

# Import Competition and Company Training: Evidence from the US Microdata on Individuals

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## Abstract

This paper empirically investigates the effect of import competition on company training in the United States. Focus on the effects of imports on training is important, since such training is an important factor in earnings and job security. Specifically, I look at the effect of imports at the three digit industry level on the incidence of company training for individuals in the National Longitudinal Survey of Youth, and thus extend empirical trade research to micro data on individuals. Overall, I find that import competition has a negative effect on company training, especially for non-production workers. I also find that imports from low- and middle- income countries have a more severe negative effect on training than do those from high-income countries. However, I do not find a significant difference between the effect of imports in high-technology and low-technology industries. Finally, I find that the final goods imports in an industry has a more negative effect on training than the imports of intermediate goods in the industry. Thus it is not surprising there is pressure to limit import competition, especially from low- or middle- income countries, since reduced training opportunities for U.S. workers can be perceived as reducing “good jobs.”

## 1 Introduction

Import competition’s impact on the labor market has become an area of great concern for the public and academics in recent years. For example, politicians often argue that foreign competitors take away American manufacturing jobs,

pointing to the flood of Japanese cars and Chinese tires as one of the main causes of the challenges faced by many U.S. manufacturing industries and their workers over the past two decades. More recently, the effect of outsourcing of service activities to foreign states has also raised concerns. Stories of Indian call centers abound, and it is believed that a large number of U.S. service industry jobs are at risk of being lost to a more economically desirable foreign workforce.<sup>1</sup> The impact of import competition on the wage structure and employment in U.S. manufacturing industries has been studied extensively using industry level data in the past two decades.<sup>2</sup> In this paper I extend the literature by examining the effect of import penetration on the provision of company training by U.S. manufacturing firms using individual level data. This is an important topic as many theoretical and empirical studies point to the substantial effects of company training on labor market outcomes.

Since the seminal paper by Becker (1962), labor economists often distinguish between general and specific training. While general training raises a worker's productivity with many employers, specific training increases his productivity only with the employer providing the training. In the original Becker model, under the assumption of a competitive labor market, employers will not pay for any general training, as they cannot secure any of the future returns. Conversely, a worker who receives specific training will be more productive at one employer than elsewhere, so specific human capital creates a bilateral monopoly and the employer and worker share the costs of and returns to specific training.<sup>3</sup> However, recent theoretical papers argue that employers might also share the costs of general training if the labor market is imperfect, as labor market imperfections may prohibit job turnovers initiated by workers who receive general training, thereby allowing employers to receive returns from general training. Among several sources of labor market imperfection are mobility costs (Acemoglu and Pischke, 1999a, 1999b), asymmetric information between current

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<sup>1</sup>For example, Blinder (2009) bases on the "tasks" and "work activities" of occupations and estimates that somewhere between 22% and 29% of all U.S. jobs are or will be potentially outsourceable within a decade or two. Jobs in the manufacturing industries are more likely to be subject to outsourcing, though several occupations in the service sector, such as telemarketers, accountants, and bill and account collectors, are also outsourceable.

<sup>2</sup>For example, Feenstra and Hanson (1996, 1999) study the effects of foreign outsourcing on relative wage shares of production and non-production workers; Katz and Murphy (1992) look at several determinants that result in wage inequality, among them is import competition; Amiti and Wei (2006) extend Feenstra and Hanson's study to service outsourcing.

<sup>3</sup>Hashimoto (1981) studies the division of costs and returns to specific training that maximize the expected value of an employer-worker match.

and potential employers (Acemoglu and Pischke, 1998), and contractual problems (Loewenstein and Spletzer, 1998). Recent empirical evidence also lends support to this new strand of literature and demonstrates that employers do sometimes sponsor training that is deemed to be general (e.g. correspondence school). The skills acquired in those forms of training that are often regarded as specific (e.g. formal company-run training) are actually transferable to future positions with different employers.<sup>45</sup>

The above theoretical and empirical studies provide us with the basis for understanding the effect of training on two important aspects of a worker's labor market outcome: namely, his earnings and job turnover rate. First, as company training endows a worker with new skills, his earnings should increase. Moreover, since some proportion of employer-sponsored training is general, it would follow that this training will be useful beyond his tenure with the current employer. In fact, empirically, both of these predictions have been confirmed. The returns from company training have been found to be at least as high as those from formal schooling education, and training from previous employers has been found to exert a positive and persistent influence on wages.<sup>67</sup> Second, one

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<sup>4</sup>Loewenstein and Spletzer (1998, 1999).

<sup>5</sup>Although one could argue that the workers pay indirectly for general training through lower wages, empirically this argument has not been confirmed. For example, Loewenstein and Spletzer (1998) find no significant evidence that workers receiving general training accept lower wages during the training period. However, as Frazis and Loewenstein (2005) point out, an explanation for the above finding is that it is due to the empirically unobserved differences between trained and untrained workers. In particular, workers who receive training may have higher ability so even if they pay for training, the wage premium given to their higher ability makes their wages look similar to the wages of untrained workers during the training period.

<sup>6</sup>Earlier studies usually study the wage effect of training incidence. For instance, Blanchflower and Lynch's (1994) study of wage growth of non-college graduates found that receiving company training raised wages by 12 percent. Few recent studies attempt to quantify the rate of return to training. For example, Bartel (1995) use the data from a company and estimated a rate of return of 35%, assuming a 10 percent depreciation rate. Frazis and Loewenstein (2005) use data from the 1979-2000 NLSY79 surveys and estimated a rate of return of about 40%, after considering various functional forms as well as corrections for direct costs, incidence of promotions, and etc. As a comparison, the estimated rates of return to schooling are usually around 10% (Card 1999).

<sup>7</sup>Loewenstein and Spletzer (1998, 1999) use the data from the NLSY79, the same dataset I used for this paper, and find that the increase in wages associated with a training event is larger for future employers than for the employer providing the training. Booth and Bryan (2002) find similar results using the UK household panel data. One explanation for this larger return to future employers is that the training provided has a large general component and has been at least partially paid for by the employer.

would expect that company training generally reduces layoffs and increases job tenure. Worker turnovers are costly not only because there are direct expenses associated with moving from one employer to another, but more importantly because firm-specific capital that is acquired through training during the job match would be lost. Empirically, the prediction that company training could reduce turnovers has also been supported. For example, Lynch (1991) and Loewenstein and Spletzer (1997), both using the NLSY79 data in different time periods, find that an increase in company training is associated with reduced job mobility.

In this paper, I propose and empirically test two potential channels through which import competition may affect whether firms provide company training. Taken together these two channels suggest that the effect of import competition on the provision of company training is a priori ambiguous, and must be determined empirically. The first channel is what I call a “competition effect,” which refers to how foreign imports may affect the incentives to provide training at domestic firms that produce similar products. As I will later show more formally in a simple model, this decision to invest in human capital may depend on the characteristics of foreign competitors, as well as the characteristics of the products domestic firms produce. In particular, my first hypothesis on this competition effect argues that import competition from low- or middle- income countries will have a more negative effect on training than that from high income countries, because these low- or middle- income countries’ relatively low labor costs hurt the competitiveness of American products in the market, and could have a more negative effect on the continued existence of U.S. firms. As their survival probability decreases, U.S. producers may be less willing to invest, as they may not be able to recoup the costly human capital investment they have made.

My second hypothesis regarding the “competition effect” argues that workers in more technologically advanced (High-Tech) industries may feel less impact from foreign competitors. Here, I define an industry to be “High-Tech” if its products have multiple opportunities for improvement. The idea is that domestic firms can escape low-cost foreign competition and survive if the quality of their products is much more superior to that of foreign goods. Therefore, domestic firms in High-Tech industries still have incentives to train their workers so as to realize these large improvements in product quality.<sup>8</sup>

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<sup>8</sup>There could be two reasons why providing company training will result in quality improvement. First, it is possible that company training allows workers to make use of the newest

The second channel through which import competition might affect company training is the “skill upgrading effect,” which arises when foreign intermediate goods enter the domestic market.<sup>9</sup> Although these imported intermediate goods might put substantial competition pressure on domestic intermediate good producers, and therefore may impose a potential negative competition effect of imports on training, they, on the other hand, provide additional benefits to the domestic industry. For example, Glass and Saggi (2001) have argued that imported intermediate goods allow the domestic final good producers to obtain cheaper inputs and henceforth earn larger profits. This creates greater incentives for firms to upgrade their product quality, and one way that this can occur is by providing more training.<sup>10</sup> Another often cited benefit of imported intermediate goods is that they allow U.S. industries to reconfigure jobs to those that are more complex and require more training.<sup>11</sup> The above discussion suggests my third hypothesis: for an industry as a whole, the overall negative effect of imported intermediate goods on training will be less than that of imported final goods. This occurs because while both final and intermediate good imports have a “competition effect” on domestic final and intermediate good producers, respectively, intermediate good imports also have a beneficial “skill-upgrading effect” on the domestic industry.

To empirically determine the net effect of import competition on training, as well as testing the above three hypotheses, I first use the National Longitudinal Survey of Youth 1979 Cohort (NLSY79), which provides the best data on training received by individuals. I then merge this dataset with several other trade and manufacturing datasets in order to see how changes in import penetration affect the incidence of company training. I start with an analysis of the overall

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technology or production procedures, whose occurrence may be exogenously determined, resulting in a higher quality outcome. Second, it is also possible that company training helps workers to become innovators themselves and directly contribute to quality improvement. In this paper, I do not attempt to distinguish between these two possibilities, but only stress the positive correlation between company training and quality improvement.

<sup>9</sup>Another reason that this “skill upgrading” effect may take into effect is that foreign imports, both final and intermediate good imports, may bring new ideas into the market, and consequently encourage domestic firms to train their workers in order to adopt these new ideas. However, since it is difficult to quantify these “new ideas,” I would not attempt to test this possibility in the paper.

<sup>10</sup>In the Glass and Saggi (2001) original argument, innovation is the venue for quality upgrading. Here I borrow their idea but instead argue that company training is the venue for quality upgrading.

<sup>11</sup>This is the main argument of the foreign outsourcing literature, e.g. as in Feenstra and Hanson (1996).

effect of import competition on company training for individuals in different three-digit manufacturing industries. I find overall that an increase in 1 percentage point of import penetration will result in a decrease in the probability of company training by 0.006. Given that in my sample period, between 1988 and 1996, the average import penetration increases from 14% to 18%, this implies a reduction in the probability of training by 0.024. This is a very large effect since each year the probability of receiving company training is approximately 0.098. I also find that this effect is concentrated primarily among non-production workers. Next, I test the three hypotheses described above. First, in support of the first hypothesis, I find that the effect of imports on training depends on the products' country of origin. Specifically, while imports from middle and low income countries exert a significant negative effect on training, high income country imports have an insignificant *positive* effect. Second, I do not find any significant difference in the effect of imports on training between High-Tech and Low-Tech industries, so the empirical support of my second hypothesis is weak.<sup>12</sup> Third, I find that, in accordance with my third hypothesis, while the effect of foreign final good imports on training is significantly negative, the effect of foreign intermediate good imports is always insignificant, implying that foreign intermediate good imports have at least some positive skill upgrading effect that neutralize its negative competition effect.

The paper is organized as follows. In the next section I discuss the related literature. In section 3 I present my illustrative model on the competition effect of imports on training, as well as an outline of my hypotheses to be empirically investigated. Sections 4 and 5 describe the data used and my econometric approach respectively. I present and interpret my empirical results in Section 6. In Section 7 I show that my results are robust to reasonable changes in the empirical specifications. In Section 8 I summarize my findings and offer concluding remarks.

## 2 Literature Review

Few papers, either empirically or theoretically, look into the relationship between trade and company training. Therefore, in this literature review I first focus on papers that motivate my theoretical predictions by discussing the re-

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<sup>12</sup>When I have an insignificant coefficient (or a difference in coefficients) with a large confidence interval, I treat it as 0. To be accurate, however, in these cases we do not really empirically learn that much about whether we should accept or reject the null hypotheses.

relationship between product market competition and innovation. Given that company training, like research and development (R&D) activity, is a form of costly investment that aims to improve future profitability, it is reasonable to look at the theoretical guidance that this strand of literature provides. Next, I discuss several papers that touch on import competition and labor productivity. I argue that my study can shed light on the channels through which imports may affect labor productivity.

## 2.1 Product Market Competition and Innovation

Although the literature seldom directly looks into the relationship between product market competition and company training, the correlation between competition and innovation has been extensively studied in the Industrial Organization literature and in the endogenous growth literature. In the earlier literature, although there exists some work that argues for a potential positive effect of competition on innovation, the most prominent models always predict a negative correlation between competition and innovation.<sup>13</sup> This occurs because under more competition, the monopoly rents that reward new innovations will be reduced, so firms have less incentive to innovate.

However, there is another factor to be considered. For example, Porter (1990) argues that product market competition is good for innovation because it forces firms to innovate in order to acquire a substantial lead over their rivals so as to escape competition. Aghion et al. (2004) theoretically formalize this idea of an “escape-competition” effect in the context of foreign entry. Specifically, the authors study how potential technologically advanced foreign entry, in the form of foreign direct investment, affects domestic incumbent firms’ incentives to conduct R&D. The authors especially emphasize the role of the difference between an incumbent’s initial state of technological development and that of potential foreign entrants. In their model, they find that the threat of technologically advanced entry encourages innovation by incumbent firms in sectors that are initially close to the foreign entrants’ technological level. This occurs because incumbent firms need to successfully innovate in order to compete with potential foreign entrants when they enter. On the other hand, the threat of technologically advanced entry would discourage innovation by incumbent firms

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<sup>13</sup>For example, in the industrial organization literature, see the Hotelling model and the monopolistic competition model by Dixit and Stiglitz (1977), while in the endogenous growth literature, see the product variety framework of Romer (1990) and the Schumpeterian model of Aghion and Howitt (1992).

that are initially further behind the foreign entrants' technological level. This result arises because incumbent firms know that even if they successfully innovate, they may not be able to compete with foreign entrants because of the initial large technological gap. In their later paper, Aghion et al. (2009) find that this theoretical argument is supported by the data. Specifically, using UK manufacturing firm data, they first calculate the distance between the labor productivity of the industry with the world technology frontier (represented by the corresponding U.S. industry average labor productivity). They then show that labor productivity growth responds positively to increased foreign entry for firms in industries that are more-than-median close to the foreign technology frontier, while labor productivity growth responds negatively to foreign entry for firms in industries that are more-than-median distant from the frontier.<sup>14</sup>

My work contributes to this literature in two aspects. First, I look at another dimension that may affect a firm's decision with regard to quality improvement. Specifically, while earlier papers such as Aghion et al. (2009) focus on how differences in technological levels between domestic and foreign firms affect quality upgrading decisions, I consider, both theoretically and empirically, how differences in production costs affects these decisions. This dimension is important because currently in the U.S. the main concern about foreign competition is that lower income countries provide goods of acceptable quality but at much lower prices. Second, instead of R&D activities, I focus on worker training, which is another mode of quality upgrading that may take place. This is an area that has not been studied before, and given its substantial effects on a worker's welfare, it is also an important issue.

## 2.2 Imports, Outsourcing, and Labor Productivity

I am not aware of any paper discussing the relationship between imports and training.<sup>15</sup> However, there are several papers that discuss the relationship between imports, outsourcing, and labor productivity.<sup>16</sup> For example, one paper

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<sup>14</sup>In their paper, they calculate the distance to technology frontier for each industry-year cell and obtain a "distance" distribution of the whole sample. "More-than-median close" refers to those industry-year cells whose distance to technology frontier is smaller than or equal to the median distance to technology frontier in the distribution.

<sup>15</sup>Aw, Roberts, and Winston (2007) study the relationship between exports and training using Taiwanese Manufactures Census Data; they find that Taiwanese firms participating in export markets are more likely to train workers.

<sup>16</sup>In this paper, the concepts of "foreign outsourcing" and "imported intermediate goods" are exchangeable. Most of the time I use "imported intermediate goods," though when re-

that looks at import penetration and labor productivity is McDonald (1994). He finds that import penetration increases labor productivity, especially in those industries that have a high concentration ratio. His argument for this finding is that import competition serves as a slack-reducing device which forces the domestic firms, especially those who initially enjoy little domestic competition, to work more efficiently.<sup>17</sup> There have also been several papers that study the relationship between foreign outsourcing and productivity, both at the industry level and the firm level.<sup>18</sup> The main theoretical argument that foreign outsourcing will increase labor productivity is that outsourcing opportunities allow firms to relocate their tasks to those over which they have a comparative advantage. In addition, there are also theoretical models which argue that imported intermediate goods will bring about new ideas and technologies that benefit the industry. Impacts such as these will all result in higher labor productivity. Empirically, however, the results are mixed. Some find positive effects of outsourcing on productivity, while others do not find significant effects. In the U.S. case, Amiti and Wei (2006) use industry level data between 1992 and 2000 and find a positive and significant, but small, impact of material outsourcing on labor productivity.

My work can contribute to this literature in two ways. To begin with, although there may be an increase in labor productivity, we do not really know how this is achieved. Generally speaking, there are three ways that this could happen. First, there could be an improvement in workers' skills. Second, as recent papers such as Melitz (2003) emphasize, within an industry there may be a reallocation effect, i.e. firms that are more efficient thrive while less efficient ones wither. Third, there may be layoffs. The three channels have significantly different implications from the point of view of the worker, and my study sheds light on the first channel. My second contribution consists of using individual micro data, which gives us a more clear-cut understanding of the effects on workers. Moreover, since our observation is at the individual worker's level, we are also less concerned about the simultaneity or endogeneity, issues that sometimes plague industry level studies.<sup>19</sup>

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ferring to arguments stemming from the outsourcing literature, I use the words "foreign outsourcing."

<sup>17</sup>A theoretical model which formalizes this notion that product market competition enhances productive efficiency is Hart (1983).

<sup>18</sup>One of the earliest studies is Feenstra and Hanson (1999). For a recent comprehensive survey, please see Olsen (2006).

<sup>19</sup>I have also used instrumental variable specifications as robustness checks to further alle-

### 3 Theoretical Predictions

As mentioned earlier in the introduction, I expect import competition to affect domestic firms' incentives to train through two channels: the "competition effect" and the "skill upgrading effect." In this section, I will first discuss through a simple model the mechanism behind the competition effect, and lay out my hypotheses that characteristics of foreign competitors as well as the products may have an effect on training incentives. Next, I will discuss the skill upgrading effect, which focuses on how imported intermediate goods offer additional benefits to the industry and may increase firms' interest in improving their workers' skills. In particular, I argue that the effect of imported intermediate goods should be less negative to that of imported final good.

#### 3.1 The Competition Effect of Imports on Training: An Illustrative Model

The model presented here will show how an increase in import competition may affect a domestic producer's incentives to provide training. The model follows closely that of Aghion et al. (2004), which considers how potential technologically advanced foreign entry affects domestic incumbent firms' incentives to innovate. The main difference between my model and theirs is that while they only allow for difference in the technological levels of the foreign and domestic goods, assuming same costs in production, my model explicitly allows for cost differences in the production of foreign and domestic goods. This distinction is important, as I will show how low cost foreign producers may discourage domestic producers from quality upgrading (here, in the form of training), even when the domestic producers already have a technologically superior product.

##### 3.1.1 The Framework

Time is discrete. In each period  $t$ , consider an industry with a final good,  $y(t)$ , which is produced competitively, that could use either one, but only one, of the intermediate inputs,  $x_d(t)$  and  $x_f(t)$ . Here,  $x_d(t)$  denotes the flow of domestically produced input used at date  $t$ , and it embodies quality  $A_d(t)$ ;  $x_f(t)$  denotes the flow of foreign produced input used at date  $t$ , and it embodies quality  $A_f(t)$ . As will be made clear later, the domestic intermediate firm can improve its quality  $A_d(t)$  through training.

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viate the simultaneity or endogeneity problem.

While final good producers can always get access to domestic inputs, they can only use foreign inputs when foreign input producers enter the domestic market. If a final good producer uses domestic inputs, her production function will be:

$$y(t) = A_d(t)^{1-\alpha} x_d(t)^\alpha \quad (1)$$

On the other hand, if she uses foreign inputs, then her production function is:

$$y(t) = A_f(t)^{1-\alpha} x_f(t)^\alpha \quad (2)$$

To produce one unit of domestic intermediate good,  $x_d$ , the domestic input producer uses one unit of labor, so the unit cost of  $x_d$  is  $w_d$ , the domestic wage level. Similarly, the unit cost of  $x_f$  is  $w_f$ , the foreign wage level. I assume that the wage levels remain constant across time.

### 3.1.2 The Autarky Case

When there is no foreign entry into the domestic intermediate input market, the domestic input market is monopolized by an incumbent producer, so final good producers can only produce based on equation (1). The domestic monopolist's profit at time  $t$ ,  $\Pi^m(t)$ , measured in units of final goods, will equal to

$$\Pi^m(t) = p(t)x_d(t) - w_d x_d(t)$$

where  $p(t)$  is the price of the intermediate input, and  $w_d$  is the domestic wage level and also the unit cost of  $x_d$ .

Since the final good is produced in a perfectly competitive final goods market, the equilibrium price  $p(t)$  of one unit of  $x_d$  equals the value of its marginal product. Thus,

$$p^m(t) = \partial y(t)/\partial x_d(t) = \alpha A_d(t)^{1-\alpha} x_d(t)^{\alpha-1}$$

Therefore, after choosing the optimal quantity  $x_d(t)$ , the monopolist could get the monopoly profit,  $\Pi^m(t)$ , which will equal to

$$\Pi^m(t) = \pi A_d(t), \text{ where } \pi \equiv (1 - \alpha) \alpha^{\frac{1+\alpha}{1-\alpha}} w_d^{\frac{-\alpha}{1-\alpha}} \quad (3)$$

### 3.1.3 Foreign Entry and Competition

The monopolized intermediate input producer is subject to an entry threat from foreign producers. Let  $q$  denotes the probability that the foreign producer shows up. A larger  $q$  implies that the domestic firm is more likely to face foreign competition.

Once the foreign intermediate input producers enter the domestic market, domestic final good producers could choose between  $x_d$  and  $x_f$  for production, so now both production functions (1) and (2) are available. Following the literature, I assume that domestic and foreign firms compete in prices for the market, though one needs to take into account of the quality difference between domestic and foreign goods, indicated by  $A_d(t)$  and  $A_f(t)$ .

From equations (1) and (2), it is obvious that when the production costs of  $x_d$  and  $x_f$  are the same, the final good producer will choose the intermediate input that is of higher quality. Therefore, the domestic (foreign) producer will dominate the market while the foreign (domestic) producer will be driven out of the market if  $A_d(t) > (<) A_f(t)$ . Hence, the only determinant of the intermediate input provider is the relative quality between the domestic and foreign producers. This is the aspect that the Aghion et al. (2004) model emphasizes.

However, when the unit costs of  $x_d$  and  $x_f$  are different, the domestic producer may still lose the market even if her product is of better quality. To see this, rearranging equation (2) in the following way:

$$\begin{aligned} y(t) &= A_f(t)^{1-\alpha} x_f(t)^\alpha = A_d(t)^{1-\alpha} \left( \frac{A_f(t)}{A_d(t)} \right)^{1-\alpha} x_f(t)^\alpha & (2a) \\ &= A_d(t)^{1-\alpha} \left[ \left( \frac{A_f(t)}{A_d(t)} \right)^{\frac{1-\alpha}{\alpha}} x_f(t) \right]^\alpha = A_d(t)^{1-\alpha} \widehat{x}_f(t)^\alpha \end{aligned}$$

$$\text{where } \widehat{x}_f(t) = \left( \frac{A_f(t)}{A_d(t)} \right)^{\frac{1-\alpha}{\alpha}} x_f(t).$$

Comparing equations (1) and (2a), we see that, from the domestic final good producers' perspective, the quality of one unit of  $x_d$  is equivalent to that of  $\widehat{x}_f$ . Since the domestic and foreign intermediate good producers compete in prices, domestic final good producers will choose the one that is cheaper. The lowest price the domestic input producer could charge for one unit of  $x_d$  is  $w_d$ , her unit production cost, while the lowest price the foreign input producer could charge for a unit of  $\widehat{x}_f$  is  $\left( \frac{A_d(t)}{A_f(t)} \right)^{\frac{1-\alpha}{\alpha}} w_f$ , the quality adjusted cost of the foreign

firm.<sup>20</sup> It is then evident that if  $w_f$  is sufficiently low, then even if  $A_d(t) > A_f(t)$ , i.e. the domestic product has better quality, the “quality-adjusted” cost of the foreign product could still be lower, and hence drive the domestic input producer out of the market.<sup>21</sup>

Next, following the assumption made in Aghion et al. (2004), I assume that the potential foreign entrant (which will show up with probability  $q$ ) can observe the effectiveness of training before it actually enters. This implies that if the foreign company finds that the domestic producer has lower (or equal) quality adjusted production costs, it will not enter at all, and the domestic input producer can maintain its monopoly position. Therefore, from the domestic intermediate input producer’s perspective, after the realization of effectiveness of training, i.e.  $A_d(t)$  is known, two cases could happen when a foreign competitor shows up.

$$\text{Case 1: } \left( \frac{A_d(t)}{A_f(t)} \right)^{\frac{1-\alpha}{\alpha}} w_f < w_d.$$

Under case 1, the domestic intermediate input producer has a larger quality-adjusted production cost, so she will be driven out of the market and earn zero profit, that is,  $\Pi^c(t) = 0$ . Here,  $\Pi^c(t)$  denotes the profit when a potential foreign entrant shows up.

$$\text{Case 2: } \left( \frac{A_d(t)}{A_f(t)} \right)^{\frac{1-\alpha}{\alpha}} w_f \geq w_d.$$

In case 2, foreign entry will not occur even if a potential foreign entrant shows up because the foreign firm realizes that the domestic firm will win the market anyway. Consequently, the domestic input producer will still hold the monopoly in the market and earn monopoly profits as in (3), i.e.  $\Pi^c(t) = \Pi^m(t)$ .

### 3.1.4 The Technology

The quality of the input takes on discrete values. At the end of period  $t-1$ , the domestic input’s quality is  $A_d(t-1) = \gamma^{k-1} A_0$ , and the quality of foreign inputs is  $A_f(t-1) = \gamma^{j-1} A_0$ . Both  $j$  and  $k$  are integers, and  $A_0$  is just a constant. For

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<sup>20</sup>To see this, note that the unit cost of  $x_f$  is  $w_f$ , and it could be used to produce  $\left( \frac{A_f(t)}{A_d(t)} \right)^{\frac{1-\alpha}{\alpha}}$  units of  $\hat{x}_f(t)$ . Therefore, one unit of  $\hat{x}_f$  requires units of  $x_f$ , so the cost is  $\left( \frac{A_d(t)}{A_f(t)} \right)^{\frac{1-\alpha}{\alpha}} w_f$ .

<sup>21</sup>When firms compete in prices, and their products are the same, the producer with a lower unit cost will always win the entire market, and the price she is going to charge will be the unit cost (minus epsilon) of the second-lowest unit cost producer.

the foreign intermediate input, I assume that its quality will always improve by a factor of  $\gamma$  in each period, so  $A_f(t) = \gamma^j A_0$ . On the other hand, the domestic intermediate input producer need to incur a training cost of  $\frac{1}{2}cz^2$ , where  $c$  is a constant, in order to improve her product's quality by a factor of  $\gamma^s$  in the next period with probability  $z$ . Hereafter, I will call  $z$  the training intensity the domestic producer chooses. The above implies that if the training is effective, which occurs with probability  $z$ , the quality of the domestic input at period  $t$  would be  $A_d(t) = \gamma^{k-1+s} A_0$ ; however, if the training is ineffective, which occurs with probability  $1 - z$ , the quality would remain to be  $A_d(t) = \gamma^{k-1} A_0$ .

The index  $s = \{1, 2\}$  is the number of steps that the domestic firm can improve once training is effective, and its value is determined by the characteristics of the industry.<sup>22</sup> In particular, I define an industry to be “*High-Tech*” when  $s = 2$ . This is intended to reflect the situation where conditional on effective training the quality improvement of the domestic product (2-steps) could be greater than that of the foreign product (1-step).<sup>23</sup> On the other hand, when  $s = 1$ , the industry is viewed as “*Low-Tech*”. The quality improvement of the domestic product under effective training is the same as that of the foreign product (both 1-step improvement).

Making the above assumptions implies that the profit levels achieved under autarky and with potential foreign competition can both be indexed by parameters:  $k, j, s, w_d$ , and  $w_f$ . For instance, when training is effective but no foreign firms show up, the associated monopoly profit can be written as  $\Pi^m = \Pi^m(k - 1 + s, w_d)$ ; when training is effective and a foreign competitor shows up, the profit can be written as  $\Pi^c = \Pi^c(k - 1 + s, j, w_d, w_f)$ .

### 3.1.5 The Training Decision

From the domestic input producer's perspective, the decision of training intensity,  $z$ , will depend on three factors. First, the probability,  $q$ , that a foreign firm shows up. Second, her potential foreign competitor's product quality and unit cost. Finally, the extent of quality improvement it may attain when training is

<sup>22</sup>Restricting  $s$  to values 1 and 2 is only for convenience. The key is to allow the steps of improvement be greater in the domestic product than in the foreign product.

<sup>23</sup>The term “High-Tech” is chosen because we would usually expect high-tech goods to be constantly improving. Since the US firms are usually thought to have a comparative advantage in making new and better quality products, at least relative to developing countries, one may expect that the quality improvement of US products in these high-tech industries is greater than the quality improvement of foreign products.

effective.

Consider a domestic intermediate input producer that chooses to train with intensity  $z$ . In this case, the domestic input producer's profit, not including the cost of training, will be  $\Pi^c(k-1+s, j, w_d, w_f)$  with probability  $zq$ , the probability that training is effective and that a foreign firm shows up; her profit will be  $\Pi^m(k-1+s, w_d)$  with probability  $z(1-q)$ , corresponding to the case when training is effective and no foreign firms show up; with probability  $(1-z)q$ , the profit will be  $\Pi^c(k-1, j, w_d, w_f)$ , and this happens when training is ineffective and a foreign competitor shows up; and finally, the domestic producer's profit will be  $\Pi^m(k-1, w_d)$  with probability  $(1-z)(1-q)$ , and this arises when training is ineffective and no foreign firms show up.

Therefore, the profit maximization problem that the domestic input producer attempts to solve, including the cost of training, is the following:

$$\begin{aligned} \max_z E\Pi &= zq\Pi^c(k-1+s, j, w_d, w_f) + z(1-q)\Pi^m(k-1+s, w_d) \\ &\quad + (1-z)q\Pi^c(k-1, j, w_d, w_f) + (1-z)(1-q)\Pi^m(k-1, w_d) - \frac{1}{2}cz^2 \end{aligned}$$

From the first order condition, we know that the solution to the above maximization problem is:

$$\begin{aligned} cz &= q\Pi^c(k-1+s, j, w_d, w_f) + (1-q)\Pi^m(k-1+s, w_d) \\ &\quad - q\Pi^c(k-1, j, w_d, w_f) - (1-q)\Pi^m(k-1, w_d) \end{aligned}$$

So the optimal intensity  $z$  depends on the probability  $q$  that a foreign competitor will show up, and the profit levels under each scenario. Given that the main interest of this paper is to see how increased import competition, i.e. a larger  $q$ , will affect the training intensity,  $z$ , one could differentiate the above equation with respect to  $q$  to get

$$\begin{aligned} \frac{dz}{dq} &= \frac{1}{c} \left[ \Pi^c(k-1+s, j, w_d, w_f) - \Pi^m(k-1+s, w_d) \right. \\ &\quad \left. - \Pi^c(k-1, j, w_d, w_f) + \Pi^m(k-1, w_d) \right] \end{aligned} \quad (4)$$

It is now apparent that how an increase in import competition may affect training intensity depends crucially on the parameters  $k$ ,  $j$ ,  $s$ ,  $w_d$ , and  $w_f$ . As I show in detail in the Appendix, the effect of import competition on training

could be either one of the three effects: a discouragement (negative) effect, an encouragement (positive) effect, or no effect. However, in this paper I exclude the last case where there is no-effect of imports on training, because it corresponds to the uninteresting case where the domestic firm is so superior that it will always win the market regardless of the outcome of training or whether a foreign competitor shows up. One would only be interested in the effect of import competition when potential foreign entrants actually impose a threat to domestic firms.<sup>24</sup>

Based on equation (4) and the analysis in the Appendix, I will make the following two testable hypotheses, where the technical derivation that leads to them is also in the Appendix. My first hypothesis is the following:

- H1: The negative effect of import competition on company training will be more severe for imports from middle or low income countries than those from high income countries.

The rationale for this first hypothesis is straightforward. In face of rising import competition, the domestic intermediate firm needs to upgrade its product's quality through training so that it at least has a chance to survive the competition.<sup>25</sup> Holding the foreign competitor's quality level fixed, when the potential foreign competitor comes from a high income country, the difference in quality-adjusted production costs of the domestic and foreign firms is relatively small, so the domestic firm has an incentive to invest more in training, i.e. increasing the probability that training is effective, because effective training will allow its product's quality-adjusted production cost to be lower than that of the foreigner's and subsequently to win the competition. On the other hand, when the potential foreign competitor comes from a low income country, the difference in quality-adjusted production costs of the domestic and foreign firms is already too large. There is no hope to win against the potential entrant even after upgrading, so the effect of increased import competition is to reduce the training intensity as the domestic firm knows that investing in training will not be profitable.

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<sup>24</sup>Empirically, it is also difficult to empirically test this no-effect of import competition when domestic quality is sufficiently superior. The reason behind this is that in this case, the foreign firms will never enter, so we could not observe an "increase" in import competition anyway.

<sup>25</sup>Note that I have already excluded the case where domestic firm always wins.

My second hypothesis considers how firms in High-Tech industries and Low-Tech industries may behave differently in provision of training when import competition increases. Specifically, the hypothesis I am going to test is:

- H2: The negative effect of import competition on company training will be less severe for High-Tech industries than Low-Tech industries.

The rationale for this second hypothesis is also intuitive. In the model, the main reason that there may be a negative effect of imports on training is because the original difference in quality-adjusted production costs of the domestic and foreign firms is too large, so that the domestic firm will lose to the potential entrant even when it successfully upgrades its quality. However, when the domestic firm is in a High-Tech industry, with effective training the domestic firm could improve its quality by a much larger extent—note that the domestic firm enjoys a two-step quality improvement while the foreign firm’s quality can only improve by one step—so that it could now win the market through successful upgrading. Consequently, the domestic firm has the incentive to invest more in training in order to escape foreign competition.

In the empirical sections of this paper, I will test the above two hypotheses. As a preview, although the data empirically support the first hypothesis, I find little evidence in support of the second hypothesis.

### 3.2 “Skill Upgrading Effect” underlying Hypothesis 3

Imports from foreign countries consist not only of final goods, but also of intermediate goods. This distinction is crucial because, from the industry perspective, imported intermediate goods provide additional benefits to the industry compared with those provided by imported final goods. For example, it has been argued that imported intermediate goods allow the importing firms who use them to have access to cheaper inputs, holding quality constant. With regard to these ideas, Glass and Saggi (2001) point out that within an industry, importing intermediate goods lowers the marginal cost of production and increases profits for the final good producers within the industry, which in turn creates greater incentives to these producers to upgrade their product quality.<sup>26</sup> One way that quality upgrading can occur is through more worker training.

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<sup>26</sup>In this paper, I only look at how the intermediate goods import in a 3-digit industry affects the domestic producers *within the same 3-digit industry*. I argue that there will be a skill upgrading effect because there are domestic final goods producers who use imports in the same 3-digit industry intermediate goods imports.

In addition, the literature on foreign outsourcing, which can also be thought of as importing intermediate goods, often argues that an outsourcing opportunity enables a firm to relocate its relatively inefficient production processes to external providers, so that the firm can focus on and expand in areas where it has a comparative advantage.<sup>27</sup> As U.S. firms are usually thought to be more technologically advanced, this means that they can focus on tasks with higher complexity levels. Accordingly, they must provide more training to workers in order to meet this expansion of high-end jobs.

At the industry level, the above discussion suggests that one would expect a more negative effect of final good imports on training than that of intermediate good imports. Both imported intermediate goods and imported final goods have the potential to impose a negative “competition effect” on training conducted by domestic intermediate good and final good producers, respectively. However, intermediate good imports bring additional benefits to the domestic industry as they allow the domestic final good producers to obtain cheaper inputs and have greater incentives to provide training in order to upgrade product quality. Intermediate goods imports also allow the U.S. industry to reconfigure jobs to those that are more complex and require more training. Therefore, the third hypothesis I will empirically test is the following:

- H3: Imports of final goods will have a more negative effect on training than that of intermediate goods imports.

## 4 Data Description and Summary Statistics

In this section, I will first discuss the data I use, the NLSY79. Second, I will discuss the derivation of import competition measures as well as the data sources for these variables. Third, I will discuss other industry-level data used in my regression analysis. Finally, I will look at the summary statistics.

### 4.1 The NLSY79: Microdata on Training, Work History, and Other Personal Characteristics

The micro dataset I use in this paper is the National Longitudinal Survey of Youth 1979 Cohort (NLSY79). The individuals in this survey were between 14 and 21 in 1979, and were followed annually until 1994. Since 1994, the survey has

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<sup>27</sup>For example, Feenstra and Hanson (1996).

been conducted biannually. In this paper, I restrict the sample to men working in the manufacturing industries between 1988 and 1996. The choice of this particular period of time is due to two main constraints. First, as I will discuss in detail later, there is a significant change in the training questions before and after 1988. Therefore, the training information is not comparable across the two periods. Second, in 1997 there was a large change in the U.S. industry classification system, from the original Standard Industry Classification (SIC) system to the new North America Industry Classification System (NAICS). The correspondence between the two classification systems is in many cases not straightforward, so the effects of import competition before and after 1997 are not comparable.<sup>28</sup> Therefore, I only consider the years before 1997. Finally, the decision to confine my study to manufacturing workers not only is because import competition mainly occurred in the manufacturing industries during that period, but also because the information on service imports in the service industries is scarce and usually of unsatisfactory quality. In total, there are 2147 individuals in the sample with a total of 7208 observations. This is an unbalanced panel dataset due to the fact that individuals moved in and out of the manufacturing sector across years.

#### **4.1.1 Training Information in NLSY79**

A variety of formal training questions were asked in the NLSY79 in all survey years, except in 1987. Individuals were asked to report on several vocational or technical programs in which they were enrolled since the previous survey. Until 1986, the maximum number of reported programs was two, and in 1988 it was increased to four. However, the main reason that I concentrate on the period after 1988 is because up until 1986, questions regarding the type of training program and the start and end dates were asked only if the training lasted over four weeks. Starting in 1988, these questions were asked for all programs, regardless of their length. Given the stark difference between the scopes of training questions before and after 1988, I only focused on the latter period.

The NLSY79 also reports the types of training programs involved. From the

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<sup>28</sup>There is another reason why only focusing on years before 1997 may not be a big limitation. Since the NLSY is a panel of data that follows the same cohort across years, the age distribution will shift to the right each year. It has been shown in many papers that most training occurs in the early years of a person's life cycle. Hence, even if I use data after 1997, it is not evident that I should merge the two time periods (before and after 1997) together since it is quite possible that the training behaviors for younger and older people will be different.

start in 1988, the following categories have been reported:

1. Business college;
2. Nurses program;
3. Apprenticeship;
4. Vocational or technical institution;
5. Barber or beauty school;
6. Flight school;
7. Correspondence;
8. A formal company training run by employer or military training (excluding basic training);
9. Seminars or training programs at work run by someone other than employer;
10. Seminars or training programs outside of work;
11. Vocational rehabilitation center; and
12. other.

Following Bartel and Sicherman's (1998) definition of company training, I will define categories 8–10 as company training. The inclusion of categories 8 and 9 is self-evident, but I also include seminars outside work as company training because several papers show that this category seems to be more similar to categories 8 and 9 than to the other categories. For example, in a series of paper using the NLSY79 as their main data source, Loewenstein and Spletzer (1997, 1998, 1999) show that while employers pay for around 90% of training programs running at work and seminars outside work (specifically, employers pay for about 82% of trainings in the form of seminars outside work), employers only pay for about 45% of other kinds of training programs. In addition, based on a question asked only in the 1993 NLSY79 survey regarding the generality of the training program, the content of training programs at work and in seminars outside work are more specific than those in other categories of training programs. Therefore, in this paper I focus on these three categories of company training programs, as they should cater more to the firm's actual needs and are the ones that firms would more likely to resort to in the face of a changing environment, such as increasing import competition. However, since recent theoretical work also suggests that companies may pay for other forms of training that are deemed to be more general, in one section of the paper I also consider the effect of imports on employer-sponsored training in categories 1-7 and 11-12. These other categories of training are much less important as they represent only 13% of all the employer-paid training. My regression result shows that import competition has no effect on training in these categories, suggesting that for my problem at least, focusing on training in categories 8-10 is appropriate.<sup>29</sup>

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<sup>29</sup>Later in the paper when I present the empirical result of the effect of imports on non-company training, I argue that one potential reason for the no-effect on non-company training could be because attending a non-company training program may be initiated by the worker, instead of the employer. The employer only pays for it because it is considered a benefit provided to the workers.

### 4.1.2 Other Personal Information in NLSY79

The NLSY79 contains records on personal characteristics such as work experience, tenure, education that are available each year. Although the NLSY79 records a maximum of five jobs in each survey year, it designates only one of these jobs as a “CPS job,” which in most cases is the most recent or current job at the time of the interview. A series of important questions are asked for the CPS jobs only, specifically the 3-digit Census industry codes of the CPS jobs. Since I want to link industry-level information in the NLSY79 to trade data, my analysis in this paper is restricted to CPS jobs.

### 4.1.3 Construction of the Training Variable

I construct my training variable on a yearly basis. In particular, since I have information on the starting and ending month and year of each training program, I define a dummy variable for the incidence of training that occurred in the past year.<sup>30</sup> Moreover, since this paper considers how import competition affects employers’ incentives to train their workers, I will only consider those company training programs, i.e. training programs in categories 8-10, that are at least partly sponsored by the CPS employers, as I only know the industry affiliations of CPS employers.<sup>31 32</sup>

## 4.2 Construction of Import Competition Measures

The measure adopted for import competition is import penetration (*impen*), which has been used extensively in the empirical trade literature. For an industry  $j$  at time  $t$ , it is defined as

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<sup>30</sup>Although the survey was conducted every year before 1994, some respondents might not have taken the survey in a particular year. In this case, it is crucial to have information on the starting and ending dates of training to identify yearly training incidences, since the original questions asked about training activities that occurred *since last survey*.

<sup>31</sup>The NLSY79 asks questions about who pays for the training. Potential sponsors may be self/family, employer, or a variety of governmental programs such as Job Training Partnership Act (JTPA), Trade Adjustment Act (TAA), etc.

<sup>32</sup>In order to make sure that the training is indeed sponsored by the current (CPS) employer and not by a previous employer, I compare the tenure information with the starting date of training. Only training that starts after the date at which the current employment begins will be considered company training. However, this definition may still result in an inaccurate identification of an incidence of company training if a person holds multiple jobs and the training is provided by a secondary employer. One could argue that this problem should not be severe as it is much less likely for secondary employers to train part-time workers.

$$impen_{jt} = \frac{\text{imports of industry } j \text{ at } t}{(\text{shipment} + \text{import} - \text{export}) \text{ of industry } j \text{ at } t} \times 100. \quad (5)$$

The denominator on the RHS of (5) is the value of domestic consumption of industry  $j$  at year  $t$ , and it equals domestic production plus imports and minus exports in the industry  $j$  and year  $t$ . The import penetration measure captures the extent of competition in the domestic market an industry faces. For firms in industries with a high ratio of imports to consumption, their domestic revenue may be more vulnerable to foreign shocks, as a substantial part of their competition comes from abroad. I construct this import penetration measure from the U.S. import and export data provided by Robert Feenstra on his website.<sup>33</sup> The annual U.S. imports and exports data are originally available at the 4-digit SIC manufacturing industry level. Since the industry level information in NLSY79 is at the 3-digit Census industry code, I aggregate the above information to the 3-digit Census industry level.<sup>34</sup>

In this study, I make two additional distinctions regarding the import competition information. First, I distinguish between imports from low, middle, and high income countries. Second, I distinguish between imports of final goods and of intermediate goods. For the former distinction, low income countries are defined as countries with income no more than 20% of the US GDP per capita on average during 1985-1996;<sup>35</sup> middle income countries are defined as those whose GDP per capita lies between 20% to 70% of the US GDP per capita; and high income countries are defined as countries whose income are at least 70% of that of the US.<sup>36</sup> For each of the countries, I have defined a separate im-

<sup>33</sup><http://www.econ.ucdavis.edu/faculty/fzfeens/>.

<sup>34</sup>For all data that are originally at the 4-digit SIC level, I will always aggregate them up to the 3-digit Census industry level to match the NLSY79 industry categories. The concordance between the 4-digit SIC industry classification and the 3-digit Census industry classification could be found from the following website: <http://www.macalester.edu/research/economics/page/haveman/Trade.Resources/tradeconcordances.html>.

<sup>35</sup>Looking at the years starting from 1985 instead of 1988 is because I use lagged three years moving averages for my import penetration variables. Specifically, for the 1988 (lagged) variable, it is defined as the average of the import penetration measures between 1985 and 1987.

<sup>36</sup>I look at the average of the relative income to the US but not the annual relative income to the US is because the latter method will result in reclassifications of countries across years. This would be unsatisfactory as one would then need to wonder whether the observed effect for a particular group of countries (say, middle income country) is indeed true or just due to artificial reclassifications. The 70% upper limit is chosen so as to cover Singapore (64%) and

port penetration measure. Specifically, I have a variable for low income country (*LIC*) import penetration (*LIC\_impen*), which is defined as

$$LIC\_impen_{jt} = \frac{\text{imports of industry } j \text{ from LIC at } t}{(\text{shipment} + \text{import} - \text{export}) \text{ of industry } j \text{ at } t} \times 100.$$

Two other variables have been defined similarly for middle and high income countries' import penetration, respectively.

My data for intermediate and final goods imports come from Peter Schott's website.<sup>37</sup> It contains information on the share of imported intermediate goods within each 4-digit SIC industry, whereas intermediate goods are defined as those imports that include the word "parts" in their import product codes. Since there is a change in the trade code systems in 1989 from the old TSUSA system to the new HS system, the classifications of intermediate and final goods before and since 1989 are not comparable. Therefore, for the empirical exercise that involves this distinction, I have separate coefficients for the two time periods so as to reflect the potential differential effects of imports under different classifications.

### 4.3 Other Industry Level Variables

#### 4.3.1 Variables Used in All Regressions

I have included several other industry level variables to serve as additional controls. The first variable is the proportion of IT capital to total equipment capital usage within the industry. This variable is included to capture the technology advancement coming from the utilization of IT capital, and it is calculated it based on the capital and multifactor productivity information provided by the Bureau of Labor Statistics. This variable is only available at the 2-digit SIC level. The second variable I include is the capital-labor ratio, and it is included because we would expect changes in capital usage may also affect firms' incentives to train workers. Following Bernard et al. (2006), I also include a variable that measures the wage share of non-production workers within an industry. This attempts to capture the change in the industry's relative demand for skilled workers during the period. Both the capital-labor ratio and non-production workers' wage share are calculated from the NBER Manufacturing Hong-Kong (67%), two important Newly Industrialized Economies (NIE), as middle income countries.

<sup>37</sup><http://www.som.yale.edu/faculty/pks4/>.

Database, and they are originally available at the 4-digit SIC level. Finally, I include a measure of the annual percentages of unionized workers in the industry. This information comes from the online Union Membership and Coverage Database, which is compiled from the Current Population Survey at the 3-digit Census level.<sup>38</sup>

### 4.3.2 Variables Used Only in Specific Extensions

**The Definition of High R&D and Low R&D Industries** In one of my extensions, I allow differential effects of imports on trainings for industries with high R&D intensity (High R&D) and low R&D intensity (Low R&D). This distinction is made because I hope to see whether firms in High-Tech and Low-Tech industries respond differently in their provision of training when facing increased import competition. The level of R&D intensity is my first indicator of whether an industry is “High-Tech” or “Low-Tech.”

The classification of an industry to be High R&D or Low R&D is based on the OECD definition. The OECD defines the following industries as High R&D industries: Office Machinery, Motor Vehicles, Other Transport, Electronic Equipment, Instruments, Chemical and Pharmaceutical Products, and TV, Radio, and Communications Equipment. The remaining industries are defined as Low R&D industries.

### Computing Industry-Level Nonroutine Cognitive Task Requirement

In another extension, I attempt to see whether industries that use different intensities of “nonroutine cognitive” task inputs behave differently in the face of import competition. Nonroutine cognitive task inputs can be thought of as those tasks that professional personnel carry out, such as product development and design, strategic planning, and managerial duties. The intensity of nonroutine cognitive task inputs within an industry is my second indicator of whether the industry in question is more “High-Tech” or “Low-Tech.” This information is from David Autor’s website, and is the same dataset he and his coauthors use in Autor, Levy, and Murnane (2003).<sup>39</sup> Autor and coauthors draw the information on detailed task contents from the U.S. Department of Labor’s Dictionary of Occupation Titles (DOT) for each of the highly detailed 12,000+ occupations. The authors then aggregate this information on occupations into the 3-digit level

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<sup>38</sup><http://unionstats.gsu.edu>.

<sup>39</sup><http://econ-mit.edu/faculty/dautor/data>.

Census industries using occupation employment shares as weights. Therefore, for each industry, they have constructed measures that reflect the importance of physical demands, skill requirements, and favorable worker aptitudes at work.

Autor, Levy, and Murnane (2003) specifically choose two variables to measure the extents of nonroutine cognitive tasks needed in implementing a job. The first variable captures the extent to which occupations involve Direction, Control, and Planning of activities (DCP), and this variable often takes on a high value for occupations that emphasize managerial and interpersonal tasks. The second variable, MATH, measures the quantitative reasoning requirement of the occupations, and it usually has a high value in scientific and engineering occupations. I interact these two variables respectively with my import penetration measure in order to see whether the training activities in those industries that involve many nonroutine cognitive tasks are less affected by imports.<sup>40</sup>

#### 4.4 Summary Statistics

Table 1 provides the summary statistics of the variables used in this paper. As one can see from the table, on average 9.8% of the observations receive employer-sponsored company training during the most recent year. It is also worth noting that, during the period of study, there is a substantial increase in total import penetration. Between 1988 and 1996, the total import penetration in the manufacturing sector increased from 14% to 18%. The shares of imports from countries of different income levels also changed dramatically. While the shares of imports coming from high income countries fell from 63% to 52%, the shares of imports from low income countries increased from 15% to 29%.

Table 2 provides information on the correlation between training incidence and several individual and industry-level variables. In accordance with most of the literature on training, in general those people who are highly educated, non-production workers, whites, and who work in large firms and in High-Tech (high R&D intensity) industries are more likely to receive company training. Interestingly, this simple correlation shows that trainings and import penetration is positively correlated. This seems to support the arguments that an increase in foreign competition will push industries forward and upgrade their workers' skills, something that may be beneficial to the workers.

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<sup>40</sup>Autor provides information on selected years between 1960 and 1998, including years 1989 to 1991 that match the time period of my study. I would only show the results using the 1990 data, though the results from using the other two years are very similar.

However, this simple exercise that relies on cross-sectional comparisons of the effect of imports has omitted an important fact: Each industry has its own special characteristics that may not be observed by econometricians, yet are correlated with import penetration. In this case, it is crucial to add industry fixed effects so as to control for these industry-specific time-invariant unobserved characteristics as well. Table 3 shows the result when I run two simple regressions that regress training incidence on import penetration, year dummies, and with/without industry fixed effects. As we can see, when there are no industry dummies, the effect of imports on training is significantly positive, while after adding dummies the effect of imports on training becomes significantly negative. A Wald test shows that the industry dummies are jointly significant, indicating the importance of adding industry fixed effects so that the effect of imports on trainings is correctly identified by the time trends in import penetration within industries. Moreover, this preliminary result of a negative correlation between import penetration and training suggests that, based on previous theoretical discussions, in the US the “competition effect” of imports on training is negative, and it overshadows the positive “skill-upgrading” effect of imports, so the overall effect of imports on training is negative. In fact, as we will see later, this pattern will be preserved (and actually stronger) even after adding additional controls on worker and industry characteristics.

## 5 Econometrics Framework

### 5.0.1 Baseline Model

In order to estimate the effect of import competition on the likelihood of company training, I adopt a linear probability framework. In each year, an individual  $i$  in region  $r$ , industry  $j$ , and at time  $t$  could either receive company training ( $Y_{ijrt} = 1$ ), or not ( $Y_{ijrt} = 0$ ). The linear probability model determining  $Y_{ijrt}$  is the following:

$$\begin{aligned}
 Y_{ijrt} &= X_{it} \alpha + \delta \text{impen}_{j,t-1} + Z_{jt-1} \beta + \theta_i + \eta_j + \phi_{rt} + \varepsilon_{ijrt} & (6) \\
 Y_{ijrt} &= 1 \text{ if received training; } Y_{ijrt} = 0 \text{ if received no training}
 \end{aligned}$$

In equation (6), the variable  $\text{impen}_{j,t-1}$  is a three year moving average of the import penetration measure in years  $t - 1$ ,  $t - 2$ , and  $t - 3$  for industry

$j$  in which the individual is working at time  $t$ .<sup>41</sup> Further,  $X_{it}$  is a vector of current time-varying individual characteristics, including marital status, race, years of education, residence in a standard metropolitan statistical area, years of experience and its square, union membership, and whether or not the individual is employed by a large firm with more than 1000 employees. Moreover,  $Z_{jt-1}$  is a vector of time-varying industrial characteristics consisting of the three year moving averages of  $t-1$ ,  $t-2$ , and  $t-3$  of the capital-labor ratio, the ratio of IT capital to total capital usage, the wage share of non-production workers, and the industry union coverage, respectively. Finally,  $\eta_j$  is the industry dummy for industry  $j$  used to capture the unobserved industry-specific time invariant effects that may bias the results, while  $\phi_{rt}$  is a vector of region-time dummies used to capture the unobserved time-variant macroeconomic changes within each region that may affect training incidence.<sup>42</sup> In addition, I have added  $\theta_i$  to represent individual unobserved characteristics, and use the random effects estimation. In calculating standard errors, I allowed for heteroskedasticity as I am using linear probability models.

There may be potential endogeneity problems under the above random effects specification. First, endogeneity may come from unobserved individual characteristics that are correlated with import penetration. For example, individuals with certain characteristics (say, lack of motivation) may not be likely to be trained by their employers. At the same time, however, these workers may also intentionally choose industries with less foreign competition in an attempt to secure their jobs. Therefore, workers' job selection may introduce bias in my estimates. To address concerns of this kind, I also consider fixed effects specifications.

A second potential source of endogeneity is unobserved time-varying industry characteristics. For example, during the period studied there may be a restructuring within the industry (e.g. intense mergers and acquisitions activities) or organizational changes within firms (e.g. flattening of the organizational hierarchies). These scenarios are mostly unobserved but may involve changing training practices, while also affecting the competence of the industry. Hence the industry's import competition measure may be endogenous. In order to

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<sup>41</sup>I use a three years lagged moving average for  $impen_{jt}$  and  $Z_{jt}$  to obtain a smoother version of the variables. Nevertheless, I do not find much difference in my results using 1-year, 2-year, or 3-year lagged values of the import penetration variable.

<sup>42</sup>In the NLSY79, there is no publicly available detailed information on the geographic area individuals live. The only information available is the region (northeast, north central, south, and west) these respondents live in.

take account of this second source of bias, I have also considered instrumental variable specifications for my study. The instrumental variables I use are the three year moving averages over  $t - 4$ ,  $t - 5$ , and  $t - 6$  of the industry level real exchange rates, industry level tariff cost, and industry level freight cost.<sup>43</sup> Here, the industry real exchange rate is defined as the import-weighted average of the real exchange rates of importing countries by industry;<sup>44</sup> tariff cost is calculated as the ratio between the duties collected and the custom value of imports; and freight cost is the sum of freight and insurance costs divided by the customs value of imports.<sup>45</sup>

It should be noted that, after conducting Hausman tests I could not reject random effects models in either case.<sup>46</sup> Therefore, when I report my results I mainly discuss the random effects models, given their efficiency. I discuss the results for fixed effects and instrumental variable specifications later in the paper as robustness checks.

## 6 Results and Discussions

### 6.1 Basic Specification

Table 4 shows the baseline results.<sup>47</sup> In addition to running a regression on the men for the full sample, I also run separate regressions for production and non-production workers respectively. This distinction is made because one would expect that the nature of production and non-production jobs is quite different

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<sup>43</sup>I have considered smaller lags—specifically, the moving average of  $t-1$ ,  $t-2$ , and  $t-3$ , as in the import penetration variable—for the instruments but reject the overidentification tests.

<sup>44</sup>The industry real exchange rate I use is the industry import-weighted real exchange rate. The weights for a given industry each year are the shares of each foreign country’s imports of the total imports in that year, and I calculate them from the U.S. import and export data. Real exchange rates are constructed from the IMF International Financial Statistics Database.

<sup>45</sup>The data for industry level tariff and freight costs again both come from Peter Schott’s website. Both variables are initially at the 4-digit SIC level, and I aggregate them to the 3-digit level.

<sup>46</sup>These tests use the bootstrap to calculate the variance of the difference in RE and FE (or IV) coefficients.

<sup>47</sup>I have also conducted my analysis on women. The result indicates no effect of import competition on training for women (with p-value 0.652). One potential reason that this occurs may be that the number of women in the manufacturing industries is less (I have only about 3800 observations in that sample), so the estimated effect is less precise. Another potential reason may be that the determinants of training may be different for women, given that women usually have higher job mobility (Royalty, 1996).

and would therefore expect that the determination of training for these two groups of workers be different.<sup>48</sup> In fact, I have found that non-production workers are more likely to receive company training (17%) than production workers (6%). As can be seen from the column 1 of the table, I find a significant negative effect of import penetration on company training for the full sample. The results suggest that when import competition increases by 1 percentage point, the probability of getting training will decrease by 0.0059. Given that in my sample period, between 1988 and 1996, the average import penetration has increased from 14% to 18%, this implies a reduction in the probability of training for about 0.024, holding all other potential factors constant.<sup>49</sup> This is a substantial effect since the average incidence of company training each year is only 0.098. As jobs that provide training are often viewed as those that provide better job security and earning prospects, this result seems to support those who argue that import penetration results in the export of more desirable jobs.

It is also useful to discuss this result in the context of the “competition effect” and “skill-upgrading effect” previously discussed. As argued earlier, while one would expect the “skill-upgrading effect” of imports on training is positive, one cannot tell *a priori* the sign of the “competition effect” of imports. However, this baseline result suggests that this “competition effect” is negative, and it is so substantial in absolute value that it reverses the positive “skill-upgrading effect.”

Another interesting point about the result is that this negative effect is mainly borne by non-production workers. While I only find insignificant negative effects for production workers, I find much more significant negative effects for non-production workers. For the non-production worker sample, a 1 percentage point increase in import penetration decreases the probability of getting training by 0.0103. This effect is large, although one should keep in mind that the average probability for non-production workers to receive training in a given year is 0.17. One potential reason that an effect on production workers is not apparent may be that production workers are much less likely to be trained in the first place, so a production worker’s reception of training is less responsive

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<sup>48</sup>Bartel and Sicherman (1998) also distinguish between production and non-production workers when they consider the effect of technological change on company training.

<sup>49</sup>In the sample, the probability of receiving training has not changed much throughout the years. Therefore, conversely, if we assume that all other factors that may affect training remain their course throughout the year, but assuming that import penetration has remained the same as in 1988, then the probability of receiving training will be 0.122, instead of being 0.098.

to import competition.

For the other control variables, as we can see from Column 1, in accordance with most papers on training incidence, I find that training opportunity increases for men who are whites, married, higher educated, non-production workers, and those working in large firms. Two other industry level variables are also important in explaining the incidence of training.<sup>50</sup> First, an increase in industry's non-production worker wage share will increase training, and second, an increase in the industry capital intensity will increase the probability that the workers receive training. Both results are not surprising, as an increase in both of these factors often signal that the industry is moving toward production procedures that are more sophisticated and capital intensive, so firms will need to upgrade their workers' quality in order to adapt to new procedures.

## 6.2 The Effect of Import Penetration on Employer-Paid Non-Company Training

Before I formally test my hypotheses, in this subsection I will first show the results when I focus on the effect of import competition on non-company training that is paid for by employers. As described above in the data section, non-company training refers to training programs that are not run by company and not in the form of seminars at or outside work. It has been argued that these non-company training programs are also the ones that provide more general training.<sup>51</sup>

The results are in Table 5, and we can see that there is no significant effect

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<sup>50</sup>I do not find a significant positive effect of IT capital usage (as a measure of technological change) on company training, which at first sight may seem to be inconsistent with what Bartel and Sicherman (1998) have found on the effect of technological change on training. One potential reason for the inconsistency may be the choice of variable to measure technological change. For example, if I use a variable indicating the growth in an industry's total factor productivity (TFP)—Bartel and Sicherman use it as one of their measures of technological change—in the regression, then I find a significant positive effect of this variable on training, a finding in accordance with Bartel and Sicherman's main result. Nevertheless, I intentionally exclude the use of this growth in TFP variable because it is a measure that captures the residual growth that cannot be explained by tangible inputs, so it may capture too much information, including the potential beneficial effects of imports. Hence, if I control for this growth in TFP variable, I could end up only measuring the detrimental effects of imports on training, which is undesirable. In fact, when I include this variable in my regression, the coefficient for import penetration becomes more negative (from -0.59 to -0.69), suggesting that the growth in TFP variable has captured part of the beneficial effect of import penetration.

<sup>51</sup>Loewenstein and Spletzer (1999).

of imports on non-company training. This could be due to two reasons. First, given their very low frequency (13% of all employer-provided training) in the first place, it may be difficult to find any effect at all. The second reason, and probably an even more important one, is that one cannot be sure if a worker's taking of these non-company training programs is initiated by the firm or by the worker himself. It is possible that in some cases it is the worker that decides to take the training, and his employer is only paying for it because the employer provides this kind of benefit. In cases like these, the training decision is made by the employee and it may differ substantially from what the firm may do had the firm is the one who makes the decision. For example, in the current situation of rising import competition, the employer may decide to send fewer workers to non-company training because he is afraid he would never recoup the investment, but the workers would want to seek for more non-company training for their own good in order to prepare for an uncertain future. In a situation like this, the employer and his employees may make completely opposite decisions, resulting in a non-effect of imports on non-company training as I have found here.

### **6.3 Testing of Hypothesis 1: Do the Effects Vary by the Income Levels of Importing Countries?**

From this subsection onwards, I will empirically test the hypotheses I propose above. Hypothesis 1 argues that the negative effects of import competition will be more severe for imports from low and middle income countries. To carry this out, low income countries are defined as countries with income no more than 20% of the US GDP per capita on average during 1985-1996; middle income countries are defined as those whose GDP per capita lies between 20% to 70% of the US GDP per capita. Relative to the US, these low and middle income countries enjoy a large labor cost advantage once they are able to produce acceptable quality goods (e.g. compete in the US market). Therefore, if my hypothesis about the importance of the foreign competitors' characteristics is correct, we should expect a more negative effect on training for the imports from these low and middle income countries. Table 6 shows the results of investigating the hypothesis. From column 1, we see that while the point estimates of the effect on training of low and middle income country imports are both about -0.95, the point estimate of the effect of high income country imports is insignificantly positive at 0.29, though I could not reject the null hypothesis

that these coefficients are the same (with a p-value of 0.12). However, given the similarity between the coefficients on low and middle income country imports, onwards I have pooled their data to achieve better estimation efficiency. In the bottom panel where I now only distinguish between imports from high and non-high countries, I find that we can reject the equivalence of the effects at the 5% level. As for the comparison between production and non-production workers, from the second and third columns of Table 6, again we see that the effect of imports on training is mostly borne by non-production workers, while the effect of imports on production workers is always insignificant, regardless of the income levels of importers.

#### **6.4 Testing of Hypothesis 2: Are the Effects of Imports on Training Different between High-Tech and Low-Tech Industries?**

My second hypothesis argues that the effect of imports on training will be less severe in High-Tech industries than in Low-Tech industries, where a High-Tech industry is defined as one whose products have more room for quality improvement. To test this second hypothesis, I attempt to distinguish between High-Tech and Low-Tech industries using two different definitions. The first one I use is the OECD's definition of "High-Tech" and "Low-Tech" industries, and the classification of an industry is based on its R&D intensities. This definition is appropriate in the current context because one would assume that in R&D intensive industries there are constant improvements, allowing domestic firms to win the market through achieving better product quality. My second definition is based on Autor, Levy, and Murnane's (2003) measures of an industry's requirement on "nonroutine cognitive" tasks, i.e. those tasks that emphasize interactive & managerial skills, and/or analytic reasoning skills. Here, I would assume that industries that are "Higher-Tech" involve more intensive nonroutine cognitive tasks, and the idea is that industries which emphasize these tasks are more capable of differentiating themselves from foreign competitors. For example, those industries that require a lot of analytic reasoning skills may be the ones that have continuous product improvements or innovations, and those industries that value interactive and managerial skills may be the ones where improvement in business operations or provision of differentiable products or services is possible.

#### **6.4.1 Comparison between High R&D and Low R&D Industries Based on the OECD Definition**

To test my hypothesis, I first compare the effect of imports on training incidences in high R&D industries and low R&D industries based on the OECD classification. Table 7a shows the results, and I find little support for Hypothesis 2. From the first column of table 7a, we see that while there is a significant negative effect of -0.74 for Low-Tech industries, there is an insignificant negative effect of -0.43 for High-Tech industries. I cannot reject the equality of the two coefficients. A similar result holds for non-production workers. However, the result for production workers is slightly different. While I find a significant negative effect of imports on training in low R&D industries, the effect is insignificantly positive in high R&D industries. Nevertheless, a Wald test shows that I still cannot reject the hypothesis that the coefficients are different.

#### **6.4.2 Effect of Industry Task Input Requirements on Import Penetration Effect**

Instead of comparing industries with different R&D intensities, another interesting exercise in order to see if U.S. industries are capable of escaping competition is to look at whether industries that involve different intensities of nonroutine cognitive tasks may have different training behavior in face of increased import competition. Following Autor, Levy, and Murnane (2003), I use two variables to measure nonroutine cognitive task inputs. The first variable measures an industry's emphasis on Direction, Control, and Planning of activities (DCP), while the second variable, MATH, measures the importance of quantitative reasoning. I have interacted these two variables respectively with my import penetration measure, and a significant positive coefficient on these interaction terms is evidence in support of the second hypothesis.

Table 7b shows the results. As we can see, although the coefficients on the interaction terms are positive in the full sample (Column 1) and non-production worker sample (Column 3), they are never significant. Therefore, similar to what I find when comparing industries by their R&D intensities, I do not find significant differences in the effects of imports on training for High-Tech and Low-Tech industries.

### 6.4.3 Are the Effects of Imports Coming from High Income Countries and Non-High Income Countries Different for High-Tech and Low-Tech Industries?

As shown in the previous subsections, empirical tests on Hypothesis 2 seem to indicate that the effects of imports on training in High-Tech and Low-Tech are not too different. These results lead to the following question: Are the negative effects of imports in both High-Tech and Low-Tech industries due to imports from non-high income countries, as Hypothesis 1 has emphasized? To investigate this issue, I allow the coefficients on the effect of high and non-high income country imports on training to be different for high R&D and low R&D industries.

Table 8 shows the result. We see that the effects of both high and non-high income country imports on an industry's training do not seem to vary based on an industry's R&D intensity. Therefore, although one might expect that the high capacity for innovation in U.S. industries could allow them to escape foreign competition, empirically this does not hold.

It is worthwhile to discuss this finding from the perspective of the model. In the model, the main reason that a domestic firm in a High-Tech industry might escape foreign competition is because, through effective training, the improvement in domestic quality is much greater than that in the foreign competitor's quality. However, it is not clear that in the real world this is true even in High-Tech industries. In the past two decades, newly industrialized countries such as the Asian Tigers play important roles in High-Tech industries, including the information and communication technology industries. These newly industrialized countries are usually middle income countries which boast high innovation capacity and mid-level labor costs. Therefore, in these High-Tech industries in which newly industrialized countries have strength, U.S. manufactures may not necessarily improve faster than their foreign counterparts.<sup>5253</sup> Therefore, U.S. manufactures still may not escape competition, even through quality upgrading.

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<sup>52</sup>For example, Finegold (2006) wrote that "... by 1990, the odds of a new infant receiving a U.S. engineering PhD were greater for a Taiwan-born child than an American one (North(1995))." One can imagine how much advanced knowledge these foreign students can bring back to their home countries once these countries become more open to businesses and innovations.

<sup>53</sup>Another reason that middle or low income countries may improve in quality faster is because it is easier to imitate than to innovate.

## 6.5 Testing of Hypothesis 3: Are There Differences between Imported Intermediate Goods and Imported Final Goods?

Hypothesis 3 claims that imports of final goods will have a more negative effect on training than that of intermediate imports. This occurs because imported intermediate goods may benefit the domestic final good producer by providing cheaper inputs. This in turn may increase the incentive for quality upgrading, and also may allow U.S. workers to relocate to higher-end jobs, which require more training. Table 9 examines this hypothesis. Note here that since the classifications of intermediate and final goods are not comparable before and after 1989, I allow different coefficients in the regression. Moreover, since I am using lagged 3 years moving average, I remove the observations in years 1990 and 1991.

As we can see from Column 1 of the table, in both periods I find a significant negative effect of imported final goods on training while the coefficients for the imported intermediate goods are insignificant. However, due to the large standard errors associate with imported intermediate goods, while I reject the null hypothesis that the effects of intermediate goods and final goods are the same for the full sample in the earlier period, I cannot do so for the later period. From Column 3 of the table, we see that the above pattern regarding the effects of imported intermediate goods and final goods again come from the effects on non-production workers in both periods. If I focus on this particular group, I can reject the equivalence of the effects of intermediate and final goods at a 6% level in the latter period, while for the former period I can only reject the null at 11% level. From these results, it appears that there exists some, though not very strong, empirical support for Hypothesis 3.<sup>54</sup>

## 7 Robustness Check: Fixed Effects Estimation and IV Estimation

In this section, I offer two robustness checks for my results to address the potential endogeneity of import penetration. First, endogeneity may arise from un-

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<sup>54</sup>One reason for not finding very strong support for Hypothesis 3 could be that in this exercise I am forced to work with a smaller sample and allow different coefficients for different periods. Both of these restrictions result in much larger standard errors.

observed individual characteristics. Individuals with certain characteristics may choose their industries intentionally and thus may result in biased estimates. To address this first concern, I use fixed effects (FE) models. Second, endogeneity may come from unobserved time-varying industry characteristics. For example, unobserved factors such as industry restructuring, or organizational structural changes, may be correlated with both training and import penetration, which would result in inconsistent estimates. To address this second concern, I separately estimate my model using a random effects instrumental variables (IV) model. The instrumental variables I use are the three year moving averages over t-4, t-5, and t-6 of the industry level real exchange rates, industry level tariff costs, and industry level freight costs.<sup>55</sup>

Table 10 shows the results for the full sample using a random effect (RE) specification, a FE specification, and an IV specification, respectively.<sup>5657</sup> Panel A in Table 10 shows the baseline results for all three specifications. We see that when using FE model, the import penetration coefficient seem to be slightly lower (-0.0047) than that under the RE model (-0.0059), but the coefficient under the IV specification is larger (-0.0116). Nevertheless, the qualitative messages under the three specifications are all the same, i.e. there is a significant negative effect of import competition on company training. To formally test whether my concerns about endogeneity are statistically important, I conduct Hausman tests to see whether the RE model is valid. It should be noted, however, that in this case I cannot directly use the standard form of Hausman test, because in the original formulation, one must assume an “efficient” model as

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<sup>55</sup>I have considered shorter lags—specifically, the moving average of t-1, t-2, and t-3 (as in the case of the import penetration variable)—for the instruments but reject the overidentification tests with these IVs.

<sup>56</sup>I have put my results for the production worker sample and non-production worker sample in the online appendix. In both samples and all extensions, after conducting Hausman Tests I could not reject the random effect models.

<sup>57</sup>For IV estimations, I conduct overidentification tests to see if the instruments are valid, i.e. uncorrelated with the errors. I also check whether the instruments are “weak.” Following Baum, Schaffer, and Stillman’s (2007) suggestion, I use the Kleibergen–Paap  $rk$  Wald Statistic, which is the robust analog of the Cragg–Donald statistic, as my test statistics and compare them to the critical values compiled by Stock and Yogo (2005) to check for weak instruments. However, since the Stock and Yogo (2005) test for weak instruments are based on i.i.d. errors, the weak instrument tests I conduct should be treated with caution because of the presence of heteroskedasticity in the data. Note also that since Stock and Yogo (2005) do not provide critical values when there are more than three endogenous variables, I could not conduct this weak instrument test when testing Hypothesis 3, as in that case I have four endogenous variables.

the null. Since I need to use the White's standard errors to correct for the heteroskedasticity problem associated with a linear probability model, my RE model is not efficient. I instead rely on a bootstrapping method to conduct my Hausman tests.<sup>58</sup> The test results suggest that the coefficients under the FE model and IV model are both not statistically different from that under the RE model, indicating that using the RE specification is valid.

Panel B shows the results when I consider RE, FE, and IV estimations when distinguishing between imports from high income countries and non-high income countries. Looking across the columns, we see that the qualitative pattern carries over different specifications. Specifically, I find a significant negative effect of non-high income country imports on training, but find an insignificant positive effect of high income country imports.<sup>59</sup> In addition, in neither the FE nor the IV case can I reject the null hypothesis that the RE estimation is appropriate.

Panels C, D, and E shows the results when I allow for the effects of imports on training to be different for High-Tech and Low-Tech industries. As we can see across the columns in Panels C through E, the results under different specifications are again very similar to what I have reported above, i.e. I could not find the effect of imports on training to be significantly different for High-Tech and Low-Tech industries. Again, the Hausman tests indicate that using RE is consistent with the data. In Panel F, I interact income status of the import with the High-Tech status of the industry. We can see that the result using the fixed effects models reinforce the random effects model result which suggests that the negative effects of imports in High-Tech and Low-Tech industries are both due to imports from non-high income countries, and that this negative effect is similar for High-Tech and Low-Tech industries. I cannot reject the equality of the RE and FE coefficients. For this particular case, I do not use IV estimation because the instrumental variables are too weak to identify all of the coefficients.<sup>60</sup>

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<sup>58</sup>For the bootstrap Hausman tests, I sample by individuals (not observations) and perform 300 bootstrap replications.

<sup>59</sup>However, because of the much larger standard errors associate with the IV estimation, I could not reject the null hypothesis that high and non-high income country imports have same coefficients.

<sup>60</sup>Since Stock and Yogo (2005) do not provide the critical values to determine whether the instruments are weak not for four endogenous variables, I could not formally test whether the instruments are weak. However, when I use the IV estimation for this particular case, the point estimate of the coefficient for the high-income country import in the low R&D industry is 0.15 and with a standard error of 0.099. Both the point estimates and the standard errors

Finally, Panel G shows the result for the comparison between intermediate imports and final goods imports using RE, FE, and IV specifications. Recall that since the classifications of intermediate and final goods are not comparable before and after 1989, I allow different coefficients for different periods in the regression. Looking across the columns, we see that the point estimates under different specifications all suggest that the negative effect of final good imports is more severe than that of intermediate good imports. However, as the standard errors under the fixed effects model and IV model are much larger, most coefficients now become insignificant in these specifications. Nevertheless, the hypothesis tests under all three specifications lend some support to the argument that the effects of intermediate good imports and final good imports are different. Specifically, for the RE and FE models, I reject the null hypothesis that the effects of intermediate good imports and final good imports are the same for the earlier period (between 1988 and 1989), but I cannot reject the null hypothesis for the later period (between 1992 and 1996). On the other hand, for the IV model, while I reject the null hypothesis in the later period, I cannot do so in the earlier period. The Hausman test results again suggest that using the RE specification is valid.

Finally, with Table 10 we can see from the coefficients, and especially from the Hausman test results, that my empirical findings are robust to different estimation methods. Therefore, although a priori one may have some concerns about potential endogeneity of the import penetration variable due to individual job choice or unobserved industry trends, empirically this is less of a concern.

## 8 Conclusion

This paper studies how import competition affects workers' opportunities to receive company training. This is an important issue, as company training has been found to be a very important source of a worker's lifetime human capital accumulation, and thus will have important implications for one's earnings and job security.

My baseline estimation shows that an increase in 1 percentage point of import penetration will result in a 0.006 decrease in the probability of company training. Given that in my sample period, between 1988 and 1996, the average blow up by 20 times (relative to the RE coefficient). This causes one to seriously doubt the strength of the instrumental variables.

import penetration rose from 14% to 18%, this implies a reduction in the probability of training for about 0.024, holding all other factors constant. This is a large effect given that the average probability of receiving company training each year is approximately 0.098. I also find that this effect is concentrated primarily among non-production workers.

In order to explain this finding, I first derive a theoretical model and arrive at two testable hypotheses. Hypothesis 1 argues that domestic producers have less incentive to train their workers when they face import competition from low or middle income countries. This occurs because these countries' low-cost products may drive the domestic firms' products out of the market in the future, preventing the domestic firms from recouping their training investment. I find empirical support for this hypothesis. Specifically, while the effect of low or middle income country imports on training is significantly negative, that of high income country is insignificantly positive.

Hypothesis 2 argues that, when import competition increases, firms in High-Tech industries will be more likely to train their workers than firms in Low-Tech industries. This prediction arises because, through effective training, while firms in High-Tech industries can achieve substantial quality improvement and win the market, firms in Low-Tech industries have little room for quality improvement so they will eventually lose the market to low-cost foreign producers. Empirically, however, the data does not seem to support this hypothesis. I do not find a significant difference in the effects of imports on training between High-Tech and Low-Tech industries, and I also find that the negative effect of middle and low income country imports on training is similar in both High-Tech and Low-Tech industries.

In addition to the above two hypotheses, I also propose the following Hypothesis 3: Imports of intermediate goods will have a less negative effect on training than that of final goods imports. This hypothesis follows from arguments made in the foreign outsourcing literature regarding incentives to product upgrading when firms can access intermediate goods imports. I find empirical support for this hypothesis. While the effect of foreign final good imports on training is significantly negative, the effect of foreign intermediate good imports is always insignificant. Finally, for the baseline estimation as well as all of the other extensions, I show that my results are robust to reasonable changes in the empirical specifications that are aimed to address potential endogeneity problems.

The results in this paper have implications for the literature. In particular,

as argued earlier in the paper, there have been some industry-level studies that find evidence of improving labor productivity in face of import competitions or foreign outsourcing. The results of this paper suggest that this improved productivity is not from increased training. Hence, as discussed earlier, it could come from the exit and entry of firms within the industry (a potentially good scenario), a decrease in the employment level (a bad scenario), or both. The identification of the exact channel is crucial as each has different implications for U.S. workers, and therefore is an important venue for future study.

There are two important caveats regarding this paper that need to be pointed out. First, although in this paper I show that in the U.S., import competition causes firms to train their workers less, it may still be a stretch to conclude that U.S. firms also slow down their innovative activities to develop new products. It is possible that U.S. firms still maintain a high level of R&D activities but reduce spending on labor, either through using more capital intensive production techniques or shutting down their domestic production and moving to a foreign site. Therefore, the results in this paper are not necessarily at odds with arguments that foreign competition will induce innovation. The important message of this paper is, however, that foreign competition will impose a cost borne by domestic labor.

It is also important to note that this study is conducted only for a specific time period, and it is possible that the effect of imports on training could be different for different time periods. In this paper, I have not conducted my study for years beyond 1996 because the industry reclassification in 1997 does not allow me to merge the industry data before and after 1997. Although in principle one could conduct a similar study using the NLSY79 for years after 1997 and compare its results with this one, one important concern would be that the age distribution of the sample will be different, making the comparison more tenuous. Specifically, since the NLSY79 is a panel data that follows the same cohort across years, while in my study the age of individuals varies between 23 and 39, a study starting in 1998 and ending in 2006, the last year of data currently available, will have a sample of individuals whose age is between 33 and 49.

In summary, it is not surprising that fierce import competition, especially from low income countries and middle income countries, is an important policy and political issue. Through the reduction in training opportunities for U.S. workers, they may suffer lower lifetime earnings and face more an unstable future. The results in this paper seem to validate some of the concerns about “exporting

good jobs.”

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## 10 Appendix

In this appendix, I will show in detail the effect of increased import competition on training for different parameters  $k$ ,  $j$ ,  $s$ ,  $w_d$ , and  $w_f$ .<sup>61</sup> For the convenience of illustration, equation (4) in the main text is replicated below as equation (A1).

$$\begin{aligned} \frac{dz}{dq} = \frac{1}{c} & \left[ \Pi^c(k-1+s, j, w_d, w_f) - \Pi^m(k-1+s, w_d) \right. \\ & \left. - \Pi^c(k-1, j, w_d, w_f) + \Pi^m(k-1, w_d) \right] \end{aligned} \quad (\text{A1})$$

In the above equation, it is obvious that the second and the fourth terms on the RHS of (A1) only depend on the parameters associated with the domestic industry, while the first and third terms also depend on the parameters describing the foreign competitors. Since the focus is on how the characteristics of foreign competitors may affect the domestic firm’s incentive to train workers, I will focus on the first and third terms on the RHS of equation (A1)

I will start with the first term,  $\Pi^c(k-1+s, j, w_d, w_f)$ , which corresponds to the profit level the domestic firm could obtain when training is effective and a foreign competitor shows up. From the main text, we know that this profit level can take on one of the two values. In particular,

when  $\left(\frac{A_d(t)}{A_f(t)}\right)^{\frac{1-\alpha}{\alpha}} w_f = \left(\frac{\gamma^{k-1+s} A_0}{\gamma^j A_0}\right)^{\frac{1-\alpha}{\alpha}} w_f = (\gamma^{k-1+s-j})^{\frac{1-\alpha}{\alpha}} w_f < w_d$ ,  $\Pi^c(k-1+s, j, w_d, w_f) = 0$ . This occurs when the domestic firm has a higher quality-adjusted production cost and hence been driven out of the market.

On the other hand, when  $\left(\frac{A_d(t)}{A_f(t)}\right)^{\frac{1-\alpha}{\alpha}} w_f = (\gamma^{k-1+s-j})^{\frac{1-\alpha}{\alpha}} w_f \geq w_d$ ,  $\Pi^c(k-1+s, j, w_d, w_f) = \Pi^m(k-1+s, w_d)$ . This occurs when the domestic firm has a lower (quality-adjusted) production cost, so it will remain the monopoly.

<sup>61</sup>Recall that  $k-1$  and  $j-1$  are the domestic and foreign quality levels, respectively, at the end of period  $t-1$ ;  $s$  is the steps of quality improvement that the domestic producer can achieve conditional on effective training;  $w_d$  and  $w_f$  are the domestic and foreign wage levels, respectively; and they are also the unit production cost of domestic and foreign intermediate inputs, respectively.

The possible values for the third term,  $\Pi^c(k-1, j, w_d, w_f)$ , are also similar. Specifically, when  $\left(\frac{A_d(t)}{A_f(t)}\right)^{\frac{1-\alpha}{\alpha}} w_f = \left(\frac{\gamma^{k-1} A_0}{\gamma^j A_0}\right)^{\frac{1-\alpha}{\alpha}} w_f = (\gamma^{k-1-j})^{\frac{1-\alpha}{\alpha}} w_f < w_d$ ,  $\Pi^c(k-1, j, w_d, w_f) = 0$ ; on the other hand, when  $\left(\frac{A_d(t)}{A_f(t)}\right)^{\frac{1-\alpha}{\alpha}} w_f = (\gamma^{k-1-j})^{\frac{1-\alpha}{\alpha}} w_f \geq w_d$ ,  $\Pi^c(k-1, j, w_d, w_f) = \Pi^m(k-1, w_d)$ .

The above discussion about the potential values of  $\Pi^c(k-1+s, j, w_d, w_f)$  and  $\Pi^c(k-1, j, w_d, w_f)$  implies that based on different values of  $k, j, s, w_d$ , and  $w_f$ , there could be three possible cases regarding the effect of increased import competition on training:

$$\text{Case 1: } (\gamma^{k-1-j})^{\frac{1-\alpha}{\alpha}} w_f < (\gamma^{k-1+s-j})^{\frac{1-\alpha}{\alpha}} w_f < w_d$$

In this case, regardless of the effectiveness of training, the domestic firm will always have a higher quality-adjusted production cost, so it will always lose the market once a potential entrant shows up. Consequently, from equation (A1), its training decision when there is an increase in import competition, i.e. a rise in  $q$ , the probability that a potential foreign competitor shows up, will be:

$$\begin{aligned} \frac{dz}{dq} &= \frac{1}{c} \left[ \Pi^c(k-1+s, j, w_d, w_f) - \Pi^m(k-1+s, w_d) \right. \\ &\quad \left. - \Pi^c(k-1, j, w_d, w_f) + \Pi^m(k-1, w_d) \right] \\ &= \frac{1}{c} [0 - \Pi^m(k-1+s, w_d) - 0 + \Pi^m(k-1, w_d)] \\ &= \frac{1}{c} [-\Pi^m(k-1+s, w_d) + \Pi^m(k-1, w_d)] < 0 \end{aligned}$$

The last inequality comes from the fact that the domestic firm's monopoly profit will be greater when its quality is better (note that  $s = 1$  or  $2$  so it is greater than zero). The intuition for this is straightforward: Once a foreign company shows up, the domestic firm investment in human capital will be in vain. Therefore, the domestic firm will decrease its training investment based on an increase in the probability that a foreign company will show up.

$$\text{Case 2: } (\gamma^{k-1-j})^{\frac{1-\alpha}{\alpha}} w_f < w_d < (\gamma^{k-1+s-j})^{\frac{1-\alpha}{\alpha}} w_f$$

In this case, when the training is effective, the domestic firm will have lower quality-adjusted production costs, so it will win the market and earn monopoly rent. However, if the training is ineffective, the domestic firm will have higher quality-adjusted production costs, so it will lose the market once a potential entrant shows up. Therefore, in terms of equation (A1):

$$\begin{aligned}
\frac{dz}{dq} &= \frac{1}{c} \left[ \Pi^c(k-1+s, j, w_d, w_f) - \Pi^m(k-1+s, w_d) \right. \\
&\quad \left. - \Pi^c(k-1, j, w_d, w_f) + \Pi^m(k-1, w_d) \right] \\
&= \frac{1}{c} [\Pi^m(k-1+s, w_d) - \Pi^m(k-1+s, w_d) - 0 + \Pi^m(k-1, w_d)] \\
&= \frac{1}{c} \Pi^m(k-1, w_d) < 0
\end{aligned}$$

Now, the domestic firm will want to increase its training investment when there is rising import competition. This result occurs because the domestic firm could win the market if its training is effective, so it has the incentive to provide more training to increase its chance to survive the competition.

$$\text{Case 3: } w_d < (\gamma^{k-1-j})^{\frac{1-\alpha}{\alpha}} w_f < (\gamma^{k-1+s-j})^{\frac{1-\alpha}{\alpha}} w_f$$

In this case, regardless of the effectiveness of training, the domestic firm's (quality-adjusted) production cost is always lower than that of the foreign firm, so it will always win the market and earn monopoly rent. Consequently, equation (A1) becomes:

$$\begin{aligned}
\frac{dz}{dq} &= \frac{1}{c} \left[ \Pi^c(k-1+s, j, w_d, w_f) - \Pi^m(k-1+s, w_d) \right. \\
&\quad \left. - \Pi^c(k-1, j, w_d, w_f) + \Pi^m(k-1, w_d) \right] \\
&= \frac{1}{c} \left[ \Pi^c(k-1+s, w_d) - \Pi^m(k-1+s, w_d) \right. \\
&\quad \left. - \Pi^m(k-1, w_d) + \Pi^m(k-1, w_d) \right] \\
&= 0
\end{aligned}$$

In this case, when the probability of a potential foreign competitor arises, the domestic firm will not change its training decision. This occurs because the domestic firm is so superior that it does not require quality upgrading to defeat the potential entrants. Therefore, its training decision will not be affected by the arrival of potential competitors. However, in this paper I ignore this third case for two reasons. First, one would only be interested in the effect of import competition when potential foreign entrants could actually impose a threat to domestic firms. From a domestic firm's perspective, it would not be concerned about foreign firms unless they present direct competition. Second, empirically it is difficult to test this no-effect of import competition when domestic quality

is sufficiently superior. The reason is that in this case, foreign firms will never enter, so we cannot observe an “increase” in import competition. Therefore, onwards I will only consider cases 1 and 2.

## 10.1 Comparative Statics

Comparing the conditions in which case 1 and 2 would occur, we can see that the main difference is that in case 1, effective training, or equivalently, quality upgrading, cannot save the domestic firm from potential entrants, while in case 2 effective training can. Mathematically, it simply means that we are comparing the values of  $w_d$  and  $(\gamma^{k-1+s-j})^{\frac{1-\alpha}{\alpha}} w_f$ . When the former is larger, we are in case 1 where increased import competition will discourage training, while we will be in case 2 where increased import competition will encourage training if the latter has a larger value.

Holding the domestic wage level,  $w_d$ , and end of period  $t - 1$  quality level,  $k - 1$ , fixed, it is then obvious that, holding all other parameters fixed, we can perform the following comparative statics:

- When the foreign wage level  $w_f$  is lower, we are more likely to be in case 1 where increased import competition will discourage training. This is the basis of Hypothesis 1 which argues that the negative effect of import competition on company training will be more severe for imports from middle or low income countries than those from high income countries.
- When the number of steps of quality improvement under effective training is larger, i.e. a larger  $s$ , we are more likely to be in case 2 where increased import competition encourages training. This observation constitute the basis of Hypothesis 2 which argues that the negative effect of import competition on company training will be less severe for High-Tech industries where there are many opportunities for improvement. Note that I define an industry to be “High-Tech” when  $s$  is larger.
- Finally, one can see that when the foreign quality level,  $j$ , is higher, case 1 is more likely to occur. In this paper, since I do not have measures for quality levels for domestic or foreign products, I have not empirically tested this.

Table 1: Summary Statistics of Key Variables

|   | Mean              | Standard Deviation |      |      |
|---|-------------------|--------------------|------|------|
| <b>Individual Variables</b>   |                   |                    |      |      |
| Incidence of Company Training   | 0.098             | 0.297              |      |      |
| Experience (weeks)  | 536.29            | 179.75             |      |      |
| Tenure (weeks)  | 228.38            | 215.44             |      |      |
| Grades Completed  | 12.55             | 2.40               |      |      |
| White Dummy   | 0.571             | 0.495              |      |      |
| Work in Large Firms (>1000 people)  | 0.450             | 0.498              |      |      |
| Union Member  | 0.172             | 0.377              |      |      |
| Total number of individuals   | 2147              |                    |      |      |
| Total number of observations  | 7208              |                    |      |      |
| <b>Industry Characteristics</b>   |                   |                    |      |      |
|   | 1985 <sup>1</sup> | 1988               | 1992 | 1996 |
| Import Penetration (%)  | 12.2              | 13.8               | 14.7 | 17.6 |
| High Income Country Import Share (%)  | 63.4              | 59.9               | 56.5 | 51.7 |
| Middle Income Country Import Share (%)  | 21.2              | 23.5               | 20.4 | 18.8 |
| Low Income Country Import Share (%)   | 15.4              | 16.6               | 22.9 | 29.4 |
| Intermediate Good Share (%) <sup>2</sup>  | 15.4              | 18.2               | 15.1 | 12.9 |
| IT Capital Ratio (%)  | 18.9              | 22.7               | 26.3 | 24.4 |
| Capital Labor Ratio (\$1000/worker)   | 5.5               | 4.9                | 6.0  | 7.5  |
| Union Coverage (%)  | 27.7              | 24.9               | 22.0 | 20.0 |
| Wage Share of Production Workers (%)  | 61.8              | 61.0               | 58.9 | 60.6 |
| <p>Note 1: I start from 1985 instead of 1988 because I use lagged three years moving averages for all of my industry level variables.</p> <p>Note 2: There is a reclassification of the intermediate goods in 1989; so values before and after 1989 are not comparable.</p> |                   |                    |      |      |

Table 2: Correlation Between Training Incidences and Individual and Industry-Level Variables

|                     | Training            | Grades Complete | Production worker   | White               | Large Firms | Hi-RD industries | Import Penetration  | Capital-Labor Ratio | Union Coverage |
|---------------------|---------------------|-----------------|---------------------|---------------------|-------------|------------------|---------------------|---------------------|----------------|
| Training            | 1                   |                 |                     |                     |             |                  |                     |                     |                |
| Grades Completed    | 0.195               | 1               |                     |                     |             |                  |                     |                     |                |
| Production worker   | -0.170              | -0.461          | 1                   |                     |             |                  |                     |                     |                |
| White               | 0.089               | 0.183           | -0.153              | 1                   |             |                  |                     |                     |                |
| Large Firms         | 0.161               | 0.198           | -0.108              | -0.009 <sup>†</sup> | 1           |                  |                     |                     |                |
| Hi-RD Industries    | 0.129               | 0.200           | -0.145              | 0.069               | 0.185       | 1                |                     |                     |                |
| Import Penetration  | 0.061               | 0.075           | -0.073              | 0.015 <sup>†</sup>  | 0.080       | 0.38             | 1                   |                     |                |
| Capital-Labor Ratio | 0.091               | 0.041           | -0.015 <sup>†</sup> | 0.007 <sup>†</sup>  | 0.096       | 0.040            | -0.007 <sup>†</sup> | 1                   |                |
| Union Coverage      | -0.008 <sup>†</sup> | -0.077          | 0.147               | -0.033              | 0.119       | 0.044            | 0.046               | 0.037               | 1              |

Note: All correlations significant at the 1% level except those with subscripts “<sup>†</sup>”(not significant).

Table 3: Comparison of the Effects of Import Competitions on Company Trainings with and without Industry Dummies

| Dependent Variable: Incidence of Company Training |   |   |
|---|---|---|
| Variable  | (1)<br>Coefficient<br>(standard errors) | (2)<br>Coefficient<br>(standard errors) |
| Import Penetration                                | 0.12<br>(0.03)***                       | -0.39<br>(0.19)**                       |
| N   | 7208                                    | 7208                                    |
| Industry Dummies                                  | N                                       | Y                                       |
| Time Dummies                                      | Y                                       | Y                                       |

Note 1: Significance of the coefficients--\*\*\*1%,\*\*5%,\*10%.  
2. The value of the import penetration variable is its three-years lagged moving average.

Table 4: Baseline Result

| Dependent Variable:  | Coefficient        | Coefficient        | Coefficient            |
|--|--------------------|--------------------|------------------------|
| Company Training   | (standard errors)  | (standard errors)  | (standard errors)      |
|  | (1)                | (2)                | (3)                    |
|  | All Workers        | Production Workers | Non-Production Workers |
| <b>Industry Import Penetration (Lagged Moving Average)</b> | <b>-0.0059</b>     | <b>-0.0019</b>     | <b>-0.0103</b>         |
| Experience (in weeks)                                      | <b>(0.0019)***</b> | <b>(0.0021)</b>    | <b>(0.0036)***</b>     |
| Experience Square  | 0.0001             | -3.64e-05          | 0.0004                 |
|  | (0.0001)           | (0.0001)           | (0.0002)**             |
| 1-8 years of Schooling                                     | 6.97e-08           | 1.69e-08           | -3.65e-07              |
|  | (8.23e-08)         | (8.73e-08)         | (2.00e-07)*            |
| 9-11 years of Schooling                                    | -0.0194            | -0.0144            | -0.0698                |
|  | (0.0107)*          | (0.0129)           | (0.0270)***            |
| 13-15 years of Schooling                                   | -0.0165            | -0.0163            | -0.0097                |
|  | (0.0075)**         | (0.0084)**         | (0.0242)               |
| 16 years of Schooling                                      | 0.0184             | 0.0079             | 0.0331                 |
|  | (0.0102)*          | (0.0119)           | (0.0217)               |
| 17+ years of Schooling                                     | 0.0785             | 0.0900             | 0.0672                 |
|  | (0.0163)***        | (0.0342)**         | (0.0221)***            |
| Production worker Dummy                                    | 0.1462             | 0.0798             | 0.1462                 |
|  | (0.0248)***        | (0.0606)           | (0.0296)***            |
| White Dummy  | -0.0351            | -                  | -                      |
|  | (0.0094)***        |                    |                        |
| Married Dummy  | 0.0131             | 0.0089             | 0.0311                 |
|  | (0.0077)*          | (0.0083)           | (0.0185)*              |
| Large Firm (>1000) Dummy                                   | 0.0249             | 0.0260             | 0.0212                 |
|  | (0.0071)***        | (0.0074)***        | (0.0168)               |
| Union Member Dummy   | 0.0595             | 0.0397             | 0.0959                 |
|  | (0.0074)***        | (0.0080)***        | (0.0165)***            |
| IT Capital Ratio (Lagged Moving Average)                   | -0.0027            | 0.0001             | 0.0017                 |
|  | (0.0098)           | (0.0107)           | (0.0300)               |
| Capital-Labor Ratio (Lagged Moving Average)                | 0.0017             | -0.0002            | 0.0040                 |
|  | (0.0016)           | (0.0017)           | (0.0029)               |
| Non-Production Worker Wage Share (Lagged Moving Average)   | 0.0014             | 0.0005             | 0.0027                 |
|  | (0.0007)**         | (0.0008)           | (0.0012)**             |
| Union Coverage (Lagged Moving Average)                     | 0.0091             | 0.0013             | 0.0205                 |
|  | (0.0051)*          | (0.0053)           | (0.0102)**             |
| Year Dummies   | -2.11e-05          | -1.17e-05          | -4.37e-05              |
|  | (2.22e-05)         | (2.21e-05)         | (5.49e-05)             |
| Industry Dummies   | Y                  | Y                  | Y                      |
| SMSA Dummies   | Y                  | Y                  | Y                      |
| Random Effects   | Y                  | Y                  | Y                      |
| N  | 7208               | 4839               | 2369                   |

Note: 1. See notes to table 3.

2. All industry-level variables are measured as their three-years lagged moving average.

Table 5: Effect of Import Penetration on Non-Company Training

| Dependent Variable: Incidence of Non-Company Training |                                  |                                  |                                  |
|---|----------------------------------|----------------------------------|----------------------------------|
| Variable  | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) |
|   | (1)                              | (2)                              | (3)                              |
|   | All Workers                      | Production Workers               | Non-Production<br>Workers        |
| Import Penetration                                    | -0.0010<br>(0.0009)              | -0.0005<br>(0.0011)              | -0.0016<br>(0.0016)              |
| N   | 7208                             | 4839                             | 2369                             |

Note: 1. All other control variables are the same as those in Table 4.  
2. See notes to Table 3.

Table 6: Testing Hypothesis 1—Comparison of the Effects on Training of Imports from Countries of Different Income Levels

| Dependent Variable: Incidence of Company Training                               |                                  |                                  |                                  |
|---|----------------------------------|----------------------------------|----------------------------------|
| Variable  | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) |
|   | (1)                              | (2)                              | (3)                              |
|   | All Workers                      | Production Workers               | Non-Production<br>Workers        |
| <b>Panel A: Comparison between Low, Middle, and High income Country Imports</b> |                                  |                                  |                                  |
| (a) Low Income Countries Imports  | -0.0094<br>(0.0025)***           | -0.0036<br>(0.0026)              | -0.0166<br>(0.0050)***           |
| (b) Middle Income Countries Imports   | -0.0096<br>(0.0039)**            | -0.0051<br>(0.0044)              | -0.0179<br>(0.0074)**            |
| (c) High Income Countries Imports   | 0.0028<br>(0.0046)               | 0.0030<br>(0.0048)               | 0.0078<br>(0.0092)               |
| Test (a)=(b)=(c)  | Accept<br>(p-value=0.12)         | Accept<br>(p-value=0.52)         | Accept<br>(p-value=0.11)         |
| <b>Panel B: Comparison between non-High and High income Country Imports</b>     |                                  |                                  |                                  |
| (d) Non-High Income Countries Imports   | -0.0094<br>(0.0026)***           | -0.0039<br>(0.0027)              | -0.0169<br>(0.0048)***           |
| (e) High Income Countries Imports   | 0.0028<br>(0.0046)               | 0.0026<br>(0.0048)               | 0.0073<br>(0.0090)               |
| Test (d)=(e)  | Reject**<br>(p-value=0.04)       | Accept<br>(p-value=0.27)         | Reject**<br>(p-value=0.03)       |
| N   | 7208                             | 4839                             | 2369                             |

Note: 1. All other control variables are the same as those in Table 4.  
2. See notes to Table 3.

Table 7a: Testing Hypothesis 2—Comparison of the Effects of Imports on Training in High-Tech and Low-Tech Industries (Comparing High R&D and Low R&D Industries)

| Dependent Variable: Incidence of Company Training |                                  |                                  |                                  |
|---|----------------------------------|----------------------------------|----------------------------------|
| Variable  | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) |
|   | (1)                              | (2)                              | (3)                              |
|   | All Workers                      | Production Workers               | Non-Production<br>Workers        |
| (a) High R&D<br>Industry *imports                 | -0.0043<br>(0.0031)              | 0.0020<br>(0.0045)               | -0.0087<br>(0.0046)*             |
| (b) Low R&D<br>Industry *imports                  | -0.0074<br>(0.0023)***           | -0.0041<br>(0.0020)**            | -0.0130<br>(0.0059)**            |
| Test (a)=(b)                                      | Accept<br>(p-value=0.40)         | Accept<br>(p-value=0.20)         | Accept<br>(p-value=0.56)         |
| N   | 7208                             | 4839                             | 2369                             |

Note: 1. All other control variables are the same as those in Table 4.  
2. See notes to Table 3.

Table 7b: Testing Hypothesis 2—Comparison of the Effects of Imports on Training in High-Tech and Low-Tech Industries (Comparing Industries with Different Nonroutine Task Inputs Intensity)

| Dependent Variable: Incidence of Company Training |                                  |                                  |                                  |
|---|----------------------------------|----------------------------------|----------------------------------|
| Variable  | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) |
|   | (1)                              | (2)                              | (3)                              |
|   | All Workers                      | Production Workers               | Non-Production<br>Workers        |
| Import Penetration                                | -0.0090<br>(0.0040)**            | -0.0014<br>(0.0045)              | -0.0221<br>(0.0087)**            |
| Import Penetration<br>*Math Skill                 | 0.0005<br>(0.0007)               | -0.0001<br>(0.0010)              | 0.0018<br>(0.0012)               |
| Import Penetration                                | -0.0073<br>(0.0040)*             | 0.0004<br>(0.0048)               | -0.0200<br>(0.0086)**            |
| Import Penetration<br>*DCP Skill <sup>3</sup>     | 0.0002<br>(0.0007)               | -0.0004<br>(0.0010)              | 0.0014<br>(0.0012)               |
| N   | 7208                             | 4839                             | 2369                             |

Note: 1. All other control variables are the same as those in Table 4.  
2. See notes to Table 3.  
3. DCP is the acronym for “Direction, Control, and Planning.”

Table 8: Comparing the Effects of Imports from High Income Countries and Non-High Income Countries on Training for High-Tech and Low-Tech Industries (Comparing High R&D and Low R&D Industries)

| Dependent Variable: Incidence of Company Training |                                  |                                  |                                  |
|---|----------------------------------|----------------------------------|----------------------------------|
| Variable  | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) |
|   | (1)                              | (2)                              | (3)                              |
|   | All Worker                       | Production Workers               | Non-Production<br>Workers        |
| (a) High R&D*High<br>Income Country imports       | 0.0020<br>(0.0058)               | 0.0034<br>(0.0064)               | 0.0043<br>(0.0103)               |
| (b) High R&D*non-High<br>Income Country imports   | -0.0079<br>(0.0047)*             | -0.0005<br>(0.0058)              | -0.0146<br>(0.0066)**            |
| (c) Low R&D* High<br>Income Country imports       | 0.0045<br>(0.0065)               | 0.0008<br>(0.0073)               | 0.0192<br>(0.0167)               |
| (d) Low R&D* non-High<br>Income Country imports   | -0.0107<br>(0.0026)***           | -0.0051<br>(0.0023)**            | -0.0212<br>(0.0065)***           |
| Test(a)=(c)                                       | Accept<br>(p-value=0.77)         | Accept<br>(p-value=0.64)         | Accept<br>(p-value=0.45)         |
| Test(b)=(d)                                       | Accept<br>(p-value=0.59)         | Accept<br>(p-value=0.43)         | Accept<br>(p-value=0.47)         |
| N   | 7208                             | 4839                             | 2369                             |

Note: 1. All other control variables are the same as those in Table 4.  
2. See notes to Table 3.

Table 9: Testing Hypothesis 3—Comparison of the Effects of Intermediate and Final Goods Imports

| Dependent Variable: Incidence of Company Training |                                  |                                  |                                  |
|---|----------------------------------|----------------------------------|----------------------------------|
| Variable  | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) | Coefficient<br>(standard errors) |
|   | (1)                              | (2)                              | (3)                              |
|   | All Workers                      | Production Workers               | Non-Production<br>Workers        |
| (a) Old Final Goods<br>Import (88-89)             | -0.0051<br>(0.0026)*             | -0.0023<br>(0.0028)              | -0.0099<br>(0.0058)*             |
| (b) Old Intermediate<br>Goods Import (88-89)      | 0.0033<br>(0.0050)               | 0.0003<br>(0.0052)               | 0.0064<br>(0.0100)               |
| (c) New Final Goods<br>Import (92-96)             | -0.0050<br>(0.0023)**            | -0.0010<br>(0.0023)              | -0.0114<br>(0.0050)**            |
| (d) New Intermediate<br>Goods Import (92-96)      | -0.0005<br>(0.0046)              | -0.0055<br>(0.0053)              | 0.0073<br>(0.0085)               |
| Test (a)=(b)                                      | Reject*<br>(p-value=0.09)        | Accept<br>(p-value=0.63)         | Accept<br>(p-value=0.11)         |
| Test (c)=(d)                                      | Accept<br>(p-value=0.36)         | Accept<br>(p-value=0.39)         | Reject*<br>(p-value=0.06)        |
| N   | 5332                             | 3579                             | 1753                             |

Note: 1. All other control variables are the same as those in Table 4.  
2. See notes to Table 3.

Table 10: Comparison of the Random Effects (RE) Model, Fixed Effects (FE) Mode, and the Instrumental Variable (IV) model

| Panel A: Baseline Result   |                            |                           |                          |
|--|----------------------------|---------------------------|--------------------------|
|  | RE Model                   | FE Model                  | IV Model                 |
| (a) Import Penetration   | -0.0059<br>(0.0019)***     | -0.0047<br>(0.0026)*      | -0.0116<br>(0.0048)**    |
| Hausman Test   | -                          | Accept<br>(p-value=0.21)  | Accept<br>(p-value=0.24) |
| Overidentification Test  | -                          | -                         | Accept<br>(p-value=0.41) |
| Weak Instrument  | -                          | -                         | No                       |
| Panel B: Comparison between Non-High Income Country Imports and High Income Country Imports        |                            |                           |                          |
|  | RE Model                   | FE Model                  | IV Model                 |
| (b) non-High Income Countries Imports  | -0.0094<br>(0.0026)***     | -0.0087<br>(0.0034)**     | -0.0166<br>(0.0066)**    |
| (c) High Income Countries Imports  | 0.0028<br>(0.0046)         | 0.0048<br>(0.0059)        | 0.0191<br>(0.0257)       |
| Test (b)=(c)   | Reject**<br>(p-value=0.04) | Reject*<br>(p-value=0.07) | Accept<br>(p-value=0.25) |
| Hausman Test   | -                          | Accept<br>(p-value=0.43)  | Accept<br>(p-value=0.45) |
| Overidentification Test  | -                          | -                         | Accept<br>(p-value=0.28) |
| Weak Instrument  | -                          | -                         | No                       |
| Panel C: Comparison between High R&D Industry and Low R&D Industry                                 |                            |                           |                          |
|  | RE Model                   | FE Model                  | IV Model                 |
| (d) Low R&D Industry *imports  | -0.0074<br>(0.0023)**      | -0.0069<br>(0.0030)**     | -0.0139<br>(0.0063)**    |
| (e) High R&D Industry *imports   | -0.0043<br>(0.0031)        | -0.0026<br>(0.0040)       | -0.0087<br>(0.0056)      |
| Test (d)=(e)   | Accept<br>(p-value=0.40)   | Accept<br>(p-value=0.38)  | Accept<br>(p-value=0.50) |
| Hausman Test   | -                          | Accept<br>(p-value=0.46)  | Accept<br>(p-value=0.50) |
| Overidentification Test  | -                          | -                         | Accept<br>(p-value=0.82) |
| Weak Instrument  | -                          | -                         | No                       |
| Panel D: Effect of Nonroutine Cognitive Task Inputs on the Effect of Imports (Measure: Math Skill) |                            |                           |                          |
|  | RE Model                   | FE Model                  | IV Model                 |
| (f) Import Penetration   | -0.0090<br>(0.0040)**      | -0.0070<br>(0.0054)       | -0.0141<br>(0.0084)*     |
| (g) Import Penetration *Math Skill   | 0.0005<br>(0.0007)         | 0.0004<br>(0.0010)        | 0.0008<br>(0.0011)       |
| Hausman Test   | -                          | Accept<br>(p-value=0.41)  | Accept<br>(p-value=0.67) |
| Overidentification Test  | -                          | -                         | Accept<br>(p-value=0.19) |
| Weak Instrument  | -                          | -                         | No                       |

Table 10: Comparison of the Random Effects (RE) Model, Fixed Effects (FE) Mode, and the Instrumental Variable (IV) model (continued)

| Panel E: Effect of Nonroutine Cognitive Task Inputs on the Effect of Imports (Measure: DCP Skill)                      |                           |                           |                           |
|--|---------------------------|---------------------------|---------------------------|
|  | RE Model                  | FE Model                  | IV Model                  |
| (h) Import Penetration   | -0.0073<br>(0.0040)*      | -0.0058<br>(0.0054)       | -0.0084<br>(0.0087)       |
| (i) Import Penetration *DCP Skill  | 0.0002<br>(0.0007)        | 0.0002<br>(0.0009)        | -0.00003<br>(0.0011)      |
| Hausman Test   | -                         | Accept<br>(p-value=0.44)  | Accept<br>(p-value=0.42)  |
| Overidentification Test  | -                         | -                         | Accept<br>(p-value=0.44)  |
| Weak Instrument  | -                         | -                         | No                        |
| Panel F: Comparison of the Effects of High and Non-High Income Countries Imports for High-Tech and Low-Tech Industries |                           |                           |                           |
|  | RE Model                  | FE Model                  | IV Model                  |
| (j) High R&D*High Income Country imports   | 0.0020<br>(0.0058)        | 0.0053<br>(0.0073)        | -                         |
| (k) High R&D*non-High Income Country imports   | -0.0079<br>(0.0047)*      | -0.0073<br>(0.0060)       | -                         |
| (l) Low R&D* High Income Country imports   | 0.0045<br>(0.0065)        | 0.0030<br>(0.0083)        | -                         |
| (m) Low R&D* non-High Income Country imports   | -0.0107<br>(0.0026)***    | -0.0096<br>(0.0036)***    | -                         |
| Test(j)=(l)  | Accept<br>(p-value=0.77)  | Accept<br>(p-value=0.83)  | -                         |
| Test(k)=(m)  | Accept<br>(p-value=0.59)  | Accept<br>(p-value=0.73)  | -                         |
| Hausman Test   | -                         | Accept<br>(p-value=0.59)  | -                         |
| Panel G: Comparison of the Effects of Intermediate and Final Goods Imports   |                           |                           |                           |
|  | RE Model                  | FE Model                  | IV Model                  |
| (n) Old Final Goods Import (88-89)   | -0.0051<br>(0.0026)*      | -0.0047<br>(0.0037)       | -0.0097<br>(0.0060)       |
| (o) Old Intermediate Goods Import (88-89)  | 0.0033<br>(0.0050)        | 0.0096<br>(0.0075)        | 0.0136<br>(0.0187)        |
| (p) New Final Goods Import (92-96)   | -0.0050<br>(0.0023)**     | -0.0043<br>(0.0032)       | -0.0120<br>(0.0048)**     |
| (q) New Intermediate Goods Import (92-96)  | -0.0005<br>(0.0046)       | 0.0038<br>(0.0069)        | 0.0241<br>(0.0210)        |
| Test (n)=(o)   | Reject*<br>(p-value=0.09) | Reject*<br>(p-value=0.05) | Accept<br>(p-value=0.20)  |
| Test (p)=(q)   | Accept<br>(p-value=0.36)  | Accept<br>(p-value=0.26)  | Reject*<br>(p-value=0.09) |
| Hausman Test   | -                         | Accept<br>(p-value=0.40)  | Accept<br>(p-value=0.16)  |
| Overidentification Test  | -                         | -                         | Accept<br>(p-value=0.35)  |

Note: 1. All other control variables are the same as those in Table 4.

2. See notes to Table 3.

3. DCP is the acronym for “Direction, Control, and Planning.”

3. The instruments used in the baseline model are industry import weighted real exchange rate, industry tariff cost, and industry freight cost; in the extension where I distinguish between high-income country and.

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non-high income country imports, I first construct dummy variables HIC\_D and noHIC\_D to indicate those industries with more-than-median and less-than-median high income country import shares, respectively. I then interact both of these variables with the instruments used in the baseline above and use them as instruments; in the extension distinguish between High R&D and Low R&D industries, I interact the indicator of high- and Low R&D industries with the baseline instruments to provide the actual instruments used; for the extensions with nonroutine cognitive task inputs, I interact nonroutine cognitive task measures with the baseline instruments as additional instruments to the baseline instruments; for the extension comparing final and intermediate goods, I create two dummy variables indicating years before and after 1991, respectively, and interact these dummy variables with baseline instruments to construct my actual instruments.

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