanded panel of U.S. manufacturing industries between 1973 and 2002, which includes a second period of significant dollar appreciation. We find that the real exchange rate primarily affects *permanent* job destruction, with no siginificant affect on temporary destruction or either component of job creation.

JEL code: F4

Keywords: Real exchange rates; Gross job flows; Openness; Permanent and temporary job flows

1 Introduction

Recent studies of the relationship between international factors and labor markets have begun to focus on the gross flows of jobs and workers, rather than soley on the behavior of aggregate employment.[1] Three reasons are driving this focus shift. First, there is increasing recognition that exposure to international factors is very heterogeneous at the most disaggregated levels of activity, such as individual establishments and workers. Thus, changes in real exchange rates, for example, can generate simultaneous creation and destruction of jobs and flows of workers even within detailed industries. Second, gross job creation and destruction are much larger than changes in aggregate employment (the net result of creation less destruction). Therefore, the effects of international factors on labor markets also may be much larger than is apparent from net employment changes. Finally, the impact of international factors such as real exchange rates on job creation and destruction may differ for reason related to labor market structure or the nature of the international factors.

Our earlier work on the relationship between international factors and labor markets (Klein, Schuh, and Triest 2003a and 2003b, henceforth KST) contributed to the shift toward focusing on gross job and worker flows by providing supporting evidence of these three reasons.[2] In particular, KST (2003b) demonstrated the importance of accounting for heterogeneity in quantifying the effects of real exchange rates on job creation and destruction in 4-digit manufacturing industries. Moreover, we found that the nature of the movements in real exchange rates also matters greatly for understanding their effects on labor markets through job creation and destruction. Growth in trend real exchange rates has an allocative effect on labor markets by moving creation and destruction in the same direction – that is, reallocation jobs across production sites – but has no effect on net employment. However, growth in the non-trend, or cyclical, part of real exchange rates has an aggregate effect on labor markets by moving only job destruction and therefore net employment.

[1] For reviews of the literature, see Matusz and Tarr (2000) and Chapter 4 of Klein, Schuh, and Triest (2003a).

[2] Gourinchas (1998, 1999) also offered early evidence of the link between real exchange rates and industry job flows.

We speculated that these results might be explained by differences in firms' willingness to engage in costly, permanent labor adjustment according to their perception of the nature of the change in the real exchange rate. Davis, Haltiwanger and Schuh (1996) emphasize that job flows tend to be primarily permanent employment changes at the establishment level. Thus, if the trend component of the real exchange rate reflects firms' perception of the permanence change then movement in trend real exchange rates may be more closely linked to the allocative part of job flows. Evaluation of this hypothesis requires data on permanent and temporary changes in job flows, as well as a dynamic model capable of identifying firms expectations of real exchange rate movements.

This paper is an empirical first step toward a deeper understanding of the link between real exchange rate movements and gross job flows. Following Haltiwanger and Schuh (1999), we have developed new job flow data that decomposes total creation and destruction into permanent and temporary components. Using KST (2003b) as a baseline, we re-estimate the econometric model for the permanent and temporary components separately. In this preliminary investigation, we are looking to see if there are important differences in the relationship between the the real exchange rate and the permanent and temporary components of the job flows.

Due to data limitations, our new industry-level panel data set is more highly aggregated, with industries being defined at the 2-digit SIC level rather than the 4-digit level. However, the panel offers some offsetting advantages. The data now extend through 2001 and thus include a second episode of significant dollar appreciation, which appears to be characterized by more heterogeneity in industry-specific exchange rates than the mid-1980s episode. This panel also offers the possibility of introducing heterogeneity in openness to international trade at the lowest level of disaggregation, in this case 4-digit industries, which allows us to build a richer theoretical model. Finally, the econometric results for 2-digit industry-level data reveal the importance of disaggreation in identifying the effects of real exchange rates on job flows and labor markets.

In this initial version, we present estimates of the baseline KST model for 1975-93 (to compare with previous results) and the baseline model with job flows decomposed into permanent and temporary components for the same period. Preliminary results indicate that the more highly aggregated data yield very similar econometric results to those reported in KST (2003b). The real exchange rate affects job destruction and net employment only, although the effect is not quite significant at conventional levels. Foreign real GDP plays a much larger and more significant role, but most other results are qualitatively and quantitatively similar to earlier results. When the job flow data are decomposed into permanent and temporary components, we find that real exchange rates affect only *permanent* job flows. Specifically, dollar appreciation increases permanent job destruction only, but not temporary destruction or either component of job creation. This result provides concrete evidence that it is important to investigate the nature of job flow movements, as well as the nature of real exchange rate movements.[3]

The results motivate the need for further development of the theoretical model along several dimensions. First, the model must be made dynamic so that firms form expectations over real exchange rate movements and make labor demand decisions according. Second, the model must incorporate justification for costly labor adjustment and inaction to temporary movements in real exchange rates. Third, the model must specify the structural form of exchange rate determination that firms use to form expectations. Given the difficulties experienced in previous attempts to develop and estimate structural exchange rate models, this task poses the most challenging hurdle.

The remainder of the paper proceeds as follows. Section 2 summarizes briefly the KST (2003b) theoretical and econometric models. Section 3 explains our empirical strategy, defining the data and discussing the similarities and differences between this data and our previous work. Section 4 presents the econometric results and provides our interpretations of them. Finally, Section 5 summarizes the preliminary conclusions and directions for future development of the paper.

[3]We do not present results for the real exchange rate decomposed into trend and cycle components in this draft. Preliminary estimation revealed significant problems with using the KST trend-cycle decomposition and industry job flows together, which will require more work to resolve.

2 Theoretical Motivation

This section provides an overview of the theoretical and modeling issues motivating this paper. We summarize the model in Klein, Schuh and Triest (2003b) that links gross job flows to changes in the real exchange rate. The model shows how, in response to a change in the real exchange rate, heterogeneity among establishments in an industry, along with the general equilibrium effect of exchange rates on wages, give rise to simultaneous job creation and destruction. We also introduce permanent and temporary gross job flows, and discuss how this distinction can be addressed in a more general theoretical model. Finally, we discuss the importance of developing and integrating a more structural model of real exchange rates that serves as the basis of firms expectations and joint decisions about the permanence of job flow and real exchange rate movements. This overview offers justification for the econometric specification of our preliminary exploration.

2.1 Klein-Schuh-Triest Model

The model begins with a specification of the cost function for the p^{th} establishment in industry i as

$$C\left(W_p, G_p; Q_p\right) = W_p^{\alpha} G_p^{(1-\alpha)} Q_p$$

where W_p is the wage paid by that establishment, G_p is the unit cost of its non-labor input and Q_p is its output. An application of Shepard's lemma allows us to obtain the labor demand function of the p^{th} establishment by taking the partial derivative of this cost function with respect to the wage. The total differential of this partial derivative is

$$\widehat{L_p} = -\left(1-\alpha\right)\widehat{W_p} + \left(1-\alpha\right)\widehat{G_p} + \widehat{Q_p} \quad (1)$$

where we use the notation that, for any variable Z, $\widehat{Z} = d\ln Z$. The change in the real exchange rate, $\widehat{E_j}$, enters this equation by assuming that the demand for the product of the p^{th} establishment in industry i is

$$Q_p = A_p Y^{\beta} \prod_{j=1}^{k} \left[E_j^{-\mu\Omega_i} Y_j^{*\beta\Omega_i} \right]^{\omega_j^i} \tag{2}$$

where A_p is an idiosyncratic demand shock facing this establishment, E_j is the real exchange rate with country j, (representing the price of the establishment's product divided by the domestic-currency price of the potential substitute product sold by competitors from country j), Y is a measure of domestic income and Y_j^* is a measure of income in country j. We assume that both the trade weights, ω_j^i, and the openness parameter, Ω_i (with $0 \leq \Omega_i \leq 1$), are common to all establishments in industry i and, therefore, the product $\omega_j^i \Omega_i$ shows the openness of all establishments in industry i with respect to trade with country j.[4] To simplify notation, define the difference in the logarithm of the trade-weighted exchange rate for all establishments in industry i as $\widehat{E_i} = \sum_{j=1}^{k} \omega_j^i \widehat{E_j}$ and the difference in the logarithm of the trade-weighted foreign output as $\widehat{Y_i^*} = \sum_{j=1}^{k} \omega_j^i \widehat{Y_j^*}$. Substituting the total differential of the logarithm of this product demand equation into the labor demand equation, we get the labor demand equation for the p^{th} establishment

$$\widehat{L_p} = -(1-\alpha)\widehat{W_p} + (1-\alpha)\widehat{G_p} + \widehat{A_p} + \beta\widehat{Y} - \mu\Omega_i\widehat{E_i} + \beta\Omega_i\widehat{Y_i^*}.$$

This equation demonstrates the positive direct effects of a depreciation of the trade-weighted real exchange rate ($\widehat{E_i} < 0$) on labor demand, all else equal.

We introduce spillover effects across establishments by assuming that all establishments within the i^{th} industry pay the same wage, W_i, so $W_p = W_i$ for all establishments in industry i. We also assume some substitutability among workers in the i^{th} industry and workers in the rest of the

[4]In this model, the exchange rate enters through its role in affecting demand, rather than supply. Campa and Goldberg (2001) develop a model in which the exchange rate enters through its effect on the price of exports, imports competing with the products of doemstic producers, and imported intermediate goods. Our main concern is to present a framework for our subsequent empirical analysis in which the unit of observation is annual gross job flows among 4-digit SIC industries. We have data on exports and imports at the 4-digit level, but there are not data on the use of intermediate imported goods at this level of disaggregation. We note, however, that Campa and Goldberg (2001) find a high intra-industry correlation between import penetration and imported intermediate use at the 2-digit SIC level and, for this reason, cannot use both measures in the empirical implementation of their model.

economy such that the labor supply equation facing the p^{th} establishment in the i^{th} industry is

$$L_p = \left(\frac{W_i}{\Gamma^{\varepsilon}}\right)^{\gamma}$$

where Γ is the prevailing wage in the "rest of the economy," γ is a measure of labor supply elasticity $(\gamma > 0)$ and ε is a measure of the cross-elasticity of labor supply between the i^{th} industry and the rest of the economy, with $\varepsilon \geq 0$. To focus on the role of openness and the real exchange rate, assume that $\widehat{G_p}$, $\widehat{Y}$ and $\widehat{Y_i^*}$ are all equal to zero. We use the labor supply equation and the assumption that all establishments in industry i pay wage W_i to obtain the equilibrium change in labor employed by the p^{th} establishment in industry i, $\widehat{L_p}$,

$$\widehat{L_p} = \left(\widehat{A_p} - k\widehat{A_i}\right) - k\varepsilon\gamma\widehat{\Gamma} - (1+k)\,\mu\Omega_i\widehat{E_i} \tag{3}$$

where $k = \frac{(1-\alpha)}{(1-\alpha)+\gamma}$ and $1 \geq k \geq 0$. The p^{th} establishment will exhibit job creation if $\widehat{L_p} > 0$ and job destruction if $\widehat{L_p} < 0$.

This solution shows that job creation or destruction by a particular firm depends upon an idiosyncratic shock specific to that firm, $\widehat{A_p}$, an aggregate shock specific to the industry of which the firm is a member, $\widehat{A_i}$, and the change in value of aggregate variables, $\widehat{E_i}$ and $\widehat{\Gamma}$.[5] The likelihood that a firm exhibits job destruction rises with $\widehat{E_i}$, that is, with a larger appreciation of the exchange rate.

The rates of job creation and job destruction for an entire industry can be calculated as the weighted average of the rates of job creation and job destruction for the establishments in that industry. Call the set of establishments that expand employment in a given period $M+$ and those

[5] Though $\widehat{E_i}$ may be considered an industry-specific variable since it is calculated using industry-specific weights. The independent effects of aggregate and idiosyncratic shocks on gross job flows have been studied by Mortensen and Pissarides (1994), among others.

that contract employment $M-$. Define

$$\Phi_+ = \sum_{p \in M+} \varphi_p \text{ and } \Phi_- = \sum_{p \in M-} \varphi_p$$

where $\Phi_+ \geq 0$, $\Phi_- \geq 0$ and $\Phi_+ + \Phi_- = 1$. Continuing with our assumption that $\widehat{G_p}$, $\widehat{Y}$ and $\widehat{Y_i^*}$ are all equal to zero, the industry rates of job creation and job destruction are

$$\begin{aligned} C_i &= \sum_{p \in M+} \varphi_p \left[\left(\widehat{A_p} - k\widehat{A_i} \right) - k\varepsilon\gamma\widehat{\Gamma} - (1+k)\,\mu\Omega_i\widehat{E_i} \right] \\ &= -\Phi_+ \left(k\varepsilon\gamma\widehat{\Gamma} + (1+k)\,\mu\Omega_i\widehat{E_i} + k\widehat{A_i} \right) + \sum_{p \in M+} \varphi_p\widehat{A_p} \\ D_i &= -\sum_{p \in M-} \varphi_p \left[\left(\widehat{A_p} - k\widehat{A_i} \right) - k\varepsilon\gamma\widehat{\Gamma} - (1+k)\,\mu\Omega_i\widehat{E_i} \right] \\ &= \Phi_- \left(k\varepsilon\gamma\widehat{\Gamma} + (1+k)\,\mu\Omega_i\widehat{E_i} + k\widehat{A_i} \right) + \sum_{p \in M-} \varphi_p\widehat{A_p}. \end{aligned}$$

These results suggest that an appreciation of the exchange rate is associated with less job creation and greater job destruction, holding constant other factors. These results also suggest that for two industries that are identical but for their respective values of openness (Ω), the effect of the exchange rate on both job creation and job destruction is more pronounced in the industry that is more open.

This static model points us towards a specification of a gross job flows equation that includes the percentage change in the exchange rate interacted with an indicator of industry-level openness. The actual specification we use, however, features lags and also disaggregates exchange rate movements into their permanent and temporary components. A theoretical model that yields these additional features would include some costs of adjustment to the labor force of an establishment. With these costs, a manager would respond more to a perceived permanent change than to a perceived temporary change. Also, if these costs are convex, the optimal response would occur over several periods rather than all at once.

2.2 Permananent and Temporary Job Flows

Following DHS (1996), we define the persistence of job flows as the fraction of job creation or destruction occurring in period t that continue to exist or not in exist, respectively, in period $t+j$ (see their Technical Appendix section A.1.3). Defining that persistence measure as $0 <= \phi_{it}^{F} <= 1$ for $F = \{C, D\}$ and industry i, we can then define permanent job creation and destruction as

$$C_{it}^{P} = \phi_{it}^{C} C_{it}$$

$$D_{it}^{P} = \phi_{it}^{D} D_{it}$$

and temporary job creation and destruction as

$$C_{it}^{T} = C_{it} - C_{it}^{P}$$

$$D_{it}^{T} = D_{it} - D_{it}^{P} \; .$$

The horizon of persistence, j, is arbitrary. We select $j = 2$, which for our annual data means that permanent job flows are the portions of job flows that last at least two years. From the perspective of the typical worker, this seems like a reasonable definition of permanence.

Most job flows are permanent. DHS (1996) found that approximately three-fourths of all plant-level job destruction and more than half of all plant-level job creation persists for at least two years. Haltiwanger and Schuh (1999) found persistence rates to be much lower among industry job flows, as one might expect given entry and exit among plants within industries. However, their surprising discovery was that industry persistence rates exhibited virtually identical time series characteristics as the plant persistence rates; likewise, the transitory flow components are similar (see their Figure 7). This similarity motivates our use of the industry job flows in this exploratory empirical study.

In future development of this paper, we will have to confront the notion of permanent and temporary job flows head on theoretically one of two ways. One is to think of persistence discretely as fractions of plants (or detailed industries) whose flows are permanent, while other plants (industries) have no employment change. This approach would require a nonconvex model of employment adjustment at the plant level. The other way is to think of persistence as sluggish adjustment that all plants (industries) exhibit as they adjust their employment levels. This approach could be modeled with convex adjustment of labor.

2.3 Real Exchange Rate Models

In our previous work, we took a simplistic approach to decomposing the real exchange rate into what we called "trend" and "cycle" components as follows:

$$E_{it} = E_{it}^{T} + E_{it}^{C}$$

where superscript T denotes the trend component, estimated from the detrending regression, and superscript C denotes the cyclical component, the residual between the actual and trend rate. The trend is a quadratic deterministic model of the log real exchange. Although the trend part is generally sensible, it is not clear that the residual part of the real exchange rate is really connected with the business cycle. Instead, there are large and persistent deviations from the trend.

Originally, we loosely interpreted these components as associated with permanent and temporary changes in the real exchange rate. However, as we begin to consider the conceptual importance of permanent and temporary job flow decisions, it becomes clear that this simplistic real exchange rate decomposition is not well matched to the the job flow decomposition. Although trend and cycle are similar to concepts of permanent and temporary movements, they are not exactly the same. More specifically, firms expectations of real exchange rate movements must be linked to firms' decisions about the permanent of job flow decisions. Thus, to proceed we must incorporate a model of real exchange rate behavior for firms to use in forming expectations. Given the lack of success in finding a data-consistent structural model of exchange rate behavior, this aspect of the project poses a significant challenge.

3 Empirical Strategy

Our empirical strategy differs from KST (2003b) because of data limitations.[6] The plant-level gross job flow data produced by DHS (1996) are only available through 1993 and for the manufacturing sector. Real exchange rates have fluctuated significantly since 1993, and nonmanufacturing industries account for a significant portion of total international trade. In addition, the permanent and temporary components of the DHS plant-level job flows are not publicly available for detailed industries yet. So, the need for longer time series with broader industrial coverage and decomposition into permanent and temporary components is clear.

To construct this desired data base for further investigation right now, it is necessary to move to a higher level of industrial aggregation. Consequently, we have constructed a panel data base at the 2-digit SIC industry level that is essentially analogous to the 4-digit industry data base used in our earlier work (see both KST 2003a and 2003b), with a few minor exceptions noted in the data appendix to this paper. This 2-digit industry data base contains all the necessary annual data from 1973 through 2001 for 20 manufacturing industries.[7] The 2-digit data base leaves only 580 observations in the full sample for estimation compared with nearly 9,000 in the 4-digit panel through 1993. Although aggregation reduces the statistical significance of the econometric results, it also provides evidence on the importance of the degree of disaggregation for identifying the effects of real exchange rates on labor markets.

3.1 Plant-Level versus Industry-Level Job Flows

The primary data limitation is in obtaining gross job flow data that are up-to-date and available for detailed industries. The plant-level Census Bureau microdata underlying the DHS job flow data are only available with a long lag, plus they require considerable time and effort to process. In late

[6] At least for this preliminary version of the paper, we work with data that provide the simplest, most defensible alternative data sources at higher levels of aggregation. However, we are working toward developing data comparable to our earlier work for future versions of this paper.

[7] With more data collection work, it should be possible to extend the data to nonmanufacturing industries later as well.

2003, the Bureau of Labor Statistics (BLS) expects to release newly developed data on gross job flows for the entire economy that will be available up to the current quarter. However, that BLS the data will only be available back to the early 1990s and detailed industry breakdowns may not be available right away.

One alternative source of up-to-date gross job flow data with industry detail is the between-industry job flows studied by Ritter (1993, 1994) and Haltiwanger and Schuh (1999). The authors of these studies used detailed industry-level BLS emoployment data to calculate measures of "gross" job flows using detailed industries as the basic unit of measurement rather than plants or establishments. Computationally, these measures are identical to the plant-level gross job flows. But conceptually, these industry job flows are based on industry-level net employment changes and thus are actually direct measures of the flows of jobs between industries (as opposed to between plants).

Because industries and plants are different economic entities, this change in the unit of observation is potentially problematic from a theoretical standpoint. For example, plants can (and often due) shut down permanently, but industries generally do not and many high-level industries never even shrink. Thus, one would expect that industry-level job flows are mostly temporary job fluctuations whereas plant-level job flows are mostly permanent. Surprisingly, however, Haltwanger and Schuh (1999) found that the industry-level job flows exhibited virtually identitical time series properties as the plant-level data, except that plant-level job flows are much larger on average. Perhaps even more surprisingly, they found that the permanent and temporary components of each type of job flows was closely correlated with the same component from the other type. That is, permanent and temporary job flows have the same cyclical properties regardless of whether they are measured at the plant-level or industry-level.

Although the close correspondence of the plant-level and industry-level job flows is striking, neither Haltiwanger and Schuh or any other analysts have been able to fully explain the similarities. Nevertheless, the industry-level job flow data seems to provide a very reliable indication of the actual job flows occurring among plants. For this preliminary exploration of the differential effects of real exchange rates, we think it is reasonable to use the between-industry flows.[8]

To do use the 2-digit data to estimate the model, we must make a fairly strong assumption about the applicability of the model to different levels of aggregation. In particular, we assume in this paper that basic unit of observation is a 4-digit industry (subscripts p in the model), rather than a plant, and that the industry-level refers to a 2-digit industry (subscripts i in the model). Obviously, this assumption is not strictly correct and should be relaxed in future theoretical and econometric developments, but we rely on the empirical similarities between the plant-level and industry-level job flows to get some preliminary results.

A potential offsetting advantage of the higher level of aggregation is that for the basic unit of observation, the 4-digit industry, we have complete data on international trade (exports and imports) whereas for plants we do not. Therefore, the aggregate panel with 4-digit industries aggregated to 2-digit industries offers an opportunity to build a joint model of labor adjustment and trade that we can estimate, which the disaggregate panel with plants and 4-digit industries does not. We plan to explore this possibility in future work.

3.2 Properties of the 2-digit Industry Data

Before proceeding to regression estimation, we compare the key properties of the aggregate 2-digit industry data and disaggregate 4-digit industry data to see if there are any obvious differences that might invalidate the empirical approach. A comparison of the job flows data can be found in Haltiwanger and Schuh (1999). This section focuses on the properties of the 2-digit industry data on international trade and real exchange rates. Heterogeneity across industries in these two properties is essential for the underlying hypotheses of the KST theoretical and econometric models.

Consider first the evidence on openness to international trade at the 2-digit industry level.

[8] In the future, we plan to construct permanent and temporary plant-level job flow data from the Census Bureau microdata if possible.

Openness is total trade as a share of domestic sales plus imports:

$$\Omega_{it} = \left[\frac{X_{it} + M_{it}}{Y_{it} + X_{it} + M_{it}}\right]$$

where X denotes exports, M imports, and Y domestic sales (all in nominal U.S. dollars); subscript i denotes 2-digit SIC industry. Figure 1 plots the cross-section distributions of industry openness by year since 1973, which can be compared with the 4-digit industry distributions plotted in Figure 1 of KST (2003b).

The magnitude of openness at the 2-digit level is broadly consistent with openness at the 4-digit level, but the shape of the cross-section distribution is somewhat different. Openness in the median 2-digit industry began at 9 percent in 1973, rose to 17 percent by 1993, and hit 25 percent by 2001. These median values are quite similar to the 4-digit medians through 1993. The range of openness also increased dramatically. In 1973, openness in the 10th and 90th percentiles ranged from 3 percent to 17 percent, by 1993 it reached 10 percent to 51 percent, and in 2001 it was 9 percent to 62 percent. Surprisingly, these ranges for 2-digit industries are quite similar to the ranges for 4-digit industries. Thus, it appears that moving to the 2-digit level of aggregation does not significantly reduce the extent of heterogeneity in openness. Note, however, that the distribution of openness became more skewed over time. The highest levels of openness move increasing far from the median over time so there is relatively more dispersion in 2-digit industry openness than was apparent at the 4-digit level.[9]

A second issue is the evidence on heterogeneity in 2-digit industry real exchange rates. The industry-specific multilateral real exchange rate is

$$E_{it} = \sum_{j=1}^{J_i} \omega_{ijt} E_{ijt} \ .$$

[9] Also, there appears to be a jump in the distribution (except for the median) in 1989 that we do not fully understand yet. It may be related to differences in the new trade data for 1989-2001, or it may be related to economic phenomena such as the Canadian Free Trade Agreement. We need to explore this issue further.

where i indexes 2-digit industries, j indexes trading partners (countries), J_i denotes the set of partners, ω_{ijt} denotes trade share weights, and E_{ijt} denotes bilateral real exchange rates. The trade share weights are

$$\omega_{ijt} = (1/2) \sum_{s=1}^{2} \left[\frac{X_{ij,t-s} + M_{ij,t-s}}{\sum_{j=1}^{J_i} X_{ij,t-s} + M_{ij,t-s}} \right] .$$

All currencies of countries whose bilateral trade share with the U.S. is either in the top 50 percent of industry trade or at least 10 percent (or greater) is included in the industry-specific multilateral real exchange rate. By aggregating to the 2-digit industry level, it is possible that the largest U.S. trading partners would dominate and fewer currencies/countries would be included than at the 4-digit level. Figures 2 and 3 plot the cross-section distributions of the levels and growth rates of the 2-digit industry real exchange rates, which can be compared with the 4-digit industry distributions in Figures 2.4 and 2.5 of KST (2003a).

As with openness, real exchange rates at the 2-digit level show surprisingly similar heterogeneity to rates at the 4-digit level. Up through 1993, the magnitude of dispersion in the levels and growth rates 2-digit industry real exchange rates is quite similar to that of the 4-digit industries, albeit a bit less. Importantly, the cross-sectional range of real exchange rate growth rates continues to encompass zero in most years. Hence, in any given year, there are many industry-level real exchange rates with opposite signs so that heterogeneity is of first order importance for discerning the effects on labor demand and job flows.

A potentially important feature of the most recent data is an apparent increase in heterogeneity around the most recent period of dollar appreciation. From 1994 through 2001, the median industry real exchange rate appreciated more than 10 percent. However, dispersion in the levels and growth rates of industry real exchange rates was generally greater than in the early 1980s. Looking at graphs of industry real exchange rates (not included in this paper) reveals that this appreciation was quite uneven. Many industry real exchange rates were essentially flat during this time, while many others appreciated much more than 10 percent. Thus, the new data reveal even more heterogeneity in industry real exchange rates.

4 Econometric Estimation and Results

The theoretical model discussed in Section 2 provides a general framework for the specification of our econometric model. In this section, we first describe the way in which we implement that model in our econometric specification, and then present our main results.

4.1 Econometric Specification

Drawing on our theoretical model, and following KST (2003a, 2003b), we specify the job flow regressions as

$$\begin{aligned} JF_{it} = \sum_{s=0}^{1} \Big[& \beta_{1,s} C_{i,t-1-s} + \beta_{2,s} D_{i,t-1-s} + \beta_{3,s} \left(\widetilde{\Omega}_{i,t-s} \widehat{E}_{i,t-s} \right) \\ & + \beta_{4,s} \widehat{\mathbf{Z}}_{i,t-s} + \beta_{5,s} \mathbf{V}_{t-s} \Big] + (\alpha_i + \nu_t + \epsilon_{it}) \end{aligned} \tag{4}$$

where i indexes industries, t indexes years, $\widehat{}$ denotes growth rates, $\mathbf{Z}_{i,t-s}$ is a vector of industry-specific variables, and $\mathbf{V}_{t-s}$ is a vector of aggregate variables. The dependent variables are the job flow rates, $JF_{it} = \{C_{it},\ D_{it},\ R_{it},\ N_{it}\}$; equations are estimated for both the permanent and temporary components of the job flows, as well as total job flows. Lagged values of C_{it} and D_{it}, as well as the other explanatory variables, are included as regressors to account for possible dynamic adjustment.

The theoretical model presented above suggests that the percentage change in the industry real exchange rate, $\widehat{E}_{it}$, as well the percentage change in foreign output, $\widehat{Y^*_{it}}$, should be interacted with the level of industry openness, Ω_{it}, in the econometric model. Accordingly, our specficiation includes the regressors $\widetilde{\Omega}_{it}\widehat{E}_{it}$ and $\widetilde{\Omega}_{it}\widehat{Y^*}_{it}$ where $\widetilde{\Omega}_{it}$ represents the lagged five-year moving average of the ratio of total trade (exports plus imports) to total market sales (domestic sales plus imports).[10] Differences across industries in $\widetilde{\Omega}_{it}$ provides one source of industry-level heterogeneity with respect to international competition.

Another source of heterogeneity is variations in industry-specific real exchange rates. This reflects both variation in the sets of bilateral trading partners across industries and, for a given set of trading partners, variation in the trade shares of particular countries. We construct industry-specific real exchange rates by weighting bilateral real exchange rates by trade shares. Trade shares are averaged over the preceding two years and then lagged to avoid potential endogeneity problems.[11]

The theoretical model also suggests the inclusion of the growth rates of industry-specific variables. Our regression specification includes the industry-specific variables

$$\widehat{\mathbf{Z}}_{it} = [(\widetilde{\Omega}_{it}\widehat{Y}^{*}_{it}),\ \widehat{Y}_{it},\ \widehat{\Psi}^{Q}_{it},\ \widehat{\Psi}^{G_1}_{it},\ \widehat{\Psi}^{G_2}_{it}].$$

We include in $\widehat{\mathbf{Z}}_{it}$ the industry-specific real prices of output, energy and materials, $\Psi^{Q}_{it} = (P^{Q}_{it}/P^{Q}_{t})$, $\Psi^{G_1}_{it} = (P^{EN}_{it}/P^{Q}_{it})$, and $\Psi^{G_2}_{it} = (P^{MAT}_{it}/P^{Q}_{it})$, respectively. Y_{it} is domestic industry demand. The industry-specific foreign demand, Y^{*}_{it}, is constructed using trade-weighted foreign output data for each trading partner in a manner analogous to the industry real exchange rates. It is interacted with openness for reasons analogous to those for the real exchange rate.

We want to be sure that our results for the industry-level real exchange rate are not merely reflecting a correlation between exchange rates and aggregate variables. Therefore, we include in our econometric specification the aggregate explanatory variables

$$\mathbf{V}_t = [\Gamma_t, N_t,\ \rho_t]$$

where Γ_t is the total manufacturing average real wage, N_t is total manufacturing net employment

[10] The openness data are lagged to avoid the potential problem that international trade may be endogenous. The use of a moving average approximates trend openness by smoothing through transitory fluctuations.

[11] We use essentially the same methodology as Gourinchas (1998) in constructing the exchange rates; see pages 165-166, especially footnote 16.

growth and $\rho_t = i_t^f - \pi_t$ is the *ex post* real federal funds rate. Total manufacturing net employment captures aggregate real shocks to the traded goods sector. The real federal funds rate captures monetary policy shocks. These aggregate variables are assumed to be exogenous to the industry.

The last three terms in the regression equation, $(\alpha_i + \nu_t + \epsilon_{it})$, represent the effects of unmeasured influences on job creation and destruction at the industry, aggregate, and time-varying industry levels. We specify α_i as a fixed (non-stochastic) effect, and treat ν_t and ϵ_{it} as stochastic. The presence of ν_t implies non-independence of the regression error term across observations for any given year. Our estimated standard errors correct for this.[12]

4.2 Preliminary Results

Our preliminary estimation restricts the sample to the 1975 to 1993 period in order to make our new results most directly comparable to those in our earlier work (KST, 2003a and 2003b). Table 1 displays regression results for total gross job flows, and Table 2 shows results for the temporary and permanent components of the flows.

The results for total gross job flows (Table 1) are qualitatively very similar to those in our earlier work. Not surprisingly, the current standard errors tend to be considerably larger than those in our earlier work, and fewer estimated coefficients significantly different from zero at conventional levels. This is a direct consequence of the smaller sample size (360 observations compared to 8376 observations) and smaller cross-sectional variance of the industry-level regressors that results from using industry-level flows aggregated to 2-digit units of observation.

As in our earlier work, we find that a real appreciation of an industry's exchange rate is associated with a substantial increase in job destruction and a much smaller (less than one fifth the size) decrease in the rate of job creation. Thus, the lion's share of the decrease in the industry's employment associated with the real appreciation is due to increased job destruction rather than decreased job creation. Although the point estimates of the coefficients are remarkably similar to

[12] Failure to correct for non-independence of regression errors arising from unmeasured aggregate effects in panel regressions with aggregate regressors can result in substantial understatement of the standard errors associated with those regressors; see Kloeck (1981) or Moulton(1990).

those we estimated using plant-level flows aggregated to the 4-digit industry level, our new coefficient estimates have larger standard errors (for the reasons discussed above) and are not statitically significant.

An interesting pattern emerges when the job flows are decomposed into temporary and permanent components (Table 2).[13] Nearly all of the effect of real exchange rate movements on gross job flows is on the *permanent* components, with virtually no effect on the temporary components. Real exchange rate movements are associated with permanent, rather than temporary, job reallocation.

Although real exchange rates have little or no effect on temporary job flows, other explanatory variables do have substantial effects. Increases in the real federal funds rate results in a large, and statistically significant, increase in both the permanent and temporary components of job destruction. But the effects on both components of job creation are statistically insignificant. An increase in an industry's real price of output is associated with statistically significant increases in both the permanent and temporary components of job creation. But the effect on the temporary component of job destruction is statistically insignificant. Interestingly, real energy prices affect only *temporary* job destruction significantly.

We are planning a number of extensions to our econometric estimation for future drafts of this paper:

- We will use our current results to generate out-of-sample forecasts of job flows for 1994-2002. This will provide a test of how well the model predicts the job flows which occured during the dollar appreciation starting in the mid-1990s. The model will be also be re-estimated using data extending through 2001, and the results compared to those for the earlier period.

- We will decompose real exchange rate movements into trend and cyclical components, and include these components in the regression specification. Our hypothesis is that trend exchange rate movements will be associated primarily with permanent job flows, and cyclical

[13] Only regressions for job creation and job destruction are shown (the implied results for net emplyment growth and job reallocation have not yet been calculated).

exchange rate movements will be associated mainly with temporary flows. The very weak estimated effects of real exchange rate movements on temporary flows which we find in our current estimation suggests that cyclical exchange rate movements may also have very weak effects.

5 Summary

This preliminary investigation into the details of the relationship between real exchange rates and gross job flows reveals important differences in the effects on permanent and temporary flows. This result, along with earlier results in KST (2003b) showing the importance of trend and cycle components of real exchange rate movements, motivates additional research. In future drafts of this paper, we plan to develop a theoretical model that links components of real exchange rate movements with analogous movements in gross job flows to better understand the link between international factors and labor markets. We also plan to expand and enhance our econometric estimation of the KST and extended models.

A Data Appendix

Annual data on U.S. exports and imports by SIC industry have been updated through 2001 and are available through the NBER, as described in Feenstra, Romalis, and Schott (2002). These data are available for 1987 SIC industries, whereas our previous data base was for 1972 SIC industries. So we converted all other data from 1972 SIC basis to 1987 SIC basis using the concordance in the NBER Productivity Data Base.

Data from the 4-digit SIC NBER Productivity Data Base were used in KST (2003a, 2003b) and aggregated to the 2-digit industry level for data prior to 1997. For 1997-2001, it was necessary to collect 2-digit industry level data that updated the NBER data. The sources for each variable are:

- *Nominal and real domestic sales* – We use value of shipments data from the Bureau of Economic Analysis to update the domestic sales variables. The data includes nominal shipments, a chain-weight quantity index, and a chain-weight price index. Nominal shipments are taken directly, while the real shipments are calculated by multiplying nominal data in the base year (1996) by the quantity index.

- *Real output price* – We use GDP by industry from the BEA to update the real output price data. The GDP by industry data exists at the 2-digit level of aggregation, and includes an industry GDP deflator.

- *Real energy price* – For now we use West Texas Intermediate oil price in $/barrel from Haver Analytics relative to the PPI for all finished goods for all industries. The data in the NBER data base were created using National Energy Accounts and Energy Department's State Energy Price and Expenditure Report to calculate an index of price growth for six types of energy, then calculating each industry's expenditure on each of the six types. A weighted index for each industry can then be calculated.

- *Real materials price* – For now we use the PPI for crude materials and PPI for crude materials excluding energy from Haver Analytics relative to the PPI for all finished goods for all industries. The data in the NBER data base was created by finding price deflators for specific inputs, using input-output tables to determine the product makeup of each industry, and weighting the price deflators appropriately to create an index for each industry.

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Table 1: Baseline Job-Flow Regression Results

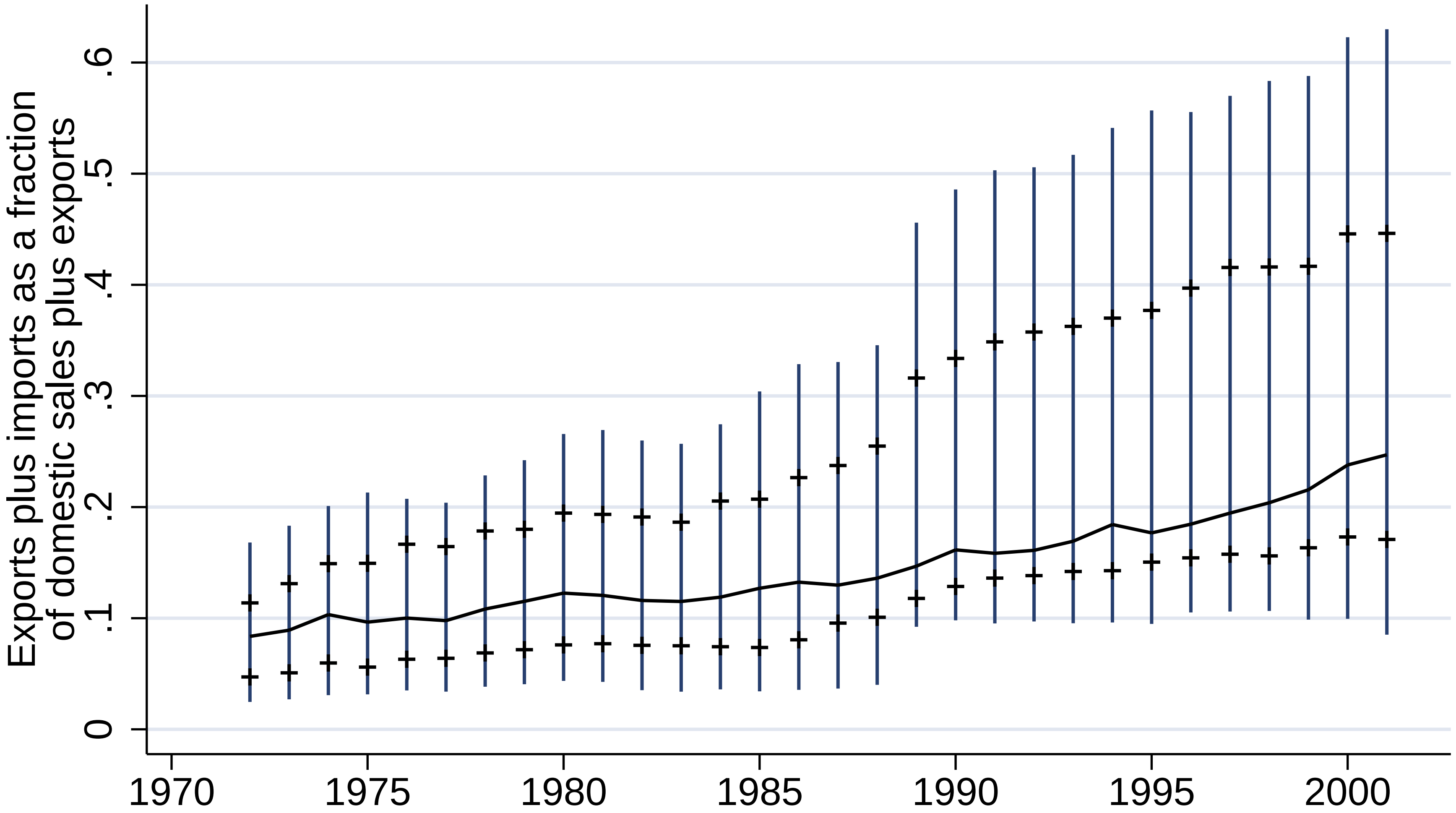
Independent Variable	**Dependent Variable**			
	N	C	D	R
Gross Job Creation	-.16	-.10	.06	-.03
	-.22	.15	.10	.12
Gross Job Destruction	.91**	.69**	-.23**	.46**
	.16	.14	.10	.17
Openness x RER growth	-.44	-.07	.37	.29
	.34	.17	.25	.26
Openness x real foreign GDP growth	.31	-.56	-.87	-1.43**
(coefficient x 100)	1.97	1.00	1.05	.59
Real Shipments growth	.55**	.31**	-.24**	.08
	.12	.08	.06	.07
MFG Net employment Growth	.23**	.08**	-.16**	-.08
	.05	.04	.04	.05
Real Fed Funds Rate	-.54**	-.14	.39**	.25**
	.20	.14	.09	.12
Real Output Price	.30*	.29**	-.01	.29**
	.16	.11	.10	.13
Real Energy Price	.00	.07	.07*	.15**
	.09	.07	.04	.07
Real Materials Price	.10	.04	-.06	-.02
	.12	.07	.08	.10
Aggregate Real Wage Growth	.00	-.07	-.07	-.13
	.19	.10	.13	.13

Table 2: Job-Flow Regression Results with Job-Flow Decomposition

Independent Variable	**Dependent Variable** N		C		D		R	
	Perm	Temp	Perm	Temp	Perm	Temp	Perm	Temp
Gross Job Creation - Total	-.20	.05	-.11	.02	.09	-.04	-.01	-.02
	.16	.09	.12	.03	.07	.06	.13	.05
Gross Job Destruction - Total	.69**	.22**	.56**	.13**	-.13**	-.09	.43**	.04
	.10	.09	.12	.04	.06	.07	.17	.06
Openness x RER growth	-.47*	.01	-.06	-.01	.41**	-.02	.35*	-.03
	.25	.17	.13	.09	.19	.13	.22	.15
Openness x real foreign GDP growth	.27	.77	-.23	.01	-.51	-.75	-.74	-.74
(coefficient x 100)	1.38	1.14	.98	.35	.45	.88	.65	.69
Real Shipments growth	.41**	.14**	.21**	.10**	-.19**	-.04*	.02	.07**
	.09	.03	.07	.02	.05	.02	.06	.03
MFG Net employment Growth	.16**	.07**	.07**	.01	-.09**	-.06**	-.02	-.06**
	.04	.02	.03	.01	.02	.02	.03	.02
Real Fed Funds Rate	-.39**	-.15*	-.17	.02	.22**	.17**	.05	.19**
	.14	.09	.11	.03	.06	.07	.12	.06
Real Output Price	.32**	-.04	.23**	.06**	-.10**	.10	.13	.16*
	.09	.11	.09	.02	.03	.10	.10	.09
Real Energy Price	.03	-.03	.05	.02	.02	.06*	.07	.08**
	.06	.04	.06	.01	.02	.03	.06	.03
Real Materials Price	.16	-.07	.09	-.05	-.07	.02	.02	-.04
	.10	.06	.07	.03	.07	.05	.09	.06
Aggregate Real Wage Growth	.09	-.10	.00	-.09**	-.09	.01	-.08	-.07
	.13	.10	.09	.04	.11	.09	.14	.10

Figure 1

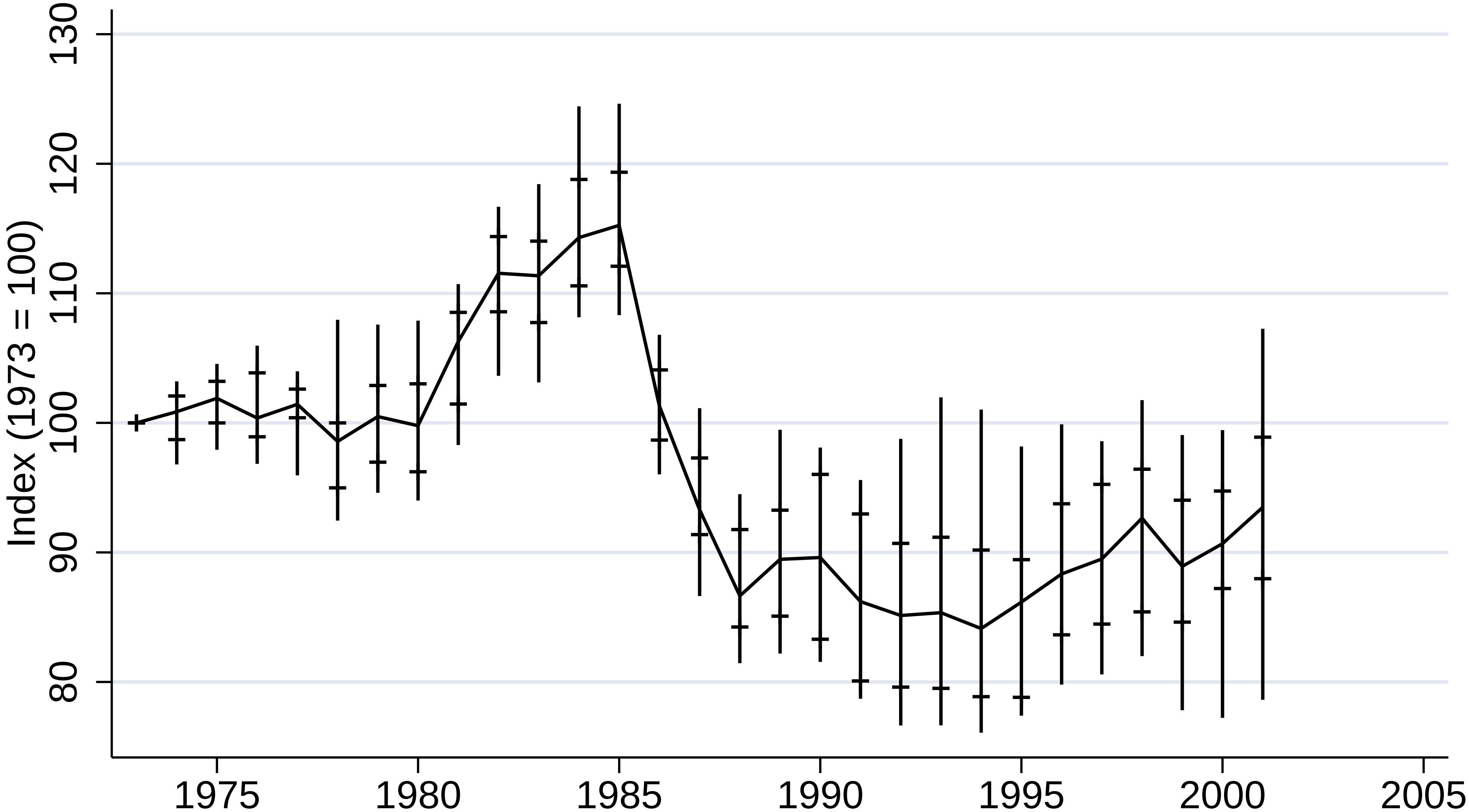
Distributions of Openness Across Industries



Note: Figure displays the time series of percentiles from the annual cross−section distributions of openness over 2−digit SIC industries.

Figure 2

Distributions of Real Exchange Rates Across Industries



Note: Figure displays the time series of percentiles from the annual cross−section distributions of real exchange rates over 2−digit SIC industries.

Figure 3

Distributions of Real Exchange Rate Growth Rates Across Industries