

# Online Appendix Workers' Reallocation, Innovation and Chinese Import Competition

Grace Gu\*, Samreen Malik†, Dario Pozzoli‡ & Vera Rocha§

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\*Email: grace.gu@ucsc.edu. University of California Santa Cruz.

†Email: samreen.malik@nyu.edu. New York University AD.

‡Email: dp.eco@cbs.dk. Copenhagen Business School.

§Email: vr.ino@cbs.dk. Copenhagen Business School.

# 1 Parameterization of the Theoretical Model

In order to solve the model numerically, we simplify the model by assuming that all type- $\Gamma$  goods share the same price, i.e.,  $p_1 = p_2$ . Parameters are detailed in the following table.

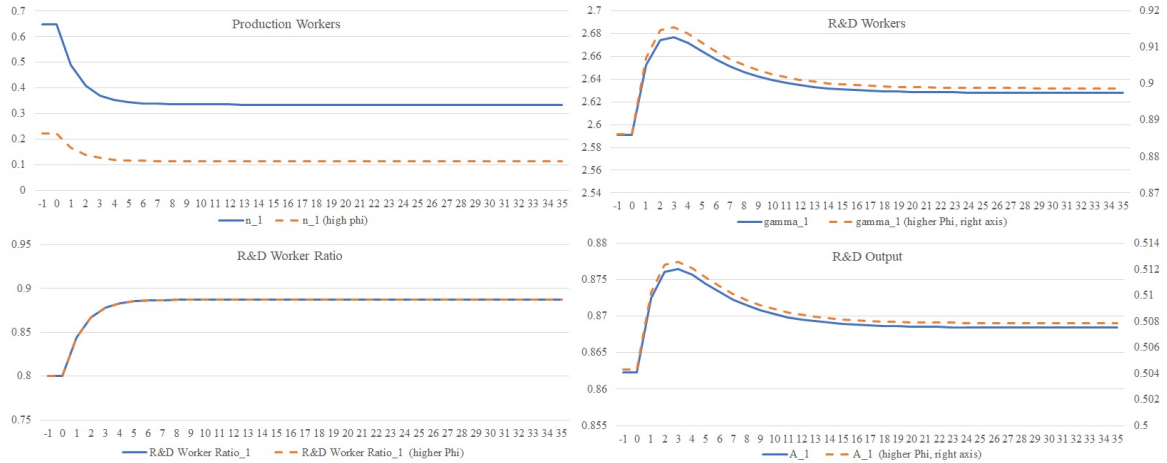
Table A: Model Parameters

Parameter	Explanation	Target
$\beta = 0.99$	Standard in the macro literature	-
$z = 1$	Normalized	-
$a_1 = 0.5357$	Type-1 firms' R&D productivity	R&D to non-R&D worker wage ratio = 1.5
$a_2 = 0.4556$	Type-2 firms' R&D productivity	High-perf. to low-perf. firm worker wage ratio = 1.1
$\alpha = 0.5$	Decreasing return to scale in prod function	-
$p_0 = 1$	Normalized before-shock type- $N$ goods price	-
$p_1 = p_2 = 5.6$	Type- $\Gamma$ goods prices	Before-2001 low-IC to high-IC goods price=5.6
$p'_0 = 0.7$	After-shock type- $N$ goods prices	After-2001 high-IC to low-IC goods price ratio relative to before-2001 ratio=0.7
$\phi = 1$	Normalized for labor adjustment cost	-
$\phi' = 5$	For comparison: higher labor adjustment cost	The increase of R&D workers in Denmark is about 3 times as that in Portugal
$s = 0.075$	Separation rate	Hobijn and Şahin (2009)
$\eta = 0.5$	Worker bargaining power	-
$b_{n_2} = 0.4680$	Unemp. benefit for type-2 firms' prod workers	83% of low-perf. firm production workers' wages
$b_{n_1} = b_{n_2} \times 1.1 = 0.5148$	Unemp. benefit for type-1 firms' prod workers	High-perf. to low-perf. firm worker wage ratio = 1.1
$b_{\gamma_1} = b_{n_1} \times 1.5 = 0.7722$	Unemp. benefit for type-1 firms' R&D workers	R&D to non-R&D worker wage ratio = 1.5
$b_{\gamma_2} = b_{n_2} \times 1.5 = 0.7020$	Unemp. benefit for type-2 firms' R&D workers	R&D to non-R&D worker wage ratio = 1.5

*Notes:* The targeted statistics are averages from various data sources. The targeted wage statistics come from the “Integrated Database for Labor Market Research” (*IDA*) database. The targeted price statistics are from Statistics of Denmark’s Industry Sales of Goods. The targeted unemployment benefits are from OECD. High-IC goods are products exposed to high import competition (import competition above 75th percentile), and low-IC goods are products exposed to low import competition (import competition below 25th percentile).

In the comparative static exercise, we increase the labor adjustment cost parameter  $\phi$  while leaving all other parameters unchanged and compare to the benchmark economy. Figure A1 plots the result differences across the two economies for type-1 firms. The differences for type-2 firms are similar and are not plotted here for brevity. With higher labor adjustment cost, type-1 firms have lower production and share of R&D workers than the benchmark economy both before and after the trade shock, as well as smaller increases in R&D output in response to the trade shock.

Figure A1: Transition Path for Type-1 firms with Higher Labor Adjustment Costs



Notes: Horizontal axis is time period. The trade shock happens at  $t = 0$ .

## 2 Additional Empirical Results

Table A-0: Share of R&D Workers and Innovation by Firm-Type

	<b>Incumbent Firms</b>	<b>Newly Established Firms</b>	<b>Exiting Firms</b>
Year	R&D Workers		
1995	0.018	-	0.018
1996	0.021	0.017	0.015
1997	0.022	0.018	0.015
1998	0.023	0.018	0.015
1999	0.022	0.019	0.017
2000	0.019	0.017	0.016
2001	0.018	0.019	0.019
2002	0.017	0.018	0.020
2003	0.013	0.015	0.013
2004	0.012	0.014	0.011
2005	0.012	0.013	0.012
2006	0.013	0.015	0.011
2007	0.015	0.016	0.015
2008	0.016	0.018	0.014
2009	0.017	0.018	0.012
2010	0.025	0.025	0.020
2011	0.026	0.026	0.021
2012	0.027	0.028	-
	<b>Incumbent Firms</b>	<b>Newly Established Firms</b>	<b>Exiting Firms</b>
year	Intensive Margin of Innovation		
1995	0.007	-	0
1996	0.005	0	0
1997	0.006	0	0
1998	0.007	0	0.009
1999	0.009	0	0.009
2000	0.005	0.001	0.015
2001	0.006	0.001	0.002
2002	0.008	0.001	0.002
2003	0.005	0.002	0.002
2004	0.006	0.002	0.003
2005	0.007	0.004	0.003
2006	0.008	0.005	0.004
2007	0.01	0.006	0.005
2008	0.012	0.005	0.007
2009	0.007	0.007	0.009
2010	0.009	0.015	0.005
2011	0.012	0.009	0.004
2012	0.01	0.008	-

*Notes:* Incumbent firms are firms that are active from 1995 through 2012. Newly established firms are firms that enter the market over the sample period. Exiting firms are firms that exit the market over the sample period.

Table A-1: Import Competition and Innovation, Additional Results

Dep. Var: Intensive Margin of Innovation	IV: Incumbent Firms (1)	IV: New Firms (2)	IV: Firm-specific Import Competition (3)	IV: Quota Instrument (4)	
Import Competition <sub>t-1</sub>	0.00121* (0.00073)	0.00045* (0.00023)	0.00125* (0.00071)	0.00122 (0.00102)	
Firm Fixed Effects	yes	yes	yes	yes	
Sector, Mun. and Year Fixed Effects	yes	yes	yes	yes	
Firm Characteristics	yes	yes	yes	yes	
Mean Y	0.036	0.024	0.029	0.016	
First Stage F-stat on Instruments	313.195	340.166	299.05	275.31	
First Stage- Import Competition IV Coeff.	0.57391*** (0.0491)	0.58701*** (0.0501)	0.57603*** (0.01284)	2.414*** (0.1454)	
R-sq	0.09176	0.08711	0.11098	0.12345	
N	98,796	84,146	215,656	17,342	
Dep. Var: Intensive Margin of Innovation	IV: Excl. Offshoring Firms (5)	IV (6)	IV (7)	IV (8)	IV (9)
Import Competition <sub>t-1</sub>	0.00178* (0.00091)				
Import Competition <sub>t-2</sub>		0.00103* (0.00054)			
Import Competition <sub>t-3</sub>			0.00108* (0.00057)		0.00063** (0.00032)
Import Competition <sub>t-4</sub>					
Import Competition <sub>t-5</sub>					0.00034 (0.00030)
Firm Fixed Effects	yes	yes	yes	yes	yes
Sector, Mun. and Year Fixed Effects	yes	yes	yes	yes	yes
Firm Characteristics	yes	yes	yes	yes	yes
Mean Y	0.014	0.030	0.032	0.033	0.034
First Stage F-stat on Instruments	435.54	409.86	407.78	449.99	430.87
First Stage- Import Competition IV Coeff.	0.65324*** (0.0129)	0.64089*** (0.0151)	0.65034*** (0.0162)	0.62307*** (0.0147)	0.75905*** (0.03821)
R-sq	0.10907	0.11678	0.11709	0.09145	0.07651
N	191,537	184,830	154,830	133,258	115,486
Dep. Var: Intensive Margin of Innovation	Negative Binomial (10)	Negative Binomial (11)	IV: Ln(Patents+1) (12)	IV: Asinh(Patents) (13)	
Import Competition <sub>t-1</sub>	0.07234* (0.03899)	<i>It does not converge</i>	0.00069** (0.00034)	0.00085** (0.00043)	
Firm Fixed Effects	yes	yes	yes	yes	
Sector and Mun. Fixed Effects	no	yes	yes	yes	
Year Fixed Effects	yes	yes	yes	yes	
Firm Characteristics	yes	yes	yes	yes	
First Stage Residuals	yes	yes	no	no	
Mean Y	1.04428		0.00582	0.00738	
First Stage F-stat on Instruments	-		435.65	435.65	
First Stage- Import Competition IV Coeff.	0.65620*** (0.0130)	<i>It does not converge</i>	0.65620*** (0.0130)	0.65620*** (0.0130)	
LL/R-sq	-4203.4992		0.21098	0.18187	
N	17,339		229,844	229,844	

*Notes:* The dependent variable is the number of patent applications at the firm level in columns 1-11. In column 1, the sample excludes newly established firms and firms that exit over the sample period. In column 2, the sample only includes newly established firms. In column 3, import competition is calculated by using firm-product export shares and the sample only includes exporting firms. In column 4, the sample only includes firms in the textile and clothing industry over the period 1995-2005. In the same column, the instrumental variable is calculated as the (value weighted) proportion of products in the four-digit industry that were covered by a quota restriction on China in 2000 (prior to China's WTO accession) that were planned to be removed by 2005. In column 5, the sample excludes offshoring firms. In columns 6-9, we use alternative lags for the import competition variable. In column 12, the dependent variable is the log(patent applications+1). In column 13, the dependent variable is asinh(patent applications+1). Firm characteristics include the lag of firm's size, offshoring status (not in column 6), share of high skilled workers, labor turnover, log of export sales, log of import sales, and log of sales per employee. Robust standard errors clustered at the industry-year level are in parentheses. Significance levels are \*\*\*1%, \*\*5%, \*10%.

Table A-2: Import Competition and the Share of R&D Workers, Additional Results (1)

Dep. Var: R&D Workers	IV: Excl. Low Skilled (1)	IV: Broad Def. (2)	IV: Incl. Liquidity Constraints (3)
Import Competition <sub>t-1</sub>	0.00057** (0.00028)	0.01101** (0.00504)	0.00211** (0.00091)
Firm Fixed Effects	yes	yes	yes
Sector, Mun. and Year Fixed Effects	yes	yes	yes
Firm Characteristics	yes	yes	yes
Mean Y	0.034	0.054	0.030
First Stage F-stat on Instruments	435.65	435.65	455.39
First Stage- Import Competition IV Coeff.	0.65620*** (0.0130)	0.65620*** (0.0130)	0.70228*** (0.02422)
R-sq	0.22363	0.22363	0.29561
N	229,844	229,844	183,008
Dep. Var: R&D Workers	IV: Excl. Exporting Firms (4)	IV: Excl. Foreign Owned Firms (5)	IV: Excl. Copenhagen (6) IV: Excl. Small Firms (7)
Import Competition <sub>t-1</sub>	0.00055** (0.00027)	0.00071** (0.00031)	0.00069** (0.00032)
Firm Fixed Effects	yes	yes	yes
Sector, Mun. and Year Fixed Effects	yes	yes	yes
Firm Characteristics	yes	yes	yes
Mean Y	0.023	0.028	0.044
First Stage F-stat on Instruments	333.39	435.65	409.11
First Stage- Import Competition IV Coeff.	0.641223*** (0.0127)	0.65620*** (0.0130)	0.627781*** (0.0121)
R-sq	0.22363	0.22363	0.22363
N	157,976	220,154	198,188

*Notes:* The dependent variable is the share of R&D workers at the firm level. In column 1, the dependent variable exclude low-skilled workers in the calculation of the share of R&D workers. In column 2, the dependent variable is calculated by including technicians in the definition of R&D workers. In column 3, we include log of total assets in the specification as a proxy of firm-level liquidity, which is only available for the sub-period 2001-2012. In column 4, the sample excludes exporting firms. In column 5, the sample excludes foreign-owned firms. In column 6, the sample excludes firms located in Copenhagen and Frederiksberg. In column 7, the sample excludes firms with fewer than 50 employees. Firm characteristics include the lag of firm's size, offshoring status, share of high skilled workers, labor turnover, log of export sales, log of import sales, and log of sales per employee. Robust standard errors clustered at the industry-year level are in parentheses. Significance levels are \*\*\*1%, \*\*5%, \*10%.

Table A-3: Import Competition and the Share of R&D Workers, Additional Results (2)

	IV: Count (1)	IV: Newly Hired from Unemp/Edu (2)	IV: Incumbent Firms (3)	IV: New Firms (4)	IV: Quota Instrument (5)
Dep. Var: R&D Workers					
Import Competition <sub>t-1</sub>	0.4087* (0.2309)	0.00001* (0.00001)	0.00108* (0.00064)	0.00233* (0.00127)	0.00208 (0.00141)
Firm Fixed Effects	yes	yes	yes	yes	yes
Sector, Mun. and Year Fixed Effects	yes	yes	yes	yes	yes
Firm Characteristics	yes	yes	yes	yes	yes
Mean Y	1.46	0.00501	0.029	0.029	0.023
First Stage F-stat on Instruments	435.65	435.65	313.195	340.166	275.31
First Stage- Import Competition IV Coeff.	0.65620*** (0.0130)	0.65620*** (0.0130)	0.57391*** (0.0491)	0.58701*** (0.0501)	2.414*** (0.1454)
R-sq	0.12432	0.11433	0.10237	0.15609	0.12345
N	229,844	229,844	98,796	84,146	17,342
Dep. Var: R&D Workers					
Import Competition <sub>t-1</sub>	0.00287** (0.00143)	0.00101* (0.00057)			
Import Competition <sub>t-2</sub>			0.00171** (0.00081)		
Import Competition <sub>t-3</sub>				0.00163** (0.00079)	
Import Competition <sub>t-4</sub>					0.00145* (0.00077)
Import Competition <sub>t-5</sub>					0.00112 (0.00077)
Firm Fixed Effects	yes	yes	yes	yes	yes
Sector, Mun. and Year Fixed Effects	yes	yes	yes	yes	yes
Firm Characteristics	yes	yes	yes	yes	yes
Mean Y	0.035	0.019	0.029	0.029	0.029
First Stage F-stat on Instruments	245.11	435.54	409.86	407.78	449.99
First Stage- Import Competition IV Coeff.	0.61673*** (0.01018)	0.65324*** (0.0129)	0.64089*** (0.0151)	0.65034*** (0.0162)	0.62307*** (0.0147)
R-sq	0.25671	0.17301	0.12448	0.11747	0.09356
N	43,873	191,537	184,830	154,830	115,486

Notes: In column 1, the dependent variable is the number of R&D workers at the firm level. In columns 2-8, the dependent variable is the share of R&D workers at the firm level. In column 2, the dependent variable only includes newly hired workers from unemployment or education in the calculation of the share of R&D workers. In column 3, the sample excludes newly established firms and firms that exit over the sample period. In column 4, the sample only includes newly established firms. In column 5, the sample only includes firms in the textile and clothing industry over the period 1995-2005. In the same column, the instrumental variable is calculated as the (value weighted) proportion of products in the four-digit industry that were covered by a quota restriction on China in 2000 (prior to China's WTO accession) that were planned to be removed by 2005. In column 6, import competition is calculated by using firm-product sales shares. In column 7, we exclude offshoring firms. In columns 8-11, we use alternative lags for the import competition variable. Firm characteristics include the lag of firm's size, offshoring status (not included in column 8), share of high skilled workers, labor turnover, log of export sales, log of import sales and log of sales per employee. Robust standard errors clustered at the industry-year level are in parentheses. Significance levels are \*\*\*1%, \*\*5%, \*10%.

Table A-4: Import Competition and the Probability of Switching to R&D Jobs Within a Firm at the Worker Level

	IV: Reverse Switching		IV: With Tertiary Education		IV: Less Than Tertiary Education		IV: More Than 50 Years Old		IV: 50 Years Old or Younger																					
Dep. Var.: R&D Switch	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)																				
Import Competition <sub>t-1</sub>	0.0001 (0.0002)	0.0027 <sup>***</sup> (0.00135)	0.00031 <sup>*</sup> (0.00018)	0.00123 <sup>**</sup> (0.00064)	0.00152 <sup>**</sup> (0.00068)																									
Worker Fixed Effects	yes	yes	yes	yes	yes																									
Sector, Mun. and Year Fixed Effects	yes	yes	yes	yes	yes																									
Worker Characteristics	yes	yes	yes	yes	yes																									
Firm Characteristics	yes	yes	yes	yes	yes																									
Mean Y	0.000473	0.02421	0.00529	0.00370	0.01569																									
First Stage F-stat on Instruments	607.14	507.14	599.03	509.06	603.17																									
First Stage- Import Competition IV Coeff.	0.6283 <sup>***</sup> (0.0168)	0.5613 <sup>***</sup> (0.0117)	0.6261 <sup>***</sup> (0.0153)	0.5787 <sup>***</sup> (0.0123)	0.6309 <sup>***</sup> (0.0165)																									
R-sq	0.21485	0.2135	0.2071	0.23088	0.23297																									
N	3,732,144	1,058,738	2,598,010	1,020,969	2,683,323																									
	IV: More Than 5 Years of Tenure					IV: 5 Years of Tenure or Less					IV: More Than 10 Years of Work Experience					IV: 10 Years of Work Experience or Less					IV: Male Workers									
Dep. Var.: R&D Switch	(6)					(7)					(8)					(9)					(10)									
Import Competition <sub>t-1</sub>	0.00028 <sup>**</sup> (0.00014)					0.00102 (0.00088)					0.00034 <sup>*</sup> (0.00018)					0.00043 <sup>**</sup> (0.00021)					0.00109 <sup>*</sup> (0.00056)									
Worker Fixed Effects	yes					yes					yes					yes					yes									
Sector, Mun. and Year Fixed Effects	yes					yes					yes					yes					yes									
Worker Characteristics	yes					yes					yes					yes					yes									
Firm Characteristics	yes					yes					yes					yes					yes									
Mean Y	0.00782					0.01663					0.00653					0.01792					0.01667									
First Stage F-stat on Instruments	612.11					580.23					612.56					580.22					601.01									
First Stage- Import Competition IV Coeff.	0.6356 <sup>***</sup> (0.0195)					0.6048 <sup>***</sup> (0.0125)					0.6355 <sup>***</sup> (0.0195)					0.6046 <sup>***</sup> (0.0124)					0.6298 <sup>***</sup> (0.0155)									
R-sq	0.23060					0.24876					0.22852					0.20826					0.23328									
N	2,983,525					720,764					2,809,081					895,201					2,625,213									
	IV: Female Workers					IV: Incumbent Firms					IV: New Firms					(11)					(12)					(13)				
Dep. Var.: R&D Switch	(11)					(12)					(13)					(11)					(12)					(13)				
Import Competition <sub>t-1</sub>	0.00019 <sup>**</sup> (0.00004)					0.00057 <sup>*</sup> (0.00031)					0.00044 <sup>*</sup> (0.00023)					0.00044 <sup>*</sup> (0.00023)					0.00044 <sup>*</sup> (0.00023)									
Worker Fixed Effects	yes					yes					yes					yes					yes									
Sector, Mun. and Year Fixed Effects	yes					yes					yes					yes					yes									
Worker Characteristics	yes					yes					yes					yes					yes									
Firm Characteristics	yes					yes					yes					yes					yes									
Mean Y	0.00836					0.01171					0.01134					0.01134					0.01134									
First Stage F-stat on Instruments	510.02					631.19					504.22					504.22					504.22									
First Stage- Import Competition IV Coeff.	0.5795 <sup>***</sup> (0.0125)					0.6402 <sup>***</sup> (0.0209)					0.5523 <sup>***</sup> (0.0115)					0.5523 <sup>***</sup> (0.0115)					0.5523 <sup>***</sup> (0.0115)									
R-sq	0.14361					0.23442					0.14155					0.14155					0.14155									
N	1,079,071					2,347,499					1,150,962					1,150,962					1,150,962									

Notes: In column 1, the dependent variable is equal to 1, if a worker  $i$  who remains employed in the same firm between  $t - 2$  and  $t$  and switches out of an R&D occupation at time  $t$ . In all the other columns, the dependent variable is equal to 1, if a worker  $i$  who remains employed in the same firm between  $t - 2$  and  $t$  and switches to an R&D job at time  $t$ . Import Competition <sub>$t-1$</sub>  (or alt. def.) is the log of the weighted sum of import values of all HS products by EU-15 and USA from China (or new EU countries) at time  $t - 1$ . Instrumental variable is the log of the weighted sum of import values of all HS products from China (or new EU countries for the alt. def.) by the following high-income countries: Australia, Canada, Japan, and New Zealand. Worker characteristics include the lagged value of age, tenure and work experience. Firm characteristics include the lag of firm's size, offshoring status, share of high skilled workers, labor turnover, log of export sales, log of import sales, and log of sales per employee. Robust standard errors clustered at the industry-year level are in parentheses. Significance levels are \*\*\*1%, \*\*5%, \*10%.

Table A-5: Import Competition and the Probability of Being Hired by Another Firm to an R&D Job at the Worker Level

	IV: Reverse Switching (1)		IV: With Tertiary Education (2)		IV: Less Than Tertiary Education (3)		IV: More than 50 Years Old (4)		IV: 50 Years Old or Younger (5)	
Dep. Var.: Move def. 1										
Import Competition <sub>t-1</sub>	-0.00072 (0.00086)		0.11424** (0.06006)		0.00258* (0.00138)		0.01404 (0.02556)		0.01944** (0.00852)	
Sector, Mm. and Year Fixed Effects		yes		yes		yes		yes		yes
Worker Characteristics		yes		yes		yes		yes		yes
Firm Characteristics		yes		yes		yes		yes		yes
Mean Y	0.00661		0.29761		0.05358		0.05994		0.06654	
First Stage F-stat on Instruments	756.11		576.76		744.48		345.08		759.05	
First Stage- Import Competition IV Coeff.	0.6179*** (0.0239)		0.5261*** (0.0227)		0.61193*** (0.0230)		0.4567*** (0.0154)		0.64509*** (0.0292)	
R-sq	0.05199		0.06902		0.12921		0.05194		0.11772	
N	989,386		177,832		761,554		161,838		777,548	
	<b>IV: More than 5 Years of Tenure (6)</b>		<b>IV: 5 Years of Tenure or Less (7)</b>		<b>IV: More Than 10 Years of Work Experience (8)</b>		<b>IV: 10 Years of Work Experience or Less (9)</b>		<b>IV: Male Workers (10)</b>	
Dep. Var.: Move def. 1										
Import Competition <sub>t-1</sub>	0.02178** (0.00871)		0.01236 (0.01014)		0.00798* (0.00481)		0.02112** (0.00978)		0.01854** (0.00906)	
Sector, Mm. and Year Fixed Effects		yes		yes		yes		yes		yes
Worker Characteristics		yes		yes		yes		yes		yes
Firm Characteristics		yes		yes		yes		yes		yes
Mean Y	0.08658		0.06072		0.06228		0.06486		0.06942	
First Stage F-stat on Instruments	565.03		742.98		687.11		570.11		740.02	
First Stage- Import Competition IV Coeff.	0.5209*** (0.0225)		0.61076*** (0.0229)		0.5913*** (0.0195)		0.5254*** (0.0227)		0.61054*** (0.0229)	
R-sq	0.10617		0.12897		0.10059		0.15531		0.11738	
N	173,700		684,470		430,544		598,842		701,188	
	<b>IV: Female Workers (11)</b>		<b>IV: Incumbent Firms (12)</b>		<b>IV: New Firms (13)</b>					
Dep. Var.: Move def. 1										
Import Competition <sub>t-1</sub>	0.00512 (0.00604)		0.01248* (0.00605)		0.01698** (0.00558)					
Sector, Mm. and Year Fixed Effects		yes		yes		yes				
Worker Characteristics		yes		yes		yes				
Firm Characteristics		yes		yes		yes				
Mean Y	0.04566		0.07032		0.05826					
First Stage F-stat on Instruments	564.05		569.23		572.87					
First Stage- Import Competition IV Coeff.	0.5205*** (0.0225)		0.5268*** (0.0227)		0.5260*** (0.0227)					
R-sq	0.13567		0.13779		0.12991					
N	238,198		475,918		325,178					

Notes: In column 1, the dependent variable is equal to 1, if a worker  $i$  moves to another manufacturing firm and switches out of an R&D job. In the other columns, the dependent variable is equal to 1, if a worker  $i$  moves to another manufacturing firm and is employed in an R&D job. Import Competition <sub>$t-1$</sub>  (or alt. def.) is the log of the weighted sum of import values of all HS products by EU-15 and USA from China (or new EU countries) at time  $t-1$ . Instrumental variable is the log of the weighted sum of import values of all HS products from China (or new EU countries for the alt. def.) by the following high-income countries: Australia, Canada, Japan, and New Zealand. Worker characteristics include the lagged value of age, education, tenure, and work experience. Firm characteristics include the lag of firm's size, offshoring status, share of high skilled workers, labor turnover, log of import sales, and log of import sales per employee. Robust standard errors clustered at the industry-year level are in parentheses. Significance levels are \*\*\*1%, \*\*5%, \*10%.