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# *Exchange Rates and Jobs: What Do We Learn from Job Flows?*

## 1. *Introduction*

This paper investigates the effect of real-exchange-rate movements on net and gross job reallocation in the U.S. manufacturing sector. Interpreting real-exchange-rate shocks as reallocation shocks, it then draws implications for modern business-cycle theories. Real exchange rates measure the relative price of domestic and foreign baskets of goods. Their fluctuations are pronounced and very persistent. Figure 1 reports the U.S. effective real and nominal exchange rates from 1972 to 1996. Most striking over this period, is the 40% appreciation of the dollar from 1980 to 1985, followed by a no less spectacular depreciation that lasted until the early 1990s. Using disaggregated quarterly data for the U.S. manufacturing from 1972 to 1988, I argue that such movements in relative prices induce a sizable job reallocation, both across and within narrowly defined tradable industries. To preview the paper's main results, the benchmark estimation yields an average 0.27% contraction in tradable employment over the three quarters following a mild 10% appreciation of the real exchange rate. This contraction is brought about through a simultaneous destruction of 0.44% and creation of 0.17% of tradable jobs.

Most importantly, these results are obtained after controlling for the potential endogeneity of the real exchange rate. In effect, this paper makes use of the substantial autonomous component driving exchange-rate movements to identify movements along the tradable industry fac-

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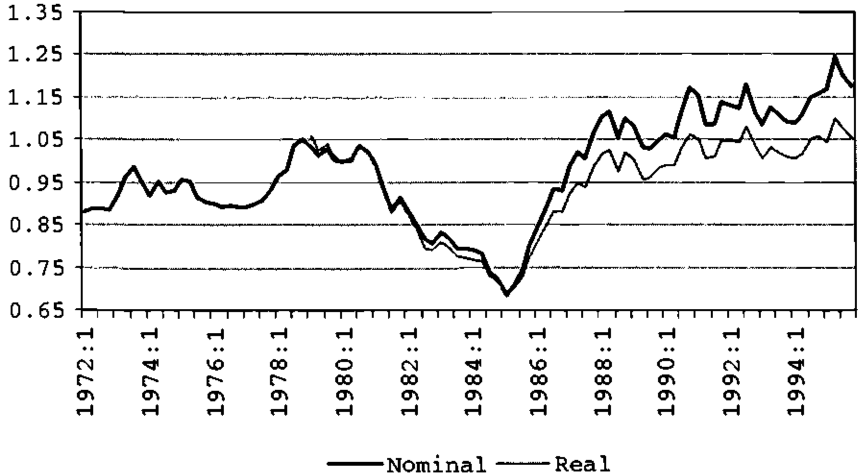
Figure 1 U.S. NOMINAL AND REAL EFFECTIVE EXCHANGE RATE INDEX (1980:1=1)




*Source:* IFS (series neu and reu).

tor demand curves. As a result, it can rule out supply or technology shocks as an alternative explanation for the results.

Investigating the dynamic response to exchange-rate shocks, this paper also finds that exchange-rate innovations induce less persistence than aggregate or monetary shocks and represent altogether a smaller source of fluctuations.

The simultaneous increase in job creation and job destruction has important implications. First, it indicates an increase in excess reallocation—the *churn*—during appreciation episodes. I find that excess job reallocation induced by a 10% appreciation represents 0.34% of tradable employment. Conversely, when the currency is depreciated, traded sector industries experience a *chill*, with lower job creation and destruction rates. Second, interpreting real-exchange-rate shocks as reallocation shocks, this paper provides useful information on how reallocative shocks propagate through the economy. Reallocation shocks have long been assumed to increase simultaneously *aggregate* job creation and destruction. The novel finding here is that relative-price shocks induce a *positive* comovement at the four-digit industry level. This suggests a cleansing effect that forces both entry and exit margins to comove positively.

The theoretical part of the paper explores the ability of a prototypical two-sector nonrepresentative business-cycle model to replicate both the aggregate and sectoral results. Since aggregate job creation and destruction comove negatively in the data, there is a tension between positive comovements at the industry level and negative ones at the aggregate level.

The next section provides a detailed motivation. Section 3 presents the empirical results and methodology, and Section 4 develops a two-sector matching model similar in spirit to that of Mortensen and Pissarides (1994).

## 2. *Motivation*

Figure 1 delivers three messages. First, changes in the nominal exchange rate account for the lion's share of real-exchange-rate fluctuations. Second, the magnitude of the fluctuations can be enormous. Lastly, in due time, those deviations appear to be reversed.

Such large movements raise two important questions. First and paramount, what is the source of these fluctuations? Second, how do firms respond to these shifts in relative prices? I address these questions in the following subsections.

### 2.1 ON EXCHANGE-RATE ENDOGENEITY

Exchange-rate movements are not exogenous. In a trivial way, the nominal exchange rate is the result of the confrontation of a relative demand for, and a relative supply of, currencies. Understanding the determinants of each side of this market has, and still is, the holy grail of international finance. In the long run, the current account has to be stabilized. At shorter horizons, the nominal exchange rate responds to domestic and foreign monetary conditions. Prices also adjust, as domestic firms may decide to stabilize their export prices in foreign currency (exchange-rate pass-through). Both variables, along with the nominal exchange rate, are determined in a dynamic equilibrium. In standard intertemporal models of exchange-rate determination, this implies that movements in the real exchange rate reflect the response of the economy to some fundamental impulses: domestic and foreign monetary policy, supply, and technology shocks, or aggregate demand. Rather than tracing the impact of the exchange-rate shock itself, a natural course of action would consist in evaluating the relative importance of the various impulses directly (Betts and Devereux, 1997; Chari, McGrattan, and Kehoe, 1996; Backus, Kehoe, and Kydland, 1995).

Instead, this paper starts with the premise that real-exchange-rate movements contain an important autonomous component. Before going any further, it is necessary to motivate this approach. A large body of empirical work has aimed to characterize the relationship between the real exchange rate and its fundamental determinants, for instance productivity differentials or real-interest-rate differentials (de Gregorio, Giovannini, and Wolf, 1994). It is widely recognized that this quest has, so far, yielded disappointing results. As Meese and Rogoff (1983) have forcefully demonstrated, the forecasting ability at short to medium horizons (1 quarter to 2 years) of the most refined models is poor compared to that of a more parsimonious random walk representation. The simple Mundell–Fleming–Dornbusch model linking real-exchange-rate depreciation to real interest rates differential does not appear to be supported by the data (Campbell and Clarida, 1987, Meese and Rogoff, 1988), and the empirical evidence in Clarida and Gali (1994) suggests that monetary shocks account for only a third of the variance of real-exchange-rate one-year-ahead forecast errors. At longer horizons (4 years), Mark and Choi (1997) find more encouraging results and conclude that monetary models retain some predictive power.[1]

Further, numerous empirical studies suggest that deviations of the real exchange rate from its time-varying equilibrium are not permanent, yet very persistent, with a half-life commonly estimated between 2.5 and 5 years [see Froot and Rogoff (1995) and Rogoff (1996) for a survey]. As emphasized by Rogoff (1996), the slow rate at which exchange-rate deviations fade away is hard to reconcile with their extreme short-run noisiness. In particular, monetary shocks or productivity shocks are unlikely to be the most important source of short-run fluctuations. Overall, this indicates that additional sources of fluctuations, beyond the standard determinants postulated in models of exchange-rate determination, are at play and indeed dominate over the short to medium term.

Such considerations constitute this paper's starting point: exchange-rate fluctuations contain an empirically important, if conceptually elusive, source of fluctuations that is independent of the other determinants of the economy (monetary and fiscal policy, technology, etc.). In other words, I use autonomous fluctuations in real exchange rates to identify disaggregated industries' factor demand.

## 2.2 ON MICRO ADJUSTMENT, AGGREGATE AND REALLOCATION SHOCKS

The real exchange rate represents the relative price of two baskets of goods. Like any relative price, movements in the real exchange rate direct

1. Mark (1995) also finds significantly better long-horizon (4 years) forecasting power for the nominal exchange rate using a fundamental equation that incorporates domestic and foreign output and money supply.

resources to and from specific sectors of the economy. One would, in general, expect large fluctuations in relative prices to have major implications on the relative quantities supplied and demanded. The levels of production, prices and markups, profit margins, and input demands and—for exporters—the decision to enter or exit foreign markets may all be affected by fluctuations in exchange rates. In the traditional two-sector model with a representative firm in each sector, competitive and frictionless markets, domestic competition for scarce factors of production induces, *ceteris paribus*, a reallocation of factors *across* sectors: following an appreciation of the currency that translates into a lower price for tradables, jobs are destroyed, workers fired, and capital dismantled in the traded goods sector, while jobs are created, the same workers hired, and the same machines reassembled in the nontraded goods sector. Inputs are continuously reallocated between sectors so as to maintain the economy on its production possibility frontier at all times.

Most previous studies focused on this *net* factor reallocation [Campa and Goldberg (1996) on investment, Branson and Love (1988), Goldberg and Tracy (1998), Burgess and Knetter (1996) on employment], on pricing-to-market and sectoral pass-through (Knetter, 1993), or on the static comparison of reallocation levels for exporters and nonexporters (Bernard and Jensen, 1995a).[2]

Nonconvexities and heterogeneity enrich this picture substantially. Consider first the entry–exit decision in the presence of irreversible adjustment costs, and uncertainty about the future value of the exchange rate. Firms may decide to stay invested in a foreign market—and absorb fluctuations in the exchange rate on their profit margin—or to postpone entry in the hope that adverse exchange-rate movements might be reversed in the near future. Similar arguments apply to the decision to hire workers, invest in new machines, upgrade capital, or set prices. Typically, the optimal policy will be one of inaction interspersed with brief adjustment episodes [a generalized $(S,s)$ policy]. In a representative firm setting, this optimal inaction region blurs the link between exchange-rate movements and reallocation of factors of production. Firms will only enter or leave a market when the exchange rate has deviated sufficiently far from equilibrium. This indicates a nonlinearity presumably hard to document on aggregate

2. Bernard and Jensen (1995b) analyze the entry–exit decision of U.S. manufacturing exporters using plant-level data from the Annual Survey of Manufactures (ASM). They conclude that entry costs are relatively small and plant characteristics are crucial. However, by design they limit their analysis to the binary decision exporter–nonexporter. This precludes looking at import-competing firms. Moreover, as Bernard and Jensen (1995a) discuss, the export measure reported in the ASM only captures direct exports. They calculate that the ASM reported exports only account for 70% of exports measured by the Foreign Trade Division at ports of export.

data and history dependence (hysteresis). Irreversibilities were advanced as a potential explanation for the continued U.S. trade and current account deficit after 1985. Krugman (1989) concluded provocatively that real exchange rates fluctuate wildly exactly because they do not matter.

However, this conclusion is only valid if the pattern of microeconomic adjustment carries over from the plant or firm level to the sectoral or aggregate one. As recent theoretical research demonstrates in the context of price setting or investment dynamics (Caballero, 1992; Caplin and Leahy, 1991; Caballero, Engel, and Haltiwanger 1997), this assumption is often not warranted. Heterogeneity across production units contemplating an entry–exit decision will typically tend to smooth out at the aggregate level any sharp microeconomic nonlinearities.

One-sector nonrepresentative agent models of reallocation have been recently developed which build upon the rich empirical evidence on microeconomic nonconvexities and heterogeneity (Mortensen and Pissarides, 1994; Ramey and Watson, 1997; Caballero and Hammour, 1996; Hall, 1997b). These models emphasize the importance of both entry and exit margins for understanding critical features of the business cycle uncovered by Davis and Haltiwanger (1990). First, generically, both entry and exit margins are active simultaneously: gross flows are substantially larger than net flows. Second, job destruction plays an essential role in aggregate fluctuations and tends to be concentrated during brief episodes that coincide with sharp downturns in economic activity. Job creation, by contrast, is substantially less volatile over the course of the business cycle. In short, recessions are times of large job destruction and mild decline in job creation. The general challenge, so far, has been to build a theory of aggregate fluctuations that matches these stylized facts.

While existing models all share to some degree the same features, their dynamic and welfare implications differ vastly. In Mortensen and Pissarides (1994) and Cooper, Haltiwanger, and Power (1994), firms want to reallocate workers across employment opportunities or engage in nonproduction activities—like search—when aggregate productivity declines. Recessions are times of *cleansing* of the productive structure. In turn, they are also the best times for firms to enter and try to hire new workers. This cleansing effect of recessions explains why destruction is very concentrated, but also implies that destruction and creation are tightly synchronized.[3] As a result, unemployment deviations will typically tend to be short-lived.[4]

In Caballero and Hammour (1996), the presence of convex creation

3. See Caballero and Hammour (1996) for a discussion of the importance of timing assumptions for the correlation between job creation and job destruction.
4. See Cole and Rogerson (1996) for developments on this point.

costs, in conjunction with contractual inefficiencies, decouples creation and destruction, implying a large buildup of inefficient unemployment in periods of recession. However, match separation is still *ex post* efficient, and agreed upon by both the worker and firm. The contractual inefficiency distorts both the first and second moments of the gross flow series and generates countercyclical reallocation.

This reorganization view of recessions is criticized by Ramey and Watson (1997), who argue that recessions do not appear to be good times for job losers. In their model, workers and firms are engaged in a dynamic version of the prisoner's dilemma. While renegotiation is possible, the key assumption is that the match becomes nonviable as soon as one party deviates. Thus matches can be terminated following a negative productivity shock, even though the surplus is still positive, as it becomes harder to prevent either party from deviating. Their model emphasizes the importance of the "fragile" matches that accumulate close to the cutoff.

Den Haan, Ramey, and Watson (1997) present and calibrate a dynamic general equilibrium model with costly capital adjustment, similar in spirit to Mortensen and Pissarides (1994). Their model emphasizes the interaction between endogenous job destruction and capital accumulation as a source of additional persistence. As more jobs are destroyed, the marginal product of capital decreases. The endogenous response of the economy is a decline in investment, to restore the marginal product of capital. However, lower investment triggers secondary waves of separation that further depress the marginal product of capital and induce considerably more unemployment persistence.

Hall (1997b) also points out the theoretical and empirical importance of the discount rate for the economics of the shutdown margin. In his model, firms will decide to liquidate their inventories and reduce their workforce simultaneously when the value of output is high and expected to decline. In general equilibrium, recessions are associated with a high Arrow–Debreu "time-zero" price of output, or equivalently, with a high interest rate.

These models are quite successful at explaining how aggregate shocks can match the Davis–Haltiwanger (1990) stylized facts. Yet, they restrict their attention to the dynamic response to *aggregate* productivity or demand shocks. A natural question, within that framework, is the extent and pattern of excess reallocation induced by exchange-rate movements. While real-exchange-rate movements may exert pressure to relocate factors of production *across* sectors, they will also influence the pattern of reallocation *within* narrowly defined sectors and industries. This paper, analyzes *inter-* and *intra*sectoral dynamic reallocation patterns in response to both aggregate and reallocation shocks.

Moreover, existing empirical work using structural VAR-based variance decompositions generally concludes that standard impulses (technology shocks, government expenditures, or monetary policy) do a poor job of explaining the volatility of aggregate output (Cochrane, 1994; Hall, 1997a, 1997b). Reallocation shocks—usually interpreted as the result of sectoral-specific technology shocks, or relative demand shifts—have long been another prime candidate to explain aggregate fluctuations, following the seminal work of Lilien (1982).[5] Davis and Haltiwanger (1996), using gross job flows and long-run restrictions to identify the relative importance of aggregate and reallocative shocks in the U.S. economy, conclude that the latter represent the major source of job reallocation. Campbell and Kuttner (1996) reach a similar conclusion looking at fluctuations in sectoral employment shares. On the other hand, Caballero, Engel, and Haltiwanger (1997), using micro data on employment adjustment, conclude that the bulk of average-employment and job-destruction fluctuations is accounted for by aggregate rather than reallocation shocks, while job creation reacts strongly to allocative shocks.[6]

Both arguments suggest that a first order of business consists in establishing more structural correlations between primitive disturbances and measures such as gross flows. Davis and Haltiwanger (1997) explore this avenue in the context of oil shocks. This paper presents an attempt in the same direction using exchange-rate fluctuations as the main driving force, and attempts to uncover the nature and importance of these adjustment patterns using a rich disaggregated data set of U.S. manufacturing plants.

To do so, I trace back sectoral fluctuations to exogenous movements in the real exchange rate and then develop a prototypical two-sector nonrepresentative-agent business-cycle model (with tradable and nontradable goods) to explore the ability of the model to replicate salient features of the data. In practice, the problem consists in mapping gross flow movements to exogenous real-exchange-rate fluctuations.

This is difficult for two different, but related, reasons. First, as noted above, exchange rates move in reaction to changes in monetary or aggregate conditions, making inference difficult. It is precisely in order to avoid similar problems that a number of papers use oil shocks as an exogenous source of disturbance (Davis and Haltiwanger, 1997; Campbell and Kuttner, 1996). Second, as Bernanke, Gertler, and Watson (1997) argue, in the context of oil shocks, the economy's response to exchange-rate innovations may also reflect the endogenous response of monetary

5. See Lilien (1982), Abraham and Katz (1986), and Blanchard and Quah (1989).

6. In the context of nonrepresentative agent models, reallocation shocks are often modeled as a mean-preserving spread on the cross-section distribution of idiosyncratic shocks, in a one-sector economy.

policy to the initial disturbance. While the original impulse can be thought of as exogenous, it is not possible, without additional identification assumptions, to separate the direct effect of exchange-rate shocks from the expected monetary policy response. The more likely it is that monetary policy reacts to the original disturbance, the more severe this problem is. Arguably, it may not be too much of a problem in the case of the United States, to the extent that monetary policy is set largely independently of the exchange rate.[7] I will allow for exchange-rate innovations to feed back on monetary policy, so that the responses should be thought of as a combination of the response to exchange innovations and the expected implied monetary response.

## 3. *Exchange Rates and Gross Flows*

This section investigates the response of gross and net employment flows to exchange-rate fluctuations. This requires an operational definition of tradables and nontradables, a measure of gross flows, and a real exchange rate. I start with a description of the data construction, then discuss the empirical specification and results. I look at both net and gross employment changes, using quarterly disaggregated data for U.S. manufacturing from 1972 to 1988. The focus on manufacturing is largely dictated by the availability of gross flow data. While this excludes services, arguably an important component of nontradables, it will soon become apparent that finely disaggregated manufacturing industries exhibit substantial variation in international exposure that allows identification of exchange-rate effects.

### 3.1 THE DATA

*3.1.1 Tradable and Nontradable Industries* I first allocate four-digit industries into a traded, a nontraded, and a residual group. This exercise aims at measuring the exchange-rate exposure of disaggregated U.S. manufacturing industries. Campa and Goldberg (1995) identify three distinct channels through which an industry is exposed to exchange-rate fluctuations: export revenues as a share of the industry's revenues, the extent of import competition, and lastly the cost of imported inputs. I abstract from the last measure, which would require use of an input–output

7. Since 1985 and the abrupt policy shift of the Reagan administration, the Fed has intervened more systematically on foreign exchange markets, sometimes in concert with partner central banks. These interventions, however, are mostly *sterilized*, implying an offsetting action at the open-market window and unchanged money supply or interest rates.

table, and concentrate on export shares and import penetration ratio.[8] While the definition of traded good industries is relatively straightforward (if we observe sufficient levels of trade in some good, then it must be traded), this is not the case for nontradables. An industry might be fully integrated internationally, yet experience very low levels of exports and imports. Luckily, this problem is only likely to lead to the spurious classification of some tradable industries as nontradable, which biases the results towards zero.[9] Using the NBER trade database, I adopt the following operational definition of tradable and nontradable industries. First, I calculate for each four-digit industry and every year in the sample the export share and import penetration ratios. Then I classify an industry as traded if *either* the export share exceeds 13% *or* the import penetration ratio exceeds 12.5% *in all the years of the sample.* Conversely, an industry is classified as nontraded when either (1) the export share is lower than 1.3% and the import penetration ratio is lower than 6.8% *in all years in the sample* or (2) the export share is lower than 5.8% and the import penetration is less than 0.8% *in all years in the sample.* All other sectors are discarded.[10] This selection criterion ensures that sectors experiencing a transition from very closed to very open or vice versa are excluded from the sample. 48 sectors are initially identified as nontraded and 69 as traded, out of a total of 450 four-digit manufacturing sectors. Based on the NBER trade database, I further exclude all sectors without detailed information on exports and imports by country of destination or origin. The final list includes 35 nontraded sectors and 68 traded ones. Tradable industries are further classified as exporters or import-competing according to their export share and import penetration ratios. Out of the 68 traded industries (with some overlap), 34 are classified as exporters and 39 as import-competing sectors.[11]

Nontradables are concentrated primarily in nondurables, where they represent around 23% of employment. By comparison, nontradables rep-

8. There are reasons to believe that omitting imported inputs may not bias the results seriously, since the direction of the effect is likely to be the same as for nontraded industries, that is, an appreciation leads to a relative gain in profitability through a decline in input costs. The bias is likely to be more serious if industries classified as traded based on their output are in fact very cost-sensitive to exchange-rate fluctuations.

9. An alternative would be to compare domestic and foreign prices. Foreign prices for exported and imported goods are relatively difficult to find.

10. The values for the export shares and import penetration ratios cutoffs are similar to the ones used in Davis, Haltiwanger, and Schuh (1996).

11. The list of industries with their SIC code, average export share, import penetration, and share of the two-digit industry labor force is reported in an appendix available from the author or on the Web: `http://www.princeton.edu/~pog/RER-home.html`.

Table 1 CHARACTERISTICS OF NONTRADED AND TRADED EXPORTERS AND IMPORT-COMPETING FIRMS

| | | | *Traded* | | |
|---|---|---|---|---|---|
| *Variable* | *All* | *Nontraded* | *All* | *Exporters* | *Import-Competing* |
| Capital: | | | | | |
| Per production worker | 89.92 | 75.51 | 102.47 | 125.29 | 95.93 |
| Per worker | 63.16 | 50.20 | 70.23 | 82.02 | 69.51 |
| Investment: | | | | | |
| Per production worker | 27.75 | 20.70 | 43.74 | 55.07 | 33.15 |
| Per worker | 19.56 | 14.95 | 29.62 | 35.62 | 23.96 |
| Employment: | | | | | |
| Production workers | 29.14 | 31.65 | 27.32 | 31.49 | 21.24 |
| Total | 40.46 | 49.13 | 41.37 | 53.93 | 26.48 |
| Shipments | 4784 | 5784 | 5689 | 5985 | 4920 |
| TFP (%) | 0.57 | 0.46 | 0.48 | 0.65 | 0.41 |
| Materials intensity (%) | 51.41 | 51.46 | 52.97 | 51.23 | 54.03 |
| Energy intensity (%) | 2.56 | 2.18 | 2.41 | 2.13 | 2.77 |
| Wages: | | | | | |
| Production workers | 19.42 | 18.33 | 20.06 | 23.23 | 17.53 |
| Total | 22.01 | 20.70 | 23.03 | 26.76 | 19.96 |

Capital, investment, shipments, and wages: thousands of 1987 dollars. Employment: thousands. Materials intensity: materials expenditures/shipment. Energy intensity: energy expenditures/shipment.
*Source:* NBER productivity database and author's calculations.

resent only 6.6% of durable manufacturing employment. Overall, nontradable goods are either perishable goods (such as food products and newspapers) or heavy durable goods (such as concrete, bricks, or stone) for which transportation costs are prohibitive. Conversely, tradables tend to be concentrated in durable goods industries, with an average share of durables employment of 21.4%. Major exporting two-digit industries, measured in terms of employment, include nonelectrical machinery (SIC 35), with a 41% share of export industries employment, transportation equipment (SIC 37, 27%), and instruments (SIC 38, 8%). Overall, import-competing industries represent quite a small fraction of total manufacturing employment (around 11%) and tend to be concentrated in paper (SIC 26), with a 14% share of import-competing industries employment, leather (SIC 31, 15%), and especially motor vehicles (SIC 3711, 31%).[12]

Table 1 reports some characteristics for industries grouped according

12. See the appendix available on the web.

to the previous classification.[13] We observe that traded-goods producers tend, on average, to be more capital-intensive, to pay higher wages, to be smaller, and to have slightly higher total factor productivity. Looking at exporting versus import-competing sectors, we observe that exporters pay higher wages, tend to be larger in terms of shipments or number of employees, and are more capital-intensive and more productive (as measured by total factor productivity).

*3.1.2. Gross Flows* Quarterly sectoral data on job creation and job destruction are tabulated by Davis and Haltiwanger (1990) for both two-digit and four-digit industries.[14] These data are constructed from the Census's Longitudinal Research Database, and cover U.S. manufacturing over the period 1972:2–1988:4.[15]

Using the previous classification, I first aggregate gross flows for traded, nontraded, exporter, and import-competing sectors. Table 2 reports descriptive statistics for the resulting gross and net flows. The main points are as follows. First, net employment growth is negative for all groups, reflecting the declining importance of manufacturing employment in the U.S. economy. This downward trend is especially marked for import-competing industries, with an average quarterly employment decline of 0.62%. Second, defined tradables and nontradables represent roughly similar shares of total manufacturing employment, around 13%. This indicates that the bulk of manufacturing employment cannot be classified as either traded or nontraded according to our criterion. Third, for all sectors, job destruction exhibits more volatility than job creation. Furthermore, creation and destruction are proportionately more volatile for tradable industries. Taken together, these results indicate larger turbulence in the traded goods sector. This paper explores the link between this turbulence and exchange-rate exposure. Lastly, as pointed out by Foote (1995), one should expect industries with a marked downward employment trend to exhibit a larger volatility of job destruction, as the exit margin is "hit" more frequently while the industry shrinks. One

13. The data referred to in the previous footnote are taken from the NBER productivity database. See Bartelsman and Gray (1996) for a description.

14. I thank John Haltiwanger for providing the sectoral data through his ftp site.

15. This data set is now widely used in macro and labor studies, and I refer the reader to Davis, Haltiwanger, and Schuh (1996) for a detailed description. Two points are worth noting. First, the timing of quarters is nonstandard, with quarter 1 of year $t$ running from November of year $t - 1$ to February of year $t$. Second, the SIC underwent substantial changes in 1987. Davis and Haltiwanger's data report sectoral job creation and destruction using the SIC72 classification for 1972–1986 and the SIC87 classification for 1987–1988. The last two years of data were spliced into the SIC72 classification using the concordance table provided in Bartelsman and Gray (1996).

Table 2 GROSS FLOWS BY SECTORS

| | *Job Creation* | | | | *Job Destruction* | | | |
|---|---|---|---|---|---|---|---|---|
| *Sector* | *Mean* | *Standard Deviation* | *Min.* | *Max.* | *Mean* | *Standard Deviation* | *Min.* | *Max.* |
| Nontraded | 5.48 | 0.79 | 4.04 | 7.54 | 5.67 | 1.02 | 3.46 | 8.61 |
| Traded | 5.36 | 0.96 | 3.16 | 7.50 | 5.76 | 1.68 | 3.04 | 10.85 |
| Exporters | 4.82 | 1.06 | 2.55 | 7.51 | 5.00 | 1.69 | 2.29 | 10.05 |
| Import-comp. | 6.01 | 1.55 | 2.86 | 9.84 | 6.64 | 2.68 | 3.44 | 16.27 |
| | *Excess Reallocation* | | | | *Net Employment Growth* | | | |
| | *Mean* | *Standard Deviation* | *Min.* | *Max.* | *Mean* | *Standard Deviation* | *Min.* | *Max.* |
| Nontraded | 10.16 | 1.20 | 6.93 | 12.50 | −0.19 | 1.29 | −3.88 | 2.80 |
| Traded | 9.38 | 1.53 | 6.09 | 13.76 | −0.39 | 2.28 | −7.69 | 3.41 |
| Exporters | 8.08 | 1.83 | 4.58 | 15.01 | −0.18 | 2.21 | −6.21 | 3.64 |
| Import-comp. | 10.29 | 2.19 | 5.72 | 16.46 | −0.62 | 3.26 | −10.42 | 4.06 |
| | *Manufacturing Employment Share* | | | | | | | |
| | *Mean* | *Standard Deviation* | *Min.* | *Max.* | | | | |
| Nontraded | 12.11 | 0.45 | 11.32 | 12.95 | | | | |
| Traded | 14.54 | 0.32 | 13.70 | 15.27 | | | | |
| Exporters | 8.48 | 0.62 | 7.29 | 9.59 | | | | |
| Import-comp. | 6.41 | 0.60 | 5.36 | 7.50 | | | | |

*Source:* Gross flows from Davis and Haltiwanger, LRD; and author's calculations.

finds indeed that the job destruction rate is both higher and more volatile for import-competing industries.

3.1.3. *Real Exchange Rate* The last ingredient for the analysis is the real exchange rate. I use an *industry-based* definition of the real exchange rate, constructed as a trade-weighted log average of bilateral WPI-based real exchange rates. The trade weights are industry-specific and constructed from the NBER trade database, which includes, for each four-digit industry, annual data on shipments, exports, and imports, disaggregated by country of destination (exports) or origin (imports). The industry-specific log real exchange rate is then a weighted average of the WPI-based log real exchange rate against *that sector's* major trading partners.[16]

16. For the purpose of this paper, I define the major trading partners by calculating the average export/import shares of total export/import for each industry and destination/origin country. Country $i$ is considered a major trading partner for industry $j$ if either (1)

For the appropriate sectors, both an export- and an import-based sectoral real exchange rate are created in this fashion. A similar methodology is also used to construct real exchange rate indices for each of the two-digit industries and for nontradable industries, whenever data on exports and imports are available.[17]

Figure 2 reports the real-exchange-rate index for some two-digit industries. At this level of aggregation, the figure reveals a similar broad pattern in all industries, with a significant real appreciation during the first half of the eighties corresponding to the nominal appreciation of the dollar, and a rapid depreciation from 1985 onwards. Note however, that the figures do exhibit substantial variation in terms of timing and amplitude. For instance, furnitures (SIC 25) experienced a rapid real depreciation between 1972 and 1977, while textiles' real exchange rate (SIC 22) remained relatively unchanged until late 1980. This sectoral variation will help identification.

### 3.2 EMPIRICAL RESULTS

In this subsection, I consider first the reduced-form response of gross and net flows to exchange-rate movements. Issues of simultaneity are discussed and controlled for. I then present dynamic structural estimation based on a VAR decomposition.

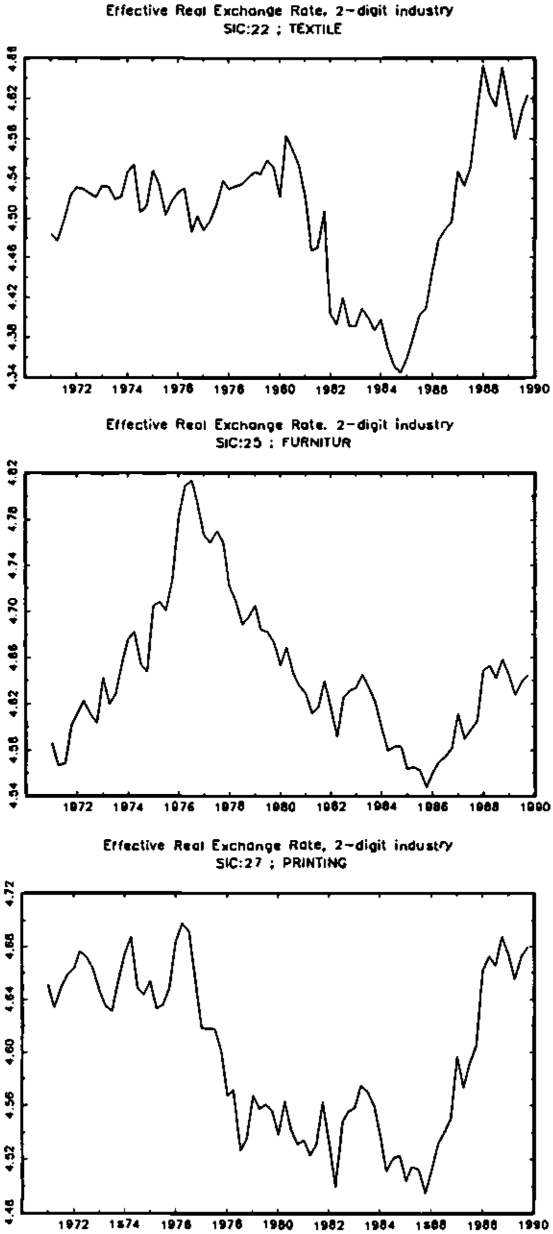
*3.2.1 Reduced-Form Estimation* One can think of the approach of this subsection as mapping an industry factor demand curve from movements in the real exchange rate. I start with the direct estimation results for net and gross job flows and then discuss simultaneity issues and instrumentation.

NET EMPLOYMENT CHANGES Given the definitions adopted, nontraded industries play the role of a control group: their international exposure is limited, and their response to exchange-rate fluctuations should be minimal. On the other hand, an appreciation of the real exchange rate should induce a reallocation of factors away from the traded-good sector. That

country *i* is among the largest trading partners accounting for the first 50% of exports/imports for industry *j* or (2) trade with country *i* represents more than 10% of exports/imports, on average over the sample period. The real exchange rate is then constructed as a log average using export/import shares as weights. For each industry, the real exchange rate is normalized to 100 in 1987:4. Data on WPI and nominal exchange rates were obtained from the International Financial Statistics Database. China, Iraq, Hong Kong, Taiwan, and the United Arab Emirates were deleted as trading partners, since no reliable data on the bilateral real exchange rate were available.

17. Trade data on all four-digit sectors were used to construct weights at the two-digit level.

Figure 2 SIC-2 LOG REAL EXCHANGE RATE




1987:4 = ln 100.

is, each traded industry's employment level should respond negatively to an appreciation of its real exchange rate. In turn, the decline in employment can result from a decline in job creation or an increase in job destruction. At the aggregate level, there is overwhelming evidence that the adjustment takes place along the exit margin.

I investigate each question in turn. Starting with net employment changes, I evaluate the amount of intersectoral reallocation that is induced by the exchange rate. I then turn to the gross flows.

Consider the following specification:

$$\hat{E}_{it} = \alpha_i + \beta(L)\lambda_{it} + \gamma(L)Z_t + \epsilon_{it}, \tag{1}$$

where $\hat{E}_{it}$ is the net employment growth in industry $i$ between time $t - 1$ and $t$, and $\lambda_{it}$ is the deviation from trend of the industry specific log real exchange rate. $Z_t$ contains aggregate variables likely to influence both the real exchange rate and employment growth. I include in $Z_t$ total manufacturing employment growth $\hat{E}_t$, to capture the effect of aggregate shocks, as well as the federal funds rate $i_t$. Finally, $\beta(L)$ and $\gamma(L)$ are lag polynomials. They are allowed to vary across groups: nontraded, traded, exporters, and import-competing. The results are presented in panel A of Table 3.

Under the null hypothesis that all variations in employment growth are unrelated to real-exchange-rate fluctuations, the real exchange rate should have no explanatory power. The table indicates that a depreciated exchange rate has a small effect on tradable employment growth.[18] A 10% depreciation of the exchange rate (a high value of $\lambda$) leads to an increase of tradable manufacturing employment of 0.27%.[19] Nontradable employment appears unresponsive to exchange-rate movements (with a sum of coefficients equal to 2.18 and a standard error of 1.88). However, note that the point estimates for tradable and nontradable are close together and one cannot reject the hypothesis that they are equal. Further, comparing export and import-competing industries, it appears that the effect comes mostly through an employment increase in import-competing industries. These reduced-form results indicate a limited amount of intersectoral reallocation. Looking at individual coefficients, it appears that employment growth increases for the first 2 quarters, then declines.

18. Note that equation (1) is a growth-level relation with the industry employment growth on the left-hand side and the real-exchange-rate deviation from trend on the other side.

19. A caveat on reading the regression results: a coefficient of $\beta$ for the real-exchange-rate coefficient implies that a 1% depreciation will increase employment growth by $\beta/100$%. A coefficient of $\alpha$ on aggregate employment growth implies that a 1% increase in growth rates will increase sectoral employment growth by $\alpha$%.

Table 3 EMPLOYMENT RESPONSE TO REAL-EXCHANGE-RATE DEVIATIONS

| *Sector:* | *Two-digit* | | | *Traded* | | | | | | *Nontraded* | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *All* | | *Exports* | | *Import comp.* | | | |
| *Regressor* | *Timing* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* |
| | | | | Panel A: Direct Estimation | | | | | | | |
| $\lambda_t$ | Cont. | 1.40 | 1.65 | 4.97 | 2.47 | 2.72 | 3.32 | 4.58 | 3.18 | 6.24 | 3.38 |
| | 1 lag | −0.64 | 2.29 | 5.47 | 3.40 | 2.60 | 4.70 | 8.24 | 4.32 | −3.13 | 4.45 |
| | 2 lags | −0.37 | 1.76 | −7.73 | 2.58 | −4.28 | 3.49 | −9.84 | 3.31 | −0.92 | 3.49 |
| | Sum: | 0.39 | 0.76 | 2.71 | 1.13 | 1.03 | 1.38 | 2.96 | 1.03 | 2.18 | 1.88 |
| $\hat{E}_t$ | Cont. | 0.68 | 0.03 | 0.66 | 0.06 | 0.48 | 0.07 | 0.77 | 0.08 | 0.52 | 0.08 |
| | 1 lag | 0.01 | 0.04 | 0.08 | 0.06 | 0.12 | 0.08 | 0.03 | 0.08 | 0.02 | 0.08 |
| | 2 lags | 0.17 | 0.03 | 0.28 | 0.05 | 0.37 | 0.07 | 0.18 | 0.07 | 0.06 | 0.07 |
| | Sum: | 0.85 | 0.04 | 1.02 | 0.07 | 0.98 | 0.10 | 0.98 | 0.10 | 0.60 | 0.10 |
| $i_t$ | Cont. | 0.05 | 0.03 | 0.05 | 0.05 | 0.18 | 0.07 | −0.08 | 0.07 | −0.03 | 0.07 |
| | 1 lag | −0.12 | 0.03 | −0.05 | 0.06 | −0.10 | 0.08 | 0.01 | 0.08 | −0.06 | 0.08 |
| | 2 lags | 0.02 | 0.03 | 0.01 | 0.06 | −0.07 | 0.07 | 0.04 | 0.08 | 0.07 | 0.07 |
| | Sum: | −0.06 | 0.02 | 0.01 | 0.03 | 0.01 | 0.05 | −0.03 | 0.04 | −0.01 | 0.04 |
| | | | | PANEL B: 2SLS | | | | | | | |
| $\lambda_t$ | Cont. | 6.34 | 1.76 | −0.42 | 2.41 | 1.65 | 3.03 | −3.15 | 3.23 | 3.81 | 3.89 |
| | 1 lag | −6.15 | 2.05 | 5.34 | 2.86 | 1.96 | 3.61 | 8.48 | 3.84 | −3.68 | 4.62 |
| | 2 lags | 0.21 | 1.67 | −3.44 | 2.34 | −3.12 | 2.95 | −4.86 | 3.14 | 0.12 | 3.85 |
| | Sum: | 0.39 | 1.47 | 1.47 | 1.87 | 0.49 | 2.24 | 0.47 | 2.58 | 0.25 | 3.12 |
| $\hat{E}_t$ | Cont. | 0.70 | 0.03 | 0.64 | 0.06 | 0.47 | 0.07 | 0.76 | 0.08 | 0.51 | 0.08 |
| | 1 lag | 0.01 | 0.04 | 0.06 | 0.06 | 0.12 | 0.08 | 0.01 | 0.09 | 0.02 | 0.08 |
| | 2 lags | 0.17 | 0.03 | 0.29 | 0.05 | 0.37 | 0.07 | 0.19 | 0.07 | 0.07 | 0.07 |
| | Sum: | 0.88 | 0.04 | 1.00 | 0.08 | 0.96 | 0.10 | 0.96 | 0.11 | 0.60 | 0.11 |
| $i_t$ | Cont. | 0.04 | 0.03 | 0.03 | 0.05 | 0.16 | 0.07 | −0.10 | 0.07 | −0.03 | 0.07 |
| | 1 lag | −0.11 | 0.03 | −0.05 | 0.06 | −0.09 | 0.08 | 0.01 | 0.08 | −0.07 | 0.08 |
| | 2 lags | 0.03 | 0.03 | 0.01 | 0.06 | −0.06 | 0.07 | 0.01 | 0.08 | 0.07 | 0.08 |
| | Sum: | −0.04 | 0.02 | −0.02 | 0.03 | −0.01 | 0.05 | −0.08 | 0.05 | −0.03 | 0.05 |

The tables shows the response of employment growth to deviations of the real exchange rate from trend for each sector ($\lambda$), change in total manufacturing employment growth ($\hat{E}$), and the federal funds rate $i_t$. The coefficients are constrained to be equal across sectors, except for a constant (not shown). The first column reports the results for all two-digit industries. The remaining columns report the result for four-digit tradables, exporters, import-competing, and nontradables. Panel A reports fixed-effect estimation. Panel B instruments the real exchange rate with the Hall–Ramey instruments (Hall, 1988): military expenditure growth, crude-oil price growth, political party of the President. Observations are quarterly, 1972:2 to 1988:4.

*Source:* Net employment change from Davis and Haltiwanger (1990), LRD; real exchange rate: author's calculations.

Table 4 JOB-DESTRUCTION RESPONSE TO REAL-EXCHANGE-RATE DEVIATIONS

| *Sector:* | *Two-digit* | | | *Traded* | | | | | | *Nontraded* | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *All* | | *Exports* | | *Import comp.* | | | |
| *Regressor* | *Timing* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* |
| | | | | Panel A: Direct Estimation | | | | | | | |
| $\lambda_t$ | Cont. | −2.88 | 1.25 | −4.26 | 1.82 | −1. 56 | 2.39 | −4.99 | 2.40 | −5.27 | 2.22 |
| | 1 lag | −2.13 | 1.74 | −8.65 | 2.51 | −7.19 | 3.39 | −10.23 | 3.25 | 0.58 | 2.93 |
| | 2 lags | 3.43 | 1.34 | 8.46 | 1.91 | 6.06 | 2.52 | 10.27 | 2.49 | 4.21 | 2.30 |
| | Sum: | −1.58 | 0.57 | −4.44 | 0.83 | −2.68 | 0.99 | −4.95 | 1.15 | −0.47 | 1.24 |
| $\hat{E}_t$ | Cont. | −0.45 | 0.02 | −0.40 | 0.04 | −0.26 | 0.05 | −0.50 | 0.06 | −0.33 | 0.05 |
| | 1 lag | −0.03 | 0.03 | −0.10 | 0.05 | −0.11 | 0.06 | −0.10 | 0.06 | −0.01 | 0.06 |
| | 2 lags | −0.16 | 0.02 | −0.23 | 0.04 | −0.27 | 0.04 | −0.16 | 0.05 | −0.06 | 0.05 |
| | Sum: | −0.65 | 0.03 | −0.73 | 0.05 | −0.65 | 0.07 | −0.75 | 0.08 | −0.39 | 0.07 |
| $i_t$ | Cont. | −0.07 | 0.02 | −0.10 | 0.04 | −0.20 | 0.05 | −0.01 | 0.05 | −0.01 | 0.05 |
| | 1 lag | 0.08 | 0.02 | 0.06 | 0.04 | 0.09 | 0.05 | 0.02 | 0.06 | 0.03 | 0.05 |
| | 2 lags | 0.01 | 0.02 | 0.01 | 0.04 | 0.05 | 0.05 | −0.01 | 0.06 | −0.01 | 0.05 |
| | Sum: | 0.01 | 0.01 | −0.03 | 0.02 | −0.05 | 0.03 | 0.01 | 0.03 | 0.01 | 0.03 |
| | | | | Panel B: 2SLS | | | | | | | |
| $\lambda_t$ | Cont. | −0.69 | 1.36 | −2.02 | 1.76 | −4.05 | 2.11 | 0.38 | 2.45 | 1.21 | 2.57 |
| | 1 lag | 0.98 | 1.59 | −4.99 | 2.09 | −4.72 | 2.52 | −5.59 | 2.91 | −1.38 | 3.05 |
| | 2 lags | −1.58 | 1.28 | 1.46 | 1.72 | 3.45 | 2.06 | 1.68 | 2.38 | 2.49 | 2.54 |
| | Sum: | −1.29 | 1.13 | −5.54 | 1.37 | −5.31 | 1.56 | −3.53 | 1.95 | 2.33 | 2.06 |
| $\hat{E}_t$ | Cont. | −0.46 | 0.02 | −0.40 | 0.04 | −0.27 | 0.05 | −0.50 | 0.06 | −0.33 | 0.05 |
| | 1 lag | −0.02 | 0.03 | −0.08 | 0.05 | −0.11 | 0.06 | −0.06 | 0.06 | 0.01 | 0.06 |
| | 2 lags | −0.17 | 0.02 | −0.24 | 0.04 | −0.27 | 0.05 | −0.19 | 0.05 | −0.08 | 0.05 |
| | Sum: | −0.65 | 0.03 | −0.73 | 0.06 | −0.65 | 0.07 | −0.76 | 0.08 | −0.41 | 0.07 |
| $i_t$ | Cont. | −0.05 | 0.02 | −0.07 | 0.04 | −0.16 | 0.05 | 0.03 | 0.05 | −0.01 | 0.05 |
| | 1 lag | 0.07 | 0.02 | 0.05 | 0.04 | 0.08 | 0.05 | 0.02 | 0.06 | 0.04 | 0.05 |
| | 2 lags | 0.01 | 0.02 | 0.01 | 0.04 | 0.03 | 0.05 | 0.01 | 0.06 | 0.01 | 0.05 |
| | Sum: | 0.02 | 0.02 | −0.01 | 0.03 | −0.05 | 0.03 | 0.05 | 0.04 | 0.04 | 0.03 |

Table is analogous to Table 3.

The coefficients on total manufacturing employment growth $\hat{E}_t$ are large and significant, and their sum is close to 1 for all sectors but nontraded, indicating that shocks that affect total manufacturing employment growth are reflected almost one for one into sectoral employment growth. Somewhat surprisingly, it appears that monetary policy does not markedly influence industry employment growth, once we control for fluctuations in total manufacturing employment.[20]

To summarize, the results indicate limited intersectoral reallocation of labor in response to exchange rates. We turn now to the next question: is the increase in employment coming from an increase in job creation, a decrease in job destruction, or a combination?

GROSS EMPLOYMENT CHANGES To answer this question, I now run the same specification, replacing industry net employment growth successively with job destruction rates and job creation in equation (1). The results are presented in panel A of Tables 4 and 5.

The results indicate the following:

- Gross flows in the nontraded good sector are insensitive to exchange-rate movements. They are, however, very sensitive to aggregate shocks, as captured by total manufacturing employment growth. Thus our definition of nontradable seems relevant as a control group.
- Traded sectors' job destruction rates are quite sensitive to exchange-rate movements. A 10% real depreciation destroys 0.44% of tradable employment. With an average quarterly job destruction rate around 5.3%, this represents a very sizeable response to relatively minor exchange-rate fluctuations.
- Job destruction in both sectors covaries negatively and significantly with aggregate shocks.
- Irrespective of the type of shock, job destruction is more responsive than job creation in all sectors.
- Tradable job creation declines mildly in response to a depreciation of the exchange rate (−0.17% for 10% depreciation) and increases in response to a positive aggregate shock.
- Import-competing industries appear more sensitive to exchange-rate fluctuations than exporters.

20. In unreported regressions, I also included the Hamilton oil price index (Hamilton, 1995) or a commodity price index as another control. The results were unchanged, and the oil price index was never significant. Results are also unchanged if one uses the spread between 6-month commercial paper and 6-month T-bills instead of the federal funds rate. Similar results are also obtained when using the import-based real exchange rate or using the absolute level of the real exchange rate instead of the deviations from trend.

Table 5 JOB-CREATION RESPONSE TO REAL-EXCHANGE-RATE DEVIATIONS

| *Sector:* | *Two-digit* | | | *Traded* | | | | | | *Nontraded* | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *All* | | *Exports* | | *Import comp.* | | | |
| *Regressor* | *Timing* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* |
| | | | | Panel A: Direct Estimation | | | | | | | |
| $\lambda_t$ | Cont. | −1.43 | 0.99 | 0.71 | 1.44 | 1.16 | 2.04 | −0.41 | 1.79 | 0.97 | 2.16 |
| | 1 lag | −2.86 | 1.37 | −3.17 | 1.99 | −4.58 | 2.90 | −1.99 | 2.43 | −2.54 | 2.85 |
| | 2 lags | 3.20 | 1.05 | 0.72 | 1.51 | 1.77 | 2.15 | 0.42 | 1.86 | 3.29 | 2.24 |
| | Sum: | −1.09 | 0.45 | −1.73 | 0.60 | −1.64 | 0.65 | −1.98 | 0.56 | 1.71 | 1.31 |
| $\hat{E}_t$ | Cont. | 0.22 | 0.02 | 0.26 | 0.03 | 0.22 | 0.04 | 0.28 | 0.04 | 0.19 | 0.05 |
| | 1 lag | −0.02 | 0.02 | −0.02 | 0.04 | 0.01 | 0.05 | −0.07 | 0.05 | 0.01 | 0.06 |
| | 2 lags | 0.01 | 0.02 | 0.06 | 0.03 | 0.09 | 0.04 | 0.02 | 0.04 | −0.01 | 0.05 |
| | Sum: | 0.21 | 0.02 | 0.29 | 0.04 | 0.33 | 0.06 | 0.23 | 0.06 | 0.20 | 0.07 |
| $i_t$ | Cont. | −0.03 | 0.02 | −0.05 | 0.03 | −0.02 | 0.04 | −0.08 | 0.04 | −0.04 | 0.05 |
| | 1 lag | −0.04 | 0.02 | 0.01 | 0.03 | −0.04 | 0.05 | 0.03 | 0.04 | −0.03 | 0.05 |
| | 2 lags | 0.02 | 0.02 | 0.02 | 0.03 | −0.02 | 0.04 | 0.02 | 0.04 | 0.06 | 0.05 |
| | Sum: | −0.05 | 0.01 | −0.03 | 0.02 | −0.04 | 0.03 | −0.04 | 0.03 | −0.01 | 0.03 |
| | | | | Panel B: 2SLS | | | | | | | |
| $\lambda_t$ | Cont. | 5.61 | 1.05 | −2.44 | 1.39 | −2.40 | 1.84 | −2.77 | 1.79 | 5.02 | 2.49 |
| | 1 lag | −5.11 | 1.23 | 0.35 | 1.65 | −2.76 | 2.19 | 2.89 | 2.14 | −5.05 | 2.96 |
| | 2 lags | −1.37 | 0.99 | −1.97 | 1.35 | 0.33 | 1.80 | −3.18 | 1.75 | 2.62 | 2.46 |
| | Sum: | −0.86 | 0.88 | −4.07 | 1.07 | −4.83 | 1.36 | −3.05 | 1.43 | 2.58 | 1.99 |
| $\hat{E}_t$ | Cont. | 0.24 | 0.02 | 0.24 | 0.03 | 0.21 | 0.04 | 0.25 | 0.04 | 0.18 | 0.05 |
| | 1 lag | −0.01 | 0.02 | −0.02 | 0.04 | 0.01 | 0.05 | −0.05 | 0.05 | 0.03 | 0.05 |
| | 2 lags | −0.01 | 0.02 | 0.05 | 0.03 | 0.09 | 0.04 | 0.01 | 0.04 | −0.01 | 0.04 |
| | Sum: | 0.22 | 0.03 | 0.27 | 0.04 | 0.31 | 0.06 | 0.20 | 0.06 | 0.19 | 0.06 |
| $i_t$ | Cont. | −0.02 | 0.02 | −0.04 | 0.03 | 0.01 | 0.04 | −0.07 | 0.04 | −0.04 | 0.04 |
| | 1 lag | −0.04 | 0.02 | 0.01 | 0.03 | −0.01 | 0.05 | 0.02 | 0.04 | −0.03 | 0.05 |
| | 2 lags | 0.04 | 0.02 | 0.01 | 0.03 | −0.04 | 0.04 | 0.02 | 0.04 | 0.07 | 0.05 |
| | Sum: | −0.02 | 0.01 | −0.03 | 0.02 | −0.05 | 0.02 | −0.03 | 0.03 | 0.01 | 0.03 |

Table is analogous to Table 3.

This last point indicates that gross flows depict a somewhat different picture than net flows for exporters and import-competing industries. In export-oriented industries, an appreciation is associated with a substantial increase in job destruction and creation that leaves, on net, employment unchanged.

The apparent similarity between the point estimates of net employment for traded and nontraded sectors disappears when looking at gross flows. The contrast between the two groups indicates that the results are not driven by a response to aggregate disturbances. Further, it appears that the dynamic adjustment to a relative price shock is quite different from the adjustment to an aggregate shock. Following an aggregate shock, job creation and destruction move in *opposite directions*. However, following an exchange-rate shock, job creation and destruction move *in the same direction*. While reallocative shocks are often assumed to induce a simultaneous increase in aggregate job creation and destruction, it is worthwhile to note that the simultaneous move occurs *within* the tradable sector, while the intersectoral channels sometimes emphasized in the literature. A similar result is obtained by Davis and Haltiwanger (1997) in response to oil shocks.

By contrast, a positive aggregate shock increases job creation by 0.29 (0.20) in the traded (nontraded) sector and a decline in job destruction of 0.73 (0.39).

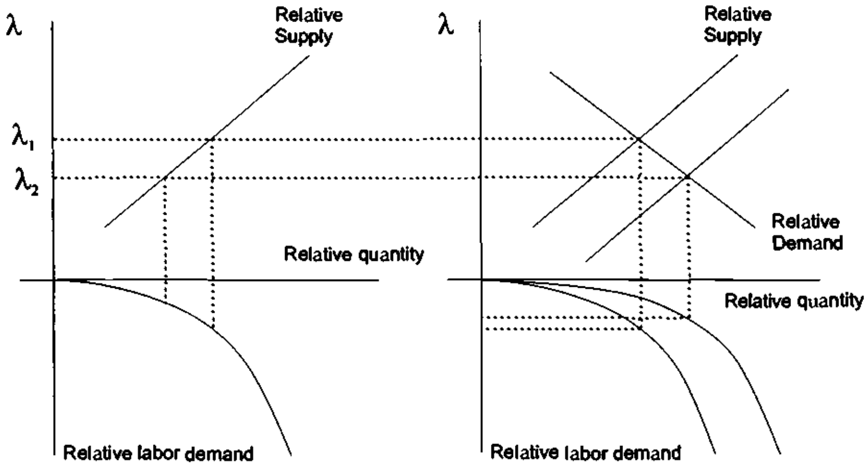
How much does each margin contribute to industry employment adjustment? Clearly, given our estimates, job destruction plays the major role, with job creation as a follower. The results also indicate that excess reallocation, or *churn*, will increase when the exchange rate appreciates, and decrease when the currency depreciates. Hence, the next point:

- Appreciations are associated with increased turbulence on the labor market. Job creation, destruction, and excess reallocation increase. Conversely, during depreciation phases, the tradable sector chills as creation and destruction rates fall.

Note that the paper does not draw any welfare implications at this stage, and that this chill does not follow a burst of destruction as in Caballero and Hammour (1998).

SIMULTANEITY AND CHOICE OF INSTRUMENTAL VARIABLES The preceding empirical analysis suggests that an appreciation of the real exchange rate that lowers the relative price of tradables is associated with a simultaneous increase in destruction and creation that results in a net employment loss. An alternative possibility is that both the appreciation and the

Figure 3 RELATIVE-TECHNOLOGY SHOCKS




increase in gross flows result from a technological shift at the industry level. To see clearly the contrast between the two interpretations, consider Figure 3. This paper's interpretation is that there is a stable industry relative-supply curve (upper left diagram) that is mapped through exogenous shifts in the relative price $\lambda$, i.e., the real exchange rate. Associated with this stable supply curve is a stable relative-factor-demand curve (lower left diagram).[21] In this rendition, an appreciation is associated with a decline in $\lambda$, in relative output, and in relative employment. An alternative interpretation (right diagrams) would assert that there is a stable demand curve, and that the relative-supply curve shifts in response to relative-technology shocks. A positive relative-technology shock in tradables shifts out the relative-supply curve, leading to a decline in $\lambda$ (an appreciation) from $\lambda_1$ to $\lambda_2$ and an increase in relative output. In terms of net job flows, this relative-technology shock may decrease relative employment in the traded sector, as illustrated in the lower right diagram.[22] While job creation may increase, job destruction

21. In the context of a specific factor model, for instance, assume that $Y_T = z_T L_T^{\alpha} K_T^{1-\alpha}$ and $Y_N = z_N L_N^{\alpha} K_N^{1-\alpha}$, where $K_T$ and $K_N$ denote sector-specific capital and $z_T$ and $z_N$ sector-specific productivities. Then clearly $Y_T/Y_N = (z_T/z_N)(L_T/L_N)^{\alpha}(K_T/K_N)^{1-\alpha}$. The lower panel describes this relationship for given relative productivities and relative capital.

22. Take the limit case described in Baumol, Blackman, and Wolff (1985): suppose the economy produces only cars and live concerts and preferences are Leontieff. Relative technological progress in car production would lead to an overall decline in the number of workers in the car industry and an increase in the share of the labor force producing live concerts.

may increase as well if old and unproductive production units are cleansed. In the latter case, the link between exchange rate and reallocation is spurious and simply reflects the response to sectoral relative-technology shocks. Note however that relative-demand shocks do not generate the same pattern, since a relative-demand shock would lead to a simultaneous depreciation (an increase in $\lambda$) and a relative increase in traded goods output and tradable employment.

There are two possible lines of defense for the previous result that I now present. First, there is a subtle difference between the real exchange rate that matters in Figure 3 and the one used in the regressions. Relative-technology shocks will undoubtedly influence the relative price of traded and nontraded goods.[23] Instead, the previous results used a WPI-based real exchange rate. Relative-technology shocks at the four-digit level are unlikely to affect the real exchange rate constructed in this fashion. This, in effect, amounts to instrumenting the real-exchange-rate measure in a way that minimizes the role of relative-technology shocks. Fluctuations in the real exchange rate will thus capture mostly variations in the nominal exchange rate.

For those still unconvinced, another solution consists in explicitly instrumenting the real exchange rate $\lambda_{it}$ in (1), using shifters of the relative demand schedule. Clearly, one will then only measure employment movements induced by the shifters themselves and mediated through changes in the real exchange rate, and one may miss the response to autonomous movements of the real exchange rate. To the extent that these relative demand shifts are uncorrelated with supply shifts and affect the real exchange rate, however, it is still a valid exercise. As a crude attempt, I report estimates using the Hall–Ramey set of instruments (see Hall, 1988): the growth rate of military expenditures, the growth rate of the crude oil price, and the political party of the President.[24] Military expenditures are likely to be the best instrument for our purpose, since they tend to be fairly concentrated in a few manufacturing industries.

Panel B in Tables 3–5 present 2SLS estimates. Comparing the results with the simple fixed-effect estimates, it is immediate that employment growth becomes nonsignificant for all groups. Looking at gross flows, we see that job creation appears to respond more strongly to exchange rates. A 10% depreciation leads to a decline of 0.40% in job creation in

23. Indeed, plots of the relative price of traded versus nontraded goods constructed from the shipment deflators of the NBER Productivity Database reveal a strong and downward trend in the price of traded goods, in accordance with the faster productivity growth in those sectors.

24. The set of instruments is common to all sectors. Yet the coefficients from the first stage are industry-dependent. A better solution, not investigated in this paper, would use sector-specific demand shifters, along the lines of Shea (1993).

traded industries. Overall, the results indicate that there is a strong response of gross flows, less so for net flows. The absence of a net effect may also suggest that the grouping remains too coarse for an analysis of exchange-rate movements.

*3.2.2 Dynamic Analysis* The preceding results describe an economy that reacts on average and with some lags to exchange-rate movements. This section takes a more rigorous approach towards controlling for possible endogeneity of the exchange rate by using sectoral VARs, along the lines of Davis and Haltiwanger (1997).

I estimate a VAR for each four-digit industry classified as traded or nontraded. The VAR for sector $j$ contains an aggregate bloc with the Hamilton oil price index $s_t$, the total manufacturing job creation and destruction for all sectors but sector $j$ (denoted $JC_t^{-j}$ and $JD_t^{-j}$) and the quality spread between 6-month commercial paper and 6-month T-bills, $m_t$.[25] This definition of aggregate flows ensures that idiosyncratic shocks to sectoral flows will not influence aggregate flows for large sectors. The VAR also includes the sectoral real exchange rate $\lambda_{st}$ as well as sectoral job creation and destruction $JC_{st}$ and $JD_{st}$. I make the following assumptions:

1. the sectoral gross flows do not affect either aggregate variables or the sectoral real exchange rate;
2. aggregate variables are block Wold-causally ordered and prior to the sectoral ones;
3. the real exchange rate is Wold-causally ordered after the aggregate variables and before the sectoral flows;
4. the covariance matrix of structural innovations is block-diagonal.

Note that under these assumptions the real exchange rate is only restricted not to influence aggregate variables within the quarter. Given the possible feedback from the real exchange rate, the assumption that sectoral flows are independent of the real exchange rate only ensures that they do not indirectly affect aggregate variables.[26]

25. The Hamilton net oil price measure is the maximum of 0 and the difference between the log level of the crude-oil price for the current month and the maximum value of the logged crude-oil price over the previous 12 months. The spread captures monetary policy. Unreported results using the federal funds rate as the instrument of monetary policy yield essentially unchanged results.
26. Given these assumptions, and unlike Davis and Haltiwanger (1997), the set of aggregate innovations is sector-dependent. In practice, the results are virtually unchanged if we assume instead that the real exchange rate does not influence aggregate variables at all lags. In addition, Davis and Haltiwanger (1997) decompose oil price movements into positive and negative components. It is comforting, however, to find that oil shocks play a similar role in this decomposition and theirs.

Formally, denoting by $Z_t$ the first four aggregate variables of the seven-variable vector (in that order), and by $S_t$ the sectoral job creation and destruction rates, the VAR system is written

$$Z_t = \sum_{i=1}^{p} (\psi_{zz,i} Z_{t-i} + \psi_{z\lambda,i} \lambda_{st-i}) + B_{zz}\epsilon_{z,t},$$

$$\lambda_{st} = \sum_{i=1}^{p} (\psi_{\lambda z,i} Z_{t-i} + \psi_{\lambda\lambda,i} \lambda_{st-i}) + B_{\lambda z}\epsilon_{z,t} + \epsilon_{\lambda,t},$$

$$S_{st} = \sum_{i=1}^{p} (\psi_{sz,i} Z_{t-i} + \psi_{s\lambda,i} \lambda_{st-i} + \psi_{ss,i} S_{st-i}) + B_{sz}\epsilon_{z,t} + B_{s\lambda}\epsilon_{\lambda,t} + B_{ss}\epsilon_{s,t},$$

where $p$ is the order of the VAR, $\psi_{ij}$ and $B_{ij}$ are matrices of the appropriate dimensions, and $\epsilon_t$ is a vector of structural innovations.[27]

Under the assumption of block recursivity, it is possible to evaluate the contribution of each block to the variance of forecast errors. The variance decomposition of the forecast errors is important for evaluating the role of exchange-rate shocks at the sectoral level. Tables 6–7 report the employment-weighted average variance decomposition at 1, 4, and 8 quarters for industry job creation and destruction rates as well as the exchange rate.[28]

First one observes that exchange-rate innovations represent a substantial fraction of the forecast error variance of the exchange rate itself, further substantiating the assumption that exchange rates contain an important autonomous component. Around 65% of the eight-step-ahead forecast error variance is attributed to the exchange-rate innovation. By contrast, monetary innovations account for only 9 to 14% of the variance. The tables also indicate that exchange-rate movements contribute a nonnegligible amount to the overall gross flow fluctuations, around 3% during the first quarter, and reaching 8 to 12% after 8 quarters. The standard errors indicate that this share is significant. Most of the fluctuations remain explained by sectoral shocks and aggregate fluctuations contributed by the innovations to aggregate job creation and destruction.

These results indicate that autonomous exchange-rate fluctuations are a significant force behind industry evolutions. Somewhat more surprisingly, the results also indicate that nontraded industries seem only slightly less sensitive to exchange-rate movements.

27. In practice, given the relatively small sample, I take $p = 4$. By assumption (2), the matrix $B_{zz}$ is lower block-triangular with 1's on the diagonal.

28. The standard errors are obtained by two-stage bootstrapping. Bias-corrected estimates are obtained after 500 iterations. Standard errors are obtained after 100 additional iterations. For each iteration, the entire matrix of residuals for all sectors simultaneously is sampled with replacement in order to preserve the cross-sectional correlation.

Table 6 VARIANCE DECOMPOSITION I

| | *Oil* | | *Aggregate* | | *Spread* | | *Exch. Rate* | | *Sectoral* | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Shock: Qtr.* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* |
| **Nontraded** | | | | | | | | | | |
| Job Creation | | | | | | | | | | |
| 1 | 4.02 | 1.98 | 13.46 | 2.88 | 2.38 | 1.43 | 3.42 | 1.07 | 76.73 | 3.60 |
| 4 | 6.84 | 1.90 | 18.31 | 2.66 | 7.31 | 1.63 | 6.93 | 0.96 | 60.85 | 2.77 |
| 8 | 9.42 | 1.87 | 20.33 | 2.49 | 8.27 | 1.64 | 8.14 | 1.04 | 53.84 | 2.41 |
| Job Destruction | | | | | | | | | | |
| 1 | 5.04 | 2.07 | 13.25 | 3.77 | 4.87 | 1.92 | 2.40 | 0.79 | 74.44 | 3.57 |
| 4 | 8.56 | 1.65 | 18.21 | 2.73 | 8.78 | 2.08 | 6.19 | 1.11 | 58.26 | 2.78 |
| 8 | 13.01 | 1.64 | 19.70 | 2.51 | 10.74 | 2.13 | 7.33 | 1.10 | 49.21 | 2.53 |
| Exchange Rate | | | | | | | | | | |
| 1 | 2.40 | 1.85 | 7.48 | 3.62 | 3.56 | 2.29 | 86.56 | 4.57 | | |
| 4 | 3.27 | 2.61 | 11.54 | 4.31 | 5.79 | 3.09 | 79.40 | 4.87 | | |
| 8 | 7.39 | 3.67 | 14.06 | 4.48 | 9.17 | 3.93 | 69.38 | 5.26 | | |
| **Traded** | | | | | | | | | | |
| Job Creation | | | | | | | | | | |
| 1 | 2.61 | 1.58 | 9.93 | 2.38 | 2.64 | 1.25 | 3.70 | 1.20 | 81.13 | 2.61 |
| 4 | 8.57 | 2.08 | 17.45 | 2.43 | 7.35 | 1.61 | 8.02 | 1.11 | 58.61 | 1.92 |
| 8 | 11.57 | 2.14 | 21.12 | 2.23 | 9.16 | 1.64 | 9.81 | 1.01 | 48.34 | 1.70 |
| Job Destruction | | | | | | | | | | |
| 1 | 3.83 | 1.70 | 11.37 | 2.19 | 2.89 | 1.26 | 2.94 | 1.17 | 78.97 | 2.73 |
| 4 | 11.33 | 2.21 | 14.56 | 2.25 | 10.54 | 1.58 | 9.76 | 0.95 | 53.80 | 2.53 |
| 8 | 15.83 | 2.51 | 17.38 | 2.13 | 13.07 | 1.91 | 11.01 | 0.84 | 42.72 | 2.12 |
| Exchange Rate | | | | | | | | | | |
| 1 | 3.13 | 2.45 | 10.16 | 2.37 | 4.08 | 1.61 | 82.63 | 3.31 | | |
| 4 | 3.93 | 2.22 | 13.06 | 3.37 | 7.89 | 2.34 | 75.13 | 3.97 | | |
| 8 | 5.54 | 2.81 | 13.47 | 4.68 | 14.27 | 2.92 | 66.71 | 4.53 | | |

The table reports the average variance decomposition for a sectoral seven-variable VAR including Hamilton's oil price index, total manufacturing job creation and destruction, a 6-month quality spread, the industry-specific real exchange rate, and industry job creation and destruction.
*Source:* Gross flows: LRD; spread, oil price, and real exchange rate: IFS and author's calculations.

Table 7 VARIANCE DECOMPOSITION II

| | *Oil* | | *Aggregate* | | *Spread* | | *Exch. Rate* | | *Sectoral* | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Shock:* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* |
| | | | | | Exporters | | | | | |
| | | | | | Job Creation | | | | | |
| 1 | 3.35 | 2.00 | 9.87 | 2.86 | 3.10 | 1.73 | 4.34 | 1.55 | 79.33 | 3.15 |
| 4 | 7.54 | 2.42 | 18.59 | 2.70 | 6.32 | 2.26 | 8.44 | 1.47 | 59.10 | 2.13 |
| 8 | 11.66 | 2.46 | 23.93 | 2.50 | 7.68 | 2.21 | 10.07 | 1.39 | 46.66 | 2.01 |
| | | | | | Job Destruction | | | | | |
| 1 | 4.76 | 2.12 | 11.85 | 2.64 | 2.83 | 1.37 | 2.91 | 1.43 | 77.65 | 3.18 |
| 4 | 9.90 | 2.06 | 14.98 | 2.46 | 11.69 | 1.91 | 12.30 | 1.38 | 51.13 | 2.54 |
| 8 | 14.86 | 2.64 | 17.44 | 2.43 | 14.78 | 2.41 | 12.75 | 1.24 | 40.18 | 2.17 |
| | | | | | Exchange Rate | | | | | |
| 1 | 3.72 | 2.30 | 11.27 | 3.08 | 3.95 | 2.01 | 81.06 | 3.88 | | |
| 4 | 3.97 | 2.41 | 14.07 | 4.05 | 7.47 | 2.61 | 74.48 | 4.75 | | |
| 8 | 5.46 | 3.14 | 14.37 | 5.72 | 14.36 | 3.41 | 65.81 | 5.41 | | |
| | | | | | Import-Competing | | | | | |
| | | | | | Job Creation | | | | | |
| 1 | 1.72 | 2.78 | 9.93 | 4.05 | 2.11 | 1.73 | 3.04 | 1.86 | 83.20 | 4.25 |
| 4 | 9.81 | 3.10 | 15.75 | 3.53 | 8.76 | 1.80 | 7.67 | 1.55 | 58.01 | 3.03 |
| 8 | 11.37 | 3.00 | 17.19 | 3.35 | 11.13 | 1.86 | 9.55 | 1.34 | 50.76 | 2.68 |
| | | | | | Job Destruction | | | | | |
| 1 | 2.46 | 2.27 | 10.73 | 3.34 | 2.88 | 2.80 | 3.01 | 1.98 | 80.90 | 4.80 |
| 4 | 13.08 | 3.45 | 13.92 | 3.54 | 8.78 | 2.37 | 6.47 | 1.48 | 57.74 | 3.81 |
| 8 | 16.93 | 3.22 | 17.13 | 3.14 | 10.54 | 2.28 | 8.76 | 1.25 | 46.65 | 3.21 |
| | | | | | Exchange Rate | | | | | |
| 1 | 2.37 | 4.33 | 8.61 | 2.64 | 4.27 | 2.28 | 84.75 | 4.87 | | |
| 4 | 3.81 | 3.23 | 11.48 | 4.25 | 8.66 | 2.94 | 76.06 | 4.76 | | |
| 8 | 5.60 | 3.48 | 12.04 | 5.34 | 14.55 | 3.07 | 67.82 | 5.25 | | |

The table reports the average variance decomposition for a sectoral seven-variable VAR including Hamilton's oil price index, total manufacturing job creation and destruction, a 6-month quality spread, the industry-specific real exchange rate, and industry job creation and destruction.
*Source:* Gross flows: LRD; spread, oil price, and real exchange rate: IFS and author's calculations.

Turning to the dynamic response of gross and net flows, Figure 4 reports the normalized cumulated average impulse response of job creation (thin line), job destruction (dashed line), and (implicitly) net employment growth (thick solid line) to the spread shocks, supply shocks, and real-exchange-rate shocks (columns) for the traded, nontraded, exporter, and import-competing sectors (rows). Complete identification is obtained by imposing a Cholesky ordering.[29] Starting with the second column, one observes that a unit standard deviation in the spread variable has a substantial and long-lasting effect on net and gross employment. Employment declines, as a result of a mild decline in job creation and a sharp increase in job destruction in all sectors. Employment growth bottoms out after 8 to 10 quarters. These impulse responses resemble what we know about the effect of monetary policy shocks on job creation and destruction (see Davis and Haltiwanger, 1996).

Turning to the response to real-exchange-rate shocks, observe first that the amplitude is smaller. An unexpected depreciation of the real exchange rate increases employment growth in all traded industries. About 4 quarters following a positive 1-standard-deviaton real-exchange-rate shock, employment growth is 1.40% higher in export sectors and roughly 0.75% higher in import-competing sectors. Job destruction declines significantly in both sectors by roughly similar amounts. However, the results indicate very different dynamics of job creation in the export and import-competing sectors. While job creation is mildly positive in the export sector following a depreciation and turns negative after 8 quarters, job creation falls significantly after only 4 quarters in import competing industries. The contrast between a monetary shock and an exchange-rate shock is most striking for import-competing firms: while job creation and job destruction move in opposite directions in response to a spread shock, they appear to comove positively in response to exchange-rate innovations. This result is further confirmed by looking at the response to oil price shocks (first column) for that sector: job creation increases by 1.5% and job destruction by 2.4% following a normalized increase in oil prices.

Table 8 reports the cumulative 8- and 16-step impulse responses to the oil, spread, and exchange-rate shocks.

First note that job destruction is more volatile than job creation in response to almost all shocks considered. Furthermore, the response to *reallocation* shocks (real-exchange-rate and oil shocks) differs markedly from the response to monetary shocks for import-competing sectors,

29. Since I do not look into the dynamic response to aggregate and sectoral job creation and destruction, the results are robust to the identification procedure.

Figure 4 AVERAGE NORMALIZED CUMULATED RESPONSE FUNCTIONS TO OIL, MONETARY, AND REAL-EXCHANGE-RATE SHOCKS.

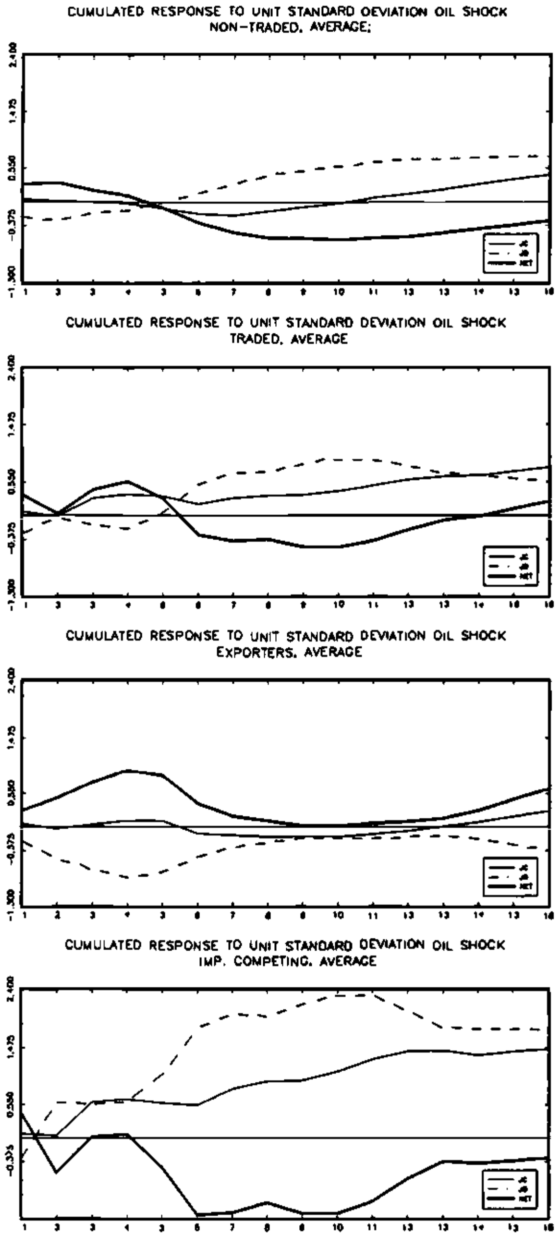


Figure 4 (continued)

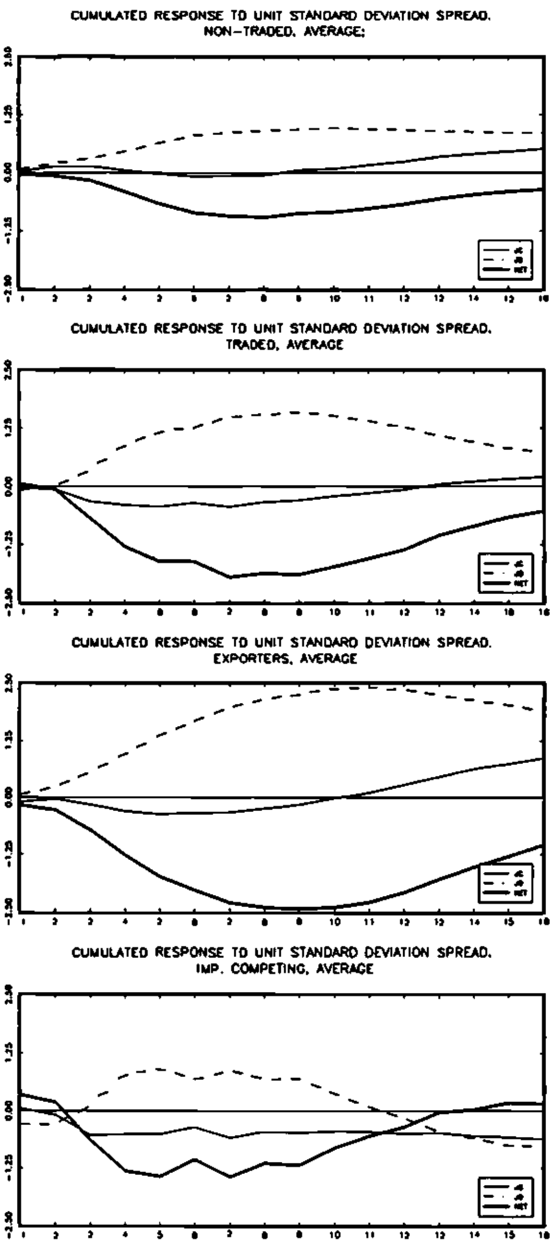


Figure 4 (continued)

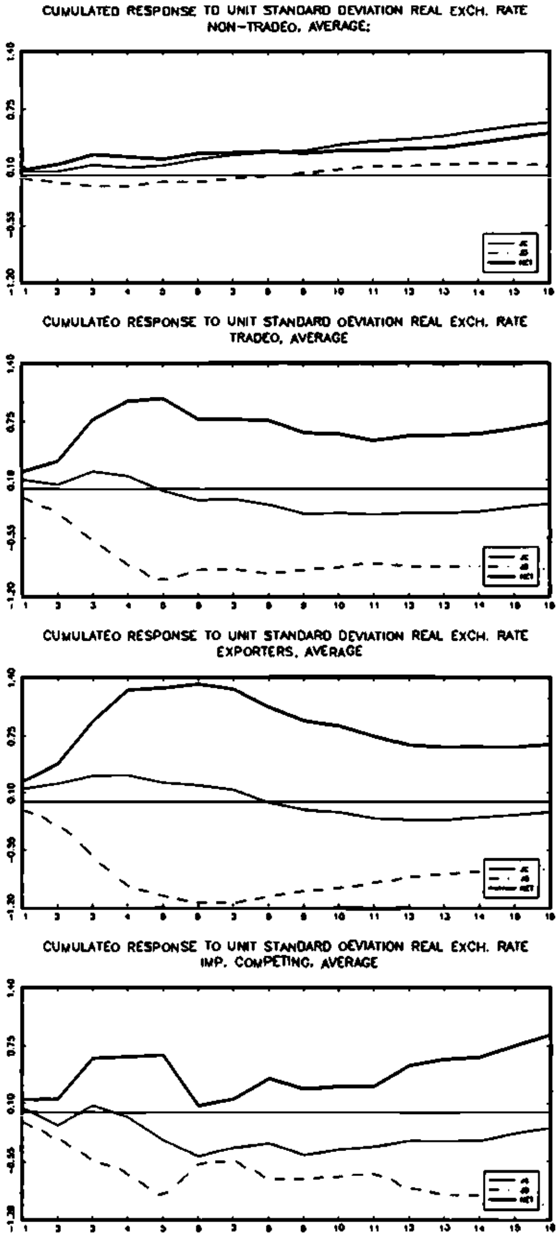


Table 8 CUMULATIVE IMPULSE RESPONSES

| | *Job Creation* | | | | | | *Job Destruction* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Oil* | | *Spread* | | *Exchange* | | *Oil* | | *Spread* | | *Exchange* | |
| *Sector* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* |
| | | | | | 8 Quarters | | | | | | | |
| Nontraded | −0.22 | 0.10 | −0.05 | 0.07 | 0.24 | 0.06 | 0.29 | 0.13 | 0.88 | 0.11 | −0.05 | 0.07 |
| Traded | 0.31 | 0.19 | −0.43 | 0.16 | −0.13 | 0.12 | 0.70 | 0.35 | 1.54 | 0.22 | −1.12 | 0.18 |
| Exporters | −0.15 | 0.16 | −0.33 | 0.15 | 0.16 | 0.09 | −0.29 | 0.25 | 2.09 | 0.21 | −1.47 | 0.11 |
| Import-competing | 0.89 | 0.33 | −0.55 | 0.26 | −0.48 | 0.22 | 1.97 | 0.65 | 0.80 | 0.65 | −0.64 | 0.35 |
| Motor vehicles, 3711 | 3.29 | 1.32 | −1.50 | 0.40 | −1.37 | 0.52 | 5.43 | 1.45 | 0.08 | 1.25 | −2.28 | 0.65 |
| Aircraft, 3721 | −0.42 | 0.17 | −0.65 | 0.18 | 0.33 | 0.23 | 0.07 | 0.21 | 2.20 | 0.23 | −0.49 | 0.21 |
| | | | | | 16 Quarters | | | | | | | |
| Nontraded | 0.48 | 0.12 | 0.57 | 0.13 | 0.59 | 0.11 | 0.72 | 0.15 | 0.90 | 0.16 | 0.14 | 0.14 |
| Traded | 0.79 | 0.37 | 0.31 | 0.28 | −0.21 | 0.22 | 0.62 | 0.51 | 0.74 | 0.43 | −1.12 | 0.26 |
| Exporters | 0.25 | 0.21 | 0.95 | 0.20 | −0.19 | 0.15 | −0.22 | 0.26 | 1.83 | 0.26 | −0.99 | 0.16 |
| Import-competing | 1.47 | 0.76 | −0.51 | 0.55 | −0.18 | 0.45 | 1.71 | 1.03 | −0.68 | 0.85 | −1.25 | 0.52 |
| Motor vehicles, 3711 | 3.49 | 1.45 | −3.04 | 0.55 | −1.21 | 0.58 | 4.32 | 1.65 | −4.86 | 1.65 | −1.58 | 0.74 |
| Aircraft, 3721 | −0.04 | 0.45 | 0.02 | 0.53 | −0.78 | 0.42 | −0.06 | 0.36 | 2.33 | 0.45 | −1.00 | 0.40 |

The table reports the average 8- and 16-step cumulative impulse responses of sectoral job creation and destruction to an oil price shock, a monetary policy shock, and a real-exchange-rate shock.
*Source:* Gross flows: LRD; spread, oil price, and real exchange rate: IFS and author's calculations.

and less so for export sectors. An appreciation triggers a wave of job separations (0.64% for a normalized appreciation after 8 quarters), but also an associated increase in job creation (0.48%). By contrast, a tightening of monetary policy increases job destruction by 0.80% and decreases job creation by 0.55%. Export industries exhibit a more traditional pattern in response to an appreciation, with a slight decline in job creation (0.16%) and a substantial increase in job destruction (1.47%).

To shed some additional light on this result, the table further presents the cumulated impulse response for motor vehicles (SIC 3711) and aircraft (SIC 3721). Each sector represents the largest sector of the import-competing and export industries, respectively, with an employment share of 30.87% and 12.60%.[30] Both sectors largely reproduce the average results, with, in particular, a substantial positive comovement of job creation and destruction in the automobile industry. While it is beyond the scope of this paper to analyze sectoral dynamics in detail, it is worth noting that this specific pattern could result from the establishment of Japanese-owned car factories in the United States in the eighties, following the appreciation of the U.S. currency. However, there is more to the results than simply the automobile industry. 21 out of the 39 import-competing industries—representing 72% of import-competing employment—exhibit a pattern similar to the average.[31] By contrast, 12 out of the 34 export industries—representing only 36% of employment—exhibit positive comovement between job creation and destruction after 8 quarters.

The positive sectoral comovement is also obtained by Davis and Haltiwanger (1997) in their study of the effect of oil shocks. While those authors do not emphasize this point, they interpret the positive comovement as an indication of the reallocative nature of oil shocks, within narrowly defined industries. The results presented in Table 8 confirm their analysis and extend it to real-exchange-rate fluctuations.

I now summarize the paper's main findings so far:

- There are substantial variations in openness and international exposure within the U.S. manufacturing sector. Using a classification based on export shares and import penetration ratios, we find that tradable-goods firms are more productive, are more capital-intensive, and pay higher wages. Further, within tradables, import-competing firms are less productive, are less capital intensive, and employ fewer workers.
- Looking at the SIC composition of the traded and nontraded groups,

30. See the on-line appendix available at **http://www.princeton.edu/~pog/RER-home.html**.

31. If one excludes the automobile industry, the number remains 60% of employment.

nontradables are concentrated in nondurables (food and printing) as well as heavy durables, for which transportation costs are presumably prohibitive (concrete, bricks). Import-competing industries represent a relatively small share of the overall manufacturing employment and tend to be concentrated in paper, leather, and motor vehicles.

- Exchange-rate fluctuations do affect tradable industries. According to this paper's benchmark estimates, a 10% depreciation of the real exchange rate boosts employment by 0.27%, combining a decline in job destruction of 0.44% and a decline of job creation of 0.17%.
- Job destruction appears more volatile than job creation, confirming a now well-established stylized fact for U.S. manufacturing as a whole.
- Although the impact of real exchange rates is significant, they constitute a relatively minor source of gross and net employment fluctuations, accounting for roughly 10% of the forecast error in sectoral gross flows.
- More strikingly, job creation and job destruction appear to comove positively in response to reallocation shocks, especially in import-competing industries. A similar result is obtained, although not emphasized, by Davis and Haltiwanger (1997) in the context of oil shocks.
- Thus, for the typical tradable industry, appreciation episodes are times of turbulence, while depreciations are times of chill, with lower job creation and destruction.

Previous empirical studies have documented extensively the negative comovements in job creation and destruction following aggregate perturbations. The new finding here is that reallocative disturbances can induce sizable positive comovements of sectoral flows. The next section aims at exploring the extent to which existing models of reallocation can account for both set of facts simultaneously. While the positive sectoral comovements are reminiscent of a cleansing mechanism, I will argue that the cleansing effect will generically be stronger in response to aggregate shocks than to sectoral ones, in direct contradiction with the evidence so far.

## 4. *Models of Reallocation and Sectoral Correlations*

To gain intuition for the previous statement, and in preview of the formal model, suppose that an economy can produce two goods, tradables and nontradables. Production units in this economy are buffeted by three types of shocks: aggregate, reallocation, and idiosyncratic shocks. The reallocation shock takes the form of a shock to the relative price of tradables in terms of nontradables—one possible definition of the real exchange rate—but this is not essential for our results. Assume also, not unrealistically, that it takes time to match workers and jobs. To make things even simpler, assume that the economy is efficient, so that the competitive equilibrium coincides with the solution to the central planner's problem.[32]

With such an environment as our background, I now turn to the equilibrium sectoral dynamics and the timing of entry and exit. Suppose, to start with, that the economy is hit by a negative aggregate productivity shock. By definition, all units, irrespective of their specialization, are worse off. The value of production declines in both sectors, compared to nonmarket activities such as search. This makes it a good time to cleanse the productive structure by releasing labor for more productive matches. This is the essence of the cleansing approach to recessions (Cooper, Haltiwanger, and Power 1994; Cohen and Saint-Paul 1992). Since the planner would want to minimize the amount of time the average worker spends unemployed in the efficient equilibrium, job creation will increase strongly on the tail of job destruction. Unemployment will be short-lived, and gross flows will tend to be positively correlated. We can also look at the same dynamics through a competitive lens: The increase in creation occurs through a decline in the opportunity cost of employment. As destruction picks up and unemployment rises in both sectors, workers become less picky about their employment opportunities, thus inducing the subsequent surge in creation.

Consider now the response to a decline in the relative price of tradables. The planner will want to reallocate workers from the tradable sector to the nontradable. The value of tradable good production declines relative to both nonmarket activities and nontradable production. As before, labor is released in the tradable sector, and as before, the planner will want to minimize the amount of time that the worker spends idle. That is easier this time around, since the nontradables sector is experiencing a boom. In other words, the efficient response is an *intersectoral* reallocation. In particular, there is no need to increase creation in the tradable sector. The very nature of a reallocation shock is such that one sector of the economy can pick up the slack. In the decentralized equilibrium, we will observe that the opportunity cost of employment remains mostly unchanged. What does this all imply for the correlation of sectoral gross flows? Although aggregate gross creation and destruction may still be positively correlated, the correlation of sectoral flows will *have* to be smaller.

32. In search models such as the one presented shortly, the decentralized equilibrium is efficient when the congestion and search externalities balance out exactly (Hosios, 1990).

While the preceding intuition assumed that the economy was efficient, the decentralized equilibrium will carry over the same features. What is essential here is that other sectors of the economy can assume the slack following reallocation shocks, preventing the opportunity cost of employment from adjusting downward.

## 4.1 THE MODEL

*4.1.1 Consumers* I make the following assumptions. Time is discrete. The domestic economy consists of two sectors: tradables and nontradables. The demand side of the economy is characterized by a representative agent with risk-neutral preferences over both goods:

$$U_0 = E_0\left[\sum_{t=0}^{\infty}\beta^t C_t\right], \tag{2}$$

where $\beta$ is the discount factor and $C_t$ is a constant elasticity of substitution consumption index defined as

$$C_t = \left[\gamma^{1/\phi}\left(x_t^d\right)^{(\phi-1)/\phi} + (1-\gamma)^{1/\phi} y_t^{(\phi-1)/\phi}\right], \qquad \phi > 0, \quad 0 < \gamma < 1, \tag{3}$$

where $\phi$ is the elasticity of substitution between tradable $x_t^d$ and nontradables $y_t$. These preferences yield standard isoelastic demand for each good. Normalizing the price of nontraded goods to 1, and denoting by $p_t$ the price of traded goods, I define the price of the consumption index $C_t$ as $q_t = [1 - \gamma(1 - p_t^{1-\phi})]^{1/(1-\phi)}$.

$p_t$ is exogenous and fluctuates stochastically. An increase in $p_t$ represents an increase in the relative price of tradables, that is, a depreciation of the real exchange rate.[33] I assume that $p_t$ follows a discrete Markov process with $n_p$ states and transition matrix $Q_p$, where $Q_p(j,i) = \Pr(p_{t+1} = p_i \mid p_t = p_j)$. Both goods are nonstorable, but agents can borrow and lend tradable goods internationally at a gross interest rate $R_t$. With an outstanding stock of international debt $B_t$ (in tradables), the budget constraint is

$$p_{t+1}B_{t+1} = \frac{q_{t+1}}{\beta q_t}(p_t B_t + H_t - q_t C_t),$$

where, given the assumption of risk neutrality, $q_{t+1}/\beta q_t$ is the reciprocal of the pricing kernel for tomorrow's nontradables. $H_t$ denotes total current income (labor and dividends) received by the representative agent.

33. A change in $p_t$ forces a reallocation of resources between the traded and nontraded sectors. Therefore, in what follows, I refer to $p_t$ indifferently as the relative-price or reallocation shock.

*4.1.2 Technology and Matching* The elementary unit of production is the combination of a worker and a technology, so that one should think of firms and plants as representing many simultaneous production units.[34] I assume that the technology is Leontieff with one worker producing $A^x(z + \epsilon_i)$ units of traded good or $A^y\ (z + \epsilon_i)$ units of nontraded goods, where $z$ represents an aggregate productivity shock that affects units in both sectors identically and $\epsilon_i$ is an idiosyncratic shock. $A^j$ represents the average labor productivity in sector $j$. Aggregate shocks follow a discrete Markov process with $n_z$ states, a transition matrix $Q_z$, and an unconditional mean of 1.

The state variables for this economy consist of the aggregate and the relative-price shocks as well as the cross-sectional distribution of firm-specific productivities in both sectors. As is common in this type of model, I will concentrate on an equilibrium in which all aggregate variables except employment are independent of the cross-section distribution. Define $s = (z,p)$; then $s$ follows a Markov process with transition matrix $Q$ derived from $Q_p$ and $Q_z$. The total number of states is $n_s = n_z n_p$.

As in Mortensen and Pissarides (1994), I assume that idiosyncratic shocks follow a Poisson process with arrival rate $\lambda$. The new value of $\epsilon$ is drawn from a fixed distribution $G(\epsilon)$ with support $[\epsilon_l, \epsilon_u]$.[35]

Denoting by $v_t^x$ and $v_t^y$ the numbers of vacancies posted in the tradable and nontradable sectors, respectively, the numbers of matches formed in the two sectors are equal to $m(u_t, v_t^x)$ and $m(u_t, v_t^y)$, where $m$ is a constant-returns-to-scale matching function.[36] There is no on-the-job search, and workers need to be unemployed first before finding a new job. I define the job matching probability as $\pi_t = m_t/v_t$ and the worker matching probability as $\mu_t = m_t/u_t$. Under the CRS assumption, one can characterize the job finding rates in each sector, $\pi_t^j$, as a function of that sector's labor-market tightness $\theta_t^j = v_t^j/u_t$: $\pi_t^j = \pi(\theta_t^j) = m\,(1/\theta_t^j, 1)$. Similarly, $\mu_t^j = m\,(1, \theta_t^j) = \theta_t^j\ \pi\ (\theta_t^j)$. The overall probability of finding a job at time $t$ is $\mu_t^x + \mu_t^y$. Under this specification, workers cannot arbitrage between traded- and nontraded-sector jobs.[37] I assume the following obvious properties: $\lim_{\theta\to 0} \pi(\theta) = 1$, $\lim_{\theta\to 0} \theta\pi\,(\theta) = 0$, and $0 \leq \eta\ (\theta) = -\ \theta\pi'(\theta)/\pi(\theta) \leq 1$. The last property ensures that $\pi'\ (\theta) \leq 0$ and $(\theta\pi\,(\theta))' \geq 0$, so that an increase in labor-market tightness decreases the worker arrival rates and increases

34. Clearly, this abstracts from any vertical aspects of the production process: a firm is the horizontal combination of many identical production units except for the realization of their idiosyncratic shock.

35. Under this assumption, new idiosyncratic shocks are independent of old ones, yet the process exhibits persistence.

36. Under that specification, one extra vacancy posted in one sector does not affect the worker's arrival rate in the other sector.

37. See Moen (1997) for a model where workers can decide which pool they apply to.

the job arrival rates. Prospective employers post vacancies at a cost $\nu$ per period, in units of the good produced in that sector.[38] Lastly, newly formed matches are the most productive with $\epsilon = \epsilon_u$, and firms enter the traded sector as long as profits are positive.[39]

*4.1.3 Market Clearing* Denote by $E_t^j(\epsilon)$ the cross section of employment in sector $j$ at time $t$. The following market clearing conditions hold:

$$E_t^x = \int E_t^x(\epsilon)\, d\epsilon, \tag{4}$$
$$E_t^y = \int E_t^y(\epsilon)\, d\epsilon, \tag{5}$$
$$u_t = 1 - E_t^y - E_t^x, \tag{6}$$
$$y_t + \nu u_t \mu_t^y = \int A^y(z_t + \epsilon)\, E_t^y(\epsilon)\, d\epsilon, \tag{7}$$
$$x_t + \nu u_t \mu_t^x = \int A^x(z_t + \epsilon)\, E_t^x(\epsilon)\, d\epsilon. \tag{8}$$

The first two equations express sectoral employment from the cross section in each sector. With a labor force normalized to 1, equation (6) is the larbor-market equilibrium. Lastly, equations (7)–(8) express the market clearing conditions for tradables and nontradables. The term $\nu u_t \mu_t^j$ represents the search and hiring costs incurred at time $t$ in sector $j$. Finally, under the free-entry condition, and assuming that workers pool income and financial resources, there is no distributed dividend and total income is simply

$$H_t = \int [w_t^x(\epsilon)\, E_t^x(\epsilon) + w_t^y(\epsilon)\, E_t^y(\epsilon)]\, d\epsilon = p_t x_t + y_t.$$

Plugging that into the representative agent's budget constraint, one obtains

$$p_{t+1}B_{t+1} = \frac{q_{t+1}}{\beta q_t}\left[p_t B_t + p_t\left(x_t - x_t^d\right)\right]. \tag{9}$$

The second term in the brackets, $p_t(x_t - x_t^d)$, is the trade balance at time $t$, expressed in units of nontradables.

## 4.2 THE COMPETITIVE EQUILIBRIUM

To characterize the competitive equilibrium, I now derive standard asset equations for a representative firm. Consider a production unit in sector

38. The vacancy cost can be thought of as forgone output.

39. The assumption that all firms enter "at the top" is common in the literature. It is not crucial in our context, but it simplifies employment dynamics, since all entrants are identical. It captures the idea that production units become—stochastically—obsolete over time.

$j$ matched with a worker and facing an idiosyncratic shock $\epsilon$ in state $s$ at the beginning of the period. Should employment be continued, the value of the match to the firm, $\tilde{J}_s^j(\epsilon)$, is equal to

$$\tilde{J}_s^j(\epsilon) = p_s^j A^j (z_s + \epsilon) - w_s^j(\epsilon) + \beta \sum_{s'} Q_{ss'} \frac{q_s}{q_{s'}} \left( (1-\lambda) J_{s'}^j(\epsilon) + \lambda \int J_{s'}^j(\epsilon')\, dG(\epsilon') \right). \tag{10}$$

The first two terms on the right-hand side represent the flow profits to the firm in the current period, where $p^y = 1$ and $p^x = p$. The remaining terms represent the option value associated with keeping the production unit active. I describe each term in turn. First the aggregate state may change from $s$ to $s'$ with probability $Q_{ss'}$. Second, the unit gets a new draw of its idiosyncratic productivity $\epsilon'$ with probability $\lambda$ or keeps its current productivity level $\epsilon$. In either case the firm will get an optimal value $J_{s'}^j$. Lastly, the value of the firm tomorrow, in terms of nontradables, is discounted using the state-contingent pricing kernel $\beta q_s/q_{s'}$.

The value to the firm of the match today is then

$$J_s^j(\epsilon) = \max \left\langle \tilde{J}_s^j(\epsilon), V_s^j \right\rangle .$$

The value of a vacancy $V_s^j$ can be determined similarly:

$$V_s^j = \max \left\langle -\nu p_s^j + \beta \sum_{s'} Q_{ss'} \frac{q_s}{q_{s'}} \left[ \pi_s^j J_{s'}^j(\epsilon_u) + (1-\pi_s^j) V_{s'}^j \right], 0 \right\rangle . \tag{11}$$

Posting a vacancy in sector $j$ costs $\nu p_s^j$. With probability $\pi_s^j$ the vacancy is filled and the unit starts producing next period in state $s'$ with an idiosyncratic shock $\epsilon_u$. Otherwise the vacancy remains unfilled with value $V_{s'}^j$. Since it is costless to stop posting the vacancy, the firm will only post if $V_s^j > 0$.

When entry occurs, the value of a vacancy must be zero in either sector: $V_s^j = 0$ for all states $s$. Substituting into (11), we have

$$\frac{\nu p_s^j}{\pi_s^j} = \beta \sum_{s'} Q_{ss'} \frac{q_s}{q_{s'}} J_{s'}^j(\epsilon_u). \tag{12}$$

This is the *entry condition*. It states that the expected cost of a vacancy is equal to the expected profit from the new match.[40]

40. Note that $1/\pi$ is the expected duration until a match is found.

Turning to the workers, denote by $W^j_s(\epsilon)$ the value of holding a job in sector $j$ when the aggregate state is $s$ and the idiosyncratic shock is $\epsilon$. The continuation value inside the match, $\tilde{W}^j_s(\epsilon)$, is determined as

$$\tilde{W}^j_s(\epsilon) = w^j_s(\epsilon) + \beta \sum_{s'} Q_{ss'} \frac{q_s}{q_{s'}} \left( (1-\lambda) W^j_{s'}(\epsilon) + \lambda \int W^j_{s'}(\epsilon')\, dG(\epsilon') \right). \quad (13)$$

The worker gets a wage $w^j_s(\epsilon)$. Next period with probability $\lambda$ a new idiosyncratic shock is drawn from the distribution $G$. The worker ends the relationship as soon as $\tilde{W}^j_s(\epsilon)$ falls below the value of being unemployed, $U_s$:

$$W^j_s(\epsilon) = \max \left\langle \tilde{W}^j_s(\epsilon), U_s \right\rangle$$

Lastly, an unemployed worker finds a job opportunity in the traded (the nontraded) sector with probability $\mu^x_s$ ($\mu^y_s$). The value of being unemployed is therefore

$$U_s = \beta \sum_{s'} Q_{ss'} \frac{q_s}{q_{s'}} [(1 - \mu^x_s - \mu^y_s) U_{s'} + \mu^x_s W^x_{s'}(\epsilon_u) + \mu^y_s W^y_{s'}(\epsilon_u)]. \quad (14)$$

Since the production unit must incur search costs before it can hire a new worker, there are quasi rents associated with the match. I assume that the surplus is divided according to the Nash bargaining rule with a share $\delta$ accruing to the worker and a share $1 - \delta$ to the firm. This implies that all separations are *ex post* efficient as workers, and firms maximize the joint surplus generated by the match, $S^j_s(\epsilon)$:

$$S^j_s(\epsilon) = J^j_s(\epsilon) + W^j_s(\epsilon) - U_s.$$

Using the Nash bargaining rule, and rewriting the asset equation for both the worker and the firm, one obtains

$$\begin{aligned} \tilde{S}^j_s(\epsilon) &= p^j_s A^j (z_s + \epsilon) \\ &\quad + \beta \sum_{s'} Q_{ss'} \frac{q_s}{q_{s'}} \Big( (1-\lambda) S^j_{s'}(\epsilon) + \lambda \int S^j_{s'}(\epsilon')\, dG(\epsilon') \\ &\quad - \delta \left[ \mu^x_s S^x_{s'}(\epsilon_u) + \mu^y_s S^y_{s'}(\epsilon_u) \right] \Big), \qquad (15) \\ S^j_s(\epsilon) &= \max \left\langle \tilde{S}^j_s(\epsilon), 0 \right\rangle. \end{aligned}$$

Lastly, one can rewrite the free-entry conditions as

$$\pi_s^j = \frac{\nu p_s^j}{\beta(1-\delta)\sum_{s'} Q_{ss'}\,(q_s/q_{s'})\,S_{s'}^j\,(\epsilon_u)}. \tag{16}$$

Defining $\tilde{S}$ as the collection of surplus functionals $S_1^x, \ldots, S_{N_s}^x$, $S_1^y, \ldots, S_{N_s}^y$, equation (16) can be implicitly inverted to obtain the job arrival rate $\mu_s^x$, $\mu_s^y$ as a function of the surplus functions $\tilde{S}$. One can then construct the operator $T(\tilde{S})$ according to the right-hand sides of (15) and (16). An equilibrium is defined as a fixed point of the operator $T$. Clearly, the proposed equilibrium does not depend on the cross-section distribution of idiosyncratic productivities, as was claimed initially.

With a production function that is linear in $\epsilon$, it is easy to show that the equilibrium surplus functions are piecewise linear, are increasing in $\epsilon$, and satisfy the cutoff property. One can then characterize the solution in terms of a cutoff vector for each sector, $\{\epsilon_s^x, \epsilon_s^y\}_{s=1}^{ns}$, such that $S_s^j\,(\epsilon_s^j) = 0$.

The following proposition fully characterizes the competitive equilibrium:

PROPOSITION 1 *The surplus functions $\{S_s^x, S_s^y\}_{s=1}^{ns}$ satisfy the cutoff property and are piecewise linear. Moreover, the cutoff for each sector $\{\epsilon_s^x, \epsilon_s^y\}_{s=1}^{ns}$ fully determine the surplus functions. Lastly, the cutoffs solve*

$$\begin{aligned} p^j A^j\left(z_s + \epsilon_s^j\right) &= \beta\delta \sum_{s'} Q_{ss'} \frac{q_s}{q_{s'}} [\mu_s^x S_{s'}^x\,(\epsilon_u) + \mu_s^y S_{s'}^y\,(\epsilon_u)] \\ &-\beta \sum_{\epsilon_s^j > \epsilon_{s'}^j} Q_{ss'} \frac{q_s}{q_{s'}} (1-\lambda)\, S_{s'}^j\,(\epsilon_s^j) \\ &-\beta \sum_{s'} Q_{ss'} \frac{q_s}{q_{s'}} \lambda \int_{\epsilon_{s'}^j}^{\epsilon_u} S_{s'}^j\,(\epsilon')\,dG\,(\epsilon'), \end{aligned} \tag{17}$$

*where the job arrival rates $\mu_s^j$ are determined by (16).*

The cutoff equations (17) characterize the *exit condition*. The left-hand side of (17) represents the lowest acceptable flow of sales from the match in state $s$. The first term on the right-hand side represents the opportunity cost of employment, that is, the expected gain from search: with probability $\mu_s^j Q_{ss'}$ the unemployed worker finds a job in sector $j$ in aggregate state $s'$. The worker then gets a fraction $\delta$ of the surplus $S_{s'}^j$. The term on the second line represents the option value associated with the realization of an aggregate or reallocation shock that lowers the cutoff $\epsilon^x$ and therefore increases the value of the existing match while the idiosyncratic component remains unchanged. Finally, the last term represents the option value associated with the realization of a new idiosyncratic shock $\epsilon'$ together with a change in the state variable to $s'$. As in Mortensen and Pissarides (1994), the lowest acceptable flow profit is lower than the opportunity cost, as both the worker and the firm are willing to incur a loss today in anticipation of a future improvement in the value of the match.

This proposition reduces enormously the dimensionality of the problem. Instead of solving for a fixed point of the mapping $T$, we are looking for a set of $2n_s$ cutoff that solve the nonlinear system (17).

Let's gather a few remarks about the equilibrium. First note that the model does not force an identical response in the two sectors to aggregate shocks. If the average tradables labor productivity $pA^x$ (in terms of nontradables) exceeds the average nontradables labor productivity $A^y$, then the response to an aggregate productivity shock $z$ will have reallocative effects: following a positive shock, resources will be reallocated away from nontraded good production towards good production. Clearly, if $pA^x = A^y$, both sectors respond identically to aggregate shocks.

Consider now the response to relative-price shocks, arguably the novel feature of this model. Inspecting the definition of the surplus function (15), the first thing to notice is that the relative price enters twice. First, it directly affects the current profits of the traded sector production units. Second, it also changes the price index and the discount factor for future profits, $\beta q_s/q_{s'}$, since under our assumptions an increase in the price of tradables increases the aggregate price index. For an easier interpretation, define $R_{ss'} = q_{s'}/\beta q_s$. $R_{ss'}$ is the (implicit) state-contingent real interest rate in terms of nontradables. Evidently, the real interest rate will be high when the price of tradables is expected to increase, or equivalently, when there is an expected depreciation. This form of interest-rate parity has to hold in this model under the assumption of risk neutrality.

A higher interest rate decreases the value of production units in both sectors and may trigger a shutdown. Hall (1997b) has emphasized the empirical and theoretical importance of fluctuations in the real interest rate on the shutdown margin. While the current model emphasizes mostly fluctuations in current profits as a source of aggregate dynamics, it is worth pointing out that expected variations in the price of one good generically affect the discount rate faced by producers of the remaining goods.

Finally, I characterize the dynamics of the labor market. The timing is as follows. At the beginning of period $t$, employment level is $E_t^j$ in sector $j$. Clearly, $E_t^j = \int_{\epsilon_{\hat{s}}^j}^{\epsilon_u} E_t^j(\epsilon)\, d\epsilon$, where the state in period $t-1$ was $\hat{s}$. A new aggregate state $s$ is realized. Consequently, all units with a productivity level $\epsilon$

below $\epsilon_s^j$ are scrapped, and the workers return to unemployment. Among the remaining units, $E_t^j - \int_{\epsilon_l}^{\epsilon_s} E_t^j(\epsilon)\, d\epsilon$, a fraction $\lambda G(\epsilon_s^j)$ experience a new idiosyncratic shock $\epsilon$ with a value below the new cutoff. Workers who are unemployed at the beginning of period $t$ are assumed to search for a new job—and potentially be rematched—within the period. A fraction $\mu_s^j$ of those unemployed finds a job at productivity level $\epsilon_u$. In summary:

$$E_{t+1}^j(\epsilon) = \begin{cases} (1-\lambda)E_t^j(\epsilon) + \lambda G'(\epsilon)\left(E_t^j - \int_{\epsilon_l}^{\epsilon_s^j} E_t^j(\tilde{\epsilon})\, d\tilde{\epsilon}\right) & \text{for } \epsilon_s^j < \epsilon < \epsilon_u, \\ (1-\lambda)E_t^j(\epsilon) + \lambda G'(\epsilon)\left(E_t^j - \int_{\epsilon_l}^{\epsilon_s^j} E_t^j(\tilde{\epsilon})\, d\tilde{\epsilon}\right) & \\ \quad + \mu_s^j\Big[ -[1-\lambda G(\epsilon_s^x)]\left(E_t^x - \int_{\epsilon_l}^{\epsilon_s^x} E_t^x(\tilde{\epsilon})\, d\tilde{\epsilon}\right) & \\ \quad\quad -[1-\lambda G(\epsilon_s^y)]\left(E_t^y - \int_{\epsilon_l}^{\epsilon_s^y} E_t^j(\tilde{\epsilon})\, d\tilde{\epsilon}\right)\Big] & \text{for } \epsilon = \epsilon_u, \\ 0 & \text{for } \epsilon \leq \epsilon_s^j. \end{cases} \tag{18}$$

The total job creation in sector $j$ is thus

$$\mu_s^j\Big[1 - [1-\lambda G(\epsilon_s^x)]\left(E_t^x - \int_{\epsilon_l}^{\epsilon_s^x} E_t^x(\tilde{\epsilon})\, d\tilde{\epsilon}\right) -[1-\lambda G(\epsilon_s^y)]\left(E_t^y - \int_{\epsilon_l}^{\epsilon_s^y} E_t^y(\tilde{\epsilon})\, d\tilde{\epsilon}\right)\Big].$$

However, the observed job creation does not take into account jobs that are rematched within the period, within the same sector. The *observed* job creation in sector $j$ is thus

$$JC_t^j = \mu_s^j\left[1 - E_t^x - E_t^y + \int_{\epsilon_l}^{\epsilon_s^i} E_t^i(\tilde{\epsilon})\, d\tilde{\epsilon} + \lambda G(\epsilon_s^i)\left(E_t^i - \int_{\epsilon_l}^{\epsilon_s^i} E_t^i(\tilde{\epsilon})\, d\tilde{\epsilon}\right)\right]. \tag{19}$$

The last two terms inside the brackets (indexed by $i$) refer to the jobs destroyed in sector $i$ and rematched in sector $j$ within the period. Similarly, the observed job destruction is given by[41]

$$JD_t^j = (1-\mu_s^j)\left[\int_{\epsilon_l}^{\epsilon_s^j} E_t^j(\epsilon)\, d\epsilon + \lambda G(\epsilon_s^j)\left(E_t^j - \int_{\epsilon_l}^{\epsilon_s^j} E_t^j(\epsilon)\, d\epsilon\right)\right]. \tag{20}$$

### 4.3 SPECIFICATION AND CALIBRATION

The purpose of this section is to evaluate the ability of the model to replicate salient features of the data. To do so, I follow the tradition in the business-cycle literature and "calibrate" the model against sample moments. The two sources of aggregate fluctuations in the model are the productivity shocks $z$ and relative-price shocks $p$.

To calibrate the real exchange-rate shocks, I fit an AR(1) process to the log of the industry-specific real exchange rate in the sample. The average

41. Given our definitions, $E_{t+1}^j = E_t^j + JC_t^j - JD_t^j$.

estimated autoregression coefficient across traded sectors is 0.916 with a standard deviation of the exchange-rate innovations equal to 0.035.[42] I take this average AR representation as characterizing the exchange rate process. Assuming that the innovations are normally distributed, I use the Tauchen–Hussey (1991) method to obtain an equivalent three-state Markov transition matrix with an identical Wold representation. I obtain

$$p = \begin{pmatrix} 0.8597 \\ 1 \\ 1.163 \end{pmatrix}, \qquad Q_p = \begin{pmatrix} 0.916 & 0.084 & 0 \\ 0.021 & 0.958 & 0.021 \\ 0 & 0.084 & 0.916 \end{pmatrix}.$$

A similar method is applied to convert an AR process for aggregate productivity into a three-state Markov chain. However, fitting an AR1 process to the quarterly deviations from a linear trend of log manufacturing output per hour yields a correlation coefficient of 0.914 with a standard deviation of the innovations of 0.009. This implies a standard deviation of aggregate innovations about 4 times smaller than that of the exchange rate. I view such large differences as implausible, especially given the small contribution of real exchange rates to the forecast MSE in the empirical section. It should be clear that one cannot hope to replicate the aggregate dynamics if the major source of fluctuations is coming from the reallocation shocks. Instead, I assume that reallocation and aggregate shocks represent similar sources of fluctuations, so that $z = p$ and $Q_z = Q_p$.

Next, I parametrize the matching function in a standard fashion:

$$m\,(u_t, v_t) = \min\,(k\, u_t^{\eta} v_t^{1-\eta}, u_t, v_t).$$

This specification imposes that the worker and job matching probabilities are less than one. $\eta$ represents the elasticity of the matching function with respect to unemployment while $k$ is a scaling parameter. Blanchard and Diamond (1989) estimate an aggregate matching function and find mild support for a constant-return specification with $\eta = 0.4$. Their measure of new hires includes flows into employment from unemploy-

42. A similar estimation in deviations from a linear trend yields an average autoregression coefficient of 0.90 with a standard deviation for the innovations of 0.034. A Philips–Perron test allowing autocorrelation of the residuals at 12 lags rejects the unit-root hypothesis for three sectors: cordage and twine (SIC 2298) with a serial correlation of 0.81, leather gloves and mittens (SIC 3151) with 0.79, and dolls (SIC 3942) with 0.658. Given the small-sample lack of power of unit-root tests, the nonrejection of the unit-root hypothesis is not particularly worrying. Studies using longer sample periods and/or multiple countries typically find a statistically significant mean reversion rate between 2.5 and 5 years, equivalent to a larger implied autoregression coefficient between 0.933 and 0.965.

ment, flows from out of the labor force, and employment minus recalled workers. These authors find that the flows into employment from out of the labor force are roughly of the same magnitude as the flows into employment from unemployment.[43] Den Haan, Ramey, and Watson (1997) and Cole and Rogerson (1996) have also pointed out that part of the out-of-the-labor-force population must be included when calibrating worker matching probabilities. Otherwise, worker matching probabilities based on unemployment duration (on average 21 weeks) yield a far too rapid adjustment of the unemployment rate to its steady-state value.

The average job destruction rates in the traded and nontraded sectors are $\rho^x = 0.0576$ and $\rho^y = 0.0567$ respectively (see Table 2). To obtain the average worker matching probabilities, observe that in steady state the number of jobs created $\mu^x u$ must equate the number of jobs destroyed $\rho^x E^x$. The second term reflects the number of workers that are rematched within the quarter. In steady state it must be equal to the number of jobs created: $\mu^x u$. A similar equation holds for the nontraded sector. From Blanchard and Diamond (1990), one gets an estimate of the ratio of unmatched to matched workers, $u/(E^x + E^y)$, of around 12%, where out-of-the-labor-force workers are considered as part of the pool of unmatched workers. Lastly, since tradable and nontraded employment represent respectively 14.54% and 12.11% of total manufacturing employment, I estimate the ratio $E^x/(E^x + E^y) = 0.5455$.[44] One can then solve for the average worker matching probabilities in both sectors, finding $\mu^x = 0.262$ and $\mu^y = 0.215$.

To calibrate the taste parameters $\gamma$ and $\phi$, I first arbitrarily set $\phi$ equal to 1 so that $\gamma$ represents the share of current expenditures on tradables. Using the definition of the trade balance, the ratio of trade balance to output is equal to

$$\frac{\mathrm{TB}}{px + y} = \frac{x - \frac{\gamma}{1-\gamma} y}{px + y}.$$

The average ratio of trade balance to GDP is equal to $-1.28\%$ over the sample period 1972–1988. This allows us to pin down $\gamma$, the share of traded goods in expenditures. Note that $\gamma$ indirectly affects the strength

43. Blanchard and Diamond (1989) adjust the CPS flow data using the Abowd–Zellner (1985) technique. However, they report that using the Poterba–Summers correction yields very different results, with flows from out of the labor force representing only 28% of the flows into employment from unemployment. In what follows I adopt their baseline specification.

44. This implicitly assumes that the ratio is 54% for the entire economy.

of the interest-rate effect discussed previously. A smaller $\gamma$ implies less variation in the price index and therefore a smaller fluctuation in the real interest rate in response to exchange-rate shocks. While $\gamma$ pins down the relative importance of tradables and nontradables in consumption, one also needs to calibrate the relative importance of both sectors in production. For lack of a direct estimate of the average relative productivity of traded and nontraded goods, I assume in what follows that $A^x = A^y$.

The discount rate $\beta$ is set so that the annualized interest rate is equal to 4%; the idiosyncratic shocks $\epsilon$ are distributed uniformly with mean 0 on $[-\epsilon_u, \epsilon_u]$, where the range $\epsilon_u$ will be calibrated to the match the average standard deviation of the job destruction series in both sectors.

Table 9 reports the main parameters together with the moments that need to be matched.[45]

### 4.4 SIMULATION AND DISCUSSION OF THE RESULTS: THE ROLE OF THE OPPORTUNITY COST OF EMPLOYMENT

For the calibrated values of the parameters, Table 10 reports the cutoff as well as the job and worker matching probabilities.[46]

We observe a few points. First, the cutoff declines in the tradable sector as both the relative price and the aggregate productivity improve. In the nontraded sector, the cutoff increases with the reallocation shock and decreases with the aggregate shock. Similarly, we observe that the job matching probabilities increase in the tradable sector with positive aggregate and reallocation shocks, implying a decline in the job matching rate. Destruction rates in this model, can be read off directly from the change in the cutoff. Suppose, to simplify, that the economy has enough time to reach its ergodic distribution $\bar{E}^j(\epsilon)$ between shocks. Then, following an adverse shock that shifts the state from $s$ to $s'$, approximately $\int_{\epsilon_s^j}^{\epsilon_{s'}^j} \bar{E}^j(\epsilon)\, d\epsilon$ jobs are destroyed if $\epsilon_s^j < \epsilon_{s'}^j$.

The interesting question is what happens to job creation. From Table 10, we know that an adverse shock, whether aggregate or reallocation, lowers the worker matching rate. Going from the highest to the lowest aggregate productivity state, the matching rate drops by 20%, from 0.268 to 0.219 in each sector. This decline in matching rates can result from an increase in unemployment or a decline in vacancies posted. Its effect is clearly to dampen the opportunity cost of employment. In turn, a decline in the opportunity cost of employment indicates that it is profitable

45. The parameters are estimated by the simulated method of moments. I use a sample of length 2000 and delete the first 500 observations to reduce dependence on initial conditions. Since there is no growth in the model, the correlation structure is estimated in levels. With eight moments and six parameters, the estimation is overidentified.

46. The states are in a lexicographic order with the aggregate shock first.

Table 9 CALIBRATION

| *Parameter* | *Symbol* | *Value* |
|---|---|---|
| Consumers | | |
| Discount rate | $\beta$ | 0.99 |
| Elasticity of substitution between $x$ and $y$ | $\phi$ | 1.00 |
| Share of traded goods $x$ | $\gamma$ | 0.532 |
| Technology | | |
| Average productivity, tradables | $A^x$ | 0.028 |
| Average productivity, nontradables | $A^y$ | 0.028 |
| Arrival rate of idiosyncratic shocks | $\lambda$ | 0.184 |
| Range of idiosyncratic shock | $\epsilon_u$ | 1.879 |
| Search cost per period | $\nu$ | 0.006 |
| Matching | | |
| Elasticity of the matching function | $\eta$ | 0.40 |
| Worker share of surplus | $\delta$ | 0.40 |
| Matching function scale parameter | $k$ | 0.086 |

| | *Value* | |
|---|---|---|
| *Moment* | *Data* | *Model* |
| Trade balance output ratio | −0.0128 | −0.016 |
| Unemployment | 0.12 | 0.126 |
| Worker matching probability (traded) | 0.262 | 0.262 |
| Worker matching probability (nontraded) | 0.215 | 0.223 |
| Standard deviation of job creation (traded) | 0.0096 | 0.013 |
| Standard deviation of job creation (nontraded) | 0.0080 | 0.012 |
| Mean job destruction (traded) | 0.057 | 0.091 |
| Mean job destruction (nontraded) | 0.056 | 0.089 |

Parameters estimated by simulated method of moments, sample length: 2000.
*Source:* Author's calculations.

to try to hire labor. This mechanism is central to all reorganization models of the business cycle: reallocation occurs efficiently when the opportunity cost of reorganization is lowest, i.e. when nonmarket activities, such as search, are relatively more productive. The subsequent large increase in unemployment lowers the opportunity cost of labor and triggers massive entry, so that unemployment is both large and very short-lived. The result is a strong synchronization between entry and exit margins. Central to this argument is the feedback mechanism from the destruction margin to the opportunity cost of employment, which in turn activates the entry margin.

Table 10 CUTOFFS AND MATCHING PROBABILITIES

| | | | *Tradable* | | | *Nontradable* | | | *Overall* |
|---|---|---|---|---|---|---|---|---|---|
| *State* | *Aggregate* | *Relative Price* | *Cutoff* | *Job Matching* | *Worker Matching* | *Cutoff* | *Job Matching* | *Worker Matching* | *Worker Matching* |
| 1 | 0.8597 | 0.8597 | −0.434 | 0.046 | 0.219 | −0.191 | 0.043 | 0.246 | 0.464 |
| 2 | 0.8597 | 1.0000 | −0.314 | 0.044 | 0.234 | −0.314 | 0.044 | 0.234 | 0.467 |
| 3 | 0.8597 | 1.1631 | −0.191 | 0.043 | 0.247 | −0.439 | 0.046 | 0.219 | 0.465 |
| 4 | 1.0000 | 0.8597 | −0.397 | 0.045 | 0.226 | −0.128 | 0.042 | 0.256 | 0.482 |
| 5 | 1.0000 | 1.0000 | −0.266 | 0.043 | 0.243 | −0.266 | 0.043 | 0.243 | 0.485 |
| 6 | 1.0000 | 1.1631 | −0.133 | 0.042 | 0.257 | −0.400 | 0.045 | 0.226 | 0.483 |
| 7 | 1.1631 | 0.8597 | −0.347 | 0.044 | 0.235 | −0.054 | 0.040 | 0.268 | 0.503 |
| 8 | 1.1631 | 1.0000 | −0.204 | 0.042 | 0.253 | −0.203 | 0.042 | 0.253 | 0.506 |
| 9 | 1.1631 | 1.1631 | −0.058 | 0.040 | 0.268 | −0.351 | 0.044 | 0.235 | 0.503 |

The table reports the cutoffs and the matching probabilities in the traded and nontraded sectors.
*Source:* Author's calculations.

Consider now the case of a reallocation shock. If anything, the feedback mechanism must be *less* effective. The reason for this is that the opportunity cost of labor remains abnormally high, from the point of view of the depressed sector, since the reallocation shock increases entry in the other sector. One can clearly see this effect at work by looking at the last column of Table 10, reporting the overall worker matching rate $\mu_s^x + \mu_s^y$. The overall matching rate varies substantially in response to aggregate shocks, from a low of 0.46 to a high of 0.50, but remains almost entirely unaffected by changes in the relative price. To see why this is the case, suppose we adopt the perspective of the central planner.[47] Following a reallocation shock, the optimal response consists in reallocating labor *between* sectors, since one sector is expanding and the other one is contracting. The opportunity cost of labor remains muted, so that there is less of a feedback on the entry margin. In turn, this implies that we should observe less of a correlation between job creation and destruction at the intrasectoral level.

To confirm this intuition, Table 11 reports the dynamic correlation between job creation and destruction at both the aggregate and the sectoral level, from the data and from simulations of the calibrated model. It is important to note that the calibrated parameters do not

47. As usual, since the sole source of inefficiency in this economy is the search externalities, efficiency can be restored if $\delta = \eta$. See Hosios (1990). The cutoff and matching probabilities are mostly unchanged if I impose $\delta = \eta = 0.5$.

attempt to replicate the dynamic correlation between job creation and destruction. As a result, it is perhaps not too surprising that the model does not replicate the overall correlation between creation and destruction (the simulation predicts a correlation of 0.35 in the presence of both shocks and 0.17 in the presence of aggregate shocks only). This failure indicates a stronger reallocation mechanism in the model than in the data: job creation picks up on the tail of job destruction. The table further decomposes the correlation into the components resulting from the aggregate and reallocation shocks respectively. The correlation of *total* job creation and destruction rates in response to reallocation shocks is similar to that in response to aggregate shocks. This is the effect discussed by Lilien (1982): a reallocation shock increases job creation in one sector and job destruction in the other, leading to a positive comovement in the overall job creation and destruction rates. However, this aggregate positive comovement masks a lower comovement at the *sectoral* level. The contemporaneous correlation between job creation and destruction in the traded (and nontraded) sectors is 0.17 in the case of aggregate shocks

Table 11 DYNAMIC CORRELATION OF $JC^{j}_{t+k}$, $JD^{j}_{t}$

| | | *Correlation* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Sector* | *Origin* | *k=−3* | *−2* | *−1* | *0* | *1* | *2* | *3* |
| Aggregate | Data | −0.24 | −0.12 | −0.27 | −0.35 | −0.06 | 0.27 | 0.25 |
| | Agg. | 0.09 | 0.11 | 0.14 | 0.17 | 0.76 | 0.57 | 0.41 |
| | Real. | −0.10 | −0.13 | −0.15 | 0.17 | 0.75 | 0.41 | 0.17 |
| | Both | 0.02 | 0.08 | −0.01 | 0.35 | 0.68 | 0.39 | 0.20 |
| Nontraded | Data | −0.09 | −0.03 | 0.01 | 0.02 | 0.013 | 0.15 | 0.31 |
| | Agg. | 0.09 | 0.11 | 0.14 | 0.17 | 0.76 | 0.57 | 0.41 |
| | Real. | −0.24 | −0.27 | −0.28 | −0.43 | −0.02 | −0.08 | −0.12 |
| | Both | −0.03 | −0.09 | −0.17 | −0.35 | 0.11 | 0.02 | −0.08 |
| Traded | Data | −0.14 | −0.24 | −0.38 | −0.43 | 0.002 | 0.0001 | 0.006 |
| | Agg. | 0.09 | 0.11 | 0.14 | 0.17 | 0.76 | 0.57 | 0.41 |
| | Real. | −0.18 | −0.21 | −0.23 | −0.36 | 0.15 | 0.09 | 0.02 |
| | Both | −0.21 | −0.14 | −0.17 | −0.25 | 0.13 | 0.07 | 0.08 |
| Exporters | Data | −0.46 | −0.35 | −0.34 | −0.24 | −0.14 | 0.05 | 0.16 |
| Import-competing | Data | −0.24 | −0.12 | −0.27 | −0.35 | −0.07 | 0.27 | 0.25 |

The table reports the dynamic correlation at various leads and lags between sectoral and aggregate job creation and destruction rates. Simulation results obtained from 100 simulations.
*Source:* LRD and author's calculations.

but falls to −0.36 (respectively, −0.43) in the case of allocative disturbances. Reallocative shocks in this model trigger an intersectoral reallocation response, as opposed to an intrasectoral reallocation.

The lower within-sector correlation points to the difficulty faced by the model: if the model aims at replicating the negative comovements in response to aggregate shocks (and negative overall comovements), the opportunity-cost channel must be sufficiently weak. However, in that case, a relative-price shock will also lead to a negative correlation of within sector gross flows. Lastly, Figure 5 reports the impulse response to an aggregate and a relative-price shock, as generated by the model.[48] The figure reports the response to a decrease in aggregate productivity and a real depreciation. An aggregate shock imparts similar dynamics in both the traded and nontraded sectors, with a surge in job destruction (the dashed line) followed by a mild increase in job creation (the thin solid line). By contrast, a depreciation triggers a surge of job destruction in the nontraded goods sector and a simultaneous increase in job creation in the traded goods sector. While the aggregate effect is a strong positive comovement of job creation and destruction, the sectoral gross flows move clearly in opposite directions.

Observe also that the problem is not solved by decoupling job creation and destruction in response to aggregate shocks. If anything, this implies an even lower algebraic correlation between sectoral flows.

This result indicates the difficulty faced by this type of model: to generate a positive comovement between sectoral job creation and job destruction, it needs to generate a positive comovement between job creation and destruction in response to an aggregate shock. The tension between the two requirements indicates some other mechanism is required. Clearly, while a great deal of effort has been spent on the dynamics of the shutdown margin, we need to think more actively about the dynamics of the entry margin and recoveries. The results in the paper point to a difference in the dynamic response that cannot be accommodated within the current framework.

## 5. *Conclusion*

This paper has aimed at uncovering the relationship between factor adjustment and real-exchange-rate fluctuations. Concentrating on gross job flows in the U.S. manufacturing sector, it was found that exchange-rate movements affect significantly both net and gross factor realloca-

48. The impulse response is generated by assuming that the system is initially in steady state.

Figure 5 NORMALIZED IMPULSE RESPONSE FUNCTIONS TO AGGREGATE AND SECTORAL SHOCKS: SIMULATED MODEL

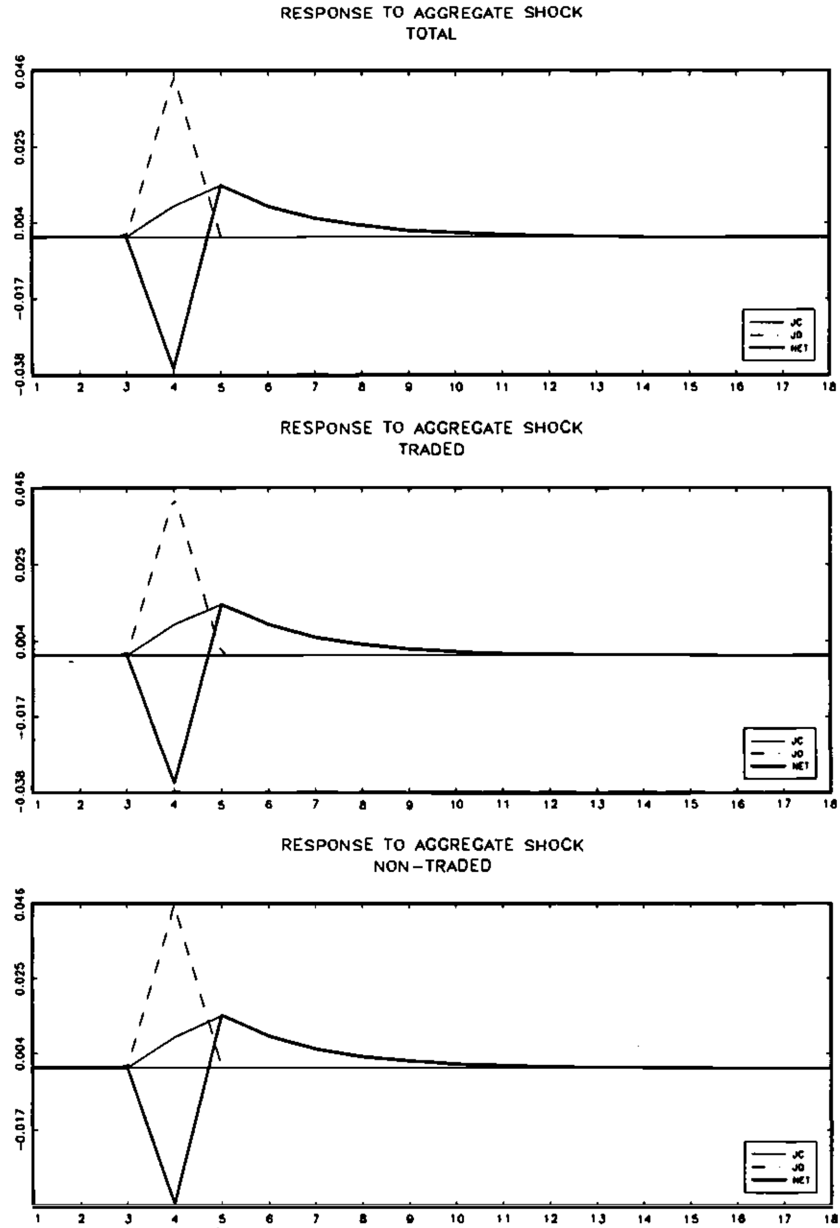
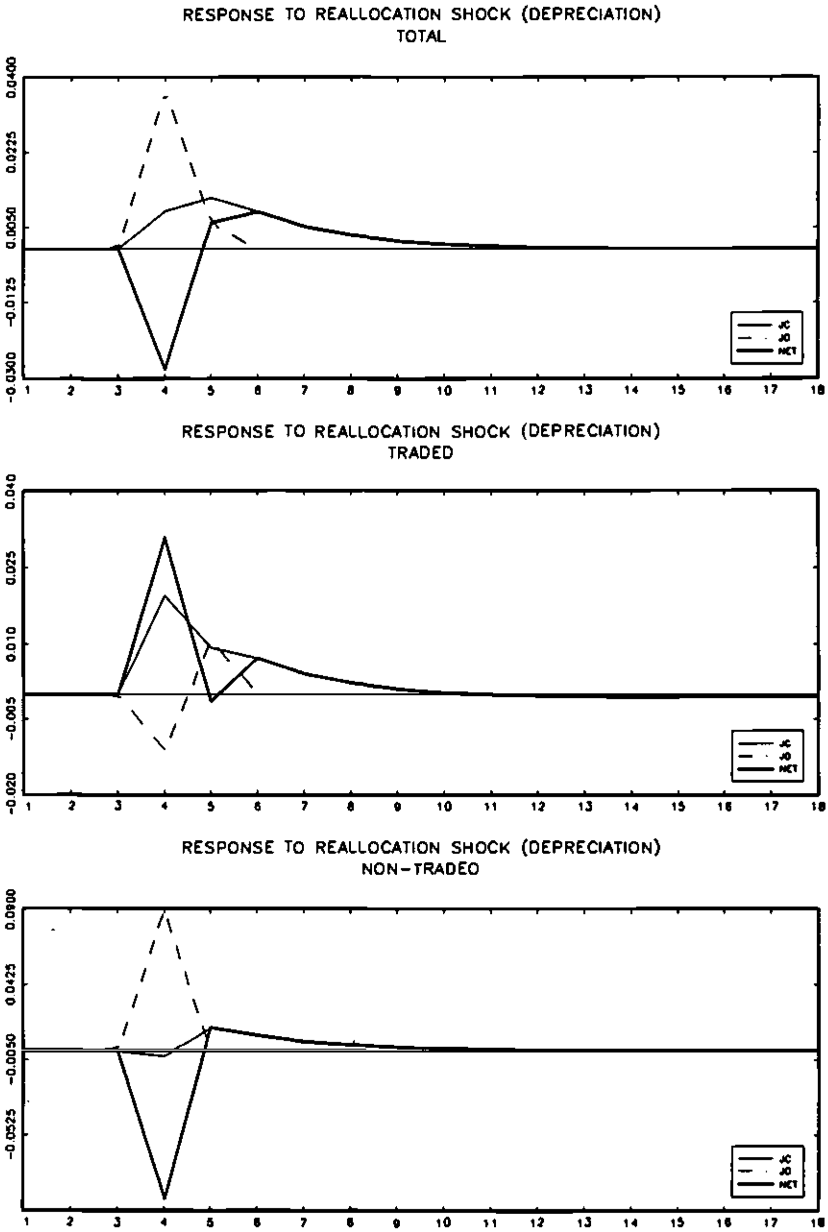


Figure 5 (continued)



tion. In the paper's benchmark estimation, a 10% appreciation of the real exchange rate translates into a contraction in tradables employment of roughly 0.3%, through a simultaneous increase in job destruction and job creation. The effect is mostly concentrated in import-competing industries, which exhibit much higher exchange-rate sensitivity. While these effects are significant, it also appears that exchange-rate shocks do not constitute a major source of fluctuations at the sectoral level. We found only roughly 9 to 11% of the 8-quarters-ahead forecast MSE accounted for by real-exchange-rate movements.

Perhaps more strikingly, the results indicate a pattern of adjustment in response to reallocative shocks essentially different from the response to aggregate shocks. While aggregate dynamics are characterized by a strong decoupling between job creation and destruction, reallocative shocks [oil shocks in Davis and Haltiwanger (1997) or real-exchange-rate shocks in this paper] induce positive comovements in sectoral gross flows. In the context of real exchange rates, appreciations are times of turbulence, with a joint increase in creation and destruction, whereas depreciations are times of chill.

Lastly, this paper has presented a canonical two-sector business-cycle model with employment reallocation and argued that the pattern found in the data is hard to replicate in current models or reallocation. This should provide fertile ground for further theoretical and empirical investigations.

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# *Comment*

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## 1. *Introduction*

Despite the implication that I've become one of the old men of the profession, I'm pleased to be here. Gourinchas has written an interesting and ambitious paper. Interesting because it looks at a good issue: the relation between employment and the substantial exchange-rate fluctuations we've seen over the last 25 years. Ambitious because the theoretical framework is state-of-the-art, and because the history of attempts to relate exchange rates to real variables is littered with wreckage.

## 2. *Sargent's Law*

This history was put into context for me by Tom Sargent. Ten or twelve years ago, Pat Kehoe and I were visiting Stanford. We met Tom for coffee and described our unsuccessful attempts to find a systematic relation between movements in exchange rates and GDP. I think of his response as Sargent's law: When you mix prices and quantities, the results stink. (This isn't an exact quote, but you get the idea.) Economics is filled with examples that make his point. 1960s-era macroeconomics, by and large, related quantities to quantities—the consumption function, for example. It worked great, in the sense that the quantities were highly correlated with each other. But when they added prices, as in cost-of-capital variables for investment equations, there were problems: the relation suggested by theory between (say) investment and the cost of capital was hard to detect in the data. Similarly, modern finance explains prices with prices, and it works pretty well, too. But when we add quantities, as in consumption-based asset pricing models, the data protest loudly. From this perspective, our experience with exchange rates doesn't seem so unusual.

This history serves as a warning to anyone who would like to document a strong statistical relation between exchange rates and real variables. There are, nevertheless, some very good reasons to do it anyway.

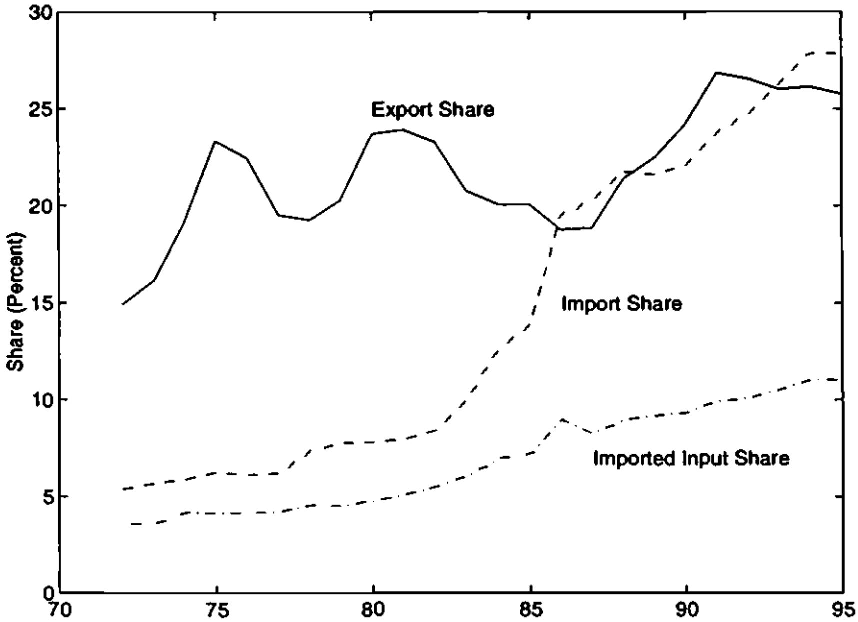
One is that the economic mechanism is often most clearly reflected in the relation between exchange rates and quantities. Another is that exchange rates highlight novel features of the economy. In this paper, the idea is that exchange rates are a convenient example of an exogenous (meaning uncorrelated with almost everything) reallocative shock. Finally, I think exchange rates are interesting in their own right. For all of these reasons, I find Gourinchas's paper extremely well motivated.

## 3. *Predecessors*

Before getting to the paper, let me give you a quick review of earlier work relating exchange rates to real variables. One of the most striking is Baxter and Stockman's (1989) study of exchange-rate regimes. After an exhaustive exploration of the IFS database, they conclude that there is no significant difference in the behavior of real variables across regimes: fixed and floating exchange-rate regimes are pretty much the same with respect to aggregate variables. An equally influential study is Frankel and Rose (1995), who summarize an enormous body of work as saying that high-frequency exchange-rate movements are unrelated to virtually any fundamental economic variable. The behavior of exchange rates, in their view and others', is something of a mystery (hence the term "exogenous"). A third line of research concerns effects on stock prices, which I regard as most notable for the amount of effort required to find a "significant" statistical relation. In short, it has proved to be extremely difficult to find nonzero correlations between exchange rates and other variables.

The first glimmer of hope comes from Campa and Goldberg (1995, 1997, 1998), whose work I have followed with interest for some time. Campa and Goldberg note that external exposure varies dramatically across industries and over time. Over the last 25 years, for example, industries have moved from net importers to net exporters and the reverse, and the extent of foreign competition has varied as well. An example is Figure 1, where we see that in SIC 35 (machinery) the share of imported inputs rose by a factor of 3, the fraction of sales by foreign firms increased by a factor of 5, and the share of domestic output sold abroad varied substantially, all over the last two decades. More relevant to this discussion, perhaps, is that these patterns show little similarity across industries. Once differences across industries and time are accounted for, Campa and Goldberg find strong effects of exchange rates on investment, somewhat smaller effects on wages, and nonzero but weak effects on employment.

Figure 1 VARIATION IN EXPOSURE (SIC 35: MACHINERY)




*Source: Campa and Goldberg (1997).*

## 4. *The Paper*

Gourinchas makes two distinct contributions: he takes a systematic look at the statistical relations between exchange rates and job flows, and constructs a dynamic model to account for them. My executive summary is this: (i) The effects of exchange rates on employment are small, but (ii) there are significant, small effects on net job flows, and larger effects on gross flows. All told, exchange-rate movements account for 5–7% of the variance of job creation and destruction. (iii) Job creation and destruction move the same way: appreciation raises both, and in this sense leads to labor-market turbulence. (iv) This last feature is not easy to mimic in a model.

One might quibble with parts of the evidence, but on the whole it agrees with earlier work: exchange-rate fluctuations play a relatively small role in the allocation of labor across firms and industries. My primary concern is the emphasis on (iii), which I worry is a fairly subtle, and perhaps fragile, feature of the data.

Perhaps the most ambitious part of the paper is the model. My initial reaction is that the model focuses on the wrong issue: Since exchange-rate fluctuations play such a small role in allocating labor, why try to model their effects? But the modeling is interesting enough in its own right to warrant attention for other reasons. The main reason, to me, is that the dynamics of the labor market are inherently interesting, whether they are related to exchange rates or not. The issue is how to formalize the allocation process. Gourinchas's model is a good start, but a number of questions come to mind:

Can we model the allocation of labor separately from that of capital? My experience has been that capital formation has a substantial—and frequently counterintuitive—effect on overall dynamics, and perhaps that is true here, too. We also gain an additional channel by which exchange-rate movements might affect the economy, one with a stronger statistical basis.

How important is the choice of matching technology? My impression is that this kind of technology, in which matching is simply the result of vacancies and unemployment, fails to reproduce many of the dynamic features of labor markets. Perhaps something like Jovanovic's (1979) model would be worth exploring.

Can we get more out of the shock process? The shock process is a relatively simple Markov chain. Even within this structure, I wonder whether we could get different responses by allowing the spread of the distribution to vary substantially across states.

None of these are complaints—more signs that the approach is interesting, and worth pursuing along new directions.

## 5. *Are Exchange-Rate Movements Big?*

I'd like to conclude with a question implicit in Gourinchas's empirical work: Are exchange-rate movements big? I'm used to thinking of the post-Bretton Woods movements in currency prices as large, but this paper and others make me wonder whether this is right. The issue is what yardstick we use to judge magnitude. Certainly log changes in exchange rates have greater variance than log changes in (say) real GDP, so in that sense exchange-rate movements are large. Alternatively, we might note that the variation is a little less than we see for equity prices: annualized volatility is about 15% for the S&P 500, and about 11% for major currencies against the U.S. dollar. By this comparison, exchange-rate movements aren't so big. This paper shows quite clearly, I think, that exchange-rate movements are small relative to other shocks driving the sectoral reallocation of labor. The work of Campa and Goldberg also suggests that there may be large effects on particular sectors or firms, but the weight of earlier work on aggregates tells us exchange rates are not a major source of aggregate fluctuations.

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# *Comment*

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## *1. Introduction*

This paper studies a number of issues that are relevant for understanding both the nature of job flows and the response of the U.S. economy to shocks created by interactions with other countries. This is clearly a very ambitious project, one that could define a research program for a group rather than be the topic of a single research paper. Nonetheless, Gourinchas touches all of the key bases in this paper and provides a basis for further study in a number of areas.

The paper bears on the following questions:

Is reallocation an important aspect of job flows?
Do real-exchange-rate movements constitute a key source of reallocation?
What does a model of the reallocation process imply for the specification of open economy macro models in general?

My comments start with the motivation for this paper and then are structured around these three questions.[1]

## 2. *Motivation*

Why should a traditional macroeconomist care about a paper on real exchange rates and job flows? It is often too easy to ignore the fact that the U.S. economy is influenced by shocks that arise from sources external to our borders. The traditional search for sources of fluctuations focuses on technology shocks and policy variations and ignores the possibility that disturbances arising in other countries may be reflected in our domestic levels of economic activity.

This paper provides a partial challenge to that view. The idea is that by looking at the impact of exchange-rate movements on job flows we can potentially learn about two important topics.

First, it could be that for some industries, real-exchange-rate movements constitute an empirically relevant source of fluctuations. Second, even when real-exchange-rate movements are relatively small, they are still useful for tracing out the process of job reallocation. This is particularly true if by studying the impact of real-exchange-rate changes we are able to identify certain structural aspects of the adjustment process that can be used to study the impact of other, perhaps more quantitatively important, shocks. From this perspective these real-exchange-rate shocks may produce small fluctuations but considerable economic information.

In the end, and perhaps not too surprisingly, real-exchange-rate movements appear not to be a main source of fluctuations. Further, the empirical exercises, while pointing to some significant comovements of job creation and destruction, fail to identify structural aspects of the adjustment process. Thus it is not clear how much one can infer about the general nature of the labor and capital adjustment processes from this exercise.

Still, this paper is extremely impressive in both its depth and its breadth. Reaching its intellectual target, while quite appealing, is no easy task. So despite not providing convincing evidence on the importance of real exchange rates, this paper sets the basis for further study in this area.

## 3. *Is Reallocation a Large Piece of Aggregate Fluctuations?*

Sources of fluctuation are generally classified as either aggregate or sectoral in nature. With regard to aggregate shocks, it is common to con-

1. My comments presented at the conference were more directed at details of the paper. My goal here is to address the arguments of the paper in a more general manner.

sider variations in technology, monetary policy, fiscal policy, and expectations as the sources. Of course, these same shocks can be sectoral in nature as well, insofar as they influence sectors differentially.

Evaluating these sources of shocks is, of course, a full-time job in macroeconomics. A persuasive analysis is one that first identifies these shocks and then, in the context of a dynamic equilibrium model, matches relevant aspects of the data. Likewise, models that stress sectoral shocks are subject to the same standards.

One of the primary empirical hurdles in evaluating sectoral models is the fact that sectors generally move together. Positive sectoral comovements in output, employment, and productivity have been documented in a number of studies. While this type of evidence is often taken as indicative of aggregate shocks, positive comovements can be created in a model with sectoral shocks *if* there is some type of complementarity (either through technology or the structure of demands) that links sectors together.

Still, there are a number of interesting features of sectoral-shock models. First, there are numerous candidates for sectoral shocks. Included would be aggregate shocks, such as shocks to government spending, that affect sectors asymmetrically. Further, oil price shocks may affect sectors in a differential manner, as in Davis and Haltiwanger (1997).

Second, once one moves away from aggregate data, there is a wealth of statistical information that can be brought into the discussion. The research summarized in Davis, Haltiwanger, and Schuh (1996) highlights a broad set of facts concerning the nature of job flows over time and across firms. These "facts" are now well known: job creation is mildly procyclical, job destruction is strongly countercyclical, and reallocation (the sum of creation and destruction) is countercyclical. This last fact gives rise to the theme that recessions are a time for reorganization, since job reallocation rises significantly in periods of low economic activity.

Along with the time-series dimension of job flows is the incredible richness of the cross-sectional diversity. Even in bad economic times, it is not unusual to have a number of plants expanding activity. Further, it is not clear that disaggregation to even the four-digit level is sufficient to create a homogeneous set of plants. Simply put, the heterogeneity across plants is not easily captured by controlling for the obvious characteristics such as sector, age, or size.

To fix these ideas, consider a simple investment model, studied, for example, by Cooper and Haltiwanger (1998). While this model does not have all of the richness of the theory presented by Gourinchas, it is a simple device for exploring some of the key points.

The optimization problem of a firm (which is taken to be equivalent to a plant for this discussion) reduces to the choice of replacing/augmenting or retaining its capital ($k$). If capital is retained, then it is productive, yielding a profit flow (net of the costs of all adjustable factors) given by $\pi(A,\xi,k)$, where $A$ represents a common shock and $\xi$ is a firm-specific shock. In the subsequent period the firm has a lower capital stock, due to physical depreciation and obsolescence (given by $\rho$ below).

If capital is replaced and/or augmented, then the firm bears both convex and nonconvex adjustment costs. For the nonconvex costs, the profit flow is reduced by a factor of $\lambda$ and the firm must incur costs of investment, given by $F$ below, independent of the size of the investment expenditure. In addition, the model allows for convex costs of adjustment, captured by a cost-of-adjustment function specified below.

The gains to investment arise from the increased capital at the firm in the following period. This may appear as simple additions to the existing stock of capital or the replacement of old machines with new ones, yielding a vintage-type model as in Cooper, Haltiwanger, and Power (1995). For our purposes here this distinction is not a critical point.

Letting $V(A,\xi,k)$ represent the value of a firm given the state $(A,\xi,k)$, the formal representation of this problem is

$$V(A,\xi,k) = \max(V^a(A,\xi,k), V^i(A,\xi,k)),$$

where the superscript $a$ refers to "action" and $i$ to "inaction." The values associated with these actions are given by

$$V^a(A,\xi,k) = \max_{k'} [\pi(A,\xi,k)(1 - \lambda) - F - C(k,k') + \beta EV(A',\xi',k')],$$

and

$$V^i(A,\xi,k) = \pi(A,\xi,k) + \beta EV(A',\xi',\rho k).$$

The solution of this dynamic optimization problem yields two policy functions. One describes the state contingent probability of investment, $h(A,\xi,k)$, and the other the level of investment contingent upon acting, $I(A,\xi,k)$. The properties of these policy functions are quite dependent upon the nature of the adjustment costs and the serial correlation of the driving processes.

As argued in Cooper, Haltiwanger, and Power (1995), lumpy investment (created by the nonconvex aspect of adjustment costs) will be procyclical when shocks to profitability are highly serially correlated and when the costs of action are largely independent of the level of current profitability. So, using the model specified above, procyclical activity is more likely to arise when the $(A,\xi)$ shocks are positively serially correlated and the adjustment cost is borne mainly through a large $F$ and not a large $\lambda$. Conversely, adjustment is likely to occur in low-profitability states when adjustment costs entail large opportunity costs, as through a large value of $\lambda$ and less persistent shocks.[2] Thus this type of model can deliver the theme that "recessions are a time for reorganization," but this result depends critically on underlying parameters.

We can use this model to exposit some of the key themes raised by Gourinchas. Clearly there is a bit of a gap between this formulation and his, since Gourinchas talks about job flows and exchange rates and this model has neither.[3] Further, to his credit, Gourinchas has more of a general equilibrium structure. Clearly, then, my exposition does not substitute for a careful reading and evaluation of his model.

In the mapping between investment and labor, a relabeling of the variable $k$ cheaply converts the model from one of investment to costly adjustment in the stock of workers. In this latter interpretation, hours per worker and capital rentals could then be viewed as the flexible factors which are already included in the optimization problem leading to the reduced-form profit function. Alternatively one can argue that adjustments in the stock of machines lead to job flows, so that an understanding of investment leads to a theory of job flows.[4]

Second, what are the shocks here relative to those studied by Gourinchas? Ignoring aggregate shocks for the moment, fluctuations in investment and jobs can arise from two sources: sectoral shocks and idiosyncratic shocks. So, being a bit more specific with labels for the shocks in the optimization problem, let $A_{it}$ be the shock to profitability in sector $i$ in period $t$, and $\xi_{ijt}$ the idiosyncratic shock to firm $j$ in sector $i$ in period $t$. The first type of shock creates reallocation across sectors, while the second type underlies the heterogeneity of job creation, destruction, and investment activity at the firm (plant) level within a sector. In principle, real-exchange-rate movements would appear as both a firm-specific and a sectoral shock.

With this classification of shocks in mind, what types of behavior does the model produce? If the primitives are such that activity is procyclical, then there will be a set of relatively high values of the shocks, $(A, \xi)$, such that positive investment arises if the state is within this set, given the existing stock of capital. There will also be a set of realizations of the

2. In Cooper and Haltiwanger (1993), profitability movements occurred due to deterministic seasonal two-cycles, so that adjustment occurred in periods of low profitability, given time to build of one period.
3. To be clear, job flows and exchange rates are at the heart of the empirical exercise. The theory model presented in Section 4 of the paper has a technology that does not distinguish capital and labor, with shocks coming from relative prices.
4. On this point see Abel and Eberly (1997) and Cooper and Haltiwanger (1998).

shocks with disinvestment. In the remainder of states, there will be inaction.

Within a sector, an optimal policy of this form will create dispersion in activity across firms due to the idiosyncratic shocks. In principle, the model can be parametrized in a way that mimics the observed heterogeneity across plants observed in, for example, the LRD. So, in the language of Davis, Haltiwanger, and Schuh (1996), there will be job creation (capital accumulation) at some high-profitability plants and job destruction (disinvestment) at others, in all sectors of the economy.

These sectoral shocks create a basis for plants within a sector to move together. Again, assuming that activity is procyclical, a sector experiencing a high-profitability shock will undertake investment activity either by expanding existing capacity or by introducing new techniques and products (machine replacement). On the job-flow side, these expanding sectors will be creating jobs, assuming either that employment is complementary with capital or that the fixed factor in the model is labor.

Sectoral shocks may also create reallocation across sectors. This arises naturally from the effects of reduced factor demands by one sector leading to variations in factor prices that lead to increased factor demands by other sectors. This reallocation process is potentially complicated by considering the actual process of worker flows. As discussed in Section 4.4 of his paper, the richer search and matching model analyzed by Gourinchas has this property of reallocation across sectors in response to a relative-price shock. The difficult element, as noted in his remarks as well, is generating reallocation within a sector in these models.

Intrasectoral reallocation might be created by shocks that lead to a mean-preserving spread across plants. In this case, given the distribution of capital holdings, an increase in the variance of the distribution of idiosyncratic shocks will simultaneously increase both creation and destruction within a sector, since more plants are pushed outside of the region of inactivity in $(A, \xi)$ space. This leads one to consider whether shocks, such as real-exchange-rate movements, can lead to changes in the distribution of the profitability of investment and employment opportunities.[5]

With this type of model in mind, we can turn to the evidence of the effects of various shocks on job and capital flows. The key points will be isolating sectoral or reallocative shocks and tracing their implications for job creation and destruction as well as investment activity.

5. Using plant-level data to investigate this type of mechanism seems quite promising. Caballero, Engel, and Haltiwanger (1997) use their characterization of "employment shortages" to construct an idiosyncratic shock series for a panel of plants in the LRD. This allows them to uncover some time-series evolution in the distribution of idiosyncratic shocks.

## 4. *Are Real-Exchange-Rate Movements a Key Source of Reallocation?*

One of the primary contributions of Gourinchas's paper is to add to the accumulation of evidence on reallocation shocks and their impact on employment. A previous paper, by Davis and Haltiwanger (1997), looks at the impact of oil price shocks on job creation and destruction. From their evidence, the reallocative component of oil price shocks leads to positive comovement in job destruction and job creation. Further, Davis and Haltiwanger find that much of the reallocation appears within rather than between sectors. Finally, there is a distinctive dynamic pattern. The immediate impact of an adverse oil price shock is for employment to fall with reallocation emerging over a longer period of time.

The paper by Gourinchas parallels Davis and Haltiwanger's study except for the nature of the reallocation shock. Clearly, the approach of Gourinchas is to view real-exchange-rate movements as partly a source of reallocation between plants and sectors that differ in their sensitivity to this variable. To conduct such a study, one must first isolate real-exchange-rate movements and then find some metric for distinguishing groups of plants in terms of their responsiveness to these movements.

As Gourinchas is using four-digit SIC data, his approach is to split the sample into a group of plants that is sensitive to real-exchange-rate movements and one that isn't. The selection is based on trade exposure, measured by either export shares or import penetration. Given the isolation of 69 out of 450 sectors, Gourinchas then constructs a sectoral measure of real-exchange-rate movements, which is used to identify the response of the sector's employment to variations in real exchange rates.

Using this measure of sectoral real exchange rates, two empirical exercises are undertaken. The first, as reported in Gourinchas's Tables 3 to 5, regresses net employment growth, job creation rates, and job destruction rates in each sector on an aggregate measure of net employment growth and the sectoral real exchange rates. Gourinchas finds that net employment is relatively insensitive to real-exchange-rate shocks within the groups of exporting and import-competing firms.[6]

The decomposition of these effects into job creation and destruction in the subsequent tables indicates a significant response of these flows within sectors to real-exchange-rate shocks. These results clearly have the sign pattern associated with reallocation shocks: job destruction and job creation move together within a sector over the three quarters. Fur-

6. In fact, none of the individual coefficients from the regressions summarized in Table 3 are significant, though their sum is different from zero.

ther, the movements of the export sectors and those identified as import competitors are quite similar.

There must be quantitatively disperse movements across plants that underlie these movements within a sector in response to these real-exchange-rate shocks. Interestingly, there is no apparent response from the nontraded goods sector and hence no general equilibrium spillovers of the type discussed in the model presentation above.

The second exercise is quite close to the approach taken by Davis and Haltiwanger: use a VAR to distinguish the innovations to real-exchange-rate movements and then trace out their impact on job flows. The details of this (including the assumptions needed) are spelled out in the paper. The main finding of this approach (see Table 8) is that while sometimes statistically significant, the effects of exchange-rate movements on employment are small. From this table, one does see that there is some evidence of reallocation. The effects seems largest in particular isolated industries, such as motor vehicles, leading to more interest in detailed studies of particular sectors.[7] Further, as Gourinchas notes there is something a bit puzzling about the results created by the VAR analysis: the responses of the nontraded and traded sectors to real-exchange-rate movements are comparable.

Overall, the quantitative analysis documents the role of real-exchange-rate shocks as a source of reallocation. While not a large source of fluctuations in job flows, movements in the real exchange rates do create some statistically significant movements in job destruction and creation that have the pattern of reallocative shocks.

## 5. *Should We Respecify Open-Economy Models?*

While not touched upon in Gourinchas's paper, there is a large literature that falls under the heading of *open-economy real-business-cycle* (ORBC) models. Papers in this tradition, such as Backus, Kehoe, and Kydland (1992), Baxter and Crucini (1993), and Stockman and Tesar (1995), consider multicountry stochastic growth models in which there are both country-specific and sector-specific shocks. In equilibrium, of course, these shocks influence real exchange rates and, in monetary models, the nominal exchange rate as well.

There are clearly two differences between these models and that presented in the last section of the paper by Gourinchas. First, the ORBC models are completely specified and are general-equilibrium in nature.

7. In fact, it would have been useful to complement this evidence with graphs of real-exchange-rate movements and job flows for particular industries.

In principle this is a great advantage, since it allows one to trace the effects of certain types of shocks on equilibrium outcomes, generally summarized by impulse response functions. In contrast, the model presented by Gourinchas talks about real-exchange-rate shocks, but, of course, they are not exogenous shocks. To the extent that the variation in the real exchange rate comes from, say, a disturbance to technology, it should affect decisions on job creation and destruction beyond the effects highlighted in Gourinchas's analysis.

Second, the model explored by Gourinchas has the distinct advantage relative to the ORBC models of specifying a richer adjustment process. This is important and not just for purposes of "realism." One of the ways in which the ORBC models fail to fit the data is precisely in terms of capital flows. Specifically, in many of these analyses, capital flows too quickly across national boundaries, yielding negative correlations in output across countries. This is of course simply the international analogue of negative comovements created by sector-specific shocks.

From the perspective of the ORBC models, the issue is how to build frictions in the adjustment of capital across international borders. In some of these exercises, explicit transactions costs are imposed. This has the desirable effect of reducing these flows, but leaves open the source of the frictions.

One could imagine constructing a model much closer to that proposed by Gourinchas in which the costs of adjustment appear through labor-market frictions. To the extent that machines need workers to operate them, the frictions in the labor market provide a simple impediment to the flow of capital. The difficult part is the construction of general equilibrium models in which there is a distribution of capital vintages.[8]

So, from this viewpoint, I see a natural merger of these research lines. The gain to the Gourinchas model would be to make the real exchange rate endogenous. The gain to the ORBC model is a more realistic specification of the factor adjustment process.

## 6. *Conclusions*

This is a very thoughtful and carefully crafted paper. While it is not clear that it provides convincing evidence that real-exchange-rate movements are an important part of the fluctuations story, it lends support to the view that they are an important source of reallocation. As we continue to study the sources of uncertainty and their implications for factor flows both across and within sectors, studies such as this will

8. For progress along these lines see, for example, Gilchrist and Williams (1998).

provide the needed evidence and modeling to understand a wide range of observations.

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# *Discussion*

Gourinchas began the discussion by responding to some comments of the discussants. He emphasized that the purpose of the paper was not to claim that exchange rates are a major driving force behind job flows, but rather to use the observed effects of exchange-rate shocks to improve our understanding of the transmission mechanism in general. He defended the use of an empirical specification in levels rather than growth rates, arguing that using growth rates would obscure the dynamic response of job creation and destruction to a one-time depreciation or appreciation. Finally, he argued that focusing on the statistical significance of sums of coefficients (as opposed to individual coefficients) in the basic regressions of Tables 3–5 was justified by the likely importance of adjustment costs and expectational effects.

Michael Klein noted that Gourinchas's time-series approach is a useful complement to the cross-sectional approach of Davis, Haltiwanger, and Schuh. He suggested that larger effects of exchange rates might be found in annual data, because of delayed responses by firms. Gourinchas pointed out that with the use of annual data the sample would be quite small in the time-series dimension.

John Shea thought the finding of positive comovement of job creation and job destruction in response to reallocative shocks to be the most interesting of the paper and he asked whether this result could be confirmed for other reallocative shocks. One possibility would be to use sector-specific demand shocks based on input–output relations, as in Shea's own work. Gourinchas noted that a positive correlation of sectoral job creation and destruction had been found for the case of oil shocks by Davis and Haltiwanger.

Henning Bohn raised the issue of durability of output. He noted that the theoretical model considers only nondurable goods, but that in the data tradable goods tend to be durable and nontradable goods tend to be nondurable. Bohn expressed the concern that the sectoral differences found in the paper might reflect differences in durability of output rather than tradability. Gourinchas replied that exporting and import-competing sectors both produce mostly durable goods, but that their responses to exchange-rate shocks appear to be different.

Robert Shimer suggested that sectoral specificity of workers' skills might be an important factor limiting intersectoral movement following a reallocative shock. Gourinchas agreed that this factor would reduce the absolute value of the expected negative correlation between job creation and destruction following a reallocative shock, but by itself it cannot account for the positive correlation found in the data.