Import Competition and the Great Employment Sag of the 2000s: A European Perspective

M.J.J. van Tiggelen (435347) – 28th of July 2019

Erasmus University Rotterdam

Erasmus School of Economics

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Supervisor: dr. Julian Emami Namini

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Abstract – With manufacturing employment in decline across the OECD and manufacturing imports from China surging after its ascension to the WTO in 2001, increasing attention has been devoted to comprehending the extent to which import competition has affected employment. Although the vast majority of this literature has focussed on the US, this study offers a first comprehensive account of the extent to which rising Chinese imports have induced job loss across the EU27. To that end, I apply an instrumental variable approach with multiple endogenous regressors and time fixed effects, akin to Acemoglu et al. (2016), to the World Input-Output Database. I find that the rise in Chinese import competition between 2000 and 2007 has had a profound impact, both directly and indirectly, on European manufacturing and non-manufacturing employment. By backing-out the exogenous employment changes, *id est* employment changes attributable to Chinese supply-side innovations, I obtain the preferred estimates that around 1.38 million manufacturing jobs and 0.23 million non-manufacturing jobs have been lost throughout the EU27 over the period 2000-2007 as a result of direct Chinese import competition. When accounting for indirect import competition from China, that is import competition in one's buyers and suppliers markets, an additional 1.04 million manufacturing and 4.1 million non-manufacturing jobs are estimated to have been lost across the EU27. Despite prior literature indicating that low-skilled workers are more susceptible to these trade-induced employment adjustments, no evidence supporting that claim can be found for the EU15. The results in this paper give rise to the notion that devising a sustainable EU trade policy, through for instance employment-driven fiscal transfers, is substantially complicated by the extensive indirect effects and the influence that local labour market policy preferences may have on these employment losses. In addition, I infer that the substantial labour displacement in the EU12 in conjunction with small within-nation social transfers, may have increased within-nation inequality in the EU12. As such, from an equality point of view, further economic integration with China at present may not be desirable.

I – Introduction

That trade can induce between factor inequality within a nation can be readily understood from classical trade models such as the Ricardo-Viner and the Heckscher-Ohlin model of international trade (Krugman, Obstfeld, & Melitz, 2018). Even though trade patterns have evolved since 1980s[i], the notion that trade can drive between-factor inequality within a nation remains largely uncontested. Despite the fact that recent and classical trade models alike describe different underlying trade patterns, both are similar in how this inequality comes about. In specific, this within-nation inequality is generally created due to adjustments of (relative) factor prices[1] following the release of factors of production from import competing industries and the absorption thereof by export industries. However, the inequality, which may be created as a result of this reallocation process, has largely been neglected as full-employment conditions imply that the loss of employment is merely transitory. As such the vast majority of the early empirical literature, examining how trade may foster within-nation inequality, has been predominantly centred around trade-induced wage differentials[2]. Yet, the notion that this reallocation is swift and transitory is largely contingent on the assumption that factor markets are not subject to rigidities such as search frictions and matching costs (Helpman & Itskhoki, 2010).

Depending on the size of the displacement which trade liberalisation brings about and the persistence of labour market frictions, these trade-induced unemployment spells can be important for our understanding of how trade can create within-nation inequality. It thus comes as no surprise, given the simultaneous upturn of primarily manufacturing imports from China following its WTO ascension in 2001 (see figure 1) and the substantial downturn of employment in manufacturing industries (see figure 2), that the academic interest has been steadily shifting towards documenting trade-induced employment differentials instead of wage differentials.[ii] Besides these recent studies providing some insight into the rise of within-nation inequality, this upturn in academic interest can also increase our understanding of whether, based on employment, fiscal transfers within custom unions and economic free-trade areas are necessary and/or feasible. Nevertheless, employment-driven studies regarding the effects of trade in Europe

[1] The relationship between trade and between-factor inequality stems for example from the magnification effect in the Heckscher-Ohlin model (Stolper & Samuelson, 1941) and relative demand for skilled and unskilled labour in the Grossman-Rossi-Hansberg model (2016).

[2] Prime examples thereof are Nilsson Hakkala and Huttunen (2016), Hummels, Munch and Xiang (2018), Garicano and Criscuolo (2010), Ashournia, Munch and Nguyen (2014) and Frederico (2014).

have been especially limited and predominantly oriented at some Western European countries, hence limiting the usefulness of these insights for designing EU trade policy.[3] As such, I endeavour to provide a comprehensive account of the extent to which the surge in Chinese imports between 2000 and 2007 has displaced workers throughout the EU27 and aim to answer *to what extent has Chinese import competition displaced European workers between 2000 and 2007?*

To that end this paper implements recent advances in the empirical and theoretical literature. In particular, to provide policy makers and academics alike with a detailed, yet intuitive, overview, I follow the methodology outlined by Autor, Dorn and Hanson (2013) to assess the effect that rising Chinese imports have had on employment growth as well as on employment levels. Moreover, the displacement caused by an increase in Chinese imports may also indirectly impact employment. In order to also account for such indirect employment effects, I will exploit the novel approach as outlined by Acemoglu et al. (2016). Nevertheless, these innovations yield little insight into the ramifications of trade on within-nation inequality as they are primarily designed to assess the overall magnitude of the employment effect. To obtain insight as to *whom* is being affected the most, in terms of employment, this paper is amongst the first to extent these innovations to examine whether the loss of employment differs across different groups of labourers. In specific, I distinguish between manufacturing and non-manufacturing workers as well as between the skill level of said workers based on educational attainment.

In fact, the results obtained through applying these innovations to the World Input-Output Database indicate the displacement of workers to have been substantial for EU27 as a whole between 2000 and 2007. More specifically, I estimate that the rise in Chinese import competition to European industries has caused the EU27 to lose 1.38 million manufacturing jobs and 0.23 million non-manufacturing jobs in the 7 years leading up to the great recession. When accounting for the indirect job loss accompanying the rise of Chinese imports, I further estimate an additional 1.04 million manufacturing jobs and 4.1 million non-manufacturing jobs to have been lost across the EU27 over the period 2000-2007. However, these effects appear to be highly heterogeneous. For instance, in Eastern Europe relatively more manufacturing workers have been displaced than

[3] Reasons why studies evaluating the impact of trade, particularly of imports, on employment in the EU as a whole has been done to a limited extent include, but are not limited to: (1) the lack of data availability for Eastern European member states, (2) the level of data aggregation and research designs differs between studies and (3) varying time spans are employed by each study.

in Western Europe, whilst the reverse holds for non-manufacturing workers. Moreover, whereas throughout Western Europe high-skilled manufacturing workers have been slightly more displaced than low-skilled manufacturing workers, the opposite is true for Eastern-European manufacturing workers. Surprisingly, no straightforward difference between differently skilled workers can be observed for non-manufacturing industries.

In order to define qualitatively by what is meant with 'direct' and 'indirect' worker displacement, section II.I outlines the economic mechanisms through which (Chinese) import competition impacts labour demand. Section II.II then uses these economic channels to yield workable hypotheses based on prior, mostly empirical, literature. Subsequently, section III operationalises the notions of 'direct' and 'indirect' employment effects and outlines the identification strategy which is an time fixed effects augmented weighted instrumental variable analysis with multiple endogenous regressors. Section IV then continues to describe the data (World Input-Output Tables and the World Socio-Economic Accounts) which is used to obtain the results in section V as summarised above. Lastly, I conclude that the displacement effect of Chinese import competition has been substantial and heterogeneous across the EU27 over the period 2000-2007 and infer from this, in conjunction with the current economic divide, that further Sino-European economic integration at present[4] may be ill-advised.

II – Literature Review

In this section I primarily aim to provide the readership with some intuition of the economic mechanisms through which rises in imports displace workers. Although I will briefly touch upon econometric challenges of identifying or disentangling these economic mechanisms, the discussion thereof will be postponed till section III. The last part of this section uses these economic mechanisms to draft the hypotheses which are explored in section V.

II.I – *Conceptual Framework*

Following Acemoglu et al. (2016) one can decompose the impact that changes in foreign import exposure have on employment into four economic channels. The first channel through which increased Chinese imports affect

[4] At current, steps towards further integration with China are in specific being advocated by the European Commission (Atlantic Council, 2019) as well as by individual EU member states such as Italy upon joining the Chinese Road and Belt Initiative (aimed at improving Sino-European trade routes) (Al Jazeera, 2019).

national labour demand is by the direct replacement of domestic products or services. That is, if a product is produced abroad it need not be produced domestically, which inadvertently decreases the demand for labour in the industry competing directly with its Chinese counterpart. Since the first channel merely evaluates isolated industry responses to direct import competition, this can be considered a partial equilibrium effect. However, the impact of a surge in direct import exposure to an industry may in turn provoke labour demand changes to occur in other industries as well, *id est* there can exist general equilibrium effects.

For instance, when an industry is faced with import replacement of its produce, it can in addition to contracting its labour demand (the direct effect) also curb its input demand. As a result this may prompt an upstream firm supplying these inputs to curtail its own labour demand as well when faced with this sudden downturn in demand for its output. By the same token, downstream industries may instead expand their labour demand to absorb an increase in input supply from foreign as it also puts downward pressure on its input prices. However, relatively cheaper inputs may also stimulate industries to swap towards more capital intensive production technologies or cause specialised suppliers to disappear, thus causing labour demand to fall in downstream industries. As such, the effect of import competition on downstream industries' labour demand is *a priori* not clear. The effect that direct Chinese import competition has on the labour demand of upstream and downstream firms is referred to as the upstream and downstream effect, respectively. The sum of both the upstream and downstream effect is what Acemoglu et al. (2016) refer to as the indirect effect, and constitutes the second channel through which imports might influence labour demand.[5]

However, these general equilibrium effects need not solely be transmitted through the input-output space. In specific, the release of labour may cause downward wage pressure for some, whilst causing complete loss of income for others, and as a result depress final consumption expenditures. Consequentially, this turndown in aggregate demand can cause further job loss in industries supplying to final consumers and hence induce further labour demand contractions, which is referred to as the aggregate demand effect. Still, the sign of

[5] Here the indirect effect has been defined as the change in labour demand of ones buyers and suppliers. However, labour demand changes of ones buyers and ones suppliers may in turn have consequences for ones buyers' buyers and ones suppliers' suppliers. The change in labour demand of ones buyers and suppliers is thus referred to as the first-order indirect effect whilst accounting for ones buyers' buyers and ones suppliers' suppliers constitutes higher-order indirect effects. See figure 3 for a graphical depiction of indirect effects using a vertical chain.

the aggregate demand effect is *ex ante* not unambiguous as falling prices may induce a rise in consumer expenditure, thus causing labour demand to expand in industries supplying to final consumers.

Although a rise in foreign import competition may thus incite the loss of employment through a manifold of channels, it is important to recognise that not all displaced workers need to become unemployed. In fact, consistent with classical economic trade models, some (or all, due to full-employment equilibrium conditions) of these displaced workers can eventually end up working in export industries which expand due to the increased market access to China. Though, this pattern of reallocation is largely extraneous to the surges in import demand, particularly when one isolates the variation driven by supply-side innovations as per section III. As such this fourth economic channel, which is the reallocation effect, is in this paper of minimal importance. The total job displacement attributable to a rise in Chinese import competition is hence given by the sum of the jobs lost due direct import competition, the jobs lost due to indirect import competition and the jobs lost due to aggregate demand effects subtracted by potential import-induced reallocation.

While the preceding paragraphs can readily provide a decomposition of the impact of import exposure on labour demand, this is econometrically a more daunting – if not next to impossible – task. For instance, if workers reallocate due to a rise in Chinese imports – which is admittingly of minor concern – these workers tend to reallocate towards similar industries (Morkuté, Koster, & Van Dijk, 2017). If the data is then sufficiently aggregated across similar industries, which is probably the case for the level of aggregation used in this paper, this reallocation effect is indistinguishable of the direct effect.[6] Similarly, given that the aggregate demand effect propagates mainly through wage differentials to industries supplying to final demand, most of this effect will effectively function as a mediator on the (in)direct import competition and employment relationship. As a logical result, the direct and the indirect import competition effect will also be mixed with a part of the aggregate demand effect. Nevertheless, in the remainder of this paper I will use the terms direct and indirect despite some effects spilling-over to the direct and indirect effect, respectively.

[6] This is partly the case because I, like the vast majority of academic articles, employ changes in employment on the industry level. As such one obtains the net-change in employment due to, for instance, direct import competition.

II.II – *Prior Estimates and Hypotheses*

A first impression of how large the direct impact of increased Chinese import competition on employment is can be deduced from the semi-elasticity of labour demand with respect to Chinese imports per worker. This metric has increasingly gained in popularity in the wake of the seminal contribution by Autor et al. (2013), who find that manufacturing employment is reduced by 0.77% if Chinese imports per worker increase by a 1000 USD, using 722 US commuting zones between 2000 till 2007. Applying the same approach to 50 Spanish provinces between 1999 and 2007, Donoso, Martín and Minondo (2015) find that this figure is a staggering 2.05%. Likewise, Malgouyres (2016) documents that each increase of a 1000 USD in Chinese imports reduces manufacturing employment by 1.77% in 348 French provinces during 2001-2007. An explanation for these substantially higher estimates[7] compared to the US, as given by Donoso et al. (2015), is that higher (downward) wage rigidity in the EU may force labour market adjustments to rising Chinese import competition to come about through changes in employment rather than through changes in wages.

Using another more intuitively appealing metric, namely the fraction of jobs lost attributable to Chinese import competition, Balsvik, Jensen and Slavanes (2015) report that about 10% in Norwegian manufacturing employment decline can be explained by the rise in Chinese imports during 1996-2007. Likewise, Malgouyres (2016) estimates this figure to be 13% which, in contrast to the provided semi-elasticities, is markedly lower compared to the findings of Autor et al. (2013) and Acemoglu et al. (2016) who estimate this to be around 25% and 20% for the US, respectively. However, at first sight, this may seem to conflict with the notion that the EU has been more adversely effected in terms of employment growth by rising Chinese import competition, as a result of larger wage rigidity in the EU. However, as pre-existing declines in manufacturing employment have been larger in the EU (Bloom, Draca, & Van Reenen, 2016), other factors may have been more important in explaining the decrease in manufacturing employment such as skill-biased technological change (Mion & Zhu, 2013).

Although all of the empirical literature which has been discussed so far is indicative of large, albeit varying by type of metric, negative manufacturing

[7] A remarkably low estimate to the contrary is documented by Pereira (2016) who, upon the examination of 28 Portuguese provinces across 2004-2012, finds that a 1000 USD increase in Chinese imports per worker diminishes manufacturing employment by a mere 0.05%. However, given the (very) small sample size (only 28 observations using 2SLS) employed this casts doubt as to its validity/bias.

employment losses due to rising direct Chinese import competition, none pertain to direct non-manufacturing employment losses. The most informative finding in this regard is provided by Oesch (2010) who reports that across the OECD, when controlling for a diversity of labour market institutions, Chinese trade seemingly has no effect on the unemployment rate when pooling non-manufacturing- and manufacturing industries. In spite of this evidence being far from very informative, though considering that the vast majority of the empirical literature does not consider the direct effect on non-manufacturing industries, I expect the direct effect of Chinese import exposure on non-manufacturing industries to be close to nil. Summarizing the above, I have come to expect that *direct Chinese import competition has decreased European manufacturing employment between 2000-2007, whilst having a negligible effect on non-manufacturing employment*.

Evidence on the effects propagating through the sectoral input-output linkages, that is the indirect import exposure effect, is less readily available. Prime evidence thereof comes from Finnish manufacturing worker-level research by Nilsson Hakkala and Huttunen (2016). They estimate that if parts of the production process are being offshored to China an employees' probability of being employed two years thereafter falls by 0.69%. Despite the fact that this does not actually quantify any of the economic channels outlined in section II.I, it does point to two essential observations: (1) the indirect effects know some form of delay and (2) the sign of the indirect effect is probably negative in this instance. The fact that the indirect Chinese import exposure effect could be negative can be further deduced from the estimates of Acemoglu et al. (2016), who document that for 368.000 manufacturing jobs were lost due to first-order upstream effects in excess of the 560.000 manufacturing jobs lost directly.[8]

While the indirect worker displacement is thus potentially large for manufacturing employment, the effect that a rise in Chinese imports has had on non-manufacturing employment may still be larger. For example, Malgouyres (2016) documents that each job lost in the manufacturing sector due to increased import competition from China, on average, causes 1.46 jobs to be lost in non-tradable industries. In fact, Acemoglu et al. (2016) estimate for the US that, between 1999 and 2011, 653.000 non-manufacturing jobs have been lost as a result of the first-order upstream indirect effect following the increase in Chinese import competition. An indirect worker displacement of almost twice that in manufacturing industries. However, for non-manufacturing and manufacturing

[8] Moreover, when accounting for the full-order upstream effects another 57,000 manufacturing jobs were lost in the US due to Chinese import competition.

industries alike the upstream effect is consistently negative, while the downstream effect is found to be insignificant, indicating that downstream industries have not tended to expand their labour demand as a consequence of cheaper inputs. An effect that Acemoglu et al. (2016) ascribe to the increase in US current account deficit as domestic expenditures thus seemingly remained constant.

Nevertheless, Donoso et al. (2015) and Dauth, Findeisen and Suedekum (2017) document for Spain and Germany, respectively, that Chinese import competition has had a negligible effect on economy wide employment. Given that the direct effect of Chinese import competition on employment is probably negative (see hypothesis 1), this ought to imply that the indirect effect be positive.[9] Although these findings are seemingly at odds with those previously presented for the indirect effect, this probably stems from the fact that both articles employ a slightly different methodology. More specifically, both articles also evaluate the effect that a surge in Chinese competition has had on the export markets of either Spain or Germany.[10] These results align with findings for the US of both Feenstra and Sasahara (2018) and Feenstra, Ma and Xu (2019) who document that about 379.000 jobs were gained when accounting for export markets. Hence, this illustrates that the choice of domestic input-output linkages (used by Acemoglu et al. (2016)) as opposed to global input-output linkages can strongly influence the indirect import exposure effect. In the remainder of this study however, I will resort to domestic input-output linkages.[11]

Provided that (1) all industry types were confronted with indirect job losses resulting from increasing (domestic) Chinese import exposure and (2) that downstream effects have been found to be insignificant, I speculate that *indirect Chinese import competition has decreased European employment due to*

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[9] A reason why this may for instance occur is that prices fall more strongly in downstream industries, thereby disproportionately expanding labour demand in downstream industries whilst former suppliers are contracting their labour demand to a lesser extent.

[10] This could explain a positive indirect effect as only a small fraction of imports from another country would be replaced and general labour demand expansions will be advantageous to exporting industries.

[11] In specific, the upstream effects would partly be comprised of Chinese competition to a foreign exporter which exports to an EU member state. However, the interpretation of instrumenting the change in import exposure becomes dubious. For example, instrumenting the exports to China from an EU member state by the exports to China from the US would amount to documenting the change in labour in said EU member state due to exports from the US to China rising which can be independent of Chinese supply-side innovations or EU supply-side innovations for evident reasons. Hence, a different methodological approach would be more preferable, e.g. tariff data after the 2001 WTO ascension of China would more adequately capture this effect (see Feenstra, Ma and Xu (2019)).

upstream import exposure from 2000-2007, whilst the effect of downstream import exposure has been negligible.

By formulating an answer to the two hypotheses posed above one obtains a comprehensive overview of the extent to which Chinese import competition has, directly and indirectly, displaced European labour. In particular, the aforementioned hypotheses also account for different effects of rising Chinese import competition for manufacturing and non-manufacturing workers over the period 2000 till 2007. Nonetheless, these differences in employment effect may not be homogenous across differently skilled labour, which is of particular interest for explaining within-nation inequality. In fact, as China exports generally low-skilled intensive goods to other countries (Nataraj & Tandon, 2011)[12], one would expect that employment, just like wages in classical economic models (Feenstra, 2016), is depressed the most for low-skilled labour. Moreover, this should indeed be the case when one incorporates labour market frictions into an Heckscher-Ohlin model (Helpman & Itskhoki, 2010). Thus, even though the overall effect of direct and indirect Chinese import competition may give an accurate depiction of the overall job loss, it may also be of particular interest to know whether low-skilled labour is more adversely affected in terms of employment compared to high-skilled labour.

In fact, this preliminary conjecture is supported by the observations of Utar (2018), who documents that especially Danish workers with vocational manufacturing education are most affected in terms of employment by rises in low-wage country imports to Denmark from 1999 till 2010. Moreover, whereas medium-skilled workers are also found to be significantly more likely to go into unemployment as a result of increased import competition, high-skilled workers are apparently not significantly impacted at all.[13] In line therewith, low-skilled workers in Norway are also, on average, more adversely effected in terms of employment due to rises in Chinese import competition than high-skilled workers (Balsvik, Jensen, & Slavanes, 2015). In addition, further research by Keller and Utar (2016) estimates that about 17% of the employment decline of medium-skilled workers in the manufacturing industry is attributable to Chinese import competition. This figure, exceeding previous European estimates of the direct import exposure effect, lends further credibility to the assertion that low- or

[12] More specifically, the factor content of trade is largely positive with regard to low-skilled labour.

[13] Workers holding either a high school degree or a vocational degree are designated as medium-skilled workers and workers in possession of a college degree are here referred to as high-skilled labourers.

medium-skilled workers face larger employment demand contractions than high-skilled workers.[14]

Although Autor et al. (2013) find that nonesuch difference exists based on skill level in the US, follow-up research actually establishes that high-skilled workers indeed tend to be less prone to negative employment effects stemming from rising Chinese import competition (Autor, Dorn, & Hanson, 2015).[15] Likewise, Belgian firm-level research documents that low-skilled workers are also more adversely impacted than high-skilled workers by increased Chinese import competition (Ornaghi, Van Beveren, & Vanormelingen, 2017). Nevertheless, both Autor et al. (2015) as wells as Ornaghi et al. (2017) find that high-skilled labourers are however also negatively impacted in terms of employment. Even though there is thus doubt as to whether college graduates (high-skilled workers) are also being harmed by rising Chinese imports, I anticipate that there exists a clear differential between the extent to which high- and low-skilled labour is displaced, akin to the heterogeneity as encompassed in the classical trade models' wage responses. That is, *Chinese import competition has displaced more low- and medium-skilled workers than high-skilled workers between 2000 and 2007*.

III – Empirical Framework

To quantify how Chinese import competition has impacted employment in EU member states, one has to operationalise the notions of changes in the direct import exposure and the indirect import exposure. To that end this section is subdivided in three parts. The first addresses the methodology and definitions used to estimate the direct effect. Subsequently, the second part addresses the methodology and definitions employed to estimate the indirect effect[16], whilst the third subsection wraps up some remaining issues such as weighting, nominal versus deflated data and the mapping of employment growth onto employment levels (*id est* the number of jobs lost).

[14] As previously mentioned there may exist different explanations for such variation, although high-skilled workers could have brought down this figure as they are seemingly least affected by foreign import competition.

[15] Moreover, they also document that age differentials (at the threshold of 40) and gender differences are not subject to heterogeneous employment effects due to rising Chinese import competition.

[16] Yet, the discussion here is kept parsimonious and a more formal discussion of how the change in indirect import exposure has been computed from the data at hand (see section IV) is provided in appendix A.

III.I – *Quantifying the Direct Effect*

The measurement of the extent to which direct Chinese import competition has risen, will be analogous to the metric employed by Acemoglu et al. (2016), which is based on the pioneering work of Bloom et al. (2016) and Autor et al. (2013). This widespread measure for direct import exposure, which is a slight variation to the metric proposed by Autor et al. (2013) which is used by most authors in section II.II[17], stems from an expression derived by Autor et al. (2013). They use a monopolistic competition model for which trade volumes can be mapped onto employment changes as proven by Arkolakis, Costinot and Rodriguez-Clare (2012). In particular, the import exposure measure of an industry is given by the change of imports from China as a fraction of the amount of production of said industry that is required for domestic production and consumption. To formalise this, let a trade flow originating from industry s in country i going to industry r in country j be denoted by $T^{(i,s)\to(j,r)}$, and let the total production of industry j in country r be denoted as $Y^{(j,r)}$. Then the metric used to depict the change of import exposure over period t of industry r in country j (*in casu* an EU member state) to country i (*in casu* China) equals:

$$(1) \qquad \Delta IP(i)_t^{(j,r)} \equiv \Delta T_t^{(i,r)\to(j,\cdot)}/A_{t_0}^{(j,r)} \text{ where } A_{t_0}^{(j,r)} \equiv Y_{t_0}^{(j,r)} + T_{t_0}^{(\cdot,r)\to(j,\cdot)} - T_{t_0}^{(j,r)\to(\cdot,\cdot)}$$

Here I use t_0 to denote the value of the respective variable at the beginning of the period and $(\cdot,r)$, $(j,\cdot)$ and $(\cdot,\cdot)$ to represent the sum of good flows 'from/to industry r in *any* country', 'from/to *any* industry in country j' and 'from/to *any* industry in *any* country', respectively.[18] Note that, whereas the numerator is in differences, the denominator is in levels due to the fact that this is consistent with the theoretically derived metric as per Autor et al. (2013), as well as that it provides some econometric advantages. Firstly, the difference in the numerator causes the counterfactual to be in changes rather than in levels, *id est* one can interpret the direct effect as had imports from China remained constant rather than had imports from China not existed at all. Secondly, provided that imports as well as

[17] See for instance Malgouyres (2016), Donoso et al. (2015), Balsvik et al. (2015), etc..

[18] Note however that $T_{t_0}^{(j,r)\to(\cdot,\cdot)}$ for instance denotes exports by industry r in country j and hence it should not include any industry in country j, or more formally $T_{t_0}^{(j,r)\to(\cdot,\cdot)} \equiv \sum_{c\in C\setminus\{j\}}\sum_{s\in S} T_{t_0}^{(j,r)\to(c,s)}$ where C and S are sets of all countries and sectors (including final demand as a 'sector'). Similarly $T_{t_0}^{(\cdot,r)\to(j,\cdot)} \equiv \sum_{c\in C\setminus\{j\}}\sum_{s\in S} T_{t_0}^{(c,r)\to(j,s)}$ as it signifies all imports to country j originating from industry r abroad. Note that if r is final demand its change in import exposure measure by definition must equal 0, that is final demand is not subjected to direct import competition.

employment are supposed to contain an unit root process ($\left\{\Delta T_t^{(i,r)\rightarrow(j,\cdot)}\right\} \sim I(1)$) and that the data at hand (see section IV) renders testing therefore unfeasible (Im, Pesaran, & Shin, 2003), differencing the numerator may yield at worst inefficient estimates, though at the very least none spurious ones. Thirdly, as industries and EU member states strongly vary in size, the level in the denominator establishes a relative metric which is comparable across countries. Its relationship with change in employment, given by the log annual growth rate of the number of employees in industry r in country j over period t ($\Delta L_t^{(j,r)}$), can subsequently be modelled as:

(2) $$\Delta L_t^{(j,r)} = \gamma_t \beta_0 + \gamma_c \beta_1 + \gamma_s \beta_2 + \gamma_c \gamma_s \beta_3 + X_{t_0}^{(j,r)} \beta_4 + \Delta IP(\text{CHN})_t^{(j,r)} \beta_5 + \varepsilon_t^{(j,r)}$$

, where γ_t, γ_c and γ_s denote the dummies for the time period, the country and the sector, respectively, and $\varepsilon_t^{(j,r)}$ represents the disturbances. In addition, $X_{t_0}^{(j,r)}$ denotes potential confounders measured at the beginning of the sample period as to prevent potential bias on β_5 due to the inclusion of colliders or mediators. An example of such an confounder is ICT investment as a share of total investment, since it can influence both the demand for labour as well as the demand for inputs (import demand). Although one can readily control for this when examining the majority of Western European EU member states, comprehensive data on this confounder as well as other required variables, such as pre-trend controls as used by Acemoglu et al. (2016) and Autor et al. (2013), are not readily available for Eastern European countries. To circumvent this data availability constraint I augment expression (2) with time fixed effects, which can be done by examining the period 1995-2007 and splitting this timeframe into two periods, 1995-2000 and 2000-2007. The reason that I will only employ stacked first differences for the periods 1995-2000 and 2000-2007 rather than resorting to annual data, is due to the fact that it allows for a gradual adjustment process of the economy (Yotov, Piermartini, Monteiro, & Larch, 2016). Following an change in Chinese import exposure, some variables, such as the change in labour demand, may inevitably adjust only sluggishly (Agarwal & Gort, 1996; Nilsson Hakkala & Huttunen, 2016). As such, applying time fixed effects, using the tilde (~) to signify the demeaned value, yields:

(3) $$\Delta \tilde{L}_t^{(j,r)} = \tilde{\gamma}_t \beta_0 + \Delta \widetilde{IP}(\text{CHN})_t^{(j,r)} \beta_5 + v_t^{(j,r)}$$ [19]

[19] Both $\Delta L_t^{(j,r)}$ and $\Delta IP(\text{CHN})_t^{(j,r)}$ have been annualised as the periods over which one demeans and regresses are not of equal length.

However, β_5 may still not yield a 'proper' estimate of the direct effect as labour demand may vary for reasons extraneous to import competition, though may nevertheless cause import demand (for Chinese imports) to change. Besides the aforementioned simultaneity bias, Autor et al. (2013) indicate that there may also exist potential time-variant omitted variable bias influencing β_5. A prime example thereof can be found in the capital stock composition. On the one hand it may influence both the quantity and type of intermediate required and thus effect the change in import exposure ($\Delta IP(\mathrm{CHN})_t^{(j,r)}$), while on the other hand it can substitute for labour as a factor of production too (Kemfert, 1998), hence effecting $\Delta L_t^{(j,r)}$. To mitigate the apparent simultaneity bias I will henceforth set t_0 to the beginning of the sample period in 1995, thereby largely predating the rise in Chinese imports. As this does not address the endogeneity stemming from the omitted variable bias I will employ an instrumental variable approach as set forth by Autor et al. (2013) and Acemoglu et al. (2016).

As the aforementioned endogeneity is primarily transmitted through changes in import demand, the idea of the instrumental variable approach is to isolate the variation in the change in import exposure due to increases in Chinese productivity. That is, one aims to isolate changes in import exposure which are attributable to import supply or simply Chinese supply-side innovations. To that end Autor et al. (2013; 2015) use the change of import exposure in other high income countries to instrument the US' change in Chinese import penetration.[20] However, this methodology only works as long as one can assume that changes in import demand are not correlated across these other high income countries.[21] In addition, also labour movement induced by changes in Chinese imports across the EU member states needs to be minimal which seems reasonable for the EU27 (Münz, 2007). Assuming that the aforementioned conditions hold and that other – though less important – identification restrictions as outlined by Autor et al. (2013) have not been violated for the period 1995-2007, a proper instrument for the change of import penetration is given by equation (4),

[20] In this paper I will use the Australia, Canada, Japan and the US as comparable high income countries. Acemoglu et al. (2016) and Autor et al. (2013) use eight other high income countries amongst which some EU member states.

[21] Hence using this methodology after 2007 is somewhat doubtful and as such this paper primarily aims at the period preceding the Great Recession. Moreover, this also is the core reason why I refrain from using some European high income countries as well.

(4) $$\Delta IP(CHN)_t^{(O,r)} \equiv \Delta T_t^{(i,r)\to(O,\cdot)}/A_{t_0}^{(j,r)} \text{ where } A_{t_0}^{(O,r)} \equiv Y_{t_0}^{(O,r)} + T_{t_0}^{(\cdot,r)\to(O,\cdot)} - T_{t_0}^{(O,r)\to(\cdot,\cdot)}$$ [22]

Including the same covariates to preserve consistency of the estimator in the first stage as in the second stage (see equation 3) (Stock & Watson, 2015), one obtains the 2SLS-FE estimate of β_5 expressed in its structural form as:

(5) $$\Delta\tilde{L}_t^{(j,r)} = \tilde{\gamma}_t\beta_0 + \Delta\widetilde{IP}(\text{CHN})_t^{(j,r)}\beta_5 + v_t^{(j,r)} \text{ where}$$
$$\Delta\widetilde{IP}(\text{CHN})_t^{(j,r)} = \tilde{\gamma}_t\alpha_0 + \Delta\widetilde{IP}(\text{CHN})_t^{(O,r)}\alpha_5 + \eta_t^{(j,r)}; \left\{v_t^{(j,r)}\right\}, \left\{\eta_t^{(j,r)}\right\} \nsim \text{i.i.d.}$$ [23]

III.II – *Quantifying the Indirect Effect*

Like the metric for the direct import exposure, I will follow Acemoglu et al. (2016) and Acemoglu, Carvalho, Ozdaglar and Tahbaz-Salehi (2012)[24] to obtain a measure for Chinese import competition effects which propagate through the input-output space. Intuitively, an upstream (downstream) industry is only impacted to the extent that it sells to (procures from) an import competing industry. In fact, the upstream industries' import exposure due to rising direct Chinese import competition in downstream industries, as per Acemoglu et al. (2016), is defined as weighting the change in Chinese import exposure in downstream industries (as per equation (1)) by the fraction of total output of the upstream industry that is purchased by each downstream industry. More formally, the first-order[25] upstream import exposure metric can be described as:

(6) $$\Delta IP(i)_{t,U}^{(j,r)} \equiv \sum_{c\in C}\sum_{s\in S} w_{t_0,U}^{(c,s)}\Delta IP(i)_t^{(c,s)} \text{ where } w_U^{(c,s)} \equiv T_{t_0}^{(j,r)\to(c,s)}/Y_{t_0}^{(j,r)}$$

However, to only incorporate domestic input-output linkages as motivated in section II.II, this expression is slightly simplified by restricting the set of countries (C) to only country j. Assuming that all value added in an industry is returned to the owners of the factors employed in said industry, and following the intuition in the previous paragraph, we obtain a similar relation for the first-order downstream import exposure metric as used by Acemoglu et al. (2016),

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[22] Note that the other high income countries (O) are treated as a high income zone, e.g. let O denote the set of high income countries than this implies that $T_{t_0}^{(O,r)\to(\cdot,\cdot)} \equiv \sum_{o\in O}\sum_{c\in C\setminus\{o\}}\sum_{s\in S} T_{t_0}^{(o,r)\to(c,s)}$.

[23] Note that Acemoglu et al. (2016) still control for pre-trends and confounders even though they employ an instrumental variable approach, hence fixed effects are also implemented in the IV research-design.

[24] They use a CET production function with constant returns to scale to derive the metric upon which the analysis of the indirect import exposure effect will rely.

[25] Note that the full-order effects (their computation) are more mathematically involved and as such, to keep the discussion here as parsimonious as possible, I discuss this further in appendix A.

(7) $$\Delta IP(i)_{t,D}^{(j,r)} \equiv \sum_{c\in C}\sum_{s\in S} w_{t_0,D}^{(c,s)} \Delta IP(i)_t^{(c,s)} \text{ where } w_D^{(c,s)} \equiv T_{t_0}^{(c,s)\rightarrow(j,r)} / Y_{t_0}^{(j,r)}$$

Yet, both the metrics put forth in expressions (6) and (7) are constructed using definition given by equation (1). As a result, both of these expressions are subject to the same (more specifically, similar) endogeneity issues. For that reason, t_0 is set to the beginning of the sample period (1995) and both measures in (6) and (7) need be instrumented. Fortunately, Acemoglu et al. (2016) show that replacing $\Delta IP(i)_t^{(c,s)}$, or simply $\Delta IP(i)_t^{(j,s)}$ with $\Delta IP(i)_t^{(O,s)}$, yields unbiased estimates of the upstream and downstream effects of Chinese import competition. As such, the full structural model employed in this study can be written as:

(8) $$\Delta\tilde{L}_t^{(j,r)} = \tilde{\gamma}_t\beta_0 + \Delta\widetilde{IP}(\text{CHN})_t^{(j,r)}\beta_5 + \Delta\widetilde{IP}(CHN)_{t,U}^{(j,r)}\beta_6 + \Delta\widetilde{IP}(CHN)_{t,D}^{(j,r)}\beta_7 + v_t^{(j,r)} \text{ with}$$
$$\Delta\widetilde{IP}_t^{(j,r)} = \tilde{\gamma}_t\theta_0 + \Delta\widetilde{IP}_t^{(O,r)}\theta_5 + \Delta\widetilde{IP}_{t,U}^{(O,r)}\theta_6 + \Delta\widetilde{IP}_{t,D}^{(O,r)}\theta_7 + u_{t,1}^{(j,r)};$$
$$\Delta\widetilde{IP}_{t,U}^{(j,r)} = \tilde{\gamma}_t\varphi_0 + \Delta\widetilde{IP}_t^{(O,r)}\varphi_5 + \Delta\widetilde{IP}_{t,U}^{(O,r)}\varphi_6 + \Delta\widetilde{IP}_{t,D}^{(O,r)}\varphi_7 + u_{t,2}^{(j,r)};$$
$$\Delta\widetilde{IP}_{t,D}^{(j,r)} = \tilde{\gamma}_t\vartheta_0 + \Delta\widetilde{IP}_t^{(O,r)}\vartheta_5 + \Delta\widetilde{IP}_{t,U}^{(O,r)}\vartheta_6 + \Delta\widetilde{IP}_{t,D}^{(O,r)}\vartheta_7 + u_{t,3}^{(j,r)};$$

, where $\left\{v_t^{(j,r)}\right\}, \left\{u_{t,k}^{(j,r)}\right\} \nsim \text{i.i.d.}\ \forall k$, that is there might exist autocorrelation in each panel and/or heteroskedasticity in the residuals. As a result, incorporating this yields that the standard errors are still reliable, although this comes at the expense of readily assessing the relevance and strength of the instruments. Using multiple endogenous regressors the relevance condition essentially comes down to the fact that (1) there should exist no (perfect) multicollinearity between any of the instruments and between any of the endogenous regressors[26] and (2) the instruments should be correlated to each endogenous regressor[27]. Whether an instrumental variable approach in fact yields a smaller bias relative to standard OLS estimation, that is whether an instrument is strong, is however not readily available in the presence of autocorrelated and potentially heteroskedastic residuals. The problem arises that, depending on the order of autocorrelation and the type of heteroskedasticity in the residuals, different critical values of the Kleibergen-Paap Wald F-statistic should be applied when using multiple endogenous regressors (Baum, Schaffer, & Stillman, 2018) and are, as such, not

[26] This condition, simply put, states that the both the first and second stages need to be estimable and that the instrument matrix multiplied from the left by its transpose is of full rank and therefore invertible. All model specifications in section V yield logical signs and statistical significance (*id est* no large uncertainty where there should not be) and as such it is probable that this condition has been met.
[27] The heteroskedasticity and autocorrelation robust Kleibergen-Paap LM test shows that one can reject that null hypothesis that there exists no correlation between the instruments and with any the endogenous regressors at the 0.1% significance level for all model specifications.

readily available. Nevertheless, the Kleibergen-Paap Wald F-statistics are generally similar to the ones reported by Feenstra et al. (2019), *id est* acceptable in the empirical literature.[28] Given that the first stages are not of any further interest or use, I have not provided them in the appendix.[29]

III.III – *Resolving some lose ends*

Although the methodology outlined in sections III.I and III.II provide an accurate description of the methodology employed in this paper, there are still some unaddressed topics. Firstly, to mitigate the influence of outliers and to obtain an average effect which is not disproportionately influenced by small industries, which are overrepresented, each observation is weighted. More specifically, whereas Acemoglu et al. (2016) weight each observation by the share of employment that said industry has of the total employment, I slightly alter this weighting to be the share of employment an industry has of the total employment of a member state, as it would otherwise unduly marginalise industries in smaller countries.[30] Secondly, the estimates of the direct effect (β_5), the upstream effect (β_6) and the downstream effect (β_7) are in terms of employment growth, while I will also project these growth developments onto the employment levels following Acemoglu et al. (2016). In specific, when defining the job loss attributable to Chinese import competition as the jobs that would not have been lost had Chinese imports remained constant (that is $\Delta \widetilde{IP}(\mathrm{CHN})_t^{(j,r)} = 0$) between 2000 and 2007, then the job loss attributable to Chinese import competition (in eq. (3)) is given by:

(9) $$\Delta l(CHN)_t^{(j,r)} = l_t^{(j,r)} \left(1 - \exp\left[-\Delta IP(\mathrm{CHN})_t^{(j,r)} \beta_5\right]\right)$$

, where $l_t^{(j,r)} \equiv \exp\left[L_t^{(j,r)}\right]$ and all things are assumed to have remained the same had import competition from China not risen. In the presence of endogeneity this equation needs to be slightly altered. The seminal article of Autor et al. (2013) shows that multiplying $\Delta IP(\mathrm{CHN})_t^{(j,r)} \beta_5$ by the partial R-squared, i.e. the proportion of variation explained uniquely by the exogenous instruments, yields a consistent estimate of the job loss attributable to surges in Chinese import competition driven by Chinese supply-side innovations. In particular, when including multiple endogenous regressors and denoting the partial R-squared as

[28] I thus conclude from this that my instruments are sufficiently strong as the heteroskedasticity and autocorrelation in my data is probably very similar to that of Feenstra et al. (2019).

[29] The accompanying do-file contains the code to produce the first stage results for the interested reader.

[30] An approach consistent with the commuting zone level analysis by Autor et al. (2013).

R_1^2, R_2^2 and R_3^2 for first stages of $\Delta\widetilde{IP}_t^{(j,r)}$, $\Delta\widetilde{IP}_{t,U}^{(j,r)}$ and $\Delta\widetilde{IP}_{t,D}^{(j,r)}$ respectively, expression (9) becomes:

$$(10) \qquad \Delta l_t^{(j,r)} = l_t^{(j,r)} \left(1 - \exp\left[-\Delta IP_t^{(j,r)} R_1^2 \beta_5 - \Delta IP_{t,U}^{(j,r)} R_2^2 \beta_6 - \Delta IP_{t,D}^{(j,r)} R_3^2 \beta_7\right]\right)$$

Thirdly, I will use nominal data in spite of the fact that Acemoglu et al. (2016) and Autor et al. (2013; 2015) use deflated trade data. First of all, deflating the trade data stems from making the effect comparable between studies using different time horizons and is thus not theoretically motivated. Second of all, the import exposure metric used by Acemoglu et al. (2016) is shown to drive down the deflator itself. Hence, by compensating for price changes one effectively introduces endogeneity into the instrument itself as Chinese imports to the EU is by construct then related to the Chinese imports to other high income countries. Third of all, by eradicating price-effects from the instrument and the instrumented variable one also removes the part of the price fluctuation which has been induced by increases in Chinese productivity. Hence, one largely negates any potential downstream effects due to changing prices, potentially explaining why Acemoglu et al. (2016) find insignificant downstream indirect effects. Fourthly, and lastly, I will also look at whether the estimates of the direct effect (β_5), the upstream effect (β_6) and the downstream effect (β_7) vary for different types of skilled-labour by replacing $\Delta\tilde{L}_t^{(j,r)}$ with the change in the logarithm the person hours worked by low-, medium- and high-skilled labourers.[31]

IV – Data and Data Sources

As may have become apparent from the previous section, the analysis requires data on changes in labour (number of persons engaged and/or number of employees employed) which can be decomposed with respect to skill-level. Furthermore, data regarding between industry-country pair trade flows needs to be available and consistent across China, the other high income countries and the EU member states. For that reason this paper uses the World Input-Output Database (WIOD) which records the World Input-Output Tables (WIOT) for 35 industries from 1995 till 2010 for 40 countries (Timmer, Dietzenbacher, Los, Stehrer, & de Vries, 2015) (see table 1). Despite only Croatia being not available in the 2013 WIOD release, all other countries of interest, including between industry

[31] Here skill type is classified according to 1997 ISCED levels: Low-Skilled (categories 1 and 2, equivalent to primary or lower second stage education), Medium-Skilled (categories 3 and 4, i.e. upper secondary education or post-secondary non-tertiary education) and High-Skilled (categories 5 and 6, i.e. first and second stage of tertiary education) (Erumban, Gouma, de Vries, de Vries, & Timmer, 2012).

trade flows of other high income countries and China, have been recorded in the WIOT. Moreover, the WIOD also contains the World Socio-Economic Accounts (WSEA) which provides consistent information on factor compensation, the number of persons engaged, the number of employees, as well as the fraction of person hours worked by low-, medium- or high-skill engaged persons. For all datasets only the data pertaining to 1995, 2000 and 2007 have been used as a consequence of using stacked differences as outlined in section III.III.

From this data it becomes evident that across 1995-2007 the amount of labour employed in EU manufacturing industries has fallen with 1.1% annually, whilst employment is rising by 1.6% annually in non-manufacturing industries (see table 2). Furthermore, as expected, the number of low-skilled workers[32] has fallen drastically in manufacturing (3.3%) and to a lesser extend in non-manufacturing industries (0.8%), although the differential (2.5%) is only slightly less for medium- and high-skilled workers (2.1% and 1.5% respectively) (see table 2). Meanwhile, exports from China to EU member states have risen by 389% and are increasingly composed out of manufactured goods as can be seen from figure 1. In particular, the change of Chinese imports which compete with manufacturing industries has risen far more strongly than Chinese imports which compete with non-manufacturing industries as can be deduced from table 3 (though are very similar to the US (see Autor et al. (2016)).[33] Despite the fact that some differences are not significant, in general, all changes in import exposure measures described in the previous paragraph are larger for manufacturing industries than for non-manufacturing industries. A noteworthy difference between the EU15 countries and the EU12 countries (the member states that joined after 1995) stems from the fact that the number of high-skilled workers as well as capital (particularly ICT equipment) available to workers has increased more rapidly in the EU15.

V – Results

V.I – *The Direct Effect*

The main results, verifying whether the association between rising Chinese import competition and employment reductions in EU member states found in section IV can in fact be construed as causal, are documented in tables 4,

[32] In fact, this is the number of hours worked by low skilled workers, but for simplicity I will refer thereto as the number of low skilled workers.

[33] Note that, on average, Chinese imports competing with manufacturing industries have risen annually with 0.438% of what was domestically required for production and consumption in 1995 whereas Chinese imports competing with non-manufacturing industries have, on average, risen by merely 0.053% of what was domestically required for production and consumption in 1995.

6.1 and 8. From table 4 it becomes apparent that a naïve before-after comparison would yield that Chinese import competition induced employment growth. Moreover, when implicitly controlling for baseline shares of employment, IT as a fraction of total investments and pre-trends using equation (3), these estimates of the direct Chinese import competition effect are only marginally altered. However, upon additionally adjusting for potential endogeneity using the instrument proposed by Autor et al. (2013), all estimates regarding the degree to which increases in the direct import exposure to China have impacted employment growth become – albeit weakly – significant as well as negative.

In specific, the estimates in table 4, column 3, shows that a rise of 1% in Chinese imports of what was required of an European manufacturing industry for domestic production and consumption in 1995 due to Chinese supply side innovations would reduce annual manufacturing employment growth by about 1.32% between 2000 till 2007 across the EU27. Remarkably, the estimate of the reduction in employment growth due Chinese imports brought about by supply-side driven innovations in manufacturing industries across the EU27 is very similar to those documented in the literature. More specifically, this estimate closely resembles the estimates of Acemoglu et al. (2016), 1.24%, for the US and Mion and Zhu (2013), 1.35%, for Belgium. Unexpectedly, the impact of direct Chinese competition on non-manufacturing employment growth is however even more profound.

In particular, a rise of 1% of what was required of an European non-manufacturing industry for domestic production and consumption in 2000 would reduce annual employment growth by a staggering 3.67% between 2000 till 2007 and is highly significant. In fact, these results are robust to excluding industries which are non-traded as they might inflate these estimates (i.e. their first stages have by definition trivial solutions). Nevertheless, the direct effect seems to be strongly heterogeneous across the EU non-manufacturing industries. Whereas the direct effect of Chinese import competition on EU12 non-manufacturing workers' employment growth is statistically indistinguishable from 0%, EU15 non-manufacturing workers' employment growth has been significantly hampered by about 5.63% due to rising import competition from China (see table 5, specifications (2) and (4)).

Likewise, when allowing for a different effect of Chinese imports on manufacturing employment growth between the EU15 and the EU12, a similar pattern can be documented (see table 5 specifications (1) and (3)) as that of the non-manufacturing industries. In specific, manufacturing employment growth

Table 4: OLS and 2SLS estimates of the Direct Chinese Import Exposure Effect on Industry-Level Employment

	Manufacturing			Non-Manufacturing			Pooled Manufacturing and Non-Manufacturing			Pooled EU15	Pooled EU27 excl. EU15
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Change in EU exposure to Imports from China	0.225	0.484	-1.317*	1.067***	-0.227***	-3.672**	-0.200	0.124	-1.081*	-2.171***	-0.864
	(0.216)	(0.308)	(0.738)	(0.215)	(0.843)	(1.589)	(0.241)	(0.342)	(0.570)	(0.524)	(0.810)
1{1995-2000}	-1.202***			1.323***			0.750***				
	(0.243)			(0.220)			(0.182)				
1{2000-2007}	-1.230***	-0.204	1.011**	1.625***	0.421***	0.737***	1.131***	0.307*	0.582***	-0.527***	2.115***
	(0.279)	(0.333)	(0.417)	(0.148)	(0.199)	(0.239)	(0.140)	(0.174)	(0.200)	(0.157)	(0.372)
Time fixed effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Only EU15	No	No	No	No	No	No	No	No	No	Yes	No
Only EU27 excl. EU15	No	No	No	No	No	No	No	No	No	No	Yes
Number of Observations	751	750	750	1121	1120	1120	1872	1870	1870	1044	826
Estimation Method	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS	2SLS	2SLS
Kleibergen-Paap LM Statistic			26.901***			19.446***			34.461***	24.221***	17.245***
Kleibergen-Paap Wald F-Statistic			32.791			20.064			51.442	80.398	21.646

Notes: All specifications, (1) through (11), have as dependent variable the log annual change in industry employment × 100. The change in EU exposure to Imports from China have been multiplied by 100 such that the variable of interest is in percentage points of begging of period industry absorption (see text). Number of observations are as described in table (3) and some observations, one in manufacturing and 1 in non-manufacturing were dropped as they had only an observation in either 1995-2000 or 2000-2007 (that is within variation was none existent). Countries in the EU15 and in the EU27 excl. EU15 are as described in table (2). All variables are weighted by industry employment as a share of overall employment in the relevant member state and the standard errors in parentheses are clustered on the country-industry level (number of observations divided by 2). Significance at the 1% level is denoted by ***, at the 5% level with ** and at the 10% level with *.

underwent significant reductions due to rises in Chinese import penetration between 2000 and 2007 in the EU15 (~1.75%), while nonesuch effect can be documented for manufacturing employment growth in the EU12. This apparent difference of the direct Chinese import competition effect between the EU15 and the EU12, as well as between the EU15 and the US (see Acemoglu et al. (2016)), seems however to be in line with the reasoning presented by Donoso et al. (2015) to reconcile their estimates for Spain with those of the US by Autor et al. (2013).

They reason that higher wage rigidity in the EU15 may cause labour market adjustments to trade shocks to be transmitted through employment rather than through wages. Considering that the downward wage rigidity in the EU15 indeed seems to have been larger than in the US and the EU12 (Pierrard & Sneessens, 2010) over this period, this line of reasoning is seemingly quite viable. In addition, given that this difference in downward wage rigidity can largely be accredited to differences in labour market institutions (most importantly differences in minimum wages), this implies that Western European labour market policies may have exacerbated the employment decline in Western Europe. This observation thus underscores the importance labour market policy harmonisation to reduce asymmetric trade-effects stemming from undifferentiated (i.e. at the EU level made) trade policy, as otherwise employment loss based compensation between EU member states would also depend on country specific labour market policy preferences.

A potential explanation for why non-manufacturing employment growth has been more susceptible to Chinese imports as opposed to manufacturing employment growth is more complicated to ascertain. Particularly, as this effect seems to persist even when allowing for different direct effects of Chinese import competition for the EU12 and for the EU15. One potential explanation for this striking observation could be that non-manufacturing wages have been traditionally higher (Francois & Hoekman, 2010) as non-manufactured goods traverse borders less in the EU (Mika, 2017). As a result, with Chinese competition to non-manufacturing industries on the rise after subsequent advancements in the tradability of non-manufacturing goods and services in the 1990s and the 2000s (Feenstra, 2016), these sectors needed to adjust its employment the most. An effect which has been more pronounced in the EU15 than in the EU12 provided that wages in the EU15 as compared to the EU12 have been more subject to greater downward rigidity.

Applying the methodology outlined in expression (9) to the estimates of table 5 one obtains the total job loss spurred by Chinese import competition

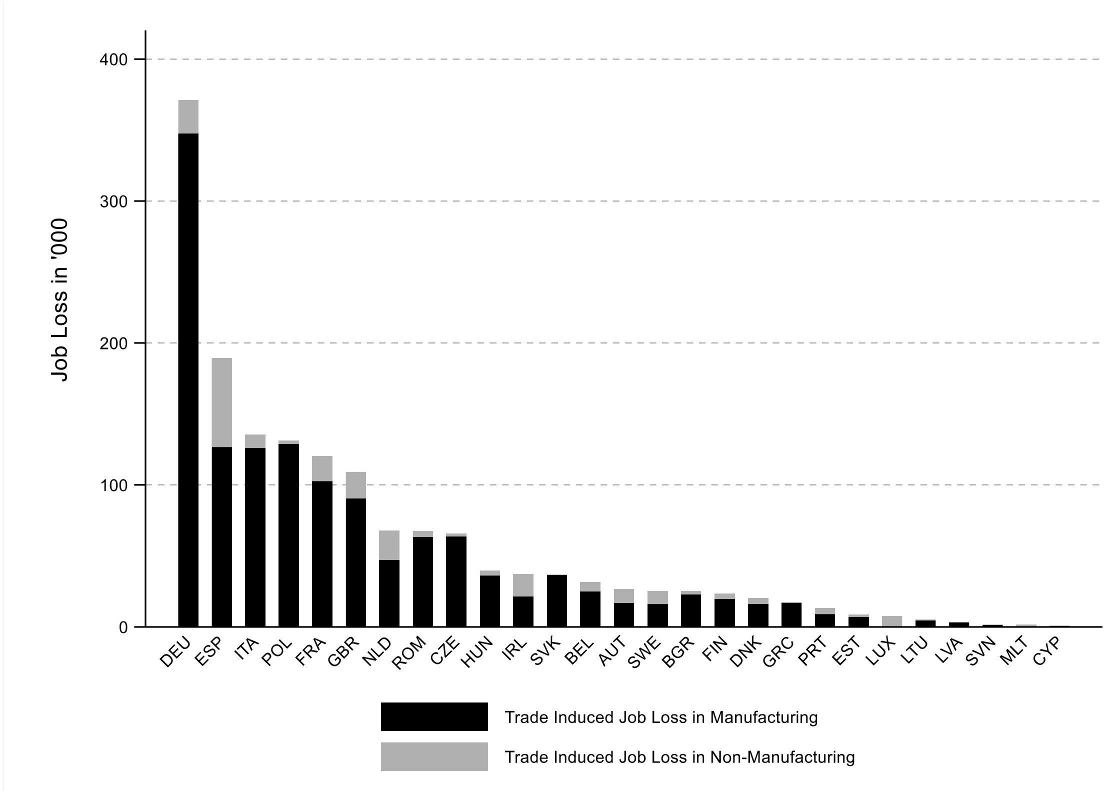

Figure 4: Total Direct Job Loss attributable to Rises in Chinese Import Competition between 2000 and 2007 as implied by table 5.

between 2000 and 2007 as depicted in figure 4. At a first glance, the largest countries, in terms of population and labour force, have lost the most jobs (Germany 381,000; Spain 192,000; Italy 139,000) as expected. In addition, despite direct Chinese import competition having a larger impact on non-manufacturing employment growth than on manufacturing employment growth, the actual number of jobs lost in manufacturing strongly exceeds the number of jobs lost in non-manufacturing irrespective of the EU member state.[34] At first sight this thus seems to support the idea that non-manufacturing employment decline due to direct Chinese import competition has been negligible. The reason for this stems probably in part from the fact that services are less traded (Mika, 2017; Feenstra, 2016), and for another part from the fact that Chinese supply-side innovations explain less[35] of the changes in Chinese imports to the EU. The latter of which can be indicative of other factors like border frictions, language barriers or spoilage

[34] Across the EU27 1.38 million manufacturing jobs have disappeared due to directly competing Chinese imports while this figure is substantially less, at 0.23 million jobs, for non-manufacturing industries.
[35] That is the partial R-squared is rather low for non-manufacturing industries. For instance, whereas the rise in Chinese non-manufacturing imports to the EU15 due to Chinese supply side innovations can explain a mere 8.3% of all variation in the changes in EU15 import exposure to China, this is almost 53.4% - surprisingly similar to the 54% estimated by Acemoglu et al. (2016) - for manufacturing imports.

(Hoekman & Winters, 2005) to be more important for trade in non-manufactures than they are for trade in manufactures.

Moreover, these estimated job losses are interestingly related to those documented in the empirical literature. For example, I estimate the absolute job loss to have occurred as a consequence of a rise in direct, supply driven, Chinese import competition in France to be 105,000, while Malgouyres (2016), using more disaggregate regional data, estimates this to be 100,000. Similarly, I find that the fraction of the decline in overall manufacturing employment, which can be explained by the surge in direct Chinese import competition across the EU, is relatively similar to that what has already been documented. For instance, I document that for Denmark and Sweden this has been 11% and 9%, respectively, whereas this is estimated by Balsvik et al. (2015) to be about 10% for Norway. Likewise, I estimate this figure to be 9% for France, while Malgouyres (with one year less) puts this figure around the 13%. Yet, the notion that Chinese import competition can explain more of the manufacturing employment decline in the US than in the EU as a result of greater skill-biased technological change in the EU, as stated in section II.II, seems to have been biased by the type of countries that have previously been examined. In particular, figure 5 demonstrates that more manufacturing/import oriented countries where manufacturing employment is in decline, such as Germany (21%), the Netherlands (15%) and Ireland (29%) have figures closer to those of the US (20%-25%). Hence, this further stresses the importance of a complete and comprehensive account of employment changes across the EU27.

In summary, I have found that that non-manufacturing employment in the EU15 has been significantly impacted – albeit that the job loss is relatively small – while manufacturing employment has not been significantly impacted at all in the EU12. In addition, I find that for some EU member states Chinese import competition has been no less important in explaining a downturn in manufacturing employment as compared to the US. As such, these findings cause me to reject the hypothesis that *direct Chinese import competition has decreased European manufacturing employment between 2000-2007, whilst having a negligible effect on non-manufacturing employment*.

V.II – *The Indirect Effect*

The results for the second hypothesis, revolving around estimating the indirect effect, are reported in table 6.1. At a first sight, it appears that the estimates of the direct effect – despite the fact that they fluctuate somewhat – are robust to the inclusion of the indirect effect. Furthermore, as one would expect, if ones buyers starts to face competition from China this, on average, adversely impacts the upstream sector its employment growth (see table 6.1 columns 7 till 9). That is, the upstream effect consistently has a negative sign as anticipated. Yet, when differentiating between manufacturing and non-manufacturing industries the upstream effect of Chinese import competition becomes insignificant for the former while more strongly significant for the latter. Yet, when examining Western- and Eastern Europe separately (see table 6) this upstream effect seems to be none existent in Eastern European non-manufacturing industries as well. That is, only Western upstream non-manufacturing industries tend, with a large degree of certainty, to contract their labour demand as a consequence of ones buyers facing elevated levels of direct Chinese import competition. The fact that such labour demand contractions are prominent in non-manufacturing in the EU15 industries is also observed by Malgouyres (2016) for the case of France.

Likewise, the distinction between type of industry is seemingly important for the downstream indirect effect too. Table 6.1 shows that, in specific, a non-manufacturing industry downstream to an industry competing directly with China tends to expand its labour demand. An observation which would be in line with price reductions of inputs being of greater importance than the adverse effects to employment stemming from either the loss of specialised suppliers or the change towards more capital intensive production technologies as hypothesised by Acemoglu et al. (2014) and Bloom et al. (2016). Provided that non-manufacturing industries do not tend to rely more on manufacturing industries than manufacturing industries themselves, this finding is relatively puzzling as price reductions are the largest in manufacturing industries (Auer & Fischer, 2010; Auer, Degen, & Fischer, 2013). Indicating that, perhaps, for manufacturing industries the loss of specialised suppliers and/or switching to more capital intensive production processes have been more important.

However, when distinguishing between the non-manufacturing industries in the EU15 and the EU12 this price-effect seems to be particularly applicable to the EU12 (see table 7). By contrast, the EU15 non-manufacturing industries are surprisingly characterised by negative downstream effects. This would indicate that the loss of specialised suppliers or the shift towards more capital intensive production technologies dominates the effect that Chinese import competition has had on input prices for the EU15 non-manufacturing employment. Especially a shift towards more capital intensive production technologies as found by Mion and Zhu (2013), Acemoglu et al. (2014) and Bloom et al. (2016) could potentially be at the root of this evident difference between the non-manufacturing industry

Table 6.1 and 6.2 Panel A: Direct and (First-Order) Indirect Chinese Import Exposure Effect on Industry-Level Employment using 2SLS with time fixed effects only.

	Manufacturing			Non-Manufacturing			Pooled Manufacturing and Non-Manufacturing			Pooled EU15	Pooled EU27 excl. EU15
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Change in EU exposure to Imports from China	-1.023	-0.936		-3.282**	-4.057***		-0.664	-1.347*		-1.555*	-0.792
	(0.811)	(0.982)		(1.551)	(1.568)		(0.615)	(0.760)		(0.843)	(1.038)
Change in Upstream (national) exposure to Imports from China	-4.078	-3.115	-2.821	-5.687*	-6.511**	-7.500***	-4.875*	-6.957***	-7.376***	-7.720***	-3.403
	(5.162)	(4.664)	(4.883)	(3.020)	(2.966)	(2.909)	(2.664)	(2.553)	(2.635)	(2.509)	(3.828)
Change in Downstream (national) exposure to Imports from China		-1.677	-6.471		16.220*	15.863**		8.13	1.416	-1.929	2.256
		(8.379)	(6.910)		(8.602)	(8.092)		(5.763)	(4.485)	(6.773)	(8.147)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Only EU15	No	No	No	No	No	No	No	No	No	Yes	No
Only EU27 excl. EU15	No	No	No	No	No	No	No	No	No	No	Yes
Number of Observations	750	750	750	1120	1120	1120	1870	1870	1870	1044	826
Estimation Method	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Kleibergen-Paap LM Statistic	22.583***	16.182***	15.099***	19.583***	21.039***	24.224***	34.620***	38.418***	28.077***	26.915***	28.094***
Kleibergen-Paap Wald F-Statistic	12.785	7.237	10.901	10.057	7.398	22.033	24.461	32.119	22.05	7.748	18.157
Partial R-Squared Total Direct Effect	0.323	0.325		0.084	0.085		0.338	0.339		0.379	0.345
Partial R-Squared Total Upstream Indirect Effect	0.333	0.333	0.333	0.489	0.490	0.490	0.440	0.441	0.441	0.549	0.493
Partial R-Squared Total Downstream Indirect Effect		0.286	0.286		0.143	0.139		0.307	0.307	0.265	0.374

Notes: All specifications, (1) through (11), have as dependent variable the log annual change in industry employment × 100. The change in EU exposure to imports from China have been multiplied by 100 such that the variable of interest is in percentage points of the beginning of period industry absorption (see text). Number of observations are as described in table 3 and some observations, one in manufacturing and 1 in non-manufacturing were dropped as they had only an observation in either 1995-2000 or 2000-2007 (that is within variation was none existent). Countries in the EU15 and in the EU27 excl. EU15 are as described in table 2. National refers to accounting only for domestic indirect up- and downstream shocks (allowing for Chinese competition in the domestic market only). All variables are weighted by industry employment as a share of overall employment in the relevant member state and the standard errors in parentheses are clustered on the country-industry level (number of observations divided by 2). Significance at the 1% level is denoted by ***, at the 5% level with ** and at the 10% level with *.

in the EU15 and in the EU12. More specifically, as the growth in real capital stock and ICT investments (see table 3) has been larger in the EU15 than it has been in the EU12, there may have been larger shifts toward capital intensive production technologies in the EU15 as a result of increased imports from China. However, this large heterogeneity in the downstream effect between regions may be a sign of trouble as there could thus exist a non-monotonous effect of downstream import competition on employment growth. As such, this non-monotonous relation could have created the relatively large uncertainty regarding the downstream effect. This would furthermore provide a – what I belief to be – compelling argument of why manufacturing downstream industries in general (see Acemoglu et al. (2016)) seemingly do not adjust by either unambiguously expanding or contracting their labour demand.

When calculating the implied job loss from the direct and first-order indirect effects from table 7, panel A, three observations can be made (see figure 6). Firstly, taking into account both the direct and indirect first-order effects, the job loss in non-manufacturing industries in Western Europe are generally more than twice as large as the number of jobs lost in manufacturing industries in Western Europe (see figure 7). This finding emphasises the importance of documenting trade-induced employment effects in non-manufacturing OECD industries as stressed by Hoekman and Winters (2005) given that the vast majority of the empirical literature focusses on trade-induced manufacturing employment. Secondly, the increase in Chinese import competition over the period 2000 till 2007 has had the most substantial effect on manufacturing workers in Eastern Europe as on average circa 10% of all manufacturing jobs in 2000 were lost in that region, while this about 5% for Western Europe (see figure 8). However, whereas manufacturing workers were thus disproportionately displaced in Eastern Europe the reversed is true for non-manufacturing workers as those have been most severely displaced in EU15 member states due to increased exposure to Chinese imports between 2000 and 2007.

Thirdly, when decomposing the implied total full-order job loss (see table 7 panel B) with respect to what job loss can be accredited to the direct effect, the first-order indirect effects and the higher-order indirect effects, it becomes apparent that each channel is distinct in magnitude by type of industry (see figures 9 and 10). For instance, whereas higher-order (i.e. trickle down effects) worker displacement is relatively small in the manufacturing industries as a fraction of total job loss, the higher-order indirect effects account for a larger fraction of total job loss in non-manufacturing industries. In specific, this observation can be extended to the first-order effects as well, yet the reversed is true for the total direct job loss. Hence, the analysis above shows that (1) downstream effects are significant in non-manufacturing industries (see figure 9 and 10 and table 6.1), (2) the indirect effects are insignificant for manufacturing industries and non-manufacturing industries alike in Eastern Europe (see table 7, columns 3 and 4) and that (3) the implied indirect job loss is larger in non-manufacturing industries as compared to manufacturing industries (see figure 6). As such, this causes me to reject the notion that: *Chinese import competition has indirectly decreased European employment due to upstream import exposure from 2000-2007.*

V.III – *A Skill-Based Decomposition of The Direct Effect*

Applying the analysis of V.I and V.II by interchanging the change in overall employment with the change in the employment of low-, medium- and high-skilled workers does not provide a complete answer to whether *Chinese import competition has displaced more low- and medium skilled workers than high skilled workers between 2000 and 2007*. In specific, due to large variations on the parameters of both the upstream and downstream Chinese import competition metrics, no reliable implied changes in the level of employment can be produced (see table 8 columns 5 till 8). As such, the analysis pertaining to the heterogeneity of employment responses amongst differently skilled workers, resulting from changes in Chinese import competition, will be restricted to the direct effect. Despite the fact that the discussion is limited to columns 1 till 4 of table 8, juxtaposing these findings with the estimates of the overall direct effect in table 5 yields some interesting insights.

Firstly, when decomposing the direct effect with respect to skill-level it is particularly interesting that both the sign, size and statistical significance of the coefficients (see table 8) align with those of estimates produced using the overall employment changes (see table 5). Secondly, although each coefficient estimate for the regions and industry types are estimated using different regressands, i.e. hindering formal hypothesis testing[36], all coefficients for the direct effect of Chinese import competition are relatively similar in size for all types of skilled-labour. Thirdly, when solely relying on the point estimates (not factoring in uncertainty) one can see that high-skilled manufacturing labourers and medium-skilled manufacturing workers are least adversely effected in the EU12 and the EU15, respectively. Lastly, the pattern visible among different skill-types of labour

[36] In addition, formal hypothesis testing as well as inferences made on the basis of standard errors must be interpreted with caution as the specifications' disturbances are assumed to be orthogonal.

in nonmanufacturing industries starkly contradicts the assertion made in section II.II that high-skilled non-manufacturing workers are most adversely impacted in the EU15.

Even though a surge in Chinese imports due to Chinese supply-side innovations is marginally more detrimental to low-skilled labour as compared to high-skilled labour in the EU15's manufacturing industries, controlling for the level of employment of these labour types in 2000 (see figure 13), reverses this pattern.[37] In specific, generally the number of jobs lost as a percentage of the amount of jobs per skill type in 2000 shows that high-skilled manufacturing workers are disproportionately displaced in the EU15 compared to the EU12. In particular, all employment responses of EU15 member states are reasonably similar. This unexpected finding is most probably due to the fact that EU15 countries are relatively homogenous with regard to the distribution of low-, medium- and high-skilled workers across industries (Galgoczi & Leschke, 2012), and that the industries with a larger mass of high-skilled workers are more exposed to Chinese imports. This finding is however puzzling to the extent that, based on the factor content of trade (Nataraj & Tandon, 2011), it should be that industries with a high density of low-skilled workers ought to be impacted the most by a rise in Chinese import competition. Nevertheless this could potentially be explained when accounting for factor intensity reversals, that is the produce of an industry in China may be low-skilled intensive while the same product is manufactured using high-skilled intensive production technologies in the EU15 (Feenstra, 2016).[38]

Contrary to the regularities which can be found in figure 13, no evident heterogenous employment response pattern exist for non-manufacturing industries (see figure 14). Instead, very similar countries such as Denmark, Sweden and Finland are characterised by (large) differences in worker displacement per skill type. In addition the number of workers per skill type that have been displaced due to direct Chinese import competition between 2000 and 2007 as a fraction of the number of jobs per skill type in 2000, also shows that these relatively similar countries react relatively differently to such shocks. Moreover,

[37] Note however that these job losses as shown in figures 11 and 12 are identical to those in figure 4 for manufacturing and non-manufacturing industries alike whilst no restrictions have been imposed on the coefficient estimates (i.e. this result is data driven and provide a sense of accuracy of the estimates).

[38] This would have substantial implications for the validity of the Factor Price equalisation theorem, which is derived under the condition that Factor Intensity Reversals (FIRs) do not exist, and for policy makers concerns regarding wages of low-, medium- and high-skilled labour equalising across the EU15 and China (which need not be the case).

both theoretical reasons (Helpman & Itskhoki, 2010) as well as a reasons stemming from heterogeneity in labour market institutions (Koeniger, Leonardi, & Nunziata, 2007) cannot account for this remarkable observation. Hence, whereas labour market institution induced wage rigidity can probably explain variation in manufacturing employment responses to direct Chinese import competition across OECD countries, no explanation revolving around differences in labour market institutions seems viable for EU15 non-manufacturing employment responses. This apparent difference for explaining job loss heterogeneity is potentially attributable to the fact that the main labour market institutions inducing wage rigidity is the minimum wage institutions (Pierrard & Sneessens, 2010) which is less important to non-manufacturing industries as wages in the informal sector have been traditionally higher than those in the formal sector (Francois & Hoekman, 2010).

Summarizing the above, I find that (1) the total job loss appears to have been slightly larger for high-skilled manufacturing workers in the EU15, (2) the point estimates are relatively comparable (assuming no correlation between the t-statistics) and (3) the non-manufacturing industries are not characterised by any obvious pattern in employment responses to direct Chinese import competition. Hence, I have come to conclusion that the notion that *Chinese import competition has displaced more low- and medium skilled workers than high skilled workers between 2000 and 2007* cannot – at least for the direct effect – be supported.

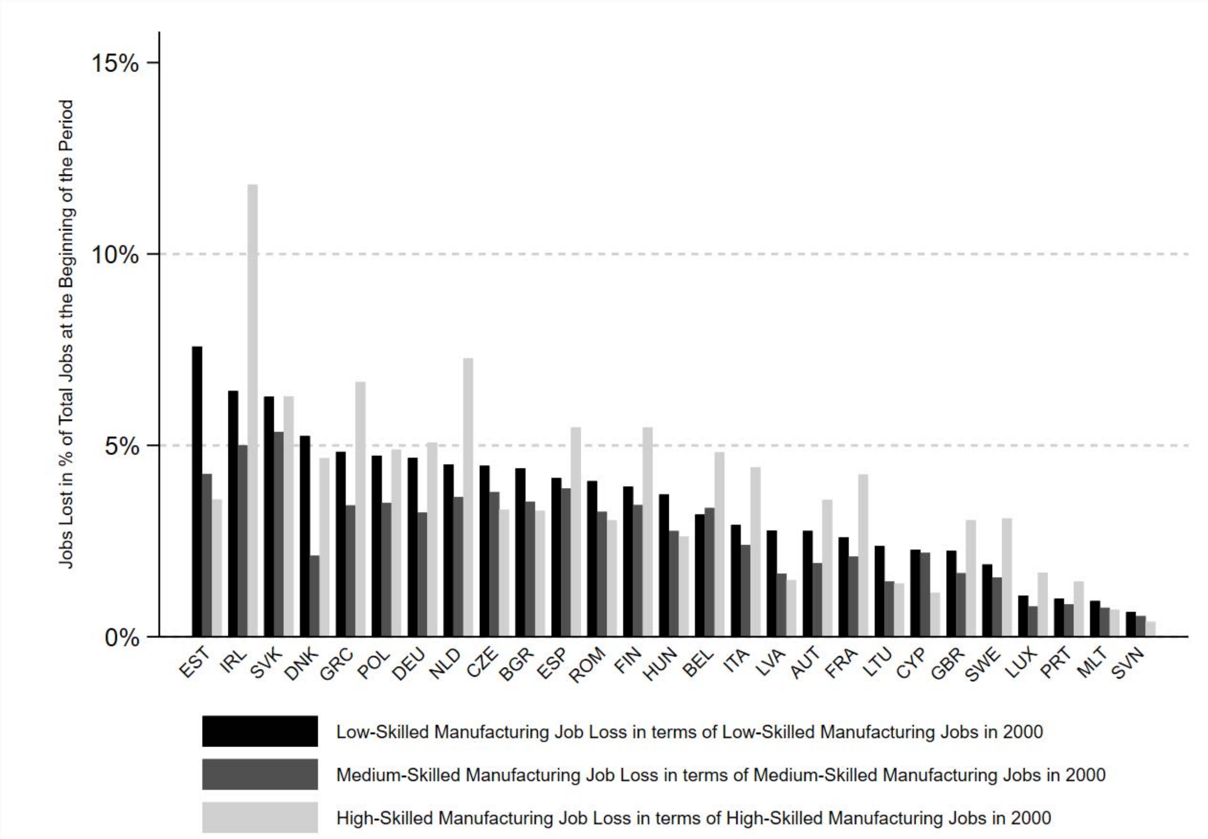

Figure 13: Total direct job loss per skill-type (FTE converted to the reduction in yearly hours worked) in manufacturing industries attributable to Chinese import competition spanning the period 2000 till 2007 as a fraction of hours worked per skill-type at the start of said period (i.e. in the year 2000) in manufacturing industries.

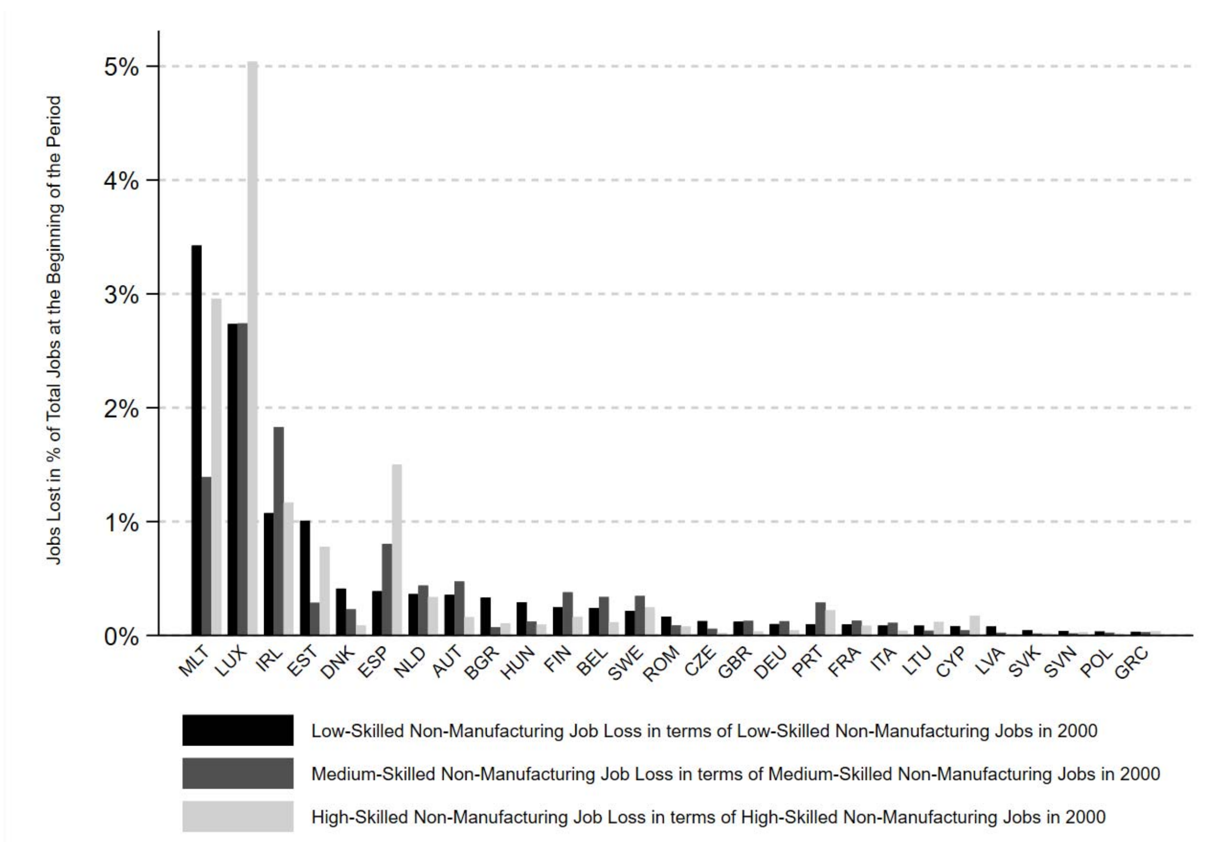

Figure 14: Total direct job loss per skill-type (FTE converted to the reduction in yearly hours worked) in non-manufacturing industries attributable to Chinese import competition spanning the period 2000 till 2007 as a fraction of hours worked per skill-type at the start of said period (i.e. in the year 2000) in manufacturing industries.

VI – Conclusion

In this paper I have set out to provide a comprehensive overview of how workers have been displaced by the rise of Chinese import competition, that is I set out to answer: *to what extent has Chinese import competition displaced European workers between 2000 and 2007?* By applying an with time fixed effects augmented weighted instrumental variable approach with multiple endogenous regressors, as per Autor et al. (2013) and Acemoglu et al. (2016), to the World Input-Output Tables and the World Socio-Economic Accounts I document the following results which are of primary interest.

Firstly, non-manufacturing employment growth has been hampered more in the EU15 between 2000 and 2007 than manufacturing employment growth due to direct Chinese import competition. Yet, the number of non-manufacturing workers that have been displaced is substantially smaller than the number of manufacturing workers. Secondly, manufacturing employment growth has been more adversely – although insignificantly – been impacted in the EU12 between 2000 and 2007 as compared to non-manufacturing employment growth as a result of more imports from China. In particular, the number of jobs that have disappeared due to direct and indirect Chinese import competition as a fraction of the number of jobs in 2000, is markedly larger for manufacturing industries in the EU12 and for non-manufacturing industries in the EU15 compared to their EU15 and EU12 counterparts, respectively. Thirdly, the reduction in employment growth due to indirect Chinese import competition originates predominantly from upstream effects in the EU15, while also downstream import competition effects contribute thereto for EU15 non-manufacturing industries. Fourthly, the extent to which this job loss is attributable to direct and indirect Chinese import competition strongly varies across industry type. For instance, whereas the indirect job loss is more profound for non-manufacturing industries, the direct job loss is more substantial for the manufacturing industries.

Fifthly, despite theory (Helpman & Itskhoki, 2011) and previous empirical literature (Autor, Dorn, & Hanson, 2015; Keller & Utar, 2017) indicating that low-skilled individuals are most adversely impacted in terms of employment, no evidence in support thereof has been documented. Moreover, high-skilled manufacturing workers are found to have been displaced to a greater extent than low-skilled manufacturing workers in the EU15. However, this pattern is not obvious from non-manufacturing industries as even similar countries have differential orderings of which skill groups have been most adversely effected due to rises in direct Chinese import competition. From the aforementioned results I thus conclude that the Chinese import competition has substantially displaced workers throughout the EU27 between 2000 and 2007. More specifically, my preferred estimates reveal that (1) direct Chinese import competition has displaced 1.38 million manufacturing workers and 0.23 million non-manufacturing workers and (2) indirect Chinese import competition has displaced an additional 1.04 million manufacturing workers and 4.1 million non-manufacturing workers. These job losses are however rather equally divided across differently skilled labour though are unequally divided between the EU15 and the EU12.

In addition some other implications can be drawn from these observations albeit that those are merely tangent to the main question. From the first and second result I deduce that, considering the differences in job losses across the EU27, a trade policy of the EU without fiscal transfers may be unsustainable in the long run as predominantly workers in Western Europe are adversely effected. Although necessary, such employment-driven transfers can be undesirable since these employment losses can be exacerbated, particularly in manufacturing industries, by differences in national labour market policy preferences. In addition, the third and fourth result give rise to the notion that even if one were to be able to (1) determine who is losing their jobs due to an hike in direct import competition and (2) settle on some employment loss figure which is not driven by local labour market policy preferences, general equilibrium effects may displace even more workers, thereby further obfuscating straightforward compensation. Even though these inferences are rather ominous for designing an EU-wide trade policy which does not stimulate between-member state inequality, the fifth result bodes an interesting implication for the development of within-nation inequality.

In fact, whereas in the EU15 the left- and right-end of the income distribution[39] become more unemployed due to rising Chinese import competition, only the left-end of the income distribution becomes more unemployed in the EU12. Contrary thus to popular belief that trade may induce within-nation inequality, the EU15 may as a result have realised an within-nation inequality decline as a result of rising Chinese imports given that there exist substantial social transfers within EU15 countries (Barr, 2005; Eurofond, 2018). However, considering that social transfers are limited in EU12 countries (Barr, 2005) and that predominantly the left-end of the income distribution is becoming unemployed, within-nation inequality in the EU12 may have increased due to rising Chinese import competition. Hence, given the difficulty that an

[39] Assuming that the income of low-skilled workers is smaller than that of medium-skilled workers, which is in turn smaller than that of high-skilled workers.

undifferentiated trade policy imposes for between member state compensation and its potential adverse impact on within-nation inequality in the EU12 (which was already large (Carmo, Rio, & Medgyesi, 2018)), further Sino-European economic integration at present may be ill-advised.

However, from these results not only inferences can be made to guide EU policy makers but it may also provide insights for academics and future research. Firstly, despite the fact that the majority of the academic literature is oriented at the effects of trade on manufacturing employment, the impact of trade – at least of imports – may be even more profound in non-manufacturing industries due to spill-overs through input-output linkages. Therefore these results support the claim of Hoekman and Winters (2005) that the research interest should be more equally be divided between manufacturing and non-manufacturing industries. Especially since barriers to tradability of non-manufactures have been substantially reduced (Feenstra, 2016). Secondly, although I hypothesise that labour market institutions are driving factors of variation between EU member states their employment losses, further research is required to assess whether this indeed imposes an additional layer of difficulty for creating an undifferentiated and sustainable trade policy for trade unions more generally.

Lastly, as the scope of this paper is limited to the degree to which Chinese import competition has induced worker displacement this may inadvertently have led to an overly grim depiction of the effects of international trade. First and foremost, both the effect of trade with China on consumer-, export prices and technological innovation tends to be positive.[40] Moreover, this paper is limited to the extent that it provides an overview of the jobs lost due to increases in Chinese import competition whilst there may be an offsetting employment gains in exporting industries (2018), albeit delayed. Beyond these limitations with regard to scope, it is important to recognise the fact that the strength of the instruments cannot formally be ascertained (even though I am convinced that the instruments to be strong) and that the direct and indirect effect also comprise some parts of the aggregate demand- and reallocation effects as outlined in section II.I.

Matthijs Johannes Jeremias van Tiggelen

Erasmus University Rotterdam

[40] See for instance Bas and Strauss-Kahn (2015) for the effect on export prices and technological change, Bloom et al. (2016) for patenting or Mion and Zhu (2013) for trade induced technical change.

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A – Computing the Indirect Import Exposure Metrics

To describe how the full order input-output linkages have been derived I define the input-output matrix analogously to Feenstra and Sasahara (2018). Let $T^{(j,r)\rightarrow(i,s)}$ denote the value of the trade flow between industry r in country j to industry s in country i. Then the world input-output table (the WIOT from the world input-output database (WIOD)) can be depicted as:

$$\text{(A.1)} \qquad T_t \equiv \begin{bmatrix} T_t^{(1,1)\rightarrow(1,1)} & T_t^{(1,1)\rightarrow(1,2)} & \cdots & T_t^{(1,1)\rightarrow(N,S)} \\ T_t^{(1,2)\rightarrow(1,1)} & T_t^{(1,2)\rightarrow(1,2)} & \cdots & T_t^{(1,2)\rightarrow(N,S)} \\ \vdots & \vdots & \ddots & \vdots \\ T_t^{(2,1)\rightarrow(1,1)} & T_t^{(2,1)\rightarrow(1,2)} & \cdots & T_t^{(2,1)\rightarrow(N,S)} \\ \vdots & \vdots & \ddots & \vdots \\ T_t^{(N,S)\rightarrow(1,1)} & T_t^{(N,S)\rightarrow(1,2)} & \cdots & T_t^{(N,S)\rightarrow(N,S)} \end{bmatrix}$$

where S is the last production industry, that is final demand is not included in this matrix. Nonetheless, each industry (due to the level of aggregation) does produce some fraction of its output for final consumption either for some consumers or for some government. Then denoting the output of industry r in country r as $Y^{(j,r)}$ and the final demand in country i for goods produced by industry r in country j as $D^{(j,r)\rightarrow s}$ then we define

$$\text{(A.2)} \qquad y_t \equiv \begin{bmatrix} Y_t^{(1,1)} \\ Y_t^{(1,2)} \\ \vdots \\ Y_t^{(2,1)} \\ \vdots \\ Y_t^{(N,S)} \end{bmatrix} \; ; \; D_t \equiv \begin{bmatrix} D_t^{(1,1)\rightarrow 1} & D_t^{(1,1)\rightarrow 2} & \cdots & D_t^{(1,1)\rightarrow S} \\ D_t^{(1,2)\rightarrow 1} & D_t^{(1,2)\rightarrow 2} & \cdots & D_t^{(1,2)\rightarrow S} \\ \vdots & \vdots & \ddots & \vdots \\ D_t^{(2,1)\rightarrow 1} & D_t^{(2,1)\rightarrow 2} & \cdots & D_t^{(2,1)\rightarrow S} \\ \vdots & \vdots & \ddots & \vdots \\ D_t^{(N,S)\rightarrow 1} & D_t^{(N,S)\rightarrow 2} & \cdots & D_t^{(N,S)\rightarrow S} \end{bmatrix}$$

As may be apparent the output of an industry is either used as an intermediate or as a final good and therefore we can express the relationship between the matrices in (A.1) and (A.2) as $y_t = T_t \cdot \mathbf{1}_{[\mathrm{N \cdot S} \times 1]} + D_t \cdot \mathbf{1}_{[\mathrm{S} \times 1]}$ where $\mathbf{1}_{[k \times l]}$ denotes a k by l vector which elements are strictly equal to 1. The first part, $T_t \cdot \mathbf{1}_{[\mathrm{N \cdot S} \times 1]}$ is commonly referred to as internal demand whilst the second part, $D_t \cdot \mathbf{1}_{[\mathrm{S} \times 1]}$, is commonly referred to as external demand.[41] By applying an isomorphic transformation G to vector spaces V and W (Poole, 2011) which are defined as $\mathbb{R}^{N \cdot S}$ and $\mathbb{M}^{N \cdot S \times N \cdot S}$ respectively, we have that:

[41] Although this relationship specifies output on the left hand side (LHS) to be composed of internal (output) and external (output) demand, one can also decompose output by the rows (or inputs) where internal input demand is the value of intermediate goods and services whilst external input demand is the return to production factors.

$$(A.3)\qquad G(y_t) = G\left(\begin{bmatrix} Y_t^{(1,1)} \\ Y_t^{(1,2)} \\ \vdots \\ Y_t^{(2,1)} \\ \vdots \\ Y_t^{(N,S)} \end{bmatrix}\right) \equiv \begin{bmatrix} 1/Y_t^{(1,1)} & 0 & \cdots & 0 \\ 0 & 1/Y_t^{(2,1)} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1/Y_t^{(N,S)} \end{bmatrix} = Y_t$$

Lastly, we define the change in Chinese import exposure vector as:

$$(A.4)\qquad \Delta IP(CHN)_t \equiv \begin{bmatrix} \Delta IP(CHN)_t^{(1,1)} \\ \Delta IP(CHN)_t^{(1,2)} \\ \vdots \\ \Delta IP(CHN)_t^{(2,1)} \\ \vdots \\ \Delta IP(CHN)_t^{(N,S)} \end{bmatrix}$$

From this point onward one can easily rewrite equation (5) and equation (7) by multiplying the matrices from (A.1) till (A.4). Let us define $Y_{t_0}T_{t_0}$ as the Leontief output matrix, denoted by $\Lambda_{t_o,O}$, and let us define $(T_{t_0}Y_{t_0})'$ as the Leontief input matrix, denoted by $\Lambda_{t_o,I}$. Then equation (5) and equation (7) can be written as:

$$(C.5)\quad \Delta IP(CHN)_{t,U} = \Lambda_{t_o,O}\,\Delta IP(CHN)_t \text{ and } IP(CHN)_{t,D} = \Lambda_{t_o,I}\,\Delta IP(CHN)_t$$

Note however that either Y_tT_t or T_tY_t are multiplied by the change in Chinese import penetration from either the left or the right, that is only internal demand is considered as D_t does not factor in for the upstream effects. Similarly, external inputs are also assumed to have no change in direct Chinese import exposure and given that internal inputs plus external inputs total an industry its output, (A.5) replaces the total value of intermediates by the total output for the first order downstream change in Chinese import exposure.[42] Second-order up- or downstream effects (influence of import competition in an industry its buyers' buyer market) are now readily obtained by weighing the first up- or downstream effects again as can be seen from (A.6).

$$(A.6)\quad \Delta IP(CHN)_{t,2U} = \Lambda_{t_o,O}^2\,\Delta IP(CHN)_t\;\; IP(CHN)_{t,2D} = \Lambda_{t_o,I}^2\,\Delta IP(CHN)_t$$

More specifically, one can define the k^{th} order up- and downstream effects as $\Delta IP(CHN)_{t,hU} = \Lambda_{t_o,O}^h\,\Delta IP(CHN)_t$ and $IP(CHN)_{t,hD} = \Lambda_{t_o,I}^h\,\Delta IP(CHN)_t$. As the upstream full-order change in import exposure effect is the sum of all upstream change in import exposure this amounts to:

[42] The fact that both external demand and external inputs

(A.7) $\Delta IP(CHN)_{t,FU} = \sum_{h=1}^{\infty} \Lambda_{t_o,O}^{h} \Delta IP(CHN)_t = \left(\sum_{h=0}^{\infty}\left[\Lambda_{t_o,O}^{h}\right] - I\right)\Delta IP(CHN)_t$

which can, using the matrix equivalent to the solution of a geometric series, be readily simplified to

(A.8) $\Delta IP(CHN)_{t,FU} = \left(\left(I - \Lambda_{t_o,O}\right)^{-1} - I\right)\Delta IP(CHN)_t$

Likewise, one can define the full-order downstream change in Chinese import competition as

(A.9) $\Delta IP(CHN)_{t,FD} = \left(\left(I - \Lambda_{t_o,I}\right)^{-1} - I\right)\Delta IP(CHN)_t$

The remainder of this appendix is aimed at proving the equivalence between the RHS of expression (A.7) and the RHS of expression (A.8), note that a proof very similar to this one exists deriving (A.9).

Proof: To do so let the partial matrix sum be defined as $s_n = \sum_{h=0}^{n}\left[\Lambda_{t_o,O}^{h}\right]$ then logically $\Lambda_{t_o,O}s_n = \sum_{h=0}^{n}\left[\Lambda_{t_o,O}^{h+1}\right]$. Subtracting the latter from the former one obtains

(A.10) $\left(I - \Lambda_{t_o,O}\right)s_n = s_n - \Lambda_{t_o,O}s_n = \sum_{h=0}^{n}\left[\Lambda_{t_o,O}^{h}\right] - \sum_{h=0}^{n}\left[\Lambda_{t_o,O}^{h+1}\right] = I - \Lambda_{t_o,O}^{n+1}$

Now if $\lim_{n\to\infty} \Lambda_{t_o,O}^{n+1} = 0$ then this would prove that the inverse of $\lim_{n\to\infty} s_n$ exists and that $\lim_{n\to\infty} s_n$ is in fact equal to $\left(I - \Lambda_{t_o,O}\right)^{-1}$, ergo what we need to prove. The fact that $\lim_{n\to\infty} \Lambda_{t_o,O}^{n+1} = 0$ can be readily observed when applying the max operator norm to $\Lambda_{t_o,O}$, denoted by $\left\|\Lambda_{t_o,O}\right\|_{\infty}$. Note that the such an operator norm abides by the following property (for any arbitrary matrices whose multiplication is defined) (Poole, 2011, p. 579):

(A.11) $0 \leq \left\|\Lambda_{t_o,O}\Lambda_{t_o,O}\right\|_{\infty} \leq \left\|\Lambda_{t_o,O}\right\|_{\infty}\left\|\Lambda_{t_o,O}\right\|_{\infty}$

and that this property can be easily be extended to higher powers through induction[43], *id est* $\left\|\Lambda_{t_o,O}^{n}\right\|_{\infty} \leq \left\|\Lambda_{t_o,O}\right\|_{\infty}^{n}$. Now since $\left\|\Lambda_{t_o,O}\right\|_{\infty}$ is equivalent to the largest absolute row sum (Poole, 2011, p. 583), which, as external output demand

[43] Verifying the induction step for $n \geq 2$ has been done by virtue of (C.10), using the induction hypotheses that $\left\|\Lambda_{t_o,O}^{k}\right\|_{\infty} \leq \left\|\Lambda_{t_o,O}\right\|_{\infty}^{k}$ holds for some arbitrary integer k larger than two, one needs to show that $\left\|\Lambda_{t_o,O}^{k+1}\right\|_{\infty} \leq \left\|\Lambda_{t_o,O}\right\|_{\infty}^{k+1}$. Working from the LHS to the RHS we obtain:

$$\left\|\Lambda_{t_o,O}^{k+1}\right\|_{\infty} = \left\|\Lambda_{t_o,O}\Lambda_{t_o,O}^{k}\right\|_{\infty} \leq \left\|\Lambda_{t_o,O}\right\|_{\infty}\left\|\Lambda_{t_o,O}^{k}\right\|_{\infty} \leq \left\|\Lambda_{t_o,O}\right\|_{\infty}\left\|\Lambda_{t_o,O}\right\|_{\infty}^{k} = \left\|\Lambda_{t_o,O}\right\|_{\infty}^{k+1}$$

Hence I conclude that $\left\|\Lambda_{t_o,O}^{n}\right\|_{\infty} \leq \left\|\Lambda_{t_o,O}\right\|_{\infty}^{n}$ $\forall n \geq 2$. ■

is strictly greater than zero, must yield $\left\|\Lambda_{t_o,O}\right\|_\infty < 1$. As such it should be evident that $\lim_{n\to\infty}\left\|\Lambda_{t_o,O}\right\|_\infty^n = 0$. By applying the analogue of the squeeze theorem for limits to matrices one obtains

(A.12) $$\lim_{n\to\infty} 0 \leq \lim_{n\to\infty}\left\|\Lambda_{t_o,O}^n\right\|_\infty \leq \lim_{n\to\infty}\left\|\Lambda_{t_o,O}\right\|_\infty^n$$
$$\Leftrightarrow 0 \leq \lim_{n\to\infty}\left\|\Lambda_{t_o,O}^n\right\|_\infty \leq 0 \Rightarrow \lim_{n\to\infty}\left\|\Lambda_{t_o,O}^n\right\|_\infty = 0$$

Given that this implies that every absolute row sum tends to 0 – every element of $\lim_{n\to\infty}\Lambda_{t_o,O}^n$ must tend to 0 – this yields that $\lim_{n\to\infty}\Lambda_{t_o,O}^n = 0$. Applying this to (A.10)

(A.13) $$\lim_{n\to\infty}\left[\left(I-\Lambda_{t_o,O}\right)s_n\right] = \lim_{n\to\infty}\left[I-\Lambda_{t_o,O}^{n+1}\right] \Leftrightarrow \left(I-\Lambda_{t_o,O}\right)\lim_{n\to\infty}s_n = I - \lim_{n\to\infty}\Lambda_{t_o,O}^{n+1}$$
$$\Leftrightarrow \left(I-\Lambda_{t_o,O}\right)\lim_{n\to\infty}s_n = I - 0 \Leftrightarrow \left(I-\Lambda_{t_o,O}\right)\lim_{n\to\infty}s_n = I$$

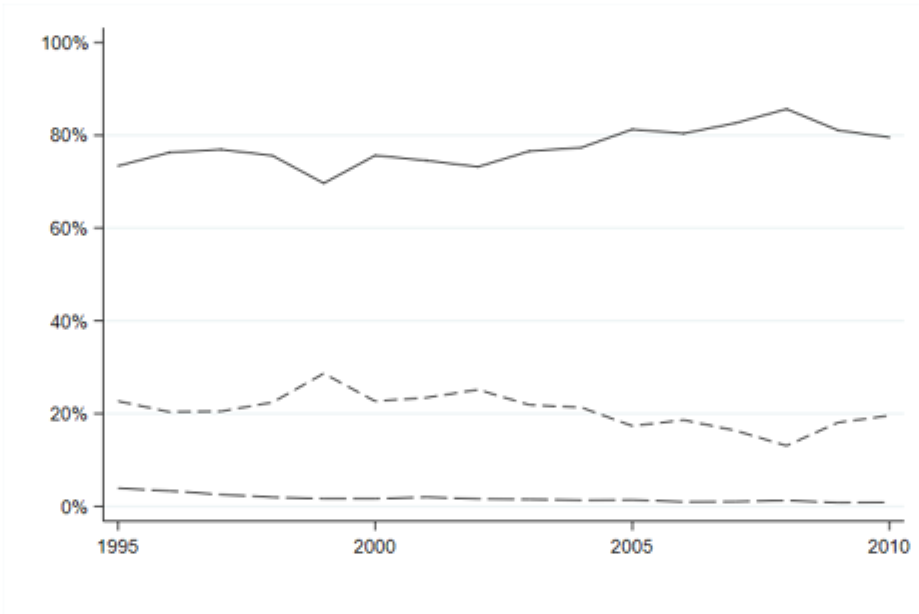
Thus this establishes that the inverse of $\lim_{n\to\infty}s_n$ exists (which is by definition unique) and as such

(A.14) $$\left(I-\Lambda_{t_o,O}\right)\lim_{n\to\infty}s_n = I \Leftrightarrow \lim_{n\to\infty}s_n = \sum_{h=0}^{\infty}\left[\Lambda_{t_o,O}^h\right] = \left(I-\Lambda_{t_o,O}\right)^{-1}$$

showing that the RHS of expression (A.7) and the RHS of expression (A.8) are in fact equivalent as required. Note that following a similar line of reasoning but then using the fact that $\left\|\Lambda_{t_o,I}\right\|_1 < 1$, one can derive expression (A.9). **QED**

B – Tables & Figures

Composition of EU27 imports from China (A)



Composition of US imports from China (B)

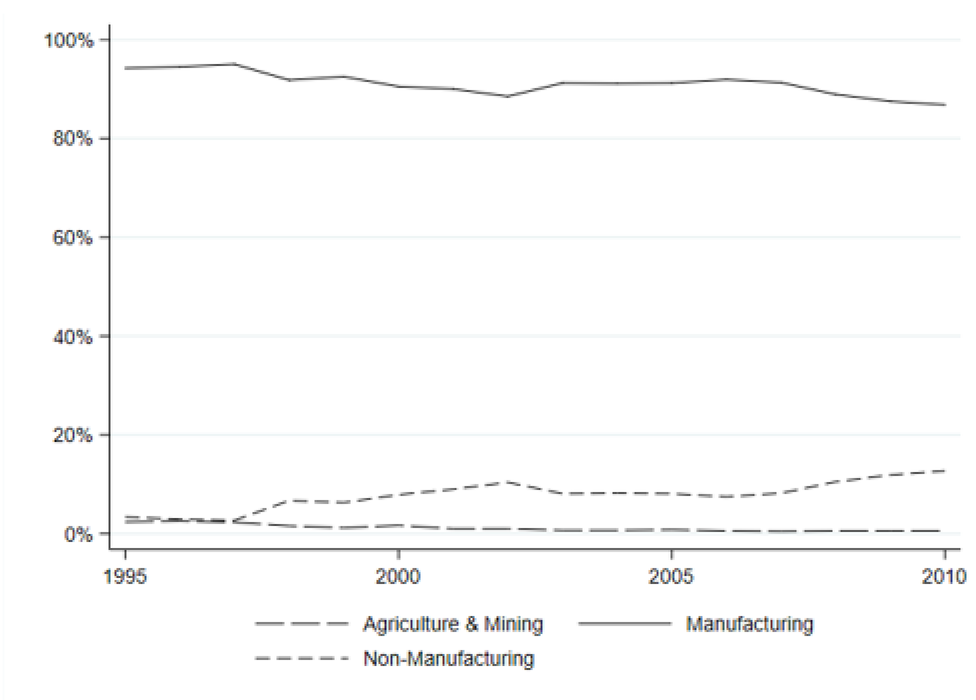


Figure 1: Composition of the imports from China to the EU27 (Panel A) and the US (panel B) using the WIOD

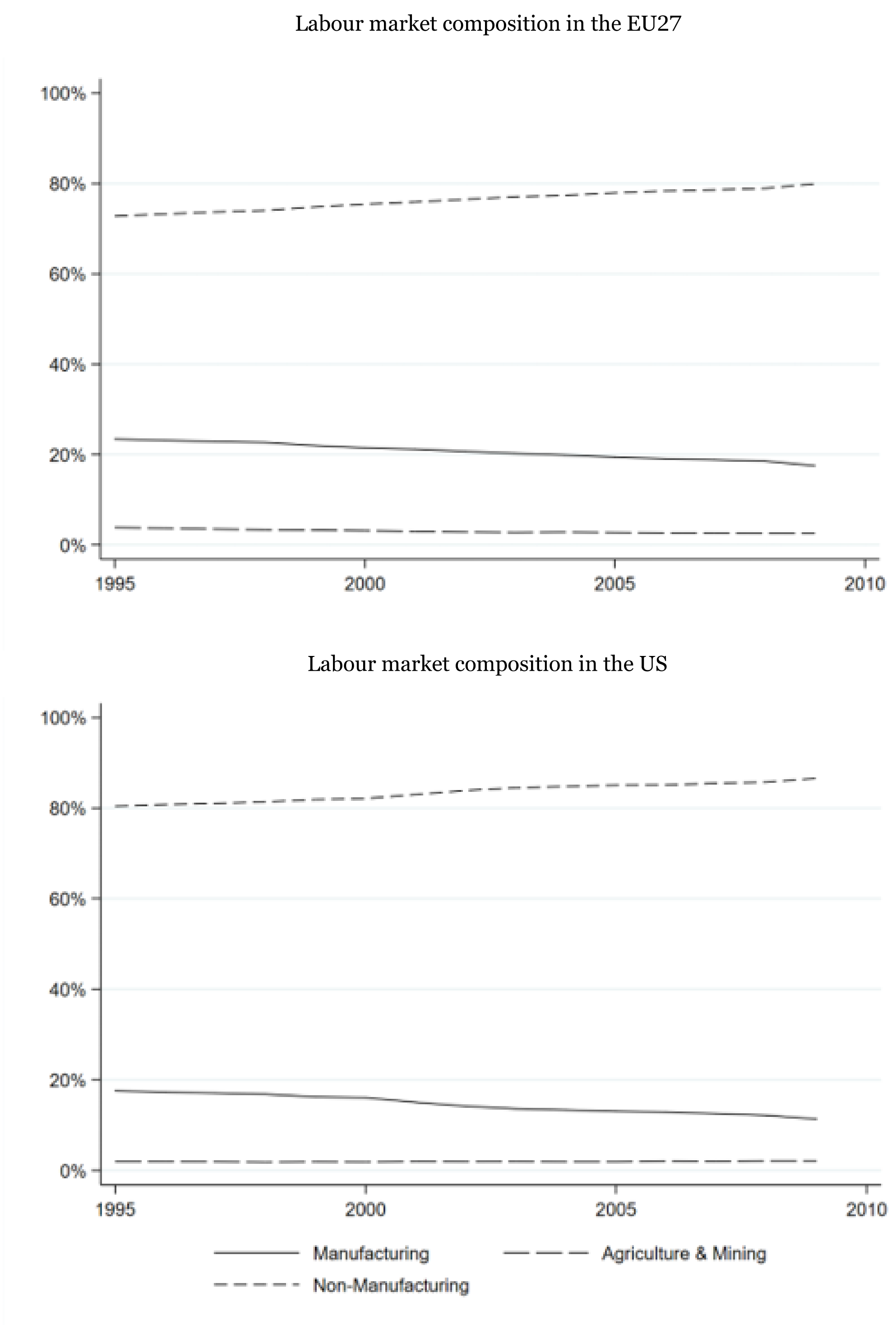


Figure 2: Composition of the labour markets (in hours worked per industry type) from China to the EU27 (Panel A) and the US (panel B)

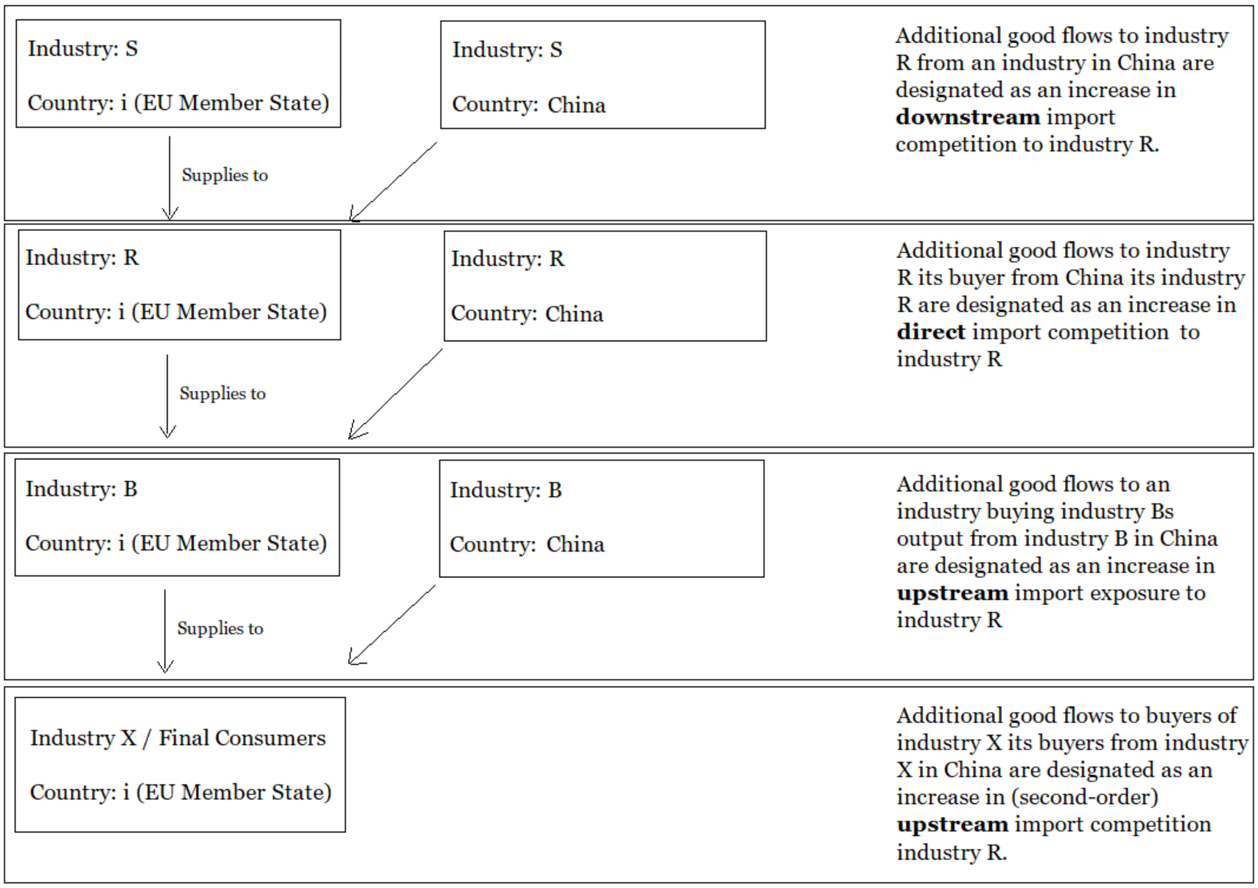


Figure 3: A visualisation of the indirect and direct import exposure as defined in III.I and III.II

Notes: Since a change in first-order upstream import competition to R can be defined as an change in the level of direct Chinese import competition to B, the intuitive idea (both behind this illustration and the derivation of these effects by Acemoglu et al. (2016)) is to weight these direct effects of downstream industries (ones buyers) by the importance of those buyers to, *in casu*, industry R. This is done by weighting the change in direct import exposure to China of all industry Bs to which industry R sells its output by the fraction of the output of industry R that each industry B buys from industry R. One can consecutively only consider weighting the direct import competition which industry R its buyers face domestically (within the same country also referred to as national) or internationally (changes in global upstream indirect import exposure). Although this procedure weights the direct import competition in downstream industries it is referred to as the change in upstream Chinese import competition as the effect propagates to upstream industries from these downstream industries (named after the destination not the origin).

Table 1: Overview of EU Member States and High Income Countries and Industries per Country in the WIOD

Countries admitted to the EU prior to 1995		Countries admitted to the EU after 2007		Countries Designated as Other High Income	
AUT	Austria	BGR	Bulgaria	AUS	Australia
BEL	Belgium	CYP	Cyprus	CAN	Canada
DEU	Germany	CZE	Czech Republic	JPN	Japan
DNK	Denmark	EST	Estonia	USA	United States
ESP	Spain	HUN	Hungary		
FIN	Finland	LTU	Lithuania		
FRA	France	LVA	Latvia		
GBR	Great Britain	MLT	Malta		
GRC	Greece	POL	Poland		
IRL	Ireland	ROM	Romania		
ITA	Italy	SVK	Slovakia		
LUX	Luxembourg	SVN	Slovenia		
NLD	Netherlands				
PRT	Portugal				
SWE	Sweden				

Non-Manufacturing Industries	Manufacturing Industries
Agriculture, Hunting, Forestry and Fishing	Food, Beverages and Tobacco
Mining and Quarrying	Textiles and Textile Products
Electricity, Gas and Water Supply	Leather, Leather and Footwear
Construction	Wood and Products of Wood and Cork
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	Pulp, Paper, Paper , Printing and Publishing
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	Coke, Refined Petroleum and Nuclear Fuel
Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	Chemicals and Chemical Products
Hotels and Restaurants	Rubber and Plastics
Inland Transport	Other Non-Metallic Mineral
Water Transport	Basic Metals and Fabricated Metal
Air Transport	Machinery, Nec
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	Electrical and Optical Equipment
Post and Telecommunications	Transport Equipment
Financial Intermediation	Manufacturing, Nec; Recycling
Real Estate Activities	
Renting of M&Eq and Other Business Activities	
Public Admin and Defence; Compulsory Social Security	
Education	
Health and Social Work	
Other Community, Social and Personal Services	
Private Households with Employed Persons	

Table 2: Descriptive Statistics of Changes in Employment by Type of Industry and Region 1995-2007

	Manufacturing Industries (N=14)					Non-Manufacturing Industries (N=21)				
	N	Mean/SD	Median	Min	Max	N	Mean/SD	Median	Min	Max
Change in Employment										
Number of Employees Employed	751	-1.117 (3.986)	-0.767	-31.661	34.439	1121	1.591 (3.571)	1.591	-30.692	36.271
Hours Worked by Persons Engaged	751	-1.148 (3.907)	-0.791	-32.200	32.093	1122	1.291 (3.433)	1.256	-30.697	34.787
Hours Worked by Low-Skill Persons Engaged	751	-3.261 (4.201)	-3.416	-32.959	31.334	1122	-0.820 (4.999)	-1.069	-31.843	32.823
Hours Worked by Medium-Skill Persons Engaged	751	-0.202 (4.427)	-0.213	-28.537	35.756	1122	1.891 (4.455)	1.500	-29.666	37.570
Hours Worked by High-Skill Persons Engaged	751	2.124 (5.384)	2.174	-28.169	38.634	1122	3.405 (5.856)	3.547	-37.480	42.382
Change in Capital (%)										
Capital Stock per Hour Worked	752	-0.023 (15.334)	3.556	-70.932	33.055	1082	2.698 (13.390)	6.279	-75.949	48.359
ICT per Hour Worked	336	10.681 (7.807)	9.924	-16.478	60.985	467	12.660 (8.129)	11.588	-25.464	55.619

	Pooled Manufacturing and Non-Manufacturing Industries (N=35)									
	EU15					EU12				
	N	Mean/SD	Median	Min	Max	N	Mean/SD	Median	Min	Max
Change in Employment										
Number of Employees Employed	1044	1.651 (2.932)	1.52	-21.65	30.364	828	-0.014 (4.571)	0.251	-31.661	36.271
Hours Worked by Persons Engaged	1044	1.332 (2.897)	1.198	-20.077	16.252	829	-0.044 (4.382)	0.295	-32.200	34.787
Hours Worked by Low-Skill Persons Engaged	1044	-1.261 (4.123)	-1.783	-19.697	19.766	829	-1.553 (5.786)	-1.375	-32.959	32.823
Hours Worked by Medium-Skill Persons Engaged	1044	2.205 (4.118)	1.736	-22.948	24.703	829	0.398 (4.824)	0.337	-29.666	37.570
Hours Worked by High-Skill Persons Engaged	1044	4.338 (4.479)	3.932	-37.48	25.859	829	1.566 (6.759)	1.830	-32.952	42.382
Change in Capital (%)										
Capital Stock per Hour Worked	1018	3.421 (7.047)	5.214	-16.283	48.359	816	0.369 (19.151)	6.335	-75.949	33.055
ICT per Hour Worked	658	12.778 (7.486)	11.511	-8.434	55.619	145	9.631 (10.190)	9.190	-25.464	60.985

Notes: Observations manufacturing are 751 (14 industries × 2 time periods × 27 member states minus industries for which employment is missing yields 751 observations). All changes in labour employment or hours worked are log annualised growth rates denoted in percentage points. Furthermore, value of ICT equipment and (real) capital stock are divided by the amount of hours worked in the industry in 1995 (the base year). All observations have been weighted by the employment share of overall employment of an industry in its member state.

Table 3: Descriptive Statistics of Changes in Direct and Indirect Chinese Import Exposure by Type of Industry 1995-2007

	Manufacturing Industries (N=14)				Non-Manufacturing Industries (N=21)			
	Mean/SD	Median	Min	Max	Mean/SD	Median	Min	Max
	Direct Import Exposure Shocks							
Direct Import Shocks								
Direct Shock	0.438 (0.888)	0.110	-0.456	8.277	0.053 (0.347)	0.000	-1.159	13.894
Instrument for Direct Shock	0.423 (0.592)	0.174	-0.033	2.617	0.014 (0.053)	0.002	-0.046	0.694
	First-Order Import Exposure Shocks							
Downstream Indirect Shocks								
Downstream (National) Shock	0.083 (0.140)	0.036	-0.016	1.405	0.037 (0.060)	0.015	-0.263	1.216
Instrument for Downstream (National) Shock	0.069 (0.092)	0.036	-0.014	0.739	0.021 (0.022)	0.012	-0.011	0.271
Downstream (Global) Shock	0.199 (0.268)	0.087	-0.011	1.688	0.073 (0.091)	0.037	-0.000	1.536
Instument for Downstream (Global) Shock	0.147 (0.200)	0.071	-0.015	1.554	0.040 (0.043)	0.026	-0.014	0.416
Upstream Indirect Shocks								
Upstream (National) Shock	0.082 (0.141)	0.028	-0.021	1.400	0.043 (0.077)	0.011	-0.203	1.156
Instrument for Upstream (National) Shock	0.076 (0.096)	0.036	-0.002	0.707	0.033 (0.049)	0.011	-0.010	0.344
Upstream (Global) Shock	0.183 (0.239)	0.078	-0.020	1.595	0.059 (0.106)	0.017	-0.142	2.740
Instument for Upstream (Global) Shock	0.141 (0.239)	0.071	-0.001	1.125	0.039 (0.055)	0.015	-0.011	0.358
	Full-Order Import Exposure Shocks							
Full (Higher-Order) Downstream Indirect Shocks								
Downstream European (National) Shock	0.126 (0.196)	0.062	-0.019	2.000	0.06 (0.087)	0.026	-0.268	1.680
Instrument for Downstream European (National) Shock	0.101 (0.125)	0.056	-0.014	1.049	0.035 (0.038)	0.021	-0.015	0.527
Downstream Global Shock	0.434 (0.462)	0.271	0.000	2.762	0.181 (0.183)	0.113	0.000	2.798
Instrument for Downstream Global Shock	0.265 (0.307)	0.162	-0.004	2.432	0.089 (0.086)	0.063	0.000	0.675
Full (Higher-Order) Global Indirect Shocks								
Upstream European (National) Shock	0.120 (0.199)	0.040	-0.023	2.003	0.072 (0.123)	0.019	-0.221	1.561
Instrument for Upstream European (National) Shock	0.108 (0.133)	0.055	-0.002	0.967	0.057 (0.080)	0.022	-0.012	0.740
Upstream Global Shock	0.406 (0.447)	0.213	0.000	2.700	0.170 (0.255)	0.065	-0.001	5.526
Instrument for Upstream Global Shock	0.251 (0.275)	0.125	0.000	1.747	0.095 (0.125)	0.040	-0.008	0.862

Notes: Observations manufacturing are 756 (14 industries × 2 time periods × 27 member states) and for manufacturing 1,134 (21 industries × 2 time periods × 27 member states). All changes in import exposure are annualised growth rates denoted in percentage points, i.e. times 100. National denotes only accounting for indirect (either upstream of downstream) import exposure stemming originating from industries within the same country (identical to the metric of Acemoglu et al. (2016)), whilst European linkages implies that the rippling effect down or upstream from other EU member states their industries have been accounted for. Finally Global indirect effects refer to taking into consideration Chinese import competition in non-EU member states as well (i.e. to compute the effect of Chinese competition in export or import markets). Full-order or higher-order linkages are as explained in the text and appendix A. All observations have been weighted by the employment share of overall employment of an industry in its member state.

Table 5: 2SLS estimates of the Direct Chinese Import Exposure Effect by Industry type and EU Membership Admittance 1995-2007

	Manufacturing EU15	Non-Manufacturing EU15	Manufacturing EU27 excl. EU15	Non-Manufacturing EU27 excl. EU15
	(1)	(2)	(3)	(4)
Change in EU exposure to Imports from China	-1.748***	-5.624***	-1.415	-1.708
	(0.671)	(2.105)	(1.131)	(2.093)
1{2000-2007}	-0.780***	-0.259	2.992***	2.093***
	(0.294)	(0.202)	(0.776)	(0.441)
Time fixed effects	Yes	Yes	Yes	Yes
Only EU15	Yes	Yes	No	No
Only EU27 excl. EU15	No	No	Yes	Yes
Number of Observations	416	628	334	492
Estimation Method	2SLS	2SLS	2SLS	2SLS
Kleibergen-Paap LM Statistic	20.896***	9.963***	12.454***	9.594***
Kleibergen-Paap Wald F-Statistic	53.055	9.665	13.005	10.459
Partial R-Squared of the Direct Effect	0.534	0.083	0.277	0.087

Notes: All specifications, (1) through (4), have as dependent variable the log annual change in industry employment × 100. The change in EU exposure to Imports from China have been multiplied by 100 such that the variable of interest is in percentage points of the beginning of period industry absorption (see text). Number of observations are as described in table (3) and some observations, one in manufacturing and 1 in non-manufacturing were dropped as they had only an observation in either 1995-2000 or 2000-2007 (that is within variation was none existent). Countries in the EU15 and in the EU27 excl. EU15 are as described in table (2). All variables are weighted by industry employment as a share of overall employment in the relevant member state and the clustering of standard errors in parentheses are by country-industry pairs (number of observations divided by 2).). Significance at the 1% level is denoted by ***, at the 5% level with ** and at the 10% level with *.

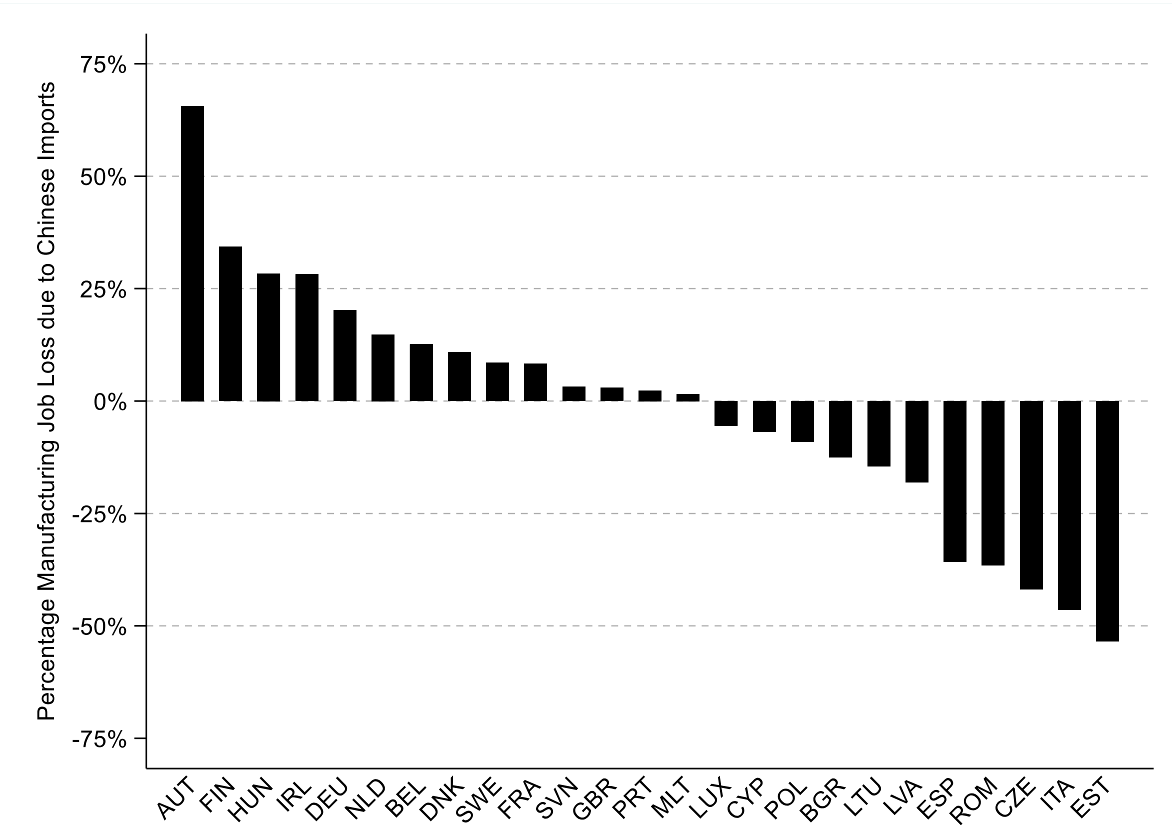


Figure 5: Total Manufacturing job loss due to trade with China between 2000 and 2007 as a fraction of observed manufacturing job loss over the period 2000 till 2007 as per table 6.

Notes: Negative values indicate that despite the direct employment effect of rising Chinese import competition being negative the overall number of workers employed in the manufacturing industry has been positive between 2000-2007. Large positive values indicate that the trade with China induced job loss in manufacturing industries was some manifold of the overall job loss in manufacturing industries. Greece and Slovakia have been omitted for readability as those countries had that the trade with China induced job loss in manufacturing industries as a fraction of overall job loss in manufacturing industries between 2000-2007 exceeded respective 200 and 600 percentage points.

Table 6.1: Direct and (First- and Full-Order) Indirect Chinese Import Exposure Effect on Industry-Level Employment using 2SLS with time fixed effects only.

	Manufacturing			Non-Manufacturing			Pooled Manufacturing and Non-Manufacturing			Pooled EU15	Pooled EU27 excl. EU15
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	First-Order Indirect Effects (A)										
Change in EU exposure to Imports from China	-1.023	-0.936		-3.282**	-4.057***		-0.664	-1.347*		-1.555*	-0.792
	(0.811)	(0.982)		(1.551)	(1.568)		(0.615)	(0.760)		(0.843)	(1.038)
Change in Upstream (national) exposure to Imports from China	-4.078	-3.115	-2.821	-5.687*	-6.511**	-7.500***	-4.875*	-6.957***	-7.376***	-7.720***	-3.403
	(5.162)	(4.664)	(4.883)	(3.020)	(2.966)	(2.909)	(2.664)	(2.553)	(2.635)	(2.509)	(3.828)
Change in Downstream (national) exposure to Imports from China		-1.677	-6.471		16.220*	15.863**		8.13	1.416	-1.929	2.256
		(8.379)	(6.910)		(8.602)	(8.092)		(5.763)	(4.485)	(6.773)	(8.147)
	Full-Order Indirect Effects (B)										
Change in EU exposure to Imports from China	-1.192	-1.122		-3.419**	-3.926**		-0.84	-1.431**		-1.621**	-0.909
	(0.772)	(-1.110)		(1.584)	(1.561)		(0.600)	(0.682)		(0.753)	(0.955)
Change in Upstream (national) exposure to Imports from China	-1.755	-1.103	-0.623	-2.994	-3.746**	-4.410**	-2.533	-3.940**	-4.120**	-5.642***	-1.199
	(3.091)	(2.940)	(3.094)	(1.869)	(1.840)	(1.782)	(1.590)	(1.592)	(1.646)	(1.726)	(2.165)
Change in Downstream (national) exposure to Imports from China		-1.103	-4.984		8.965*	9.818**		5.393	0.880	-1.958	1.206
		(5.202)	(4.704)		(4.881)	(4.732)		(3.343)	(2.895)	(4.401)	(4.608)
	Model Specifications										
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Only EU15	No	No	No	No	No	No	No	No	No	Yes	No
Only EU27 excl. EU15	No	No	No	No	No	No	No	No	No	No	Yes
Number of Observations	750	750	750	1120	1120	1120	1870	1870	1870	1044	826
Estimation Method	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS

Notes: All specifications, (1) through (11), have as dependent variable the log annual change in industry employment × 100. The change in EU exposure to Imports from China have been multiplied by 100 such that the variable of interest is in percentage points of the beginning of period industry absorption (see text). Number of observations are as described in table 3 and some observations, one in manufacturing and 1 in non-manufacturing were dropped as they had only an observation in either 1995-2000 or 2000-2007 (that is within variation was none existent). Countries in the EU15 and in the EU27 excl. EU15 are as described in table 2. National refers to accounting only for domestic indirect up- and downstream shocks (allowing for Chinese competition in the domestic market only). All variables are weighted by industry employment as a share of overall employment in the relevant member state and the standard errors in parentheses are clustered on the country-industry level (number of observations divided by 2). Significance at the 1% level is denoted by ***, at the 5% level with ** and at the 10% level with *.

Table 6.2: Corresponding statistics of the specifications as put forth in table 6.1 together with the partial R^2's of each channel

	Manufacturing			Non-Manufacturing			Pooled Manufacturing and Non-Manufacturing			Pooled EU15	Pooled EU27 excl. EU15
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	First-Order Indirect Effects (A)										
Kleibergen-Paap LM Statistic	22.583***	16.182***	15.099***	19.583***	21.039***	24.224***	34.620***	38.418***	28.077***	26.915***	28.094***
Kleibergen-Paap Wald F-Statistic	12.785	7.237	10.901	10.057	7.398	22.033	24.461	32.119	22.05	7.748	18.157
Partial R-Squared of the Direct Effect	0.323	0.325		0.084	0.085		0.338	0.339		0.379	0.345
Partial R-Squared of the Upstream Indirect Effect	0.333	0.333	0.333	0.489	0.490	0.490	0.440	0.441	0.441	0.549	0.493
Partial R-Squared of the Downstream Indirect Effect		0.286	0.286		0.143	0.139		0.307	0.307	0.265	0.374
	Full-Order Indirect Effects (B)										
Kleibergen-Paap LM Statistic	22.790***	16.737***	14.097***	19.555***	20.443***	27.397***	34.823***	49.165***	29.299***	26.684***	23.364***
Kleibergen-Paap Wald F-Statistic	13.704	7.966	12.407	10.046	7.137	27.814	24.958	44.627	27.017	7.128	10.836
Partial R-Squared of the Direct Effect	0.323	0.325		0.084	0.086		0.338	0.339		0.379	0.346
Partial R-Squared of the Upstream Indirect Effect	0.373	0.373	0.371	0.542	0.543	0.543	0.485	0.486	0.484	0.577	0.596
Partial R-Squared of the Downstream Indirect Effect		0.304	0.303		0.218	0.215		0.344	0.334	0.288	0.438

Notes: The above table provides both the relevant Kleibergen-Paap (heteroskedasticity robust) statistics and the partial R^2's of each channel corresponding to the specifications in table 6.1. All observations are weighted by industry employment as a share of overall employment in the relevant member state and the standard errors in parentheses are clustered on the country-industry level (number of observations divided by 2). Significance at the 1% level is denoted by ***, at the 5% level with ** and at the 10% level with *.

Table 7: Direct and (First- and Full-Order) Indirect Effects of Rises in Chinese Import Competition on Industry-Level Employment Growth by Region and Industry Type.

	Manufacturing EU15	Non-Manufacturing EU15	Manufacturing EU27 excl. EU15	Non-Manufacturing EU27 excl. EU15
	(1)	(2)	(3)	(4)
	First-Order Indirect Effects (1.A)			
Change in EU exposure to Imports from China	-1.218	-4.414**	-0.582	-2.518
	(1.007)	(2.180)	(1.369)	(2.203)
Change in Upstream (national) exposure to Imports from China	-0.852	-8.705***	-4.068	-1.885
	(4.116)	(3.020)	(6.603)	(4.736)
Change in Downstream (national) exposure to Imports from China	-7.252	-4.060	-4.643	15.541
	(8.779)	(12.982)	(11.048)	(11.402)
	Full-Order Indirect Effects (1.B)			
Change in EU exposure to Imports from China	-1.364	-4.115**	-0.898	-2.180
	(0.873)	(2.032)	(1.313)	(2.125)
Change in Upstream (national) exposure to Imports from China	-1.153	-6.337***	0.045	-0.853
	(2.761)	(2.046)	(4.071)	(2.493)
Change in Downstream (national) exposure to Imports from China	-4.612	-4.478	-4.487	6.734
	(5.924)	(8.109)	(7.000)	(6.122)
	Model Specifications			
Time fixed effects	Yes	Yes	Yes	Yes
Only EU15	Yes	Yes	No	No
Only EU27 excl. EU15	No	No	Yes	Yes
Number of Observations	416	628	334	492
Estimation Method	2SLS	2SLS	2SLS	2SLS
	First-Order Indirect Effects (2.A)			
Kleibergen-Paap LM Statistic	13.715***	13.414***	13.310***	9.225***
Kleibergen-Paap Wald F-Statistic	3.072	4.181	4.768	3.588
Partial R-Squared of the Direct Effect	0.617	0.085	0.285	0.089
Partial R-Squared of the Upstream Indirect Effect	0.484	0.574	0.397	0.529
Partial R-Squared of the Downstream Indirect Effect	0.374	0.096	0.349	0.188
	Full-Order Indirect Effects (2.B)			
Kleibergen-Paap LM Statistic	12.982***	10.350***	12.900***	9.289***
Kleibergen-Paap Wald F-Statistic	2.968	3.318	4.484	3.556
Partial R-Squared of the Direct Effect	0.618	0.086	0.288	0.0909
Partial R-Squared of the Upstream Indirect Effect	0.505	0.604	0.480	0.666
Partial R-Squared of the Downstream Indirect Effect	0.351	0.131	0.403	0.288

Notes: : All specifications have as dependent variable the log annual change in industry employment × 100. The change in EU exposure to Imports from China, both direct and indirect, have been multiplied by 100 such that the variable of interest is in percentage points of the beginning of period industry absorption (see text). Countries in the EU15 and in the EU27 excl. EU15 are as described in table 2. National indirect effects refer to accounting only for domestic indirect up- and downstream shocks (allowing for Chinese competition in the domestic market only). Panel 1.A and 1.B provide the point estimates and standard errors in parentheses (weighted by fraction of employment to overall, that is nationwide, employment) of the direct and indirect effects of increases in Chinese import exposure. Panel 1.A provides the first order estimates and panel 1.B provides the full-order estimates. The above table also incorporates the relevant Kleibergen-Paap (heteroskedasticity robust) statistics as well as the partial R^2's of each channel in panels 2.A and 2.B, corresponding to the specifications in panels 1.A and 1.B respectively. Significance at the 1% level is denoted by ***, at the 5% level with ** and at the 10% level with *.

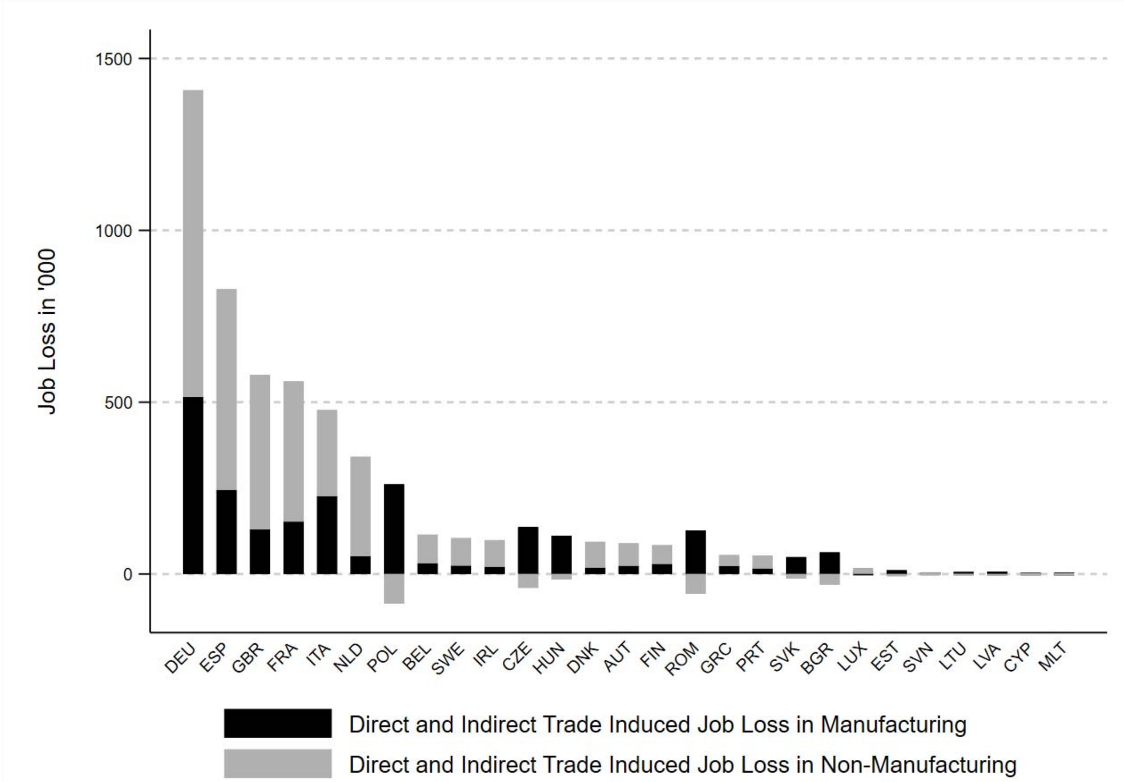


Figure 6: Total direct and indirect absolute job loss due to trade with China between 2000 and 2007 as per table 8

Notes: Negative job losses imply increases of the number of workers in that sector.

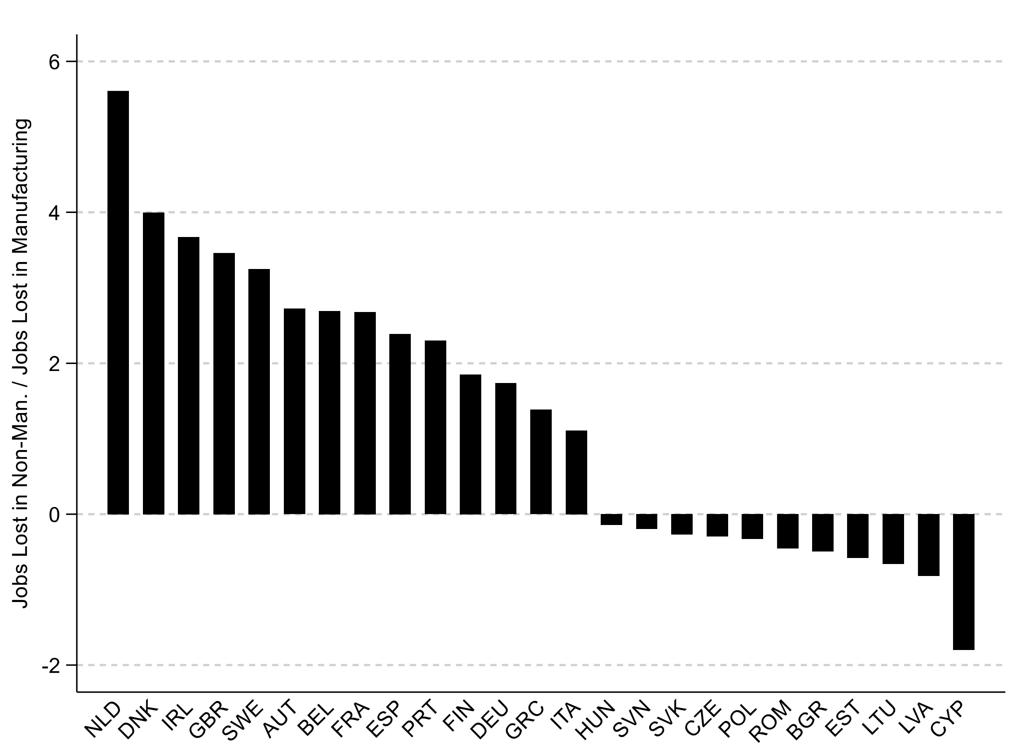


Figure 7: Total direct and indirect absolute job loss in non-manufacturing as a fraction of the total direct and indirect absolute job loss in nonmanufacturing industries due to increasing Chinese imports between 2000 and 2007.

Notes: Negative fractions imply that for each job lost in manufacturing, x jobs were gained in the non-manufacturing industries (EU12 members).

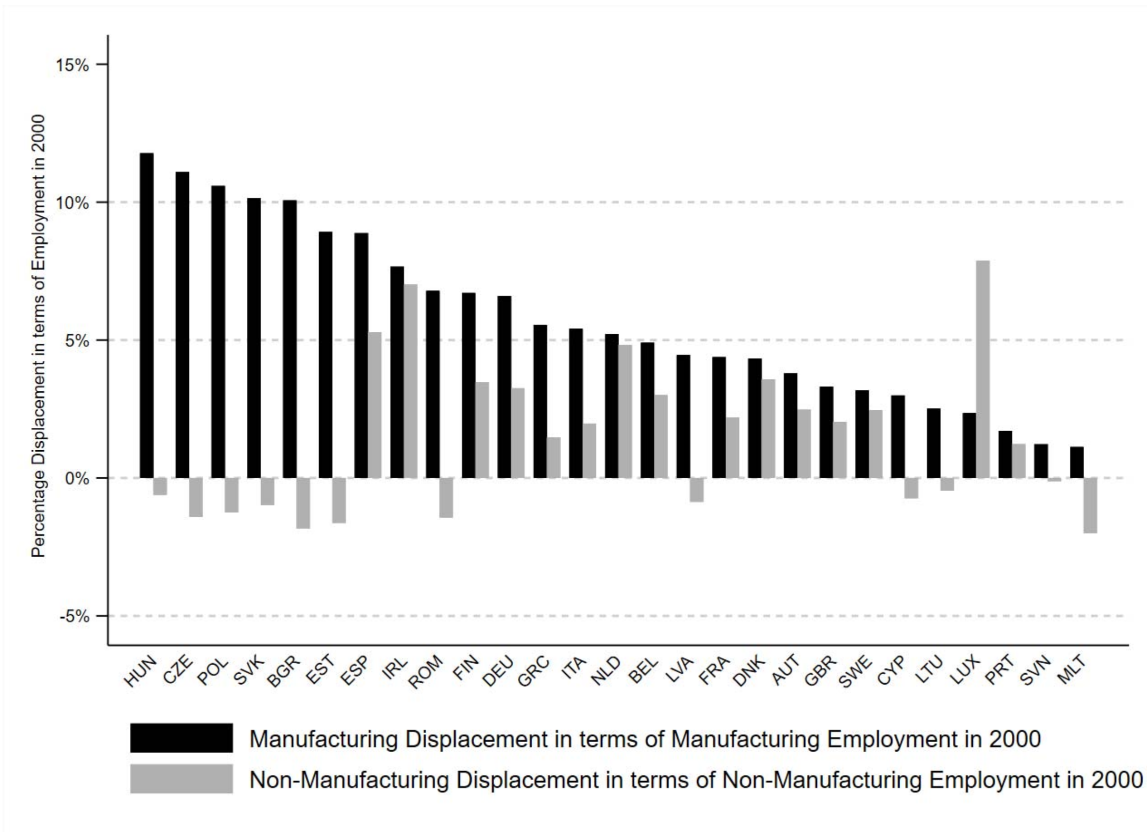


Figure 8: Total direct and indirect job loss attributable to Chinese import competition spanning the period 2000 till 2007 as a fraction of employment at the start of said period (i.e. in the year 2000).

Notes: This figure shows that (par example) about 10% of the jobs of manufacturing employees in 2000 have been lost in Slovakia and Bulgaria as a result of either direct or indirect Chinese import competition

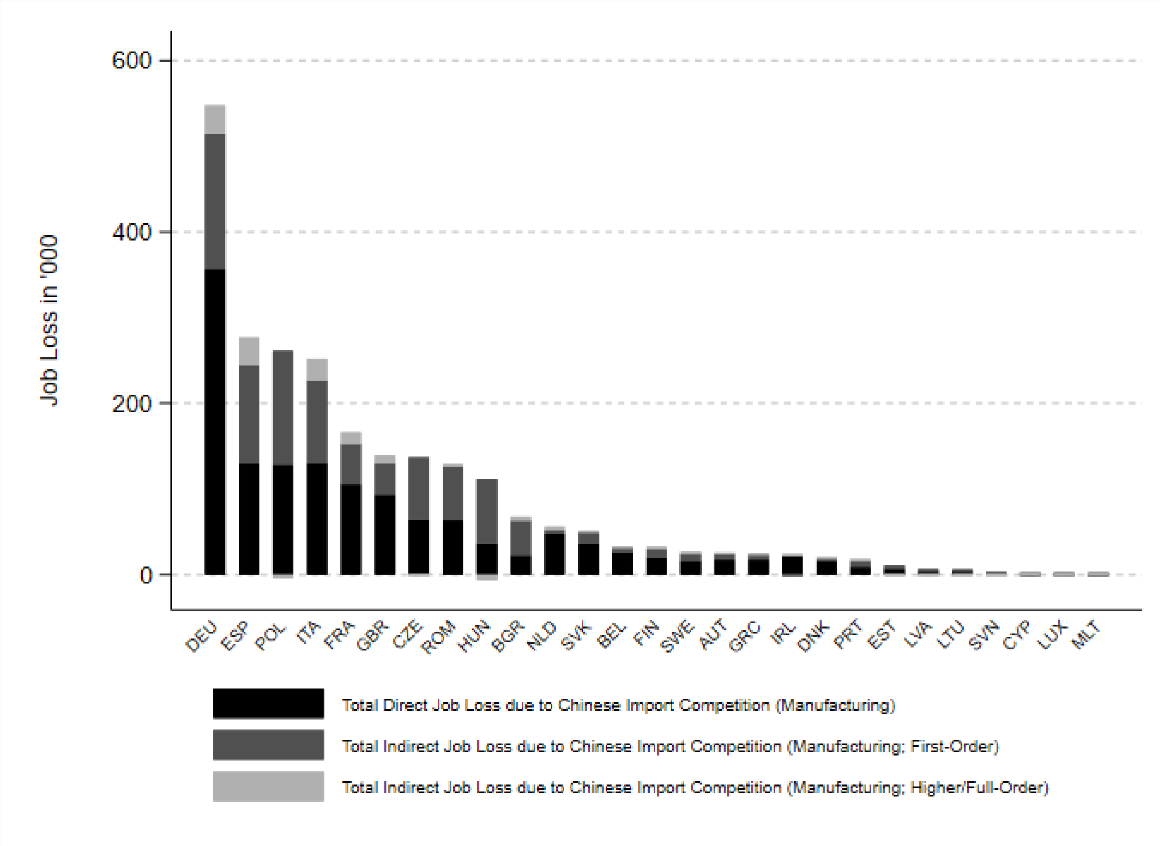


Figure 9: Total direct and indirect job loss attributable to Chinese import competition spanning the period 2000 till 2007 decomposed into higher-order, first-order and direct effects as per tables (6 and 8) for manufacturing job loss.

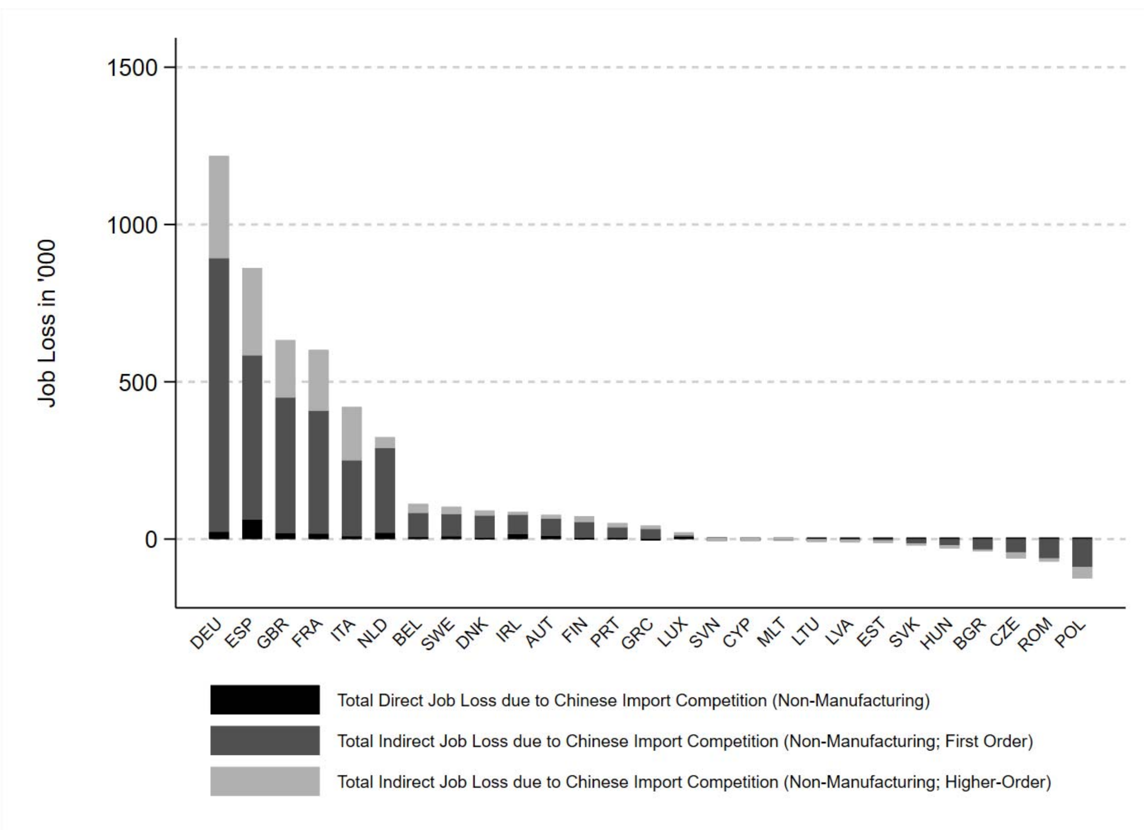


Figure 10: Total direct and indirect job loss attributable to Chinese import competition spanning the period 2000 till 2007 decomposed into higher-order, first-order and direct effects as per tables (6 and 8) for non-manufacturing job loss.

Table 8: Direct and (First- and Full-Order) Indirect Effects of Rises in Chinese Import Competition on Industry-Level Hours Worked per Skill Type Growth split up by Region and Industry Type consistent with table 6 and 8.

	Compounded Direct Effect				Compounded Indirect Effect (First-Order)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable: Hours Worked by Low-Skilled Workers (A)								
Change in EU exposure to Imports from China	-2.005**	-6.577**	-1.801	-5.052*	-1.581	-1.981	-0.619	-6.562**
	(0.856)	(3.079)	(1.195)	(2.994)	(1.301)	(4.021)	(1.524)	(3.089)
Change in Upstream (national) exposure to Imports from China					-5.078	-17.674**	1.866	-1.22
					(5.846)	(7.761)	(7.585)	(7.641)
Change in Downstream (national) exposure to Imports from China					-2.839	-52.015*	-12.559	27.981
					(11.713)	(30.298)	(12.569)	(20.319)
Dependent Variable: Hours Worked by Medium-Skilled Workers (B)								
Change in EU exposure to Imports from China	-1.258*	-7.520***	-1.075	-1.582	-1.864**	-8.771***	-0.049	-3.422
	(0.734)	(2.649)	(1.017)	(2.048)	(0.834)	(2.896)	(1.336)	(2.408)
Change in Upstream (national) exposure to Imports from China					0.998	-2.966	-3.204	-9.665
					(5.474)	(5.891)	(7.913)	(6.284)
Change in Downstream (national) exposure to Imports from China					8.269	32.622	-7.134	37.674**
					(10.119)	(22.058)	(12.919)	(15.221)
Dependent Variable: Hours Worked by High-Skilled Workers (C)								
Change in EU exposure to Imports from China	-1.743*	-7.689***	-0.823	-4.835	-0.344	-8.489**	-2.102	-5.444*
	(0.985)	(2.799)	(1.318)	(3.031)	(1.490)	(4.018)	(1.926)	(3.250)
Change in Upstream (national) exposure to Imports from China					1.529	8.839	-8.403	15.26
					(6.528)	(14.352)	(8.293)	(11.539)
Change in Downstream (national) exposure to Imports from China					-21.662	-4.633	18.591	4.35
					(13.274)	(29.610)	(18.591)	(26.170)
Model Specifications								
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Including EU15	Yes	Yes	No	No	Yes	Yes	No	No
Including EU27 except EU15	No	No	Yes	Yes	No	No	Yes	Yes
Including Manufacturing	Yes	No	Yes	No	Yes	No	Yes	No
Including Non-Manufacturing	No	Yes	No	Yes	No	Yes	No	Yes
Number of Observations	416	628	334	492	416	628	334	492
Estimation Method	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS

Notes: All specifications have as dependent variable the log annual change in hours worked per skill type × 100 depending on the panel. Skill type is classified according to 1997 ISCED levels: Low-Skilled (categories 1 and 2, equivalent to primary or lower second stage education), Medium-Skilled (categories 3 and 4, i.e. upper secondary education or post-secondary non-tertiary education) and High-Skilled (categories 5 and 6, i.e. first and second stage of tertiary education). The change in EU exposure to Imports from China, both direct and indirect, have been multiplied by 100 such that the variable of interest is in percentage points of the beginning of period industry absorption (see text). Countries in the EU15 and in the EU27 excl. EU15 are as described in table 2. National indirect effects refer to accounting only for domestic indirect up- and downstream shocks (allowing for Chinese competition in the domestic market only. All observations are weighted by the industry employment as a fraction of nationwide employment. Significance at the 1% level is denoted by ***, at the 5% level with ** and at the 10% level with *.

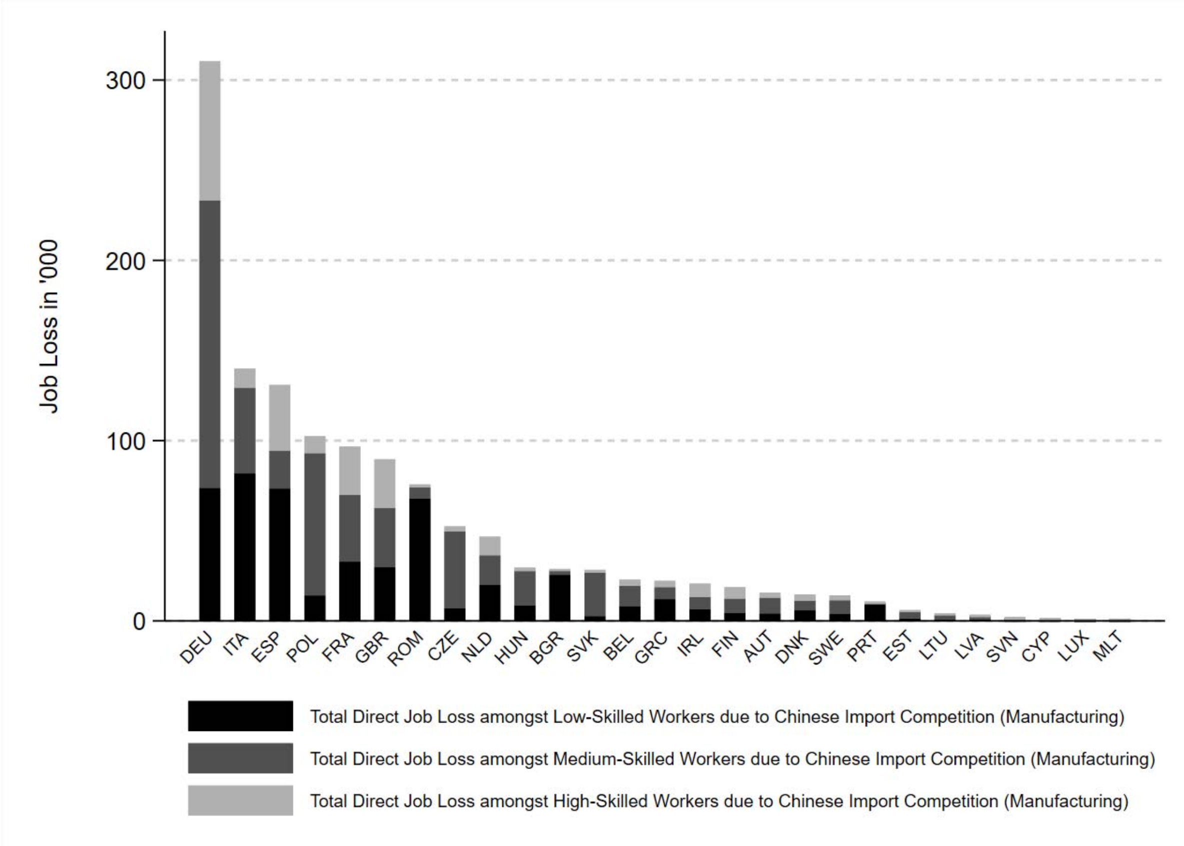


Figure 11: Total Direct Loss in FTE attributable to rises in Chinese Import Competition between 2000 and 2007 as implied by specifications (1) through (4) of table 9.

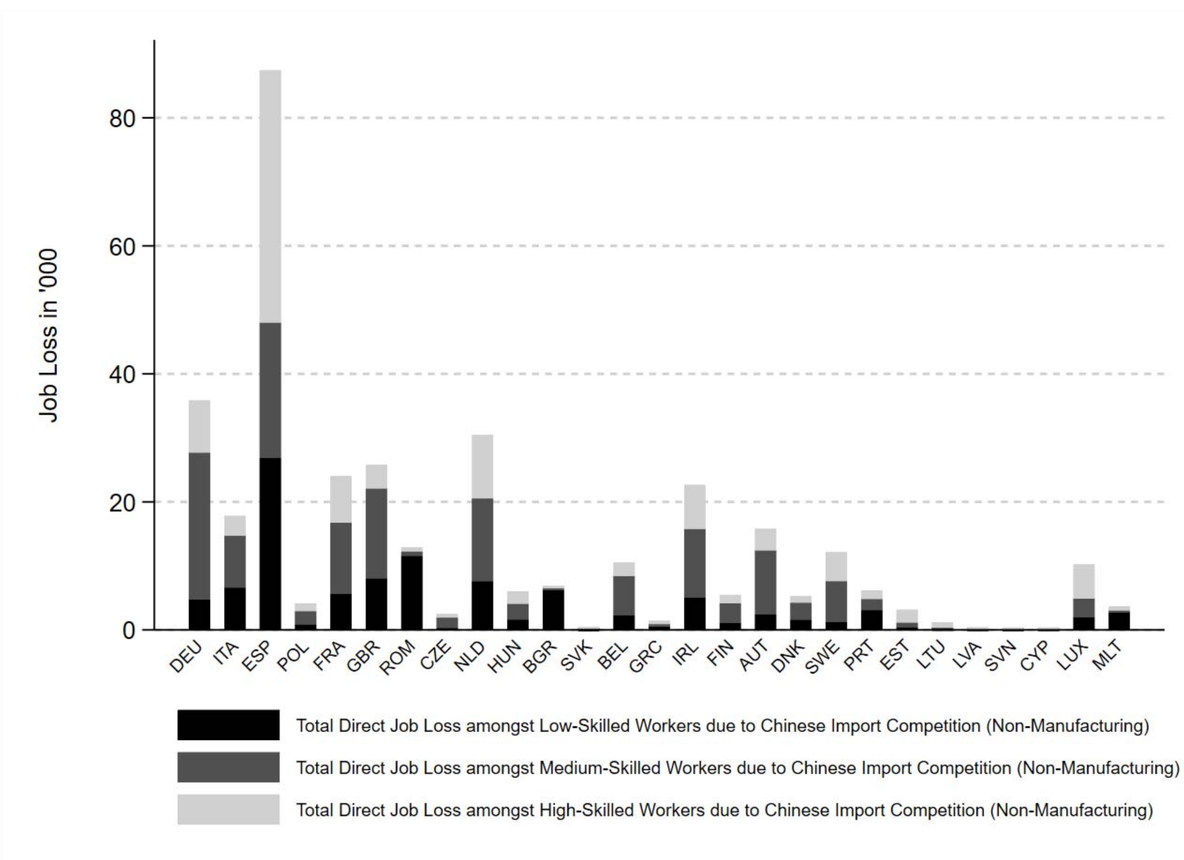


Figure 12: Total Direct Loss in FTE attributable to rises in Chinese Import Competition between 2000 and 2007 as implied by specifications (1) through (4) of table 9.

End Notes – Historical Background

[i] Prior to the 1980s trade was primarily in final goods (Feenstra, 2016). However, since the 1980s trade in intermediates has starkly increased due to tariff barriers being eliminated across the globe and this spurred new modelling by Feenstra and Hanson (1996; 1997). Moreover, as a result of advances in both information and communication technology services (amongst which IT) increased in tradability in the 1990s and lead to the overseas procurement thereof expanding the set of traded intermediates. Lastly, due to further reduced barriers to trade the globalisation of production processes was further promoted as even individual production tasks are being offshored which has been theoretically modelled by Grossman and Rossi-Hansberg (2008).

[ii] This shift primarily occurred in the search of the potential roots of the US employment downturn in the 7 years leading up to the great recession in 2007, undoing the staggering employment growth in the 1990s (Moffitt, 2012). Autor (2010) finds that labour demand contractions are the primary culprits. Autor, Dorn and Hanson (2013) and Acemoglu, Autor, Dorn, Hanson and Price (2016) go on to document that Chinese imports are an important determinant of these labour demand contractions as about 20% of manufacturing employment decline can be attributed to increased imports from China. Hence, trade-induced unemployment has increasingly taken a centre-stage role.