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US Manufacturing and Vertical/Horizontal Intra-Industry Trade: Examining the Smooth Adjustment Hypothesis

Roger White
Franklin & Marshall College, rwhite1@whittier.edu

Cheng Chen
Franklin & Marshall College

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Roger White* and Cheng Chen

Department of Economics,
Franklin & Marshall College,
415 Harrisburg Pike,
Lancaster, PA 17603, USA
E-mail: roger.white@fandm.edu
E-mail: cheng.chen@fandm.edu
*Corresponding author

Abstract: Using data that represent the six-digit North American Industrial Classification System-classified industries that comprise the US manufacturing sector and that span the years 1989–2005, we test the validity of the smooth adjustment hypothesis (SAH). To our knowledge, this is the first examination of the SAH for the USA. The results of our empirical analysis are consistent with the confirmation of the SAH. Further, using measures of vertical marginal intra-industry trade and of horizontal marginal intra-industry trade, we find that the latter has a stronger effect on employment of production workers than does the former. The findings suggest that for total industry-level employment and for industry-level production worker employment, intra-industry trade expansion inherently involves lower adjustment costs as compared to inter-industry trade expansion.

Keywords: adjustment; manufacturing; IIT; intra-industry trade (horizontal, vertical, marginal); SAH; smooth adjustment hypothesis.

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Biographical notes: Roger White is an Associate Professor of Economics at Franklin & Marshall College. He received his PhD in International Economics from the University of California, Santa Cruz.

Cheng Chen is a graduate of Franklin & Marshall College and is currently completing his graduate studies at Columbia University.

1 Introduction

Compared to the 'different-different' trading patterns that standard models of international trade suggest will materialise in the long run, we observe consistent 'similar-similar' trade between countries over shorter time horizons. Underlying this intra-industry trade (IIT) framework are crucial distinctions between horizontal and vertical IIT. One such distinction is that the former is characterised by trade in different varieties of products, while the latter involves the trade of products at different stages of processing. While a large portion of the related literature has typically placed an emphasis on identifying the determinants of IIT for given countries and time periods, in recent decades increased attention has been devoted towards the study of the labour adjustment costs associated with IIT – namely, examination of the smooth adjustment hypothesis (SAH). The SAH states that labour-related adjustment costs are positively related to the likelihood that a worker switches industries and, thus, such adjustment costs are lower if the trading patterns is characterised by a greater incidence of IIT as compared to inter-industry trade.

Previous studies involving IIT were extensively built on the index created by Grubel and Lloyd (1975). Hamilton and Kniest (1991) have argued that the observation of a high proportion of IIT in one particular year does not fully capture the likely patterns of change in trade flows. As a result, several alternative measurements of IIT have been developed to more precisely capture the dynamic nature of IIT. One such approach that relates to the SAH is the utilisation of marginal intra-industry trade (MIIT) as a dynamic measure of changes in trading partners over time. Rather than identifying the static specialisation within certain industries throughout time, MIIT places more weight on capturing the structures of changes in trade patterns for a particular country across time (Hamilton and Kniest, 1991). Deviating from prior studies and, by doing so, extending the literature on the SAH, we disentangle and implement the MIIT transformation separately to horizontal and vertical product differentiation from traditional MIIT. By using measures of vertical marginal intra-industry trade (VMIIT) and horizontal marginal intra-industry trade (HMIIT), we are able to more precisely represent changes in trading patterns. As Greenaway et al. (1995) notes, vertical IIT can be related more to traditional theories of comparative advantage, while horizontal IIT falls much more within the 'modern' theories of trade.

Several studies have sought to identify and disentangle the separate effects of horizontal and vertical IIT (e.g. Abdel-Rahman, 1991; Greenaway et al., 1994, 1995). Extending the literature, we build upon on the work of Faustino and Leitao (2009) to examine the SAH while considering the influences of MIIT, VMIIT and HMIIT, separately. Using data that are classified according to the North American Industrial Classification System (NAICS) at the six-digit industry level and that comprise the US manufacturing sector during the years 1989–2005, we test the validity of the SAH. Our findings offer two distinct contributions to the literature on IIT. Firstly, to our knowledge, this is the first examination of the SAH for the USA. The evidence obtained from our battery of estimations is consistent with the confirmation of the SAH. Secondly, using measures of VMIIT and of HMIIT, we test the validity of the SAH in a rather disaggregate manner. We find that HMIIT has a stronger effect on employment of production workers than does VMIIT. Our results suggest that for total industry-level employment and for production worker employment at the industry level, IIT expansion inherently involves lower adjustment costs as compared to inter-industry trade expansion.

The remainder of this paper is organised as follows. We follow this introduction with a review of the related literature in Section 2. In Section 3, we describe the data, including the construction of the MIIT, VMIIT and HMIIT series, and detail our empirical specification. In Section 4, we discuss the results of our analysis and Section 5 concludes this paper.

2 Literature review

Under the monopolistic competition IIT framework, Helpman (1981) and Helpman and Krugman (1985) note that undertaking an IIT expansion will incur little adjustment problems across industries since differentiated varieties produced by each industry have similar factor requirements. This implies rather limited factor reallocation within each industry. Contrary to the standard scenario of monopolistic competition, vertical IIT entails an exchange of varieties produced with different factor requirements wherein high quality varieties are more capital-intensive than low quality varieties (Falvey and Kierzkowski, 1987). More recently, Lovely and Nelson (2000) develop a model based on the general equilibrium framework of Ethier (1982) and find the link between IIT and intra-industry adjustment may not necessarily be positive.

Table 1 summarises prior studies that have examined the SAH. The studies are listed in chronological order from earliest to most recent. In total, the 18 studies have examined the SAH for only 10 economies. Further, as is noted, several different proxy variables have been employed to represent labour market adjustment costs. The variety of adjustment cost measures that have been employed and the limited breadth of economies examined likely contributes to the variation in findings. The SAH has been confirmed by only slightly more than one-half of the studies.

Table 1 Summary of prior studies of the SAH

Study	*Reference period*	*Dependent variable employed*	*SAH confirmed?*	*Reference country*
Hine et al. (1994)	1979–1987	Observed change in industry-level employment	No	UK
Brulhart (1995)	1980–1990	Observed change in industry-level employment	Yes	Ireland
Brulhart and McAleese (1995)	1985–1990	Observed change in industry-level employment	No	Ireland
Brulhart and Elliott (1998)	1980–1990	Observed change in industry-level employment	Yes	Ireland
Porto and Costa (1998)	1986–1989	Observed change in industry-level employment	Yes	Portugal
Rossini and Burratoni (1998)	1979–1987	Observed change in industry-level employment	No	Italy
Smeets and Reker (1998)	1979–1990	Observed change in industry-level employment	Yes	France
Harfi and Montet (1999)	1980–1987	Observed change in industry-level employment	No	Germany
Sarris et al. (1999)	1978–1990	Observed change in industry-level employment	Yes	Greece
Tharakan and Calfat (1999)	1980–1990	Observed change in industry-level employment	No	Belgium
Brulhart (2000)	1977–1990	Share of total plant-level employment reallocation	Yes	Ireland
Brulhart and Thorpe (2000)	1970–1995	Absolute change in industry-level employment	No	Malaysia

Table 1 Summary of prior studies of the SAH (continued)

Study	*Reference period*	*Dependent variable employed*	*SAH confirmed?*	*Reference country*
Brulhart and Elliott (2002)	1979–1991	Average duration of unemployment; standard deviation of real wages (at industry level)	Yes	UK
Erlat and Erlat (2003)	1974–1975, 1998–1999	Absolute change in industry-level employment	No	Turkey
Brulhart et al. (2004)	1979–1990	Share of total plant-level employment reallocation	Yes	Ireland
Brulhart et al. (2006)	1986–1994, 1995–2000	Share of workers changing industries; share of workers changing occupations	Yes	UK
Cabral and Silva (2006)	1995–1999	Total employment reallocation effect (i.e. sum of the net variations in employment in each occupation group weighted by average total employment)	Yes	Portugal
Faustino and Leitao (2009)	1996–2003	Observed change in industry-level employment	No (contemporaneous); yes (lagged effects)	Portugal

Several studies have used the observed annual change in industry-level employment as a proxy for adjustment costs. Brulhart (1995) and Brulhart and Elliott (1998) examine data for Ireland and report evidence in support of the SAH. Similarly, Harfi and Montet (1999), Porto and Costa (1998) and Sarris et al. (1999) report findings that suggest the validity of the SAH for France, Portugal and Greece, respectively. Hoping to more precisely represent adjustment costs, Brulhart (2000) uses the share of total plant-level employment reallocation to represent adjustment costs and again confirms the SAH, this time using data for Ireland's manufacturing sector. Employing potentially more direct measures of adjustment costs – the average duration of unemployment and the standard deviation of real wages (both measured at the industry level) – to examine the SAH for the UK manufacturing sector. For both proxy variables, the authors confirm the SAH. Similarly, Brulhart et al. (2004) reconfirm the validity of the SAH while using data for Ireland and yet another proxy for adjustment costs; namely, the share of total plant-level employment reallocation. More recently, Brulhart et al. (2006) and Cabral and Silva (2006) construct measures of adjustment costs from worker-level data that represent industry- and occupation-switching and report findings for the UK and Portugal, respectively, that suggest verification of the SAH.

While several studies confirm the SAH, a number of studies fail to do so. For example, employing observed changes in industry-level employment, Hine et al. (1994) (for the UK), Brulhart and McAleese (1995) (for Ireland), Rossini and Burratoni (1998) (for Italy), Tharakan and Calfat (1999) (for Belgium) and Smeets and Reker (1999) (for Germany) fail to find support for the SAH. Brulhart and Thorpe (2000) and Erlat and Erlat (2003) examine the SAH using data for Malaysia and Turkey, respectively, while using the absolute change in industry-level employment as the proxy variable for adjustment costs. In both studies, the authors fail to confirm the SAH. Finally, Faustino and Leitao (2009) examine the SAH using data for Portugal and fail to find a contemporaneous relationship between adjustment costs and MIIT; however, when allowing for one- and two-year lags in their explanatory variable series, the authors find evidence that support the SAH.

Given the variation in findings across studies that have examined a diverse set of economies, a number of reference periods, and several different proxy variables that are intended to represent adjustment costs, the SAH remains an open empirical question.

3 Empirical specification, variables and data

Data representing 415 six-digit NAICS-US manufacturing industries during 1989–2005 are from the NBER-CES Manufacturing Industry Database (Becker and Gray, 2009). Corresponding industry-level trade data are from Feenstra (2010). Due to limitations – more specifically, that industry variables are not available at a more disaggregate level or for years more recent than 2005 and that import quantity data are unavailable for 1988 – the reference period for our analysis is 1989–2005.

3.1 Empirical specification

As noted in Section 2, prior studies of the SAH have employed a variety of measures that serve to represent industry-level adjustment costs: net industry-level employment changes, absolute changes in industry-level employment, unemployment duration, rates of industry- and occupation-switching and the standard deviation of industry-level wages. Consistent with a large number of these earlier studies, we employ the change in industry employment as an inverse proxy measure of labour market adjustment costs. Accordingly, our vector of dependent variables ($\Delta \ln L_{jt}$ in Equation (1)) is comprised of measures of the total annual industry-level employment change ($\Delta \ln \text{EMP}_{jt}$) as well as the annual industry-level changes in both production employment ($\Delta \ln \text{PRODE}_{jt}$) and in non-production employment ($\Delta \ln \text{NPRODE}_{jt}$), each of which is used in turn in our battery of estimations. For all three dependent variable series, the changes in the natural logarithm of the variables are employed.

The set of explanatory variables includes our variables of primary interest (noted in Equation (1) by the vector IIT) and several control variables (noted by the vector *X*) that are thought to significantly affect adjustment costs. Equation (1) describes our general form estimation equation. The vectors *Z* and Ω represent industry- and time-specific (year) fixed effects.

$$\Delta \ln L_{jt} = \alpha_0 + \beta_{\text{IIT}} \text{IIT}_{jt} + \beta_X \Delta X_{jt} + \beta_Z Z + \beta_\Omega \Omega_t \tag{1}$$

The vector *X* includes the annual changes in the natural logarithm of average annual wages for all employees ($\Delta \ln \text{W}_{jt}$), production employees ($\Delta \ln \text{W\_P}_{jt}$) and non-production employees ($\Delta \ln \text{W\_NP}_{jt}$). One of these variables (as dictated by the choice of dependent variable) is included each time we estimate our regression equations. While our empirical specification closely follows that utilised by Brulhart (2000), as noted by Faustino and

Leitao (2009) the change in employment fails to account for labour movement that is induced by cross-industry wage differences. To control for this effect, we follow their lead and include a measure of wages. The vector X also includes measures of the annual changes in the natural logarithm of the industry-level productivity variable (ΔlnPROD_{jt}), the natural logarithm of the variable that measures domestic consumption of industry output (ΔlnDOM_{jt}) and the measure of industry-level trade exposure (ΔOPEN_{jt}).

As noted, the vector IIT contains five measures of MIIT. Firstly, we have our principle measure: marginal intra-industry trade (MIIT_{jt}). Considering that the influences of vertical and horizontal IIT may affect adjustment costs in different ways, we also include two measures of vertical marginal intra-industry trade (VMIIT15_{jt} and VMIIT25_{jt}) and two accompanying measures of horizontal marginal intra-industry trade (HMIIT15_{jt} and HMIIT25_{jt}). Expanding these vectors, along with the addition of an assumed independent and identically distributed error term, ε_{jt}, results in Equation (2) – a more detailed version of our estimable baseline regression specification. Expected coefficient signs are noted in parentheses.

$$\begin{aligned} \Delta L_{jt} = \alpha_0 + &\underset{(+)}{\beta_{\text{IIT}}\text{IIT}_{jt}} + \underset{(-)}{\beta_2 \Delta W_{jt}} + \underset{(-)}{\beta_3 \text{PROD}_{jt}} + \underset{(+)}{\beta_4 \text{DOM}_{jt}} + \underset{(\pm)}{\beta_5 \text{OPEN}_{jt}} + \underset{(\pm)}{\beta_Z Z} + \underset{(\pm)}{\beta_\Omega \Omega_t} + \varepsilon_{jt} \end{aligned} \qquad (2)$$

We alter/modify Equation (2), as necessary, when performing our analysis. For example, we use the three dependent variable series (ΔEMP_{jt}, ΔPRODE_{jt} and ΔNPRODE_{jt}) in turn. Likewise, we employ the noted alternative measures of MIIT.

We anticipate that all the estimated coefficients on the MIIT variables will be positive. The basis for this expectation is that according to the SAH, when an individual changes jobs (either voluntarily or out of necessity), they will first attempt to gain employment within the same industry. This affords the individual the opportunity to utilise firm- and industry-specific human capital and, thus, to remain more productive and receive higher earnings relative to if the individual switches industries. The individual will only move across industries if it is necessary to do so. If MIIT is, as the SAH posits, significantly associated with lower adjustment costs and, hence, with greater employment growth then the expectation is that the sign of the estimated IIT coefficients will be positive (Jayanthakumaran, 2004).

The coefficients on the set of annual wage variables are expected to be negative since higher real wages correspond to higher labour costs and, thus, lower levels of employment (Greenaway et al., 1999). The coefficients on the variables representing domestic consumption (DOM_{jt}) and worker productivity (PROD_{jt}) are expected to be positive and negative, respectively. This is simply because increased product demand (i.e. higher domestic consumption) implies employment growth and increased worker productivity is negatively related to employment growth (Brulhart and Elliot, 1998). While one may anticipate a positive relationship between general trade openness (OPEN_{jt}) and employment, as we are examining data for the US manufacturing sector and the trend, in recent decades, has been employment decline coupled with increased trade intensity, we are reluctant to formulate any sort of rigid expectation for this coefficient estimate.

3.2 Variable construction and descriptive statistics

As noted, the IIT vector contains several measures of MIIT. Following Brulhart (1994), the MIIT variable is constructed as $\text{MIIT}_{jt} = 1 - (|\Delta X_{jt} - \Delta M_{jt}| / |\Delta X_{jt}| + |\Delta M_{jt}|)$. X and M represent the value of exports and imports, respectively, of industry j during year t. Δ denotes the annual change in the corresponding series. Thus, the MIIT_{jt} series ranges in value from 0 to 1 with a value of 0 indicating that the industry's marginal trade is entirely inter-industry and a value of 1 indicating that the marginal trade is entirely intra-industry.

We derive our measures of VMIIT and HMIIT analogously; however, we first categorise the output of our industry observations as 'vertical' or 'horizontal'. More specifically, we define industry output as horizontal if $1-\alpha \leq (\text{uv}_{jkt}^{x} / \text{uv}_{jkt}^{m}) \leq 1+\alpha$ and as vertical if either $(\text{uv}_{jkt}^{x} / \text{uv}_{jkt}^{m}) < 1-\alpha$ or $(\text{uv}_{jkt}^{x} / \text{uv}_{jkt}^{m}) > 1+\alpha$, where uv_{jkt}^{x} and uv_{jkt}^{m} represent export and import unit values, respectively, for trade in industry j products between the USA and country k during year t (Greenaway et al., 1995). Import and export unit values are derived as the quotient of bilateral industry-level trade values and corresponding unit quantities traded. Following Abdel-Rahman (1991), Aturupane et al. (1999) and Greenaway et al. (1995), we initially set $\alpha = 0.15$ and, as a robustness check, then increase α to 0.25. For example, defining trade to be 'vertical' if the ratio of average export-to-import unit values fall between 0.85 and 1.15 (i.e. $\alpha = 0.15$), we construct our measure of VMIIT as

$$\text{VMIIT15}_{jt} = 1 - \frac{\left|\Delta\sum_{k=1}^{K} X_{jt}^{\text{Vertical}} - \Delta\sum_{k=1}^{K} M_{jt}^{\text{Vertical}}\right|}{\left|\Delta\sum_{k=1}^{K} X_{jt}^{\text{Vertical}}\right| + \left|\Delta\sum_{k=1}^{K} M_{jt}^{\text{Vertical}}\right|}$$

Table 2 presents descriptive statistics. The first three variables listed are our set of dependent variables. Annual average values (levels) are presented in column (a) and annual average changes in the corresponding variables (in logarithms except for the trade openness variable) are presented in column (c). Beginning with the values presented in column (a), we see that the typical manufacturing industry employed about 33,435 workers in the typical year during our reference period. This figure does not include auxiliary (i.e. administrative) workers. Less than 30% of the typical industry's non-administrative workforce was non-production workers. Non-production workers (NPRODE_{jt}) are defined as those non-administrative employees who are supervisors above the line-supervisor level, clerical, sales, office, professional or technical workers (Bartelsman and Gray, 1996). All other non-administrative employees (i.e. the remaining 70% or more) are categorised as production workers (PRODE_{jt}). Based on the noted standard deviations for these variables, we can say that considerable variation in employment levels exists across the six-digit NAICS industry classifications.

Table 2 Descriptive statistics

Variable	Expected sign	Description	Levels (annual) Mean (a)	Levels (annual) SD (b)	Changes (one year) Mean (c)	Changes (one year) SD (d)
EMP_{jt}	----	Employment (total)	33.4350	(44.4003)	–0.0219	(0.0978)
$PRODE_{jt}$	----	Production worker employment	23.6163	(32.4078)	–0.0238	(0.1051)
$NPRODE_{jt}$	----	Non-production worker employment	9.8187	(15.0465)	–0.0171	(0.134)
$MIIT_{jt}$	+	MIIT	0.2336	(0.3154)	----	----
$VMIIT15_{jt}$	+	Vertical MIIT (α = 0.15)	0.2304	(0.3146)	----	----
$HMIIT15_{jt}$	+	Horizontal MIIT (α = 0.15)	0.0851	(0.2113)	----	----
$VMIIT25_{jt}$	+	Vertical MIIT (α = 0.25)	0.2294	(0.3133)	----	----
$HMIIT25_{jt}$	+	Horizontal MIIT (α = 0.25)	0.0979	(0.228)	----	----
W_{jt}	–	Average wage (total)	36.2521	(9.6428)	0.0055	(0.0452)
W_P_{jt}	–	Production worker average wage	30.8123	(9.0261)	0.0042	(0.0518)
W_NP_{jt}	–	Non-production worker average wage	49.8638	(9.1599)	0.0047	(0.0868)
DOM_{jt}	+	Domestic consumption (millions USD)	8,730	(16,500)	0.0001	(0.3964)
$PROD_{jt}$	–	Productivity (millions USD)	268	(279)	0.0172	(0.0891)
$OPEN_{jt}$	±	Trade openness	0.5073	(1.4626)	0.0342	(0.8396)

Note: Sample size is equal to 7,055 for all 'levels' values (columns (a) and (b)) and is equal to 6,607 for all 'changes' variables (columns (c) and (d)).Employment and wage values in thousands. Productivity and consumption values in millions. All monetary values are expressed in year 2000 USD. Values in columns (c) and (d) are changes in natural logarithms for all variables except $OPEN_{jt}$.

Turning to the values presented in column (c), we first note that employment contraction was typical during the reference period. This applies to aggregate industry-level employment (EMP_{jt}) as well as to the employment of production and non-production workers. This is not surprising given the observed employment contraction of the US manufacturing sector in recent decades. We also see that average annual real wages, again for both production workers (W_P_{jt}) and non-production workers (W_NP_{jt}), increased during the period. Likewise, the levels of domestic consumption of industry-level output (DOM_{jt}) (constructed as total industry shipments less export plus imports), worker productivity ($PROD_{jt}$) (given as total industry shipments divided by total industry employment) and general openness to trade ($OPEN_{jt}$) (given as the sum of industry exports and imports divided by industry shipments) all increased during the typical reference year. As with the levels reported in column (a), the standard deviations reported in column (d) indicate that there is considerable variation across industries in terms of both our dependent variable series and the set of explanatory variables.

The *ad hoc* nature of our estimation equations and the construction of our explanatory variable series provide reason to consider the possibility of collinearity. Table 3 presents pair-wise correlation coefficients. The shaded cells in the matrix identify the correlations for pairs of explanatory variables that are included in the same regression specification (e.g. ignoring the correlation between, say, $MIIT_{jt}$ and $VMIIT15_{jt}$ since no specification includes both variables). The average change in worker productivity is, as expected, positively correlated with average annual wages. Similarly, productivity and general industry-level openness to trade are both positively correlated with domestic consumption. Although these coefficients range from 0.22 to 0.44, none are sufficiently high to suggest serious multicollinearity and most are very near to zero. While conducting our empirical analysis, we checked variance inflation factor levels for each specification and found no indication that collinearity was sufficiently present to bias our coefficient estimates. Similarly, diagnostic testing indicates that the data does not suffer from first order autocorrelation; however, we do find the presence of heteroskedasticity. As a result, when estimating our regression specifications, we employ fixed (time and year) effects regression with robust standard errors to compensate for the effects of heteroskedasticity.

Table 3 Correlation matrix

	Variables	*(a)*	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(k)*	*(l)*	*(m)*
(a)	$\Delta lnEMP_{jt}$	1												
(b)	$\Delta lnPRODE_{jt}$	0.93	1											
(c)	$\Delta lnNPRODE_{jt}$	0.71	0.43	1										
(d)	ΔlnW_{jt}	–0.18	–0.20	–0.07	1									
(e)	ΔlnW_P_{jt}	–0.14	–0.20	0.01	0.72	1								
(f)	ΔlnW_NP_{jt}	–0.08	0.08	–0.41	0.56	–0.01	1							
(g)	$\Delta lnPROD_{jt}$	–0.18	–0.14	–0.15	0.42	0.35	0.22	1						
(h)	$\Delta lnDOM_{jt}$	0.39	0.38	0.25	0.08	0.07	0.06	0.36	1					
(i)	$MIIT_{jt}$	0.04	0.04	0.01	0.00	0.00	0.01	0.03	0.02	1				
(j)	$VMIIT15_{jt}$	0.04	0.04	0.01	0.01	0.00	0.02	0.02	0.01	0.91	1			
(k)	$HMIIT15_{jt}$	0.03	0.03	0.01	0.00	0.01	0.00	–0.01	0.00	0.07	0.07	1		
(l)	$VMIIT25_{jt}$	0.03	0.04	0.01	0.01	0.01	0.01	0.02	0.01	0.88	0.90	0.07	1	
(m)	$HMIIT25_{jt}$	0.01	0.02	–0.01	0.01	0.01	0.01	–0.02	–0.02	0.11	0.10	0.43	0.09	1
(n)	$\Delta OPEN_{jt}$	–0.07	–0.06	–0.09	–0.03	–0.01	0.00	–0.07	0.44	–0.01	–0.01	0.01	–0.01	0.00

Note: $n = 7{,}055$.

4 Econometric results

To test whether the SAH holds, we estimate a series of regression specifications that employ observed annual changes in industry-level employment as the dependent variable series. The summary of studies provided in Table 1 notes several alternative dependent variable series that have been employed in earlier studies. Due to data limitations, of the measures listed in Table 1, the only options available to us are the observed and absolute changes in annual industry-level employment. While there are legitimate reasons for employing either measure as a proxy for labour market adjustment costs, we opt to employ the observed change in employment as our dependent variable series. The results are reported in Tables 4–9.

Table 4 Industry-level employment change and MIIT

Dependent variables	$\Delta lnEMP_{jt}$ (a)	$\Delta lnPRODE_{jt}$ (b)	$\Delta lnNPRODE_{jt}$ (c)	$\Delta lnEMP_{jt}$ (d)	$\Delta lnPRODE_{jt}$ (e)	$\Delta lnNPRODE_{jt}$ (f)
$MIIT_{jt}$	0.0034	0.0057*	–0.0011	0.0068**	0.0087**	0.0032
	(0.0025)	(0.0033)	(0.0039)	(0.0032)	(0.0038)	(0.0044)
$MIIT_{jt} \times \Delta OPEN_{jt}$				–0.1365**	–0.1197**	–0.1702*
				(0.0675)	(0.0591)	(0.089)
$\Delta lnWAGE_{jt}$[a]	–0.1421***	–0.251***	–0.6003***	–0.1391***	–0.2473***	–0.5983***
	(0.051)	(0.0398)	(0.0426)	(0.0497)	(0.0395)	(0.0404)
$\Delta lnPROD_{jt}$	–0.4534***	–0.3965***	–0.3894***	–0.4589***	–0.4015***	–0.3959***
	(0.0439)	(0.0432)	(0.0526)	(0.042)	(0.0419)	(0.051)
$\Delta lnDOM_{jt}$	0.3227***	0.3115***	0.3213***	0.3188***	0.3081***	0.3165***
	(0.0368)	(0.0354)	(0.0372)	(0.0365)	(0.0351)	(0.0368)
$\Delta OPEN_{jt}$	–0.045***	–0.0418***	–0.0507***	–0.0412***	–0.0384***	–0.0459***
	(0.0129)	(0.0123)	(0.0126)	(0.0121)	(0.0116)	(0.0116)
Constant	–0.0386***	–0.041***	–0.0334***	–0.037***	–0.0395***	–0.0314***
	(0.0052)	(0.0053)	(0.0058)	(0.0052)	(0.0052)	(0.0059)
n	7,055	7,055	7,055	7,055	7,055	7,055
Adjusted R^2	0.4495	0.4048	0.3701	0.4609	0.4131	0.378

[a] The coefficient estimates listed for the $\Delta WAGE_{jt}$ variable correspond with ΔW_{jt}, ΔW_P_{jt} and ΔW_NP_{jt} variables which are used, in turn, given the corresponding dependent variable series). Robust standard errors are in parentheses. Year and industry fixed effects not reported here. '***', '**' and '*' denote significance from zero at the 1%, 5% and 10% levels, respectively.

Table 5 Industry-level employment change and VMIIT15/HMIIT15

Dependent variables	$\Delta lnEMP_{jt}$ (a)	$\Delta lnPRODE_{jt}$ (b)	$\Delta lnNPRODE_{jt}$ (c)	$\Delta lnEMP_{jt}$ (d)	$\Delta lnPRODE_{jt}$ (e)	$\Delta lnNPRODE_{jt}$ (f)
$VMIIT15_{jt}$	0.0038	0.0059*	0.0009	0.0071**	0.0088**	0.005
	(0.0025)	(0.0032)	(0.0038)	(0.0032)	(0.0037)	(0.0044)
$HMIIT15_{jt}$	0.0119***	0.0143***	0.0077	0.0121***	0.0145***	0.008
	(0.0041)	(0.005)	(0.0064)	(0.0042)	(0.0052)	(0.0064)
$VMIIT15_{jt} \times \Delta OPEN_{jt}$				–0.1413**	–0.1241**	–0.1744*
				(0.0717)	(0.0626)	(0.0947)
$HMIIT15_{jt} \times \Delta OPEN_{jt}$				0.0056	0.005	0.0057
				(0.027)	(0.0277)	(0.025)
$\Delta lnWAGE_{jt}$	–0.1422***	–0.251***	–0.6003***	–0.1384***	–0.247***	–0.5982***
	(0.0509)	(0.0398)	(0.0426)	(0.0496)	(0.0395)	(0.0403)
$\Delta lnPROD_{jt}$	–0.4531***	–0.396***	–0.3894***	–0.4595***	–0.4017***	–0.3968***
	(0.0438)	(0.0432)	(0.0526)	(0.042)	(0.0419)	(0.0511)
$\Delta lnDOM_{jt}$	0.3225***	0.3113***	0.3213***	0.3187***	0.308***	0.3166***
	(0.0368)	(0.0354)	(0.0372)	(0.0364)	(0.0351)	(0.0368)

Table 5 Industry-level employment change and VMIIT15/HMIIT15 (continued)

Dependent variables	$\Delta lnEMP_{jt}$ (a)	$\Delta lnPRODE_{jt}$ (b)	$\Delta lnNPRODE_{jt}$ (c)	$\Delta lnEMP_{jt}$ (d)	$\Delta lnPRODE_{jt}$ (e)	$\Delta lnNPRODE_{jt}$ (f)
$\Delta OPEN_{jt}$	–0.045***	–0.0418***	–0.0507***	–0.0415***	–0.0387***	–0.0462***
	(0.0129)	(0.0123)	(0.0126)	(0.0134)	(0.0128)	(0.013)
Constant	–0.0397***	–0.0422***	–0.0344***	–0.0379***	–0.0406***	–0.0323***
	(0.0052)	(0.0053)	(0.0058)	(0.0052)	(0.0053)	(0.0059)
n	7,055	7,055	7,055	7,055	7,055	7,055
Adjusted R^2	0.45	0.4056	0.3702	0.4615	0.4139	0.378

Note: See Table 4 footnote.

Table 6 Industry-level employment change and VMIIT25/HMIIT25

Dependent variables	$\Delta lnEMP_{jt}$ (a)	$\Delta lnPRODE_{jt}$ (b)	$\Delta lnNPRODE_{jt}$ (c)	$\Delta lnEMP_{jt}$ (d)	$\Delta lnPRODE_{jt}$ (e)	$\Delta lnNPRODE_{jt}$ (f)
$VMIIT25_{jt}$	0.0029	0.0048	–0.00001	0.0061**	0.0076**	0.0039
	(0.0024)	(0.0031)	(0.0038)	(0.0031)	(0.0036)	(0.0042)
$HMIIT25_{jt}$	0.0041	0.0072	–0.0018	0.0062	0.0095**	–0.0001
	(0.0041)	(0.0046)	(0.0067)	(0.004)	(0.0046)	(0.0067)
$VMIIT25_{jt} \times \Delta OPEN_{jt}$				–0.1381*	–0.1223*	–0.1678*
				(0.0745)	(0.0667)	(0.0944)
$HMIIT25_{jt} \times \Delta OPEN_{jt}$				–0.06***	–0.0699***	–0.0449*
				(0.0233)	(0.0239)	(0.0266)
$\Delta lnWAGE_{jt}$	–0.1426***	–0.2515***	–0.6002***	–0.1391***	–0.245***	–0.6***
	(0.0509)	(0.0398)	(0.0425)	(0.0494)	(0.0394)	(0.0405)
$\Delta lnPROD_{jt}$	–0.4532***	–0.3962***	–0.3896***	–0.4626***	–0.4059***	–0.3988***
	(0.0439)	(0.0432)	(0.0526)	(0.0413)	(0.0413)	(0.0505)
$\Delta lnDOM_{jt}$	0.3227***	0.3116***	0.3213***	0.3193***	0.3085***	0.3172***
	(0.0368)	(0.0354)	(0.0372)	(0.0367)	(0.0354)	(0.0369)
$\Delta OPEN_{jt}$	–0.045***	–0.0418***	–0.0507***	–0.0394***	–0.0363***	–0.0447***
	(0.0129)	(0.0123)	(0.0126)	(0.0126)	(0.012)	(0.0124)
Constant	–0.0389***	–0.0415***	–0.0334***	–0.0373***	–0.04***	–0.0313***
	(0.0052)	(0.0053)	(0.0058)	(0.0053)	(0.0054)	(0.006)
n	7,055	7,055	7,055	7,055	7,055	7,055
Adjusted R^2	0.4496	0.4051	0.3701	0.4644	0.4175	0.3787

Note: See Table 4 footnote.

Table 7 Industry-level employment change and MIIT with lagged changes in explanatory variables

Dependent variables	$\Delta lnEMP_{jt}$ (a)	$\Delta lnPRODE_{jt}$ (b)	$\Delta lnNPRODE_{jt}$ (c)	$\Delta lnEMP_{jt}$ (d)	$\Delta lnPRODE_{jt}$ (e)	$\Delta lnNPRODE_{jt}$ (f)
$MIIT_{jt}$	0.0053*	0.0078**	0.0012	0.0052*	0.0073*	0.0012
	(0.0029)	(0.0036)	(0.0041)	(0.0029)	(0.0038)	(0.0042)
$MIIT_{jt-1}$	0.0056*	0.0052	0.0055	0.0057*	0.0047	0.0064
	(0.0031)	(0.0034)	(0.0048)	(0.0031)	(0.0035)	(0.0049)
$MIIT_{jt-2}$				0.0062*	0.0048	0.0052
				(0.0032)	(0.0038)	(0.0052)
$MIIT_{jt} \times \Delta OPEN_{jt}$	–0.1614***	–0.1438***	–0.1943**	–0.137**	–0.114**	–0.1853**
	(0.0592)	(0.0503)	(0.0819)	(0.0596)	(0.0535)	(0.0769)
$MIIT_{jt-1} \times \Delta OPEN_{jt-1}$	0.0463**	0.0413*	0.0623**	0.0705***	0.0641**	0.0887***
	(0.0207)	(0.0229)	(0.0284)	(0.0242)	(0.0275)	(0.0259)
$MIIT_{jt-2} \times \Delta OPEN_{jt-2}$				0.0346	0.0644**	–0.037
				(0.0253)	(0.0275)	(0.0323)
$\Delta lnWAGE_{jt}$	–0.1079**	–0.2192***	–0.5866***	–0.1213***	–0.2399***	–0.5813***
	(0.048)	(0.0406)	(0.042)	(0.0458)	(0.041)	(0.0425)
$\Delta lnWAGE_{jt-1}$	0.0621**	0.0561**	0.0409	0.0559**	0.0379	0.0596
	(0.0287)	(0.0249)	(0.0385)	(0.0273)	(0.0245)	(0.042)
$\Delta lnWAGE_{jt-2}$				–0.0062	–0.0327	0.0429
				(0.0364)	(0.0324)	(0.0274)
$\Delta lnPROD_{jt}$	–0.4958***	–0.4365***	–0.427***	–0.5039***	–0.447***	–0.4373***
	(0.0375)	(0.0386)	(0.0479)	(0.0329)	(0.0364)	(0.0456)
$\Delta lnPROD_{jt-1}$	–0.0038	0.0021	–0.0028	0.01	0.0149	0.0069
	(0.0211)	(0.0233)	(0.0289)	(0.0195)	(0.0218)	(0.03)
$\Delta lnPROD_{jt-2}$				–0.0188	–0.0219	–0.0137
				(0.0202)	(0.0188)	(0.031)
$\Delta lnDOM_{jt}$	0.3582***	0.3459***	0.3541***	0.3649***	0.3521***	0.3628***
	(0.0329)	(0.0321)	(0.0335)	(0.0289)	(0.0286)	(0.03)
$\Delta lnDOM_{jt-1}$	0.086***	0.0823***	0.08***	0.0721***	0.0696***	0.0691***
	(0.0153)	(0.0142)	(0.0209)	(0.014)	(0.0127)	(0.0215)
$\Delta lnDOM_{jt-2}$				0.0208*	0.0249*	0.0255
				(0.0115)	(0.0128)	(0.0156)
$\Delta OPEN_{jt}$	–0.0419***	–0.0392***	–0.0465***	–0.0499***	–0.0465***	–0.0555***
	(0.0103)	(0.0098)	(0.0099)	(0.0086)	(0.0083)	(0.0083)
$\Delta OPEN_{jt-1}$	0.009*	0.0089*	0.009**	0.0078***	0.008***	0.0071*
	(0.0048)	(0.005)	(0.0044)	(0.0029)	(0.0031)	(0.0038)
$\Delta OPEN_{jt-2}$				–0.0219***	–0.0218***	–0.0211***
				(0.0055)	(0.005)	(0.0079)
Constant	0.0053*	0.0067**	–0.0074	–0.0064***	–0.0075***	0.0002
	(0.0027)	(0.0028)	(0.0052)	(0.0024)	(0.0029)	(0.0043)
n	6,607	6,607	6,607	6,161	6,161	6,161
Adjusted R^2	0.5119	0.4562	0.4036	0.5293	0.4706	0.4172

Note: See Table 4 footnote.

Table 8 Industry-level employment change and VMIIT15/HMIIT15 with lagged changes in explanatory variables

Dependent variables	$\Delta lnEMP_{jt}$ (a)	$\Delta lnPRODE_{jt}$ (b)	$\Delta lnNPRODE_{jt}$ (c)	$\Delta lnEMP_{jt}$ (d)	$\Delta lnPRODE_{jt}$ (e)	$\Delta lnNPRODE_{jt}$ (f)
$VMIIT15_{jt}$	0.0057**	0.008**	0.003	0.0065**	0.0082**	0.0039
	(0.0027)	(0.0035)	(0.0041)	(0.0027)	(0.0036)	(0.0042)
$HMIIT15_{jt}$	0.0121***	0.0148***	0.0071	0.0121**	0.0146***	0.0072
	(0.0046)	(0.0056)	(0.0068)	(0.0047)	(0.0057)	(0.0074)
$VMIIT15_{jt-1}$	0.0054*	0.0046	0.0057	0.0058*	0.0044	0.0069
	(0.0031)	(0.0036)	(0.0049)	(0.0032)	(0.0037)	(0.0051)
$HMIIT15_{jt-1}$	–0.0011	–0.0023	0.0013	–0.003	–0.0045	–0.0007
	(0.0044)	(0.0051)	(0.0064)	(0.0045)	(0.0053)	(0.0066)
$VMIIT15_{jt-2}$				0.0054	0.0039	0.004
				(0.0033)	(0.0039)	(0.0052)
$HMIIT15_{jt-2}$				–0.0013	–0.0016	0.0034
				(0.0049)	(0.0055)	(0.007)
$VMIIT15_{jt} \times$	–0.1693***	–0.1513***	–0.2015**	–0.1569***	–0.1338**	–0.2047***
$\Delta OPEN_{jt}$	(0.0579)	(0.0494)	(0.0805)	(0.0587)	(0.0526)	(0.0762)
$HMIIT15_{jt} \times$	0.0115	0.011	0.0123	0.0048	0.0062	0.0032
$\Delta OPEN_{jt}$	(0.0317)	(0.0319)	(0.0306)	(0.024)	(0.0249)	(0.0213)
$VMIIT15_{jt-1} \times$	0.0522**	0.0466*	0.0666**	0.0526	0.0434	0.0733**
$\Delta OPEN_{jt-1}$	(0.0235)	(0.0251)	(0.0312)	(0.0375)	(0.0409)	(0.0364)
$HMIIT15_{jt-1} \times$	0.0379	0.0321	0.0493*	0.0221	0.0203	0.0262
$\Delta OPEN_{jt-1}$	(0.0245)	(0.0245)	(0.0255)	(0.0229)	(0.0205)	(0.0302)
$VMIIT15_{jt-2} \times$				0.0362	0.0694***	–0.0407
$\Delta OPEN_{jt-2}$				(0.0224)	(0.0264)	(0.0295)
$HMIIT15_{jt-2} \times$				0.1063**	0.1132**	0.099***
$\Delta OPEN_{jt-2}$				(0.0432)	(0.049)	(0.0376)
$\Delta lnWAGE_{jt}$	–0.1056**	–0.2187***	–0.5845***	–0.121***	–0.2417***	–0.5805***
	(0.0477)	(0.0405)	(0.0421)	(0.0462)	(0.0406)	(0.0429)
$\Delta lnWAGE_{jt-1}$	0.0631**	0.055**	0.0441	0.0574**	0.0385	0.062
	(0.0282)	(0.0254)	(0.0385)	(0.0274)	(0.0246)	(0.0422)
$\Delta lnWAGE_{jt-2}$				–0.0056	–0.0344	0.0438
				(0.0354)	(0.0315)	(0.0276)
$\Delta lnPROD_{jt}$	–0.5002***	–0.4398***	–0.4326***	–0.507***	–0.4493***	–0.4411***
	(0.0388)	(0.0396)	(0.0492)	(0.0333)	(0.0366)	(0.0459)
$\Delta lnPROD_{jt-1}$	–0.0006	0.0057	–0.0001	0.0095	0.0146	0.0063
	(0.0216)	(0.0241)	(0.029)	(0.0193)	(0.0218)	(0.0298)
$\Delta lnPROD_{jt-2}$				–0.0144	–0.0172	–0.009
				(0.0201)	(0.0188)	(0.0314)
$\Delta lnDOM_{jt}$	0.3602***	0.3475***	0.3568***	0.3655***	0.3525***	0.3638***
	(0.0338)	(0.033)	(0.0344)	(0.029)	(0.0287)	(0.03)
$\Delta lnDOM_{jt-1}$	0.0837***	0.0802***	0.0773***	0.0719***	0.0692***	0.0689***
	(0.0161)	(0.0151)	(0.0214)	(0.0139)	(0.0126)	(0.0214)
$\Delta lnDOM_{jt-2}$				0.0199*	0.0243**	0.024
				(0.011)	(0.0124)	(0.0156)

Table 8 Industry-level employment change and VMIIT15/HMIIT15 with lagged changes in explanatory variables (continued)

Dependent variables	$\Delta lnEMP_{jt}$	$\Delta lnPRODE_{jt}$	$\Delta lnNPRODE_{jt}$	$\Delta lnEMP_{jt}$	$\Delta lnPRODE_{jt}$	$\Delta lnNPRODE_{jt}$
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*
$\Delta OPEN_{jt}$	–0.0441***	–0.0411***	–0.0493***	–0.0511***	–0.0476***	–0.0568***
	(0.0131)	(0.0123)	(0.0129)	(0.0095)	(0.0091)	(0.0092)
$\Delta OPEN_{jt-1}$	0.0075	0.0077	0.007	0.0072**	0.0079**	0.0059
	(0.0052)	(0.0056)	(0.0047)	(0.0033)	(0.0033)	(0.0044)
$\Delta OPEN_{jt-2}$				–0.0227***	–0.0229***	–0.0217**
				(0.0074)	(0.0069)	(0.0097)
Constant	0.0041	0.0056**	–0.0087*	–0.0073***	–0.0082***	–0.0013
	(0.0025)	(0.0027)	(0.0052)	(0.0024)	(0.003)	(0.0042)
n	6,607	6,607	6,607	6,161	6,161	6,161
Adjusted R^2	0.5147	0.4583	0.4058	0.5336	0.4748	0.4191

Note: See Table 4 footnote.

Table 9 Industry-level employment change and VMIIT25/HMIIT25 with lagged changes in explanatory variables

Dependent variables	$\Delta lnEMP_{jt}$	$\Delta lnPRODE_{jt}$	$\Delta lnNPRODE_{jt}$	$\Delta lnEMP_{jt}$	$\Delta lnPRODE_{jt}$	$\Delta lnNPRODE_{jt}$
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*
$VMIIT25_{jt}$	0.0045	0.0065*	0.0019	0.0046*	0.0059*	0.0022
	(0.0027)	(0.0035)	(0.004)	(0.0027)	(0.0035)	(0.0041)
$HMIIT25_{jt}$	0.0072*	0.0109**	–0.0004	0.0067	0.0107**	–0.0012
	(0.0042)	(0.005)	(0.0069)	(0.0045)	(0.0054)	(0.0074)
$VMIIT25_{jt-1}$	0.007**	0.0055	0.0098**	0.0071**	0.0048	0.0108**
	(0.0031)	(0.0036)	(0.0049)	(0.0032)	(0.0037)	(0.0051)
$HMIIT25_{jt-1}$	0.0015	0.0001	0.0066	0.0015	–0.0001	0.0078
	(0.0039)	(0.0043)	(0.0059)	(0.0041)	(0.0045)	(0.0064)
$VMIIT25_{jt-2}$				0.0044	0.0031	0.001
				(0.0034)	(0.004)	(0.0053)
$HMIIT25_{jt-2}$				0.0032	0.003	0.003
				(0.0049)	(0.0053)	(0.0071)
$VMIIT25_{jt} \times$	–0.1626**	–0.1456**	–0.1922**	–0.1448**	–0.1233**	–0.188**
$\Delta OPEN_{jt}$	(0.0665)	(0.0589)	(0.0859)	(0.0629)	(0.0572)	(0.079)
$HMIIT25_{jt} \times$	–0.0529*	–0.0644**	–0.0332	–0.0416**	–0.0491**	–0.032
$\Delta OPEN_{jt}$	(0.0282)	(0.0268)	(0.0344)	(0.0202)	(0.0216)	(0.0196)
$VMIIT25_{jt-1} \times$	0.0388	0.0298	0.0607*	0.0604*	0.0505	0.083***
$\Delta OPEN_{jt-1}$	(0.0274)	(0.0298)	(0.0331)	(0.0322)	(0.036)	(0.0304)
$HMIIT25_{jt-1} \times$	–0.0164*	–0.022**	0.0122	–0.0109	–0.0109	0.0036
$\Delta OPEN_{jt-1}$	(0.0098)	(0.0096)	(0.0102)	(0.0167)	(0.0195)	(0.019)
$VMIIT25_{jt-2} \times$				0.0252	0.0557*	–0.0459
$\Delta OPEN_{jt-2}$				(0.0296)	(0.0327)	(0.0355)

Table 9 Industry-level employment change and VMIIT25/HMIIT25 with lagged changes in explanatory variables (continued)

Dependent variables	$\Delta lnEMP_{jt}$ *(a)*	$\Delta lnPRODE_{jt}$ *(b)*	$\Delta lnNPRODE_{jt}$ *(c)*	$\Delta lnEMP_{jt}$ *(d)*	$\Delta lnPRODE_{jt}$ *(e)*	$\Delta lnNPRODE_{jt}$ *(f)*
$HMIIT25_{jt-2} \times$				0.072***	0.085***	0.0488**
$\Delta OPEN_{jt-2}$				(0.0181)	(0.0191)	(0.0245)
$\Delta lnWAGE_{jt}$	–0.1061**	–0.2166***	–0.5868***	–0.124***	–0.2425***	–0.5824***
	(0.0475)	(0.0406)	(0.042)	(0.0457)	(0.0406)	(0.0426)
$\Delta lnWAGE_{jt-1}$	0.0633**	0.0563**	0.0429	0.0542**	0.0353	0.0609
	(0.0283)	(0.0246)	(0.0384)	(0.0272)	(0.0244)	(0.0422)
$\Delta lnWAGE_{jt-2}$				–0.0087	–0.0374	0.0437
				(0.0363)	(0.0323)	(0.0276)
$\Delta lnPROD_{jt}$	–0.4991***	–0.4405***	–0.4285***	–0.5067***	–0.4503***	–0.4393***
	(0.0367)	(0.038)	(0.0476)	(0.0328)	(0.0365)	(0.0456)
$\Delta lnPROD_{jt-1}$	–0.0027	0.0034	–0.0015	0.0113	0.0165	0.0077
	(0.0209)	(0.0231)	(0.0287)	(0.0197)	(0.0219)	(0.0301)
$\Delta lnPROD_{jt-2}$				–0.0148	–0.017	–0.0114
				(0.0196)	(0.0182)	(0.0304)
$\Delta lnDOM_{jt}$	0.3586***	0.3462***	0.3543***	0.3659***	0.3534***	0.3636***
	(0.0332)	(0.0324)	(0.0337)	(0.0288)	(0.0285)	(0.0302)
$\Delta lnDOM_{jt-1}$	0.0862***	0.0824***	0.0808***	0.0722***	0.0698***	0.0695***
	(0.0153)	(0.0141)	(0.021)	(0.0141)	(0.0128)	(0.0215)
$\Delta lnDOM_{jt-2}$				0.0219*	0.0264**	0.0257*
				(0.0118)	(0.0132)	(0.0156)
$\Delta OPEN_{jt}$	–0.0403***	–0.0372***	–0.0457***	–0.0496***	–0.046***	–0.0553***
	(0.0109)	(0.0102)	(0.0109)	(0.0088)	(0.0083)	(0.009)
$\Delta OPEN_{jt-1}$	0.0095**	0.0099**	0.0077*	0.0075**	0.0078**	0.0058
	(0.0047)	(0.0049)	(0.0046)	(0.0034)	(0.0034)	(0.0046)
$\Delta OPEN_{jt-2}$				–0.0256***	–0.0263***	–0.0237***
				(0.0069)	(0.0064)	(0.009)
Constant	0.0048*	0.0066**	–0.009	–0.0068***	–0.0075**	–0.0008
	(0.0028)	(0.0029)	(0.0058)	(0.0024)	(0.003)	(0.0043)
n	6,607	6,607	6,607	6,161	6,161	6,161
Adjusted R^2	0.515	0.4604	0.4045	0.536	0.4787	0.4191

Note: See Table 4 footnote.

4.1 MIIT and the SAH

Beginning with the results reported in Table 4, we see that the SAH is confirmed (i.e. the estimated coefficient on the MIIT variable is positive and significant) when the annual industry-level change in production worker employment is used as the dependent variable series. This result is found both when the MIIT variable is not interacted with the trade openness variable and when it is (i.e. columns (b) and (e), respectively). Somewhat less conclusive, we find that the coefficient on the MIIT variable is positive in columns (a) and (d); however, the coefficient is significant only for the specification where the MIIT and trade openness variables are interacted. When considering the influence of MIIT on the annual change in non-production worker employment, in both specifications (columns (c) and (f)) the corresponding coefficient estimates are insignificant from zero. These findings appear quite reasonable when one considers that sum of production worker employment and non-production worker employment equal to total employment and that production worker employment may be more responsive to changes in trade exposure relative to non-production worker employment.

Turning to the estimated coefficients on the remaining explanatory variables that are reported in Table 4, we see that the coefficients are all significant and of the anticipated signs. More specifically, increases in the levels of industry wages (overall and for both production and non-production workers) are indicative of higher labour costs and, thus, correspond with lower employment changes. We also find that greater openness to trade is negatively related to changes in industry-level employment. Again, this finding applies for overall industry employment and for employment of production workers and of non-production workers. This is taken as the result of increased trade intensity as it pertains to US manufacturing industries coinciding with declining sector-level employment – perhaps the result of a loss of comparative advantage among some US producers. Similarly, as expected, increases in worker productivity are found to be negatively related to employment growth, and increases in domestic consumption are positively related to industry-level employment changes.

4.2 Vertical and horizontal marginal intra-industry trade and the SAH

In Tables 5 and 6, we report the findings obtained when modifying Equation (2) such that the MIIT variable is replaced by separate VMIIT and HMIIT variables. Recall that within the IIT framework, vertical IIT relates more to the traditional comparative advantage trade approach (inter-industry pattern), whereas horizontal IIT relates more to the IIT pattern. Thus, we expect horizontal IIT to have a greater impact on the labour adjustment cost than does vertical IIT. Both variables are expected to be positively related to our dependent variable series. Our results show that, when α is set equal to 0.15, coefficient estimates on the VMIIT15 variable are both positive and statistically significant when the annual change in production worker employment is utilised as the dependent variable (columns (b) and (e)) and when the change in total industry-level employment is considered (column (d)). Considering the HMIIT15 variable, we find positive and significant relationships with respect to changes in both total industry-level employment and industry-level production worker employment (columns (a), (b), (d) and (e)). As was reported in Table 4, the coefficient estimates on the VMIIT15 and HMIIT15 variables are insignificant when non-production workers employment is utilised as the dependent variable.

Employing our alternative measures of VMIIT and HMIIT, where α is set equal to 0.25, we find a different pattern of statistical significance. The estimated coefficients on the VMIIT25 and HMIIT25 are both significant and positive when incorporating the interaction term into the estimation equation that employs production employment as the dependent variable series. We also report a positive and significant coefficient on the VMIIT25 variable when total industry-level employment is used as the dependent variable series. However, when considering non-production employment as the dependent variable series, we do not find any significance for the coefficients on the VMIIT25 and HMIIT25 variables.

4.3 Extensions and robustness checks: inclusion of lagged explanatory variables

Finally, we extend our analysis to incorporate one- and two-year lagged values for each of our explanatory variable series. This is done for two reasons. Firstly, given the *ad hoc* nature of our baseline empirical specification that results from the lack of a theoretical foundation for the SAH, it may be reasonable for past changes in the explanatory variables to influence adjustment costs. That is, since whether the SAH is a contemporaneous relationship remains an open empirical question, we adopt a modified estimation strategy. Secondly, the use of lagged explanatory variable series serves as a robustness check, of sorts, for the results presented in Tables 4–6.

When estimating our modified empirical specifications, obtained results are reported in Tables 7–9. We begin, as before, by examining the relationship between MIIT and industry-level employment (Table 7). Both one-year lagged explanatory variables and one- and two-year lagged values, in addition to the contemporaneous changes, are considered in separate specifications. Similar to the specification that produced the results presented in columns (d)–(f) of Table 4, we interact the MIIT variable (contemporaneous and lagged values) with the measure of trade openness. We find that, as before, the coefficients on the MIIT variables are positive and significant when the annual change in total employment or in production worker employment is utilised as the dependent variable series (i.e. columns (a) and (d)). Similarly, we once more find no significant relationship between MIIT and the change in the level of non-production worker employment.

Considering the separate effects of VMIIT15 and HMIIT15 on industry-level employment (reported in Table 8) and of VMIIT25 and HMIIT25 (Table 9), we find that both measures – whether α is set equal to 0.15 or to 0.25 – are positively correlated with total annual industry-level employment changes and with annual changes in industry-level production worker employment. Somewhat surprisingly, we see little significance for the coefficients on the corresponding lagged explanatory variables; however, unsurprisingly, we do not report any significant relationship between either VMIIT or HMIIT and the annual change in industry-level non-production worker employment. We take these findings as an indication of the robustness of our primary results and additional support for the confirmation of the SAH.

In summary, the results we have reported from the use of different measures of MIIT are both reasonable and justified. Using our MIIT measure, we find strong evidence supporting the SAH for both total employment and production worker employment. At the same time, the estimated coefficients on the remaining explanatory variables are consistent with the intuition and expectations detailed in Section 3. This is not inconsequential since the lack of a theoretical basis for empirical examination of the SAH places greater emphasis on the results from empirical research. Additionally, when we incorporate our measures of VMIIT and of HMIIT, and thus disentangle the overall effect of MIIT, we obtain coefficient estimates for the VMIIT and HMIIT variables that lend greater support for the confirmation of the SAH.

5 Conclusions

Our research makes two distinct contributions to the literature on IIT. Firstly, we examine SAH using data for NAICS six-digit industries that comprise the US manufacturing sector. To our knowledge, this is the first examination of the SAH for the USA. Using a panel of industry-level data that span the years 1989–2005, we control for both time (year) and industry fixed effects. The evidence obtained from our battery of estimations is consistent with the confirmation of the SAH. Further modification of our estimation equations to include lagged values for our explanatory variable series produces evidence that is also consistent with the SAH. Secondly, we find that HMIIT has a stronger effect on employment of production workers than does VMIIT. By using measures of VMIIT and of HMIIT, we test the validity of the SAH in a rather disaggregate manner. Based on our use of measures of VMIIT and of HMIIT, we report a stronger effect (as is predicted by theory) for the HMIIT measure on both the annual change in total industry-level employment and the annual change in production worker employment.

Our results suggest that, for total industry-level employment and for production worker employment at the industry level, IIT expansion inherently involves lower adjustment costs as compared to inter-industry trade expansion. Nevertheless, due to the aforementioned lack of a formal theoretical model of the SAH, our findings remain open to two crucial questions/criticisms. Firstly, whether the use of industry-level employment changes is a reliable proxy for adjustment cost has been extensively debated (e.g. Brulhart and Elliott, 1998; Cabral and Silva, 2006). Although scholars have made progress in constructing new variables that potentially better-reflect these adjustment costs (Brulhart and Elliott, 2002; Brulhart et al., 2004; Elliott and Lindley, 2006), the validity of the SAH is very much dependent on the choice of dependent variable series. Secondly, the validity of the SAH also likely is conditional on the empirical specification employed, the explanatory variables selected and the reference period examined.

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