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Revisiting the Effective Rate of Protection in the Late Stages of Chinese Industrialisation

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1. INTRODUCTION

RECENT experience with the global financial crisis has called into question the role of global imbalances in exacerbating financial fragility and, thus, the prospect of generating future crises (Taylor, 2014). Generally, this perspective emphasises policy distortions, particularly those in China and the United States, which gave rise to unprecedented current account surpluses and deficits, respectively (Ferguson and Schularick, 2007). In the case of China, particular concern has been expressed with respect to export promotion through the use of an undervalued nominal exchange rate and accommodative trade policy. Leaving aside consideration of the exchange rate, economists have long struggled with developing summary measures of protectionism as statistics such as the simple or value-weighted averages of tariffs have long been known to be theoretically unsound and usually plagued by serious bias (Rodriguez and Rodrik, 2001).

In this paper, we revisit the effective rate of protection (ERP), arguing that this insightful but at times problematic approach is increasingly relevant in world economy predominated by trade in tasks and in value added (Johnson and Noguera, 2012). In particular, we extend the conventional framework of the effective rate of protection (Corden, 1966) by relaxing its most binding assumptions. First, we decompose the incidence of tariffs on import demanders and, from there, estimate the pass-through to domestic producers. Second, we conceptually incorporate multiple stages of production and, from there, capture the iterated use of intermediate inputs using elements of the inverse Leontief matrix as measures of cumulative input intensity. At the same time, we show that our new measure of the effective rate of protection retains the most attractive feature of the conventional measure, namely its ease of application to readily obtainable data.

Our next step is to confront the theory with data by applying our new measure to China in the period from 1992 to 2010. Naturally, China is an interesting case study for a few reasons. First, this period marks China's transition from relatively limited international engagement to its present role as the world's largest exporter and the world's second largest importer. Second, a critical part of China's miraculous growth in this period has not simply been international trade, but rather the degree to which China has been able to embed itself at the very centre of the global supply chain. In this case, multiple and well-articulated stages of production as well as the repeated use of the same intermediate inputs are more common than not. Thus, a comparison of our measure of the effective rate of protection with more conventional ones can help us understand the degree of bias induced by maintaining their more restrictive assumptions. Our results indicate that the conventional effective rates of protection largely overstate the degree of protectionism afforded by Chinese import tariffs.[1] Furthermore, the new measures are also related to industry characteristics in sensible ways, calling into question the applicability of conventional measures in the context of present-day China.

2. TWO APPROACHES TO MEASURING PROTECTIONISM

Traditionally, there have been two main approaches to measuring protectionism in a summary form. One of these comes under the rubric of a trade restrictiveness index (or TRI) which approaches the question from the standpoint of import demanders. The goal of this method is in calculating the counterfactual, uniform tariff that would need to be applied to all imports in the same industry/sector/economy in order to generate the same welfare effects as the existing set of product-specific (that is, non-uniform) tariffs. Anderson and Neary (1992, 1994, 1996) are the key contribution to the literature, grounding the analysis in general equilibrium terms. Conveniently, Feenstra (1995) proposes a partial equilibrium framework which has allowed for the ready calculation of a TRI with highly disaggregated trade data and for a burgeoning related literature. For example, Kee et al. (2008, 2009) apply Feenstra's formulation to investigate multicountry tariff and non-tariff barriers. Likewise, Irwin (2010) provides an annual estimate of Feenstra's TRI for the United States from 1867 to 1961 while Chen and Ma (2012) do so for China from 1997 to 2008, finding more significant effects related to its accession into the WTO than conventional measures. Finally, Chen and Ma (2014) propose a generalised form of the TRI which relaxes its small-economy assumptions.

The TRI has clearly enjoyed marked success in providing researchers with a tractable and theoretically consistent summary measure of protectionism. However, due to fundamental changes in global trade and, in particular, the rise of globally fragmented production processes, it is argued that our notion of protection should incorporate trade in value added as opposed to trade in final goods (see, among others, Hummels et al., 2001; Hanson et al., 2005). As a result, we argue that it is worthwhile revisiting an older approach to measuring protectionism, namely the effective rate of protection (ERP) which emphasises the impact of tariff on domestic producers. The basic idea of the ERP is to measure the share of additional value added to domestic producers which is due to tariff protection relative to the total domestic value added under free trade. Corden (1966) is one of the earliest attempts to provide a theoretical framework for the ERP. However, his formulation relies on a few strong assumptions. First, the production technology must be Leontief in form (that is, input intensities must be fixed). Second, for those countries imposing tariffs, the small-country assumption is invoked, implying that tariff pass-through is complete. Finally, production is simply a one-step process such that output will not be used in successive stages of production.

Naturally, Corden's original work, while well received, was not without its critics (Ethier, 1977). Yet most of this criticism focuses on the first assumption, arguing that Leontief-type technologies are likely to exist only in the short run when adjustments induced by tariff changes do not have time to take place. It has been accordingly argued that to relax this first assumption, one should take into account the input reallocation effect due to tariff changes

[1] Note that our ERP measure solely relies on tariffs, which may bias the estimation on effective protection, in particular when reduced tariffs and 'old' forms of non-tariff measures (NTMs) are replaced with new forms of protection (Milner, 2013). We discuss the implications of NTMs in Section 6.

(Grubel and Lloyd, 1970) and preferably in a general equilibrium setting (Anderson, 1970; Bhagwati and Srinivasan, 1973). Taylor and Black (1974) and Anderson (1998) propose measures of ERP grounded in general equilibrium analysis. However, these measures – just like their general equilibrium TRI counterparts – prove empirically intractable when confronted with highly disaggregated production, tariff and trade data.

Despite this caveat, the conventional measure of the ERP continues to be widely applied in empirical studies (cf. Greenaway and Milner, 2003; Anderson, 2011). At the same time, very little attention has been paid to addressing the second and third assumptions underlying the conventional ERP. For example, empirical work has repeatedly shown that countries rarely face world supply curves with infinite elasticities. By assuming perfect pass-through, conventional ERPs may overestimate the degree of protection to domestic producers, especially in the context of large economies. Moreover, as the production process becomes increasingly fragmented across international borders, an intermediate input can be used, directly and indirectly, many times over before final goods are consumed and/or exported. Thus, assuming a simple one-step production process and directly applying input intensities from input–output tables may result in an misleading estimate of protection. That is, tariff protection on intermediate inputs strongly counteracts protection on final output, and this effect only increases as the stages of production multiply. Given these concerns, it is possible that the second and third assumptions acting in combination may generate even more bias than the well-known input reallocation effects in general equilibrium. To this end, we turn to Chinese data to establish the scale of the problem.

3. DATA AND CONCORDANCE

To calculate the conventional measure of the ERP, data on tariff and production – usually based on an IO table – are required. In addition, our proposed measure of the ERP, which is detailed below, requires estimates of trade elasticities to calculate tariff pass-through. For our purposes, the structure of production is based on the 1995, 2002 and 2007 input–output tables produced by the National Bureau of Statistics of China (NBSC). It covers 33 sectors in total, in which 16 are tradable sectors.[2] Using a moving average method, the NBSC also provides annual IO tables from 1995 to 2010 based on the three complete IO tables mentioned above. To exploit the full set of trade data at our disposal, we assume that the structure of production from 1992 to 1994 is the same as in 1995.

Estimating export and import elasticities has always been a challenge for empirical trade economists. Recently, two approaches have seen wide application. Feenstra (1994) provides an approach to estimate the unbiased export supply and import demand elasticities simultaneously. Broda and Weinstein (2006) improve on this methodology by adding a weighted scheme such that the estimation is best linear unbiased estimator (BLUE). Another approach

[2] Particularly, the 16 tradable sectors are agriculture, hunting, forestry and fishing, mining and quarrying, food, beverages and tobacco, textiles and textile products, leather, leather and footwear, wood and products of wood and cork, pulp, paper, paper, printing and publishing, coke, refined petroleum & nuclear fuel, chemicals and chemical products, rubber and plastics, other non-metallic mineral, basic metals and fabricated metal, machinery, nec, electrical and optical equipment, transport equipment, manufacturing, nec; recycling. The 17th sector, electricity, gas and water supply, also has some tradable goods, but they only account for less than 1.5 per cent of the total tradable goods in China. Thus, we treat this sector as a non-tradable one.

TABLE 1
Import and Export Elasticities for China's Imports

Sector	*Omega*	*Sigma*	*Pass-through Ratio*
Agriculture, hunting, forestry and fishing	2.19	3.24	0.14
Mining and quarrying	0.83	2.88	0.24
Food, beverages and tobacco	0.75	4.49	0.25
Textiles and textile products	1.36	3.94	0.16
Leather, leather and footwear	2.26	3.36	0.17
Wood and products of wood and cork	3.54	2.75	0.06
Pulp, paper, paper, printing and publishing	0.75	6.05	0.19
Coke, refined petroleum & nuclear fuel	9.99	3.73	0.01
Chemicals and chemical products	1.46	3.99	0.15
Rubber and plastics	1.20	3.67	0.15
Other non-metallic mineral	3.05	3.19	0.10
Basic metals and fabricated metal	0.92	5.00	0.17
Machinery, nec	32.62	3.01	0.01
Electrical and optical equipment	43.23	2.75	0.01
Transport equipment	2.11	5.00	0.18
Manufacturing, nec; recycling	3.26	4.69	0.06

Source: Broda et al. (2006, 2008).

is proposed by Kee et al. (2008) which is based on a translog multi-industry production function. However, the former approach is more suitable for our purposes since it can generate estimates for both export and import elasticities for the same imported goods. In particular, Broda et al. (2006) estimate import demand elasticities for 73 countries including China at the three-digit HS level. Based on the same data and methodology, Broda et al. (2008) estimate export supply elasticities facing 15 non-WTO (as of 1995) countries including China at the four-digit HS level. Thus, we adopt the estimates for China from these two studies in our calculation of the ERP.

Table 1 summarises the export and import elasticities for China's 16 tradable sectors. Columns (2) and (3) report the median values of import demand and inverse export elasticities facing China (σ and ω, respectively). A high sigma indicates that varieties are less differentiated. While a high omega or low export supply elasticity reflects the country may have larger market power over the foreign export suppliers in the sector. For instance, electrical and optical equipment has the lowest export elasticities (i.e. highest omega), which indicate that China has the strongest influence on the import prices in this category among the 16 tradable sectors. At the same time, wood and products of wood and cork has the lowest import elasticities, which indicates that the imports in this sector have the highest level of differentiation to the import demanders. More importantly, combining the two elasticities, we can obtain the linear approximation of the tariff pass-through, $\left(\frac{\varepsilon}{\varepsilon+\sigma}\right)$. According to the pass-through ratio in column (4), the lowest values are found in machinery, nec. and electrical and optical equipment, and electricity whereas coke, refined petroleum & nuclear fuel finds has the highest value. Overall, China's tariff pass-through is small, indicating that China is a large importer such that the tariff incidence to foreign suppliers is significant.

Tariff data come from the World Integrated Trade Solution (WITS). In particular, this source provides detailed data on Chinese tariffs at the six-digit HS level[3] from 1992 to 2010. However, the data in 1995 and 2002 are missing. As a partial solution, we generate the 2002 data from the WTO Integrated Database and extrapolate the values for 1995 using a simple average of its counterparts in 1994 and 1996, again, at the HS6 level. We aggregate the HS6 tariffs to the HS3 level using import values as weights. Then, we concord the HS3 tariff data with the 16 tradable sectors as specified in the Chinese IO tables. After the concordance, we are able to obtain input and output tariffs for the 16 tradable sectors.

Table 2 reports these for 1995, 2002 and 2007. The output tariff is the import value-weighted tariff of all the HS-6 digit level tariffs in each sector whereas the input tariffs are the weighted output tariffs of all the sectors with weights corresponding to input shares of particular sectors in the IO tables. Some of the patterns in Table 2 reflect China's commitment to tariff reduction when it entered the WTO in 2001. Mining and quarrying persistently have the lowest output tariffs, reflecting the fact that China's production mix relies heavily on this sector such that the direct tariff protection on this sector is minimised. Meanwhile, the category of coke, refined petroleum and nuclear fuel has the lowest input tariffs because this sector relies mainly on inputs from relatively low tariff sectors such as mining, chemicals and machinery.

TABLE 2
China's Input–output Tariffs by Sector: 1995, 2002 and 2007

Sector	*1995*		*2002*		*2007*	
	Output	*Input*	*Output*	*Input*	*Output*	*Input*
Agriculture, hunting, forestry and fishing	33.81	30.20	10.51	11.99	9.52	8.97
Mining and quarrying	2.11	19.35	0.55	7.31	0.32	4.86
Food, beverages and tobacco	38.16	32.93	20.79	12.94	10.41	9.38
Textiles and textile products	41.98	35.06	16.16	13.79	9.32	8.66
Leather, leather and footwear	28.77	32.07	8.45	11.26	7.59	8.36
Wood and products of wood and cork	14.17	21.45	1.63	5.04	0.57	3.22
Pulp, paper, paper, printing and publishing	19.78	22.73	5.33	6.98	2.01	3.93
Coke, refined petroleum & nuclear fuel	25.36	7.13	6.52	2.49	6.53	1.38
Chemicals and chemical products	17.23	20.60	10.12	9.10	6.30	5.98
Rubber and plastics	29.12	25.25	11.34	10.13	8.48	7.07
Other non-metallic mineral	30.40	20.28	11.49	7.99	11.62	6.12
Basic metals and fabricated metal	14.68	15.48	5.85	5.90	4.65	4.40
Machinery, nec	18.96	19.53	7.96	7.44	6.36	5.50
Electrical and optical equipment	36.46	25.24	8.48	8.41	5.46	5.72
Transport equipment	12.11	17.70	3.78	5.95	3.86	4.92
Manufacturing, nec; recycling	12.31	23.67	0.93	7.97	0.59	5.12

Source: WITS (2011) and China's IO tables 1995, 2002 and 2007.

[3] The Harmonized Commodity Description and Coding System generally referred to as 'Harmonized System' or simply 'HS' is a multipurpose international product nomenclature developed by the World Customs Organization (WCO). The six-digit HS level comprises about 5,000 commodity groups. The system is used by more than 200 countries and economies as a basis for their Customs tariffs and for the collection of international trade statistics. Over 98 per cent of the merchandise in international trade is classified in terms of the HS.

4. A NEW EFFECTIVE RATE OF PROTECTION

We begin by assuming a tariff structure with n goods (t_1, t_2,. . .,t_n). The conventional ERP (Corden, 1966) on good j is defined as:

$$\mathrm{ERP}_j = \frac{t_j - \sum_{i=1}^{n} a_{ij} t_i}{1 - \sum_{i=1}^{n} a_{ij}}, \tag{1}$$

where a_{ij} is the share of the intermediate input i in the value of output j. The input tariff for industry j is therefore $\sum_{i=1}^{n} a_{ij} t_i$.[4] Note equation (1) only applies to tradable goods which is the focus of this paper. We discuss the possibility of including non-traded goods in Section 6.

Necessarily, this formation ignores any potential endogeneity between input intensity and tariffs. What is more, this measure has two other major caveats. First, it invokes the small-country assumption whereby complete tariff pass-through is achieved. Second, it only characterises the case of a single-step production process. That is, the intermediate input i is just used in the production of product j once. Naturally, this is inconsistent with known patterns of production which feature multiple stages and for which inputs may be used directly or indirectly many times before final goods are produced.

In considering the second caveat, we note that for a given year, gross output j can be decomposed into aggregate final usage in industry j (i = 1,. . .,N) and aggregate intermediate usage of the industry i:

$$y_{jt} = f_{jt} + \sum_{j} m_{ijt} \qquad i, j = 1, \ldots, N; t = 1992, \ldots, 2010, \tag{2}$$

where y_j is gross output in industry j, f_i denotes the final consumption of output j by industry i, and m_j is the intermediate usage of j in industry i.

Stacking equation (2) for all industries, we have $N \times 1$ market clear conditions:

$$y_t = f_t + A_t y_t, \tag{3}$$

where:

$$y_t = \begin{pmatrix} y_{1t} \\ y_{2t} \\ \cdots \\ y_{Nt} \end{pmatrix}, A_t = \begin{pmatrix} A_{11t} & A_{12t} & \ldots & A_{1Nt} \\ A_{21t} & A_{22t} & \ldots & A_{2Nt} \\ \cdots & \cdots & \cdots & \cdots \\ A_{N1t} & A_{N2t} & \ldots & A_{NNt} \end{pmatrix}, f_t = \begin{pmatrix} f_{1t} \\ f_{2t} \\ \cdots \\ f_{Nt} \end{pmatrix} \text{ and } M_t = \begin{pmatrix} \sum_i M_{1it} \\ \sum_i M_{2it} \\ \cdots \\ \sum_i M_{Nit} \end{pmatrix} = A_t Y_t.$$

Rearranging equation (3), we have:

$$y_t = (I - A_t)^{-1} f_t, \tag{4}$$

where $(I - A_t)^{-1}$ refers to the Leontief inverse of the input–output matrix.

[4] According to Corden (1966), there are five assumptions underlying equation (1). First, the protecting country is a small, open economy such that the import/export elasticities it faces are infinite. Second, the production technology represented by the input-output table is fixed. Third, all tradable goods remain traded. Fourth, fiscal and monetary policies are appropriate such that aggregate expenditure equals full employment income. Finally, tariffs and subsidies are not discriminatory across countries. In the paper, we will show our measure of the ERP can relax assumptions (1) and (2).

It is worth noting that $(I - A_t)^{-1} = I + A_t^1 + \ldots + A_t^{\infty}$. That is, equation (4) also captures the indirect absorption effect: industry j's output may not be directly absorbed by industry i, instead it may be used by other industries first and finally absorbed by industry i. In other words, when potentially complex multiple steps of production are considered, the coefficient a_{ij} should be replaced with b_{ij} from the matrix $B = (I - A_t)^{-1} - I$. B, in the I/O literature, is often called the complete-use coefficient matrix, as compared with the direct use coefficient matrix A. Yet the elements of B matrix cannot be directly used in the ERP calculation since unlike A, B is not a coefficient matrix. Thus, we need to normalise the B matrix such that each column (i.e. the input of a sector) sums up to be unity minus the share of value added. Alternatively, the sum of the elements in the normalised B matrix (we call the C matrix) should be equal to that of the A matrix. That is, the elements of column i are the final (i.e. both direct and indirect use) input shares in sector i:

$$C_t = B_t N,$$

where N is a column vector with each element equal to the inverse of the sum of the corresponding column of B times the corresponding share of the intermediate inputs given in the A matrix.

Returning to the first caveat, we know that, under linear approximation, the tariff incidence to demanders compared to that to suppliers is:

$$\frac{t_d}{t_s} \approx \frac{\varepsilon}{\sigma},$$

where t_d and t_s are the tariff incidence to demanders and suppliers, respectively, with the total tariff $t = t_d + t_s$. ε is the export supply elasticity and σ is the import demand elasticity (in absolute value). Therefore, given these trade elasticities, the tariff is eventually passed through to the domestic market at a given rate. More precisely, the actual tariff protection is $t_d = \frac{\varepsilon}{\varepsilon + \sigma} t$. In the case of a small economy where importers face infinite supply elasticity, tariff pass-through is complete:

$$t_d = \lim_{\varepsilon \to \infty} \frac{\varepsilon}{\varepsilon + \sigma} t = t.$$

In this way, if we take into account the existence of multiple stages of production and incomplete tariff pass-through, the new ERP should be:

$$\mathrm{NERP}_j = \frac{\frac{\varepsilon_j}{\varepsilon_j + \sigma_j} t_j - \sum_{i=1}^{n} c_{ij} \frac{\varepsilon_i}{\varepsilon_i + \sigma_i} t_i}{1 - \sum_{i=1}^{n} c_{ij}}. \tag{5}$$

Conveniently, this measure keeps the ready applicability of the conventional ERP while relaxing two of the stronger assumptions it imposes.

With data on tariffs, trade elasticities and input–output structure, we are ready to calculate our new measure of ERP. Possessing annual IO tables, we can relax the standard assumption on a time-invariant underlying technology. In Table 3, we report the conventional ERPs (OERP) and our new ERPs (NERP) for the years of 1995, 2002 and 2007.[5] We also consider three departures from the OERP. First of all, we relax the small-country assumption and take into account the fact that a tariff imposed by a large country might induce its supplier to

[5] China's Statistical Bureau reported the so-called extended IO Table in these three years. Other years' results can be obtained from the authors upon request.

TABLE 3
Various China's Effective Rates of Protection: 1995, 2002 and 2007

Sector	*1995*				*2002*				*2007*			
	OERP	*DERP*	*SERP*	*NERP*	*OERP*	*DERP*	*SERP*	*NERP*	*OERP*	*DERP*	*SERP*	*NERP*
Agriculture, hunting, forestry and fishing	44.16	32.98	113.82	32.39	9.68	5.94	21.67	5.33	9.61	5.64	24.67	5.16
Mining and quarrying	1.80	1.70	3.66	−6.49	0.05	0.01	0.09	−0.53	0.02	0.01	0.03	−0.51
Food, beverages and tobacco	91.93	29.84	188.23	−6.42	46.05	12.36	87.76	9.17	20.07	6.41	38.82	2.83
Textiles and textile products	62.43	12.20	126.67	1.56	22.33	4.73	44.44	3.54	15.28	3.39	31.92	1.67
Leather, leather and footwear	51.83	5.30	107.30	−21.70	14.44	2.59	28.74	−0.25	16.73	3.23	37.23	0.16
Wood and products of wood and cork	16.19	1.94	33.85	−21.25	1.46	0.08	2.77	−1.74	0.62	0.02	1.31	−1.81
Pulp, paper, paper, printing and publishing	28.29	5.07	54.54	−5.86	6.99	1.49	13.09	0.53	2.86	0.57	5.97	−0.69
Coke, refined petroleum & nuclear fuel	20.36	15.27	37.94	20.39	11.56	10.77	18.53	9.60	11.27	10.55	23.68	9.34
Chemicals and chemical products	23.42	7.58	43.92	0.29	15.22	4.43	26.87	3.60	9.74	3.28	17.43	2.30
Rubber and plastics	53.93	3.95	106.45	−2.77	19.85	1.87	37.83	−0.23	16.96	1.89	32.68	−0.12
Other non-metallic mineral	44.81	3.99	83.07	0.88	16.91	0.89	29.26	−0.07	19.76	0.92	35.33	0.07
Basic metals and fabricated metal	20.18	5.08	34.17	3.04	7.02	1.68	11.79	0.96	4.56	0.74	8.17	0.05
Machinery, nec	30.83	1.18	62.88	−2.29	11.39	0.43	21.66	−0.72	13.64	0.22	27.65	−0.61
Electrical and optical equipment	54.60	12.17	114.96	9.28	5.91	1.15	12.16	0.33	1.30	0.38	2.84	−0.34
Transport equipment	12.32	1.83	25.75	−1.88	4.14	0.79	8.23	−0.28	5.18	0.93	10.70	0.07
Manufacturing, nec; recycling	26.42	0.20	54.53	−5.65	1.27	0.09	2.74	−1.29	0.46	0.07	1.15	−1.08

Source: Authors calculation.

lower their export price at the dock. Therefore, in column (2), the direct ERP (DERP) considers the case with incomplete tariff pass-through but ignores the iterative use of intermediate inputs. Compared with the conventional measure, the DERP is much smaller, reflecting the fact that only part of the tariffs passed through such that the tariff protection to the domestic import competing producers is smaller than otherwise indicated by the full tariff. When we just consider the iterative use of inputs and ignore the incomplete tariff pass-through, the small-country ERP (SERP) is, however, much larger than conventional measures. This finding implies that China's non-traded sectors actually account for a much smaller share of total value added, after taking into account of the iterated use of inputs mainly coming from traded sectors.

After considering both incomplete pass-through and the iterated use of inputs, our new effective rate of protection (NERP) exhibits significantly different patterns from OERP. First of all, about half of the sectors indeed receive negative protection. In other words, our new ERP indicates that some of the sectors actually suffer a reduction in their domestic value added due to the existence of non-trivial tariff protection on the input to their sector. Second, relative rates of protection are substantially different. For instance, OERP shows that the food, beverages and tobacco sector received the highest level of protection and the mining and quarrying sector received the lowest in the three reported years. On the contrary, neither held this distinction when measured by NERP. At the same time, the likely effects of China's ascension into the WTO can be tracked in both the conventional and new ERP as both dramatically declined between 1995 and 2002 followed by a more modest decline between 2002 and 2007. In general, NERP is much smaller than OERP with some exceptions (like the coke, refined petroleum & nuclear fuel and agriculture sectors in some years).

5. ROBUSTNESS

After we relax the assumptions on complete tariff pass-through, the direct use of inputs and time-invariant technology, we show that the new ERP is quite different from the conventional one. However, this in itself is not sufficient to prove that the new ERP is actually a better measure than the traditional one. In this section, we show the robustness of our new measure by comparing the correlations between the new and conventional ERP with selected industrial statistics, checking to see which make more intuitive sense.

Industry level statistics by sector were obtained from the Chinese Industry Annual Survey. China's National Bureau of Statistics conducts an annual survey on two types of manufacturing firms: all state-owned enterprises (SOEs) and non-SOEs whose annual sales exceed 5 million RMB (roughly, $800,000) from 1997 to 2008. It includes approximately 230,000 manufacturing firms. On average, it accounts for more than 95 per cent of China's total annual manufacturing output. The data set covers more than 100 accounting variables including annual sales, firm type, fixed capital stock, total assets and presence of FDI. Given this abundance of riches, the related firm-level production data set is now widely used in research (cf. Cai and Liu, 2009; Brandt et al., 2012; and Feenstra et al., 2014).

We then aggregate the firm-level manufacturing data into the sectors defined by the IO tables, but must necessarily exclude the agriculture and recycling sectors. As a result, we have statistics on 14 sectors from 1998 to 2007. For our purposes, the statistics of interest are the following: (i) concentration measured by the Herfindahl index of the largest 10 firms in a sector as large firms are more likely to influence policies which favour their business; (ii) employment as the government may care to maintain its levels through tariff policy; (iii) wages as it

TABLE 4
Correlations b/t two ERPs and Industry Variables

	OERP	*NERP*
HHI_top10	−0.1477*	0.2927***
	(0.0873)	(0.0006)
Upstreamness/downstreamness	−0.2606***	0.3604***
	(0.0019)	(<0.0001)
Employment	−0.0587	0.2148**
	(0.4909)	(0.0108)
Sales	−0.2356***	0.2829***
	(0.0051)	(0.0007)
State-owned capital	−0.1619*	0.2881***
	(0.0559)	(0.0006)
FDI(flow)	−0.1733**	0.1893**
	(0.0406)	(0.0251)
Wage	−0.2266***	0.4851***
	(0.0071)	(<0.0001)

Notes:
(i) Pearson Correlation Coefficients; Prob > |*r*| under H0: Rho = 0; *N* obs: 140.
(ii) OERP and NERP refer to old and new effective rate of protection, respectively.
(iii) HHI_top10 is the Herfindahl index of the largest 10 firms in a CIC sector.
(iv) Upstreamness/Downstreamness is calculated according to Antràs et al. (2012).
(v) ***, ** and * stands for 1%, 5% and 10% significance levels respectively.
Source: Authors calculation.

is suspected that sectors with more protection may to be able to afford higher average wages; (iv) sales as protection is usually biased towards more important sectors such as those with high annual sales; (v) state-owned capital as it is widely believed that China's protection favours state-owned enterprises; (vi) FDI inflows as horizontal flows used for penetrating the local market may actively seek sectors afforded higher levels of protection; and (vii) upstreamness/downstreamness as China has emerged to be the largest manufacturing country in the world, and thus, the incentives for protection on downstream industries are in decline.

Table 4 shows the correlation results between the above-mentioned statistics with the new and conventional ERPs. Most of the correlations between the OERP and the industry statistics are not in line with reasonable priors. For instance, the results show that China's protection, if measured by OERP, is not in favour of the state-owned enterprises, seems to care little about employment issues and is biased towards downstream industries in which China has an obvious comparative advantage. When we investigate the correlations with the NERP, however, they are all consistent with the prior laid out above and in a highly significant way. Thus, compared to the OERP, the NERP is qualitatively a better measure as it is more reasonably relates to the observed characteristics of firms.

6. DISCUSSION

Section 5 has demonstrated that there are several features which distinguish our new proposed measure of the ERP from its traditional measure. Nonetheless, our measure is subject to two major concerns. First, non-tariff barriers may exert additional – and unaccounted for – levels of protection. That is, by excluding non-tariff barriers, we may have an inaccurate assessment of the ERP in that we can only incorporate information on tariff levels. Second, we follow Corden's original formulation (Corden, 1966, pp. 226–228) which treats non-tradable inputs in the same way as primary factors. In this way, Corden suggests using the Leontief inverse of the input–output matrix to solve for non-traded inputs and decompose them into value-added and tradable inputs.[6] Alternatively, it could be argued that non-tradables should be treated as inputs into traded intermediates but with zero tariffs (Balassa, 1965). In what follows, we discuss the implications of these two issues.

a. Non-tariff Measures

As mentioned previously, our ERP measure relies solely on tariffs. This approach may naturally underestimate levels of effective protection using, in particular in those cases in which countries replace reduced tariffs and 'old' forms of non-tariff measures (NTMs) with new forms of protection (Milner, 2013). However, while NTMs are certainly important, they are often imposed in diverse – and non-transparent – forms such as antidumping duties, countervailing penalties, import licenses and product standards of various forms. Because of this diversity, calculating the tariff equivalents for these measures is very challenging.

To ensure free and fair trade, international organisations, most notably the WTO, have repeatedly called for the elimination of NTMs and/or their substitution with transparent tariff-equivalent measures. Researchers have also made significant progress in quantifying the tariff-equivalent of NTMs (see Kee et al., 2009). However, the literature has still not arrived at any sort of consensus on methodology and measurement. For instance, the estimated average tariff-equivalent of NTMs in Japan is 11 per cent in Kee et al. (2009) whereas it is 58 per cent in Bradford (2003).

Furthermore, we are aware of no extant work on the measure of Chinese NTMs and their tariff equivalents – especially at the sectoral level – for our sample period. As a result, due to the absence of average tariff-equivalent of NTMs, we are not able to take into account the effects of NTM on our ERP calculation. Given the general substitution of NTMs for tariff barriers (Kee et al., 2009), ignoring NTMs will tend to underestimate the ERP in sectors which see their wider use (such as the agricultural sector) and overestimate the ERP in sectors which see their more limited use (such as the mining sector).

b. Non-traded Goods

In general, prices of non-traded products change when tariffs are imposed on traded inputs. This, in turn, will affect the rate of protection for traded goods since they require the use of non-traded products (such as services) as inputs for production. Therefore, one should take into account changes in the prices of non-traded inputs as these will be reflected as changes in the cost of tradable inputs (Ray, 1973). In theory, our approach can incorporate the effects of non-tradables. As discussed in Corden (1966), there are two ways to incorporate non-traded inputs into the ERP framework. First, one can treat a non-traded input just like a tradable input with a zero tariff (Balassa, 1965). In this case, non-tradables usually have negative effective protection. Alternatively, one can treat non-tradable inputs in the same way as primary factors so that they are treated as value added but not as inputs into traded

[6] We thank our referee for this point.

intermediates. The latter approach is adopted by Corden (1966), who further suggests iteratively using the inverse of Leontief matrix to solve for non-traded inputs. The essence of our approach follows this insight, in the sense that we rely on the complete-use IO table which, in principle, has taken into account the use of non-tradable services embedded in tradable inputs in multiple stages.

As an extension, we also calculate our ERP again by treating the non-tradables as inputs with zero tariffs, following Balassa (1965). Note that the sum of input share ($\sum c_i$) in equation (5) increases due to the inclusion of non-traded sectors as inputs.[7] Table 5 reports the results. It is obvious that the ERPs of tradable sectors become smaller compared to Table 3 since the inclusion of the non-tradables only affects the denominator, noting that the tariffs for non-tradables are zero. The non-traded sectors apparently receive negative protection with the absolute value of this effective protection becoming smaller as tariffs decline over time.

7. CONCLUDING REMARKS

Although roundly criticised for its lack of consistency with general equilibrium principles, the conventional measure of ERP is nevertheless widely applied in empirical studies due to its tractability. Without sacrificing this particularly convenient feature of the measure, we can still improve the accuracy of the ERP by correcting for some of its stronger assumptions which may lead to even more serious bias than ignoring reallocation effects.

In this paper, we revisit the conventional measure of the ERP by relaxing its small-country and simple one-step production assumptions. First, we decompose the tariff incidence to domestic demanders using detailed export supply and import demand elasticities by linearly approximating the supply and demand curves for imports. Thus, we can estimate the actual tariff protection that is passed through to domestic producers. Second, we take into account multiple stages of production and the iterated use of intermediate inputs using the elements of the inverse Leontief matrix as measures of the ultimate input intensity. Although it relaxes these two strong assumptions underlying the conventional measure of the ERP, our new measure nevertheless retains its chief attractive feature, namely its applicability to highly disaggregated IO and tariff data. Furthermore, by taking advantage of the annual IO table, our new ERP also relaxes the rigid assumption on time-invariant Leontief technology.

We apply our new ERP to the case of China from 1992 to 2010. As a large economy firmly embedded in global supply chains with high degrees of fragmented production and iterated use of intermediate inputs, China serves as a good example to illustrate the inherent biases of the conventional measure of the ERP. Our results indicate that the conventional measure largely overstates the degree of protectionism due to import tariffs and generates correlations with industry characteristics which run counter to the ‘received wisdom’. Our new measure of ERP indicates that China’s level of tariff protection is fairly low and even negative in some sectors. We show that compared to the traditional ERP, our new ERP relates well with the macroeconomic variables. Finally, we provide the NERP when the non-traded products are treated as inputs rather than primary factors.

[7] The non-traded products are treated as inputs rather than primary factors such that the value-added to factors in each sector declines. However, the final value-added share of created in each traded sector (c_i) remains the same.

TABLE 5
China's Effective Rates of Protection: 1995 and 2007 (Non-traded Sectors Included)

Traded Sectors	*1995*	*2002*	*2007*	*Non-traded Sectors*	*1995*	*2002*	*2007*
Agriculture, hunting, forestry and fishing	45.38	7.33	6.53	Electricity, gas and water supply	−2.64	−0.87	−0.61
Mining and quarrying	−0.55	−0.74	−0.59	Construction	−3.83	−1.56	−0.87
Food, beverages and tobacco	6.37	8.90	2.20	Wholesales and maintenance	−3.49	−0.95	−0.49
Textiles and textile products	5.63	3.06	1.05	Retailing and repairing	−3.49	−0.95	−0.49
Leather, leather and footwear	−4.25	−0.19	0.10	Hotels and restaurants	−13.15	−3.50	−2.33
Wood and products of wood and cork	−5.09	−1.56	−1.27	Inland transport	−2.24	−0.96	−0.91
Pulp, paper, printing and publishing	0.48	0.56	−0.54	Water transport	−3.25	−1.57	−1.34
Coke, refined petroleum & nuclear fuel	12.50	10.60	10.50	Air transport	−3.51	−1.35	−1.67
Chemicals and chemical products	3.28	3.63	1.92	Other auxiliary transport activities; travel service	−2.65	−1.62	−1.47
Rubber and plastics	−2.41	−0.21	−0.08	Post and telecommunications	−2.00	−0.60	−0.35
Other non-metallic mineral	0.86	−0.07	0.06	Financial intermediation	−1.89	−0.53	−0.36
Basic metals and fabricated metal	2.54	0.87	0.04	Real estate activities	−1.15	−0.35	−0.21
Machinery, nec	−2.07	−0.65	−0.48	Renting and other business activities	−3.64	−0.88	−0.76
Electrical and optical equipment	8.38	0.31	−0.29	Public admin and defence; compulsory social security	−2.98	−1.00	−0.63
Transport equipment	−1.50	−0.22	0.05	Education	−2.30	−0.73	−0.55
Manufacturing, nec; recycling	−5.39	−1.36	−0.96	Health and social work	−4.10	−1.33	−1.17
				Other social and personal services	−3.83	−1.47	−0.91

Source: Authors calculation.

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