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Trade and Product Market Policies in Upstream Sectors and Productivity in Downstream Sectors: Firm-Level Evidence from China

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ABSTRACT/RÉSUMÉ

TRADE AND PRODUCT MARKET POLICIES IN UPSTREAM SECTORS AND PRODUCTIVITY IN DOWNSTREAM SECTORS: FIRM-LEVEL EVIDENCE FROM CHINA

This paper explores the productivity impact of trade, product market and financial market policies over the last decade in China – a fast growing country where, despite significant reform action, regulatory stance remains still far from OECD standards. The paper makes a critical distinction between downstream and upstream industries, focusing on the indirect effects of regulation in upstream industries on firm performance in downstream manufacturing industries. This framework allows investigating the link between these policies and productivity growth depending on how far incumbents are relative to the technological frontier. The analysis is novel in several respects. Drawing on new OECD policy indicators of sector-level product market regulation and firm level data, econometric estimates deliver new evidence on the potential gains from product and financial market reforms in China, two policy areas that had not been studied in previous empirical literature. Firm-level microeconomic data further allow shedding light on the differential effects of policies within industries, while also highlighting the potential channels through which productivity is affected by reform. The key conclusion that can be derived from the empirical analysis is that further product, trade and financial market reforms would bring substantial gains in China and could therefore speed up the convergence process. Taken at face value, the empirical estimates would imply that aligning product, trade and financial market regulation to the average level observed in OECD countries would bring aggregate manufacturing productivity gains of respectively 9%, 4% and 6.5% after five years. Trade and product market reforms are found to deliver stronger gains for firms that are closer to the industry-level technological frontier, while the reverse holds for financial market reforms.

JEL classification: D24; F13; O1/O5; L8

Key words: Firm-level data; productivity; trade liberalisation; product market reform; financial liberalisation; China

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L'IMPACT DES RÉGLEMENTATIONS COMMERCIALES ET DU MARCHÉ DES PRODUITS DANS LES SECTEURS EN AMONT SUR LA PRODUCTIVITÉ EN CHINE: UNE ANALYSE SUR DONNÉES DE FIRMES

Cet article explore l'impact des réformes structurelles dans les domaines du commerce international, du marché des produits et des marchés financiers sur la productivité Chinoise au cours des dix dernières, la Chine pouvant être considéré comme un pays en forte croissance dans lequel, malgré la mise en ouvre de réformes importantes, la politique réglementaire reste bien loin des standards de l'OCDE. Cet articule fait une distinction cruciale entre les secteurs en amont et les secteurs en aval, et se concentre sur les effets indirects de la régulation en amont sur la productivité en aval. Ce cadre permet d'étudier le lien entre ces politiques et la croissance de la productivité en fonction de la distance qui sépare les firmes de la frontière technologique. L'analyse est nouvelle à plusieurs égards. S'appuyant sur de nouveaux indicateurs de l'OCDE sur la réglementation du marché des produits et sur une base de données au niveau de la firme, l'analyse délivre des résultats nouveaux sur les gains potentiels en Chine de réformes sur les marchés de produits et financiers, deux domaines inexplorés dans la littérature précédente. Les données au niveau de la firme permettent de mettre en lumière l'effet différentiel des politiques au sein de chaque secteur, et donc par là même les mécanismes potentiels via lesquels les réformes affectent la productivité. La conclusion principale est que davantage de réformes dans les domaines précités pourraient apporter des gains substantiels en Chine, ce qui pourrait donc accélérer le processus de convergence. Les résultats empiriques impliqueraient, pris tels à la lettre, qu'un alignement des politiques réglementaires dans les domaines du marché des produits, du commerce international et des marchés financiers sur le niveau moyen observé dans les pays de l'OCDE apporterait des gains agrégés de productivité de l'ordre de 9%, 4%, et 6.5% respectivement au bout de cinq ans. Les réformes commerciales et du marché des produits délivrent des gains plus importants pour les firmes prés de la frontière technologique tandis que le résultat inverse est trouvé pour les réformes des marchés financiers.

Classification JEL : D24 ; F13 ; O1/O5 ; L8

Mots clés : Données de firme ; productivité ; libéralisation commerciale ; réformes du marché des produits ; libéralisation financière ; Chine

TABLE OF CONTENTS

TRADE AND PRODUCT MARKET POLICIES IN UPSTREAM SECTORS AND PRODUCTIVITY IN DOWNSTREAM SECTORS: FIRM-LEVEL EVIDENCE FROM CHINA

By

Maria Bas and Orsetta Causa[1]

1. Introduction

1. Empirical evidence on the growth effects of structural reforms is abundant for high income countries, notably members of the OECD (see OECD, *Going for Growth*, *e.g.* OECD, 2012). Primarily reflecting data limitations, evidence on developing and emerging economies is much scarcer. While reasonable measures of economic performance exist, there is a critical unavailability of sound policy indicators, especially "hard" as opposed to "soft" ones. This is important for empirical work as the former are less prone to endogeneity and perception bias. Yet, it is precisely for those emerging, catching-up countries that one would be interested to analyse and quantify the growth effects of structural reforms. This paper aims to fill part of this gap as it exploits new policy indicators measuring the extent to which the policy environment encourages or, on the contrary, represses competition between firms. The paper explores the productivity impact of trade, product market and financial market policies over the last decade in China – a fast growing and fast reforming country where regulatory stance remains still far from OECD standards. The focus is on reform-induced productivity gains in the manufacturing sector as the latter is a clear key driver of Chinese economic performance, and a major sector in China. While policy data are defined at the industry level, the empirical analysis is based on recently microeconomic, firm-level data.

2. This innovative feature allows exploring firm heterogeneity and associated non linearities, topical issues in the recent economic literature for which empirical evidence remains relatively scarce in the case of China. In particular, relying on microeconomic analysis allows exploiting firm heterogeneity *within* industries. Compared with aggregate analysis, it should yield richer and more accurate conclusions on the determinants of productivity. Moreover, the use of firm-level data provides a better understanding of the mechanisms driving the link between reforms and productivity. This paper relies on the neo-Schumpeterian framework (Aghion and Howitt, 1998) to explore the differential effect of trade, product market and financial market policies on firm productivity depending on firms' distance to the industry-level frontier (see *e.g.* Nicoletti and Scarpetta, 2003; Griffith *et al.*, 2006; Bourlès *et al.*, 2010).[2] The empirical analysis allows identifying some of the theoretical channels through which productivity is affected by reform along with nonlinearities and compositional effects underlying aggregate policy-induced outcomes.

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1. CEPII and OECD Economics Department, respectively. The authors would like to thank Jens Arnold, Romain Duval, Jorgen Elmeskov, Giuseppe Nicoletti and Jean-Luc Schneider for their comments. The authors would also like to thank Alexandros Ragoussis for his precious help on ORBIS data, Zheng Wang for kindly sharing the price deflators for China, Celia Rutkoski and Diane Scott for editorial assistance.

2. Other empirical works based on cross-country industry-level data (Inklaar *et al.*, 2008; Buccirossi *et al.*, 2009) and aggregate productivity measures (Conway and Nicoletti, 2006) have confirmed this evidence.

3. The paper makes a critical distinction between downstream and upstream industries, focusing on the indirect effects of regulation in upstream industries on firm performance in downstream manufacturing industries. The motivation for this approach is that firms in downstream industries rely on intermediate inputs produced in upstream industries, in particular services, which are generally characterised by relatively strict regulation and weak competitive pressure. Lack of competition in upstream sectors both among domestic firms and between domestic and foreign firms can generate trickle-down effects that affect the productivity performance of other sectors through different channels.[3] Anticompetitive regulations in an upstream sector may reduce competition in downstream sectors if access to the latter requires using intermediate inputs produced upstream, particularly in the case of services inputs where import competition is limited. For example, if financial market regulations narrow the range of available financial instruments or products, access to finance by downstream firms can be made difficult, thereby curbing new entry and firm growth. Indeed, several studies following Rajan and Zingales (1998) have found that financial and banking liberalisation is positively correlated with economic growth and firm performance. For catching-up countries, limited import competition in manufacturing may further limit technology transfer through *e.g.* access to intermediate inputs produced abroad in more technologically-advanced countries.[4] Even if anticompetitive upstream regulations do not restrict market access downstream, they can still curb efficiency in downstream firms. In particular, if markets for intermediate inputs are imperfect, downstream firms may have to negotiate with (and can be held up by) suppliers and face greater production costs.

4. The upstream-downstream approach has been widely used in the empirical literature on the impact of input trade and product market liberalisation on industry or firm performance.[5] The identification strategy generally consists in exploiting the variation in the magnitude of impacts from a given reform across industries, depending on the extent to which the reform affects their inputs. The bulk of these papers apply the so called "differences-in-differences" methodology,[6] and so does the present analysis. Specifically, the econometric identification strategy exploits the cross-upstream industry variance in policy indicators and assumes that the gains from the reforms vary depending on the extent to which input prices and availability are affected by the reform. The idea is that regulation has a differential impact on downstream firms depending on the extent to which they rely on inputs produced in upstream regulated industries.

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3. See Bourlès *et al.* (2010) for a review.

4. For instance, recent empirical work shows that importing intermediate goods boosts productivity in developing countries (Schor (2004) for Brazil; Amiti and Konings (2007) for Indonesia; Kasahara and Rodrigue (2008) for Chile; Halpern *et al.* (2009) for Hungary and Topavola; and Khandelwal (2011), for India). Using firm level data for China, Ge *et al.* (2011) find that input tariff liberalisation encourages firms to source a higher range of imported varieties of intermediate inputs from developed economies and is associated with higher firm total factor productivity. Along the same lines, Goldberg *et al.* (2010) show that Indian firms producing in industries experiencing the greatest fall in input tariffs experience the most significant increase in their ability to manufacture new local products. Using firm-level data for Argentina, Bas (2012) shows that the probability of exporting is higher for firms producing in industries that have experienced greater input tariff reductions. Bas and Strauss-Kahn (2011), using French firm-product level data, find that importing more varieties of foreign inputs from developed countries increases the TFP level and also the number of exported varieties by a firm.

5. For trade liberalisation, see *e.g.* Amiti and Konings, (2007); Goldberg, *et al.*; (2010); Bas, 2012 and Bas and Strauss-Kahn (2011). For product market liberalisation, see *e.g.* Conway and Nicoletti, (2006), Barone and Cingano (2011), Bourlès *et al.* (2010), Arnold *et al.* (2010; 2011). For FDI services liberalisation, see Fernandes and Paunov (2012).

6. See Card and Krueger (2004) for one of the first pioneering "diff-in-diff" studies. See Rajan and Zingales (1998) on the productivity effects financial liberalisation, closer to this paper.

5. Firm-level data allow exploring the heterogeneous effects of policies across Chinese firms, thereby contributing to the rich literature on firm heterogeneity[7] which so far has been given little coverage to China.[8] Focusing on firm heterogeneity allows making the link with economic theory by shedding some light on specific mechanisms through which product market regulation affects firm performance. In particular, recent models of endogenous growth (*e.g.* Acemoglu *et al.*, 2006; Aghion and Howitt, 2006) predict that the aggregate impact of (domestic or foreign) competition on productivity can be non-linear and depends on the characteristics of incumbent firms (*e.g.* on the degree of firm heterogeneity). In these models, anticompetitive regulations can therefore have differential aggregate effects on productivity in different countries and industries depending on specific technological and market factors, such as the average distance to frontier of firms. This theoretical approach is applied to the data by estimating a model in which the effects of upstream competition vary with firms' distance to the industry-level frontier. While this approach has been widely applied to industry-level data as way to provide evidence of the nonlinear impact of regulation across countries, it has been rarely applied to firm-level data and (to the authors' knowledge) never to Chinese data.[9]

6. In this paper, input trade policy is captured by input tariffs defined at the 2-digit industry level for the period 2003-08. In the case of product market regulation, the analysis relies on a new set of time-series indicators of product market regulation in energy, transport and communications (ETCR) computed by the OECD for China for the period 2001-04. Finally, financial market policy is captured by the IMF financial reform index developed by Abiad *et al.* 2008.[10] The empirical analysis is based on Chinese firm-level-data from the ORBIS database collected by the Bureau van Dijk for the period 2001-08. The dataset includes 160.000 firms per year on average in the manufacturing sector. Previous firm-level empirical studies on the direct growth impact of structural reforms in China have focused on trade (Feenstra, 1998; Branstetter and Lardy, 2006; and Ge *et al.*, 2011), foreign direct investment (Liu, 2001; Hu and Jefferson, 2002; Mayneris and Poncet, 2010; and Bloningen and Ma, 2010) and financial sector (Allen *et al.*, 2008; Berger *et al.*, 2009, Lin and Zhang, 2006; Ferri, 2009; and Chang *et al.*, 2010) policies. More recently, relying on Chinese city-level data, Zhang *et al.* (2012) have found that most traditional indicators of financial development (*e.g.* credit to GDP, deposits to GDP) are positively associated with economic growth at the city level.

7. The key conclusion that can be derived from the empirical analysis is that product, trade and financial market reforms undertaken in China over the last decade boosted firm productivity in the manufacturing sector. Given the remaining room for reform in these areas in China (see *OECD Economic survey of China*, 2010, OECD, 2010 and OECD, *Going for Growth* 2012, OECD, 2012), the analysis decisively shows that further reforms would bring substantive gains and could therefore speed up the convergence process. The empirical estimates would imply that aligning product, trade and financial

7. See Hopenhayn (1992). New trade models (Bernard *et al.*, 2003; Melitz, 2003 and Melitz and Ottaviano, 2008) introduce firm heterogeneity in Krugman's standard monopolistic competition framework and predict heterogeneous effects of trade liberalisation within industries (Bernard *et al.*, 2003; Melitz, 2003; Melitz and Ottaviano, 2008).

8. Jarreau and Poncet (2010) show that financial constraints have a heterogeneous effect on Chinese firms' export performance depending on their ownership status. Ge *et al.* (2011) find that input trade liberalisation has a different impact on firm performance depending on their import status (ordinary vs. processing trade). Bloningen and Ma (2010), explore how FDI policies in China affect firms' export performance depending on their ownership structure and type of good exported.

9. See below a brief review of relevant papers. Cross-country regressions based on industry-data include *e.g.* Bourlès *et al.* (2010) while firm-level evidence is scarce, Aghion *et al.* (2004) being an exception.

10. Section 3.2, presents a detailed description of the indicators used as a proxy for each reform in upstream sectors.

market regulation to the average level observed in OECD countries would bring aggregate manufacturing productivity gains of respectively 9%, 4% and 6.5% after five years.

8. Trade and product market liberalisation are found to deliver stronger gains for bigger firms and for firms that are closer to the industry-level technological frontier. From a theoretical perspective, this would be consistent with the view in Aghion and Howitt (2006) that the "escape competition" effect dominates close to the frontier whereas this effect is weakened by a "discouragement" effect far from the frontier. On the contrary, financial market reforms are found to be of greater benefit to laggard firms, tentatively suggesting that these reforms accelerate the catch-up process within industries, possibly by easing credit constraints. The estimates are robust and stable across a variety of specifications, among which the inclusion of industry-level controls such as capital intensity and industry concentration and the use of alternative input-output matrixes.

9. The remainder of the paper is organized as follows. Section II provides some background information on the reform process in China over the period under consideration. Section III describes the firm level and policy data and Section IV details the empirical approach. Section V presents the results and a number of robustness and sensitivity tests. Section VI illustrates the results by performing policy simulations on the potential productivity gains of adopting OECD average levels of regulation in China. Section VII concludes.

2. Structural reforms in China: an overview[11]

2.1. Trade liberalisation reforms

10. China's trade policy during the 1980s and 1990s was characterised by a so called "dual" system.[12] The export processing regime instituted in 1979 distinguished two trade regimes depending on the type of traded good: ordinary goods on the one hand and processing and assembling goods on the other. Traded ordinary goods consisted in imports of final and intermediate goods that were sold in the domestic market to consumers or to domestic firms, whereas processing and assembling goods consisted in imports that were directly re-exported or assembled into final products to be sold into the export market.

11. Processing and assembling goods enjoyed a specific duty-free trade regime, according to which firms importing under the processing trade regime were exempted from paying the tariff rates if they re-exported their goods. This legal framework provided incentives to process raw materials and assemble imported parts and components to produce finished goods for export markets. International joint-ventures and foreign affiliates of multinational companies located in China were the main beneficiaries from this special trade regime. Ordinary goods were on the contrary subject to high levels of nominal tariffs.

12. China's accession to the World Trade Organization (WTO) in 2001 accelerated the unilateral trade liberalisation process. The authorities undertook a series of important commitments to open and liberalise the economy and offer a more predictable environment for trade and foreign investment. The government gradually reduced tariffs, non-tariff measures, licences and quotas. Between 2000 and 2005, applied Chinese tariffs declined on average by 7 percentage points, with a wide variation in tariff changes across manufacturing industries. Importantly, tariff reductions directly affected ordinary goods. This had notable implications for domestically-owned firms who benefited from both a relative reduction in the

11. This brief overview mainly relies on the *OECD Economic survey of China*, (OECD, 2010).

12. See Feenstra (1998), Lardy (2002) and Branstetter and Lardy (2006).

costs of imported intermediary goods and the availability of new imported input varieties. Trade liberalisation also indirectly affected processing and assembling trade through competition effects.[13]

2.2. Product market reforms[14]

13. Over the period 2000-04, product market reforms took place mainly in the telecommunications and energy sectors. Telecommunications were under government monopoly in the 1980s and at the beginning of the 1990s. The Ministry of Posts and Telecommunications held both functions of public operator and regulator. In 1994, the government started liberalising by allowing entry of a new telecommunications company, China Unicom, which was affiliated with the State Economic and Trade Commission. This new public company was in charge of building and operating the nationwide cellular network. Hence, the competition structure of the telecommunications sector was transformed from a public monopoly to a public duopoly composed by China Telecom and Unicom.

14. The telecommunications sector was further liberalised at the end of the 1990s in the context of the debates on China's accession to WTO. Foreign companies were allowed to enter the market through participation in state-owned enterprises (SOEs). In 2000, the Telecoms Law was adopted, establishing the separation of policy, regulatory and management functions within government. The law also prohibited the existence of monopolies in the telecommunications sector. Product market reform encouraged competition and China's telecommunications network became the largest and fastest growing in the world.

15. Energy sector liberalisation took place in the early 2000s. In 2002, electricity generation and transmission were unbundled, as the State Power Corporation was separated into two electricity transmission companies and five electricity generating companies. At the same time, the government adopted the Electricity Law allowing private-sector generation, and in 2003 it created the State Electricity Regulatory Commission. These reforms dramatically increased the number of private firms in the generation market and encouraged the development of several regional wholesale electricity markets.

2.3. Financial reform

16. During the 1980s and at the beginning of the 1990s, the Chinese financial regime was characterised by a closed and centralised system with a predominant role for the People's Bank of China. Only four commercial banks were operating and credit allocation to the private sector was *de facto* controlled by the Central Bank. The first areas of reform consisted in the creation of the stock exchange in 1990, the foreign exchange market in 1994 and the inter-bank bond market in 1997.

17. Financial liberalisation became a key reform objective in the context of China's accession to WTO after 2001, with several deregulation measures aimed at improving transparency and efficiency in credit allocation, *e.g.* reducing regulatory restrictions for private banks and barriers to entry for foreign banks as well as encouraging financial market deepening and its integration with international credit markets. Recent measures to allow greater freedom for banks to set their own interest rates might be a first step towards interest rate deregulation.

13. See Ge *et al.* (2011) who analyze the differential impact of trade liberalisation on firm productivity in China depending on the trade orientation of the firm (processing *versus* ordinary trade).

14. See OECD Economic survey on China for a detailed discussion on product market reforms in China (OECD, 2010).

3. The data

3.1. Firm-level data: the ORBIS database

18. This study relies on the ORBIS firm-level-dataset from Bureau van Dijk[15] over the period 2001-08. Detailed firm-level information is available on total revenues and number of employees. Capital stock and material costs are also available but with low coverage,[16] making it unwise to use total factor productivity (TFP) as a dependent variable in the empirical analysis. Instead the study relies on labour productivity, measured as real revenues (*i.e.* deflated sales revenues) over total employment. Capital stock data are used to construct an industry-level estimate of capital intensity, which is used as a control variable. Table 1 details the variables used in the empirical analysis.

19. Since data on firm-level prices are not available, the empirical analysis, as is the case in the bulk of comparable studies, relies on industry-level deflators. This constraint should be kept in mind, as it could imply that measured productivity differences across firms might reflect differences in mark-ups or in the quality of products rather than differences in efficiency. Also, industry deflators may poorly capture the potential effects of structural reforms themselves on the variety and quality of products. Revenue and capital values are deflated using 2-digit industry-level output deflators.[17]

20. Following standard practice with firm-level analysis, the data are cleaned up as follows. Since the focus of the study is on labour productivity, only firms reporting positive values of revenues and number of employees are kept. Moreover, outliers are excluded based on the following criteria: *i)* implausible levels of employment; and, *ii)* firms exhibiting extreme shifts in one characteristic relative to another, *e.g.* revenues *vis-à-vis* number of employees. The ORBIS dataset is known to be mainly representative of medium and large firms in the manufacturing sector. There are on average 160 000 firms per year during the period 2001-08 and less than 1% of them report having at least one subsidiary. Average firm size for the period under consideration is 21 employees. Industry-level capital intensity is measured by the median ratio of the capital stock to total employment for all firms producing in a 2-digit industry. The Herfindhal index measures the concentration in revenues for each 2-digit industry, and is also used as a control variable in the analysis.

15. See Bureau van Dijk - Orbis.

16. Only 45% of total observations have positive values of investment and 35% of observations have positive values of material costs.

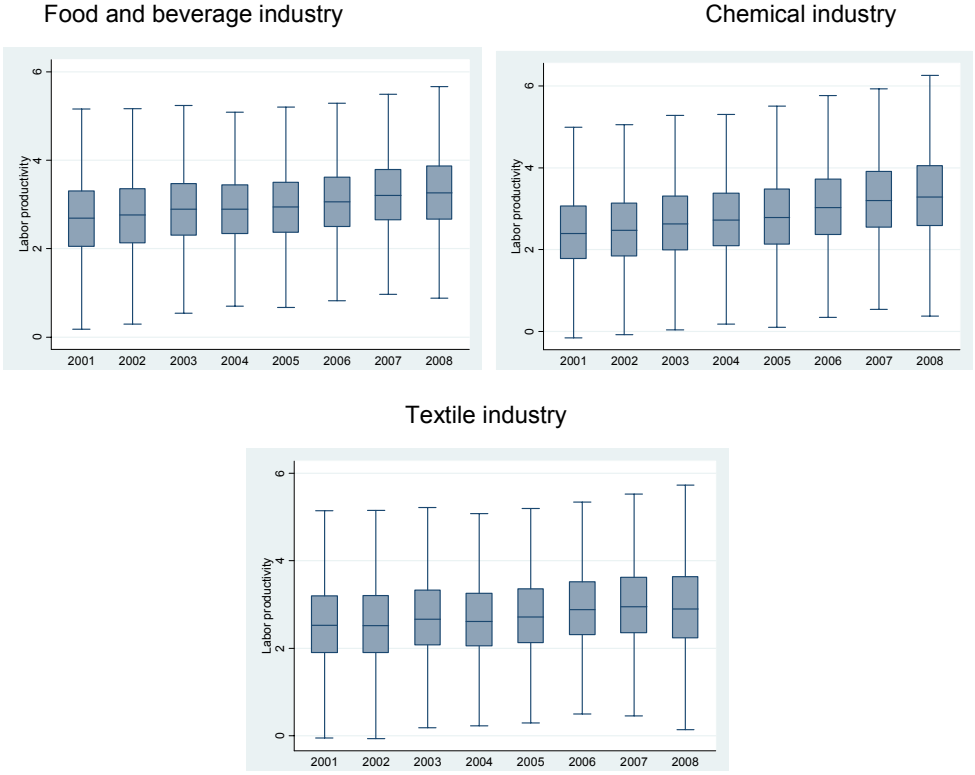
17. These deflators were provided by Upward *et al.* (2010).

Table 1. Variables used in the empirical analysis

Variable Name	Variable description	Source
Productivity (firm-level)	(Logarithm of) firms' real revenue over total employment.	ORBIS dataset provided by Bureau van Dijk.
Output tariffs (industry-level)	Most Favourite Nation (MFN) tariffs applied by China.	WTO-TRAINS.
Input tariffs (industry-level)	MFN applied tariffs weighted by input shares based on Input-Output tables for China.	Input-output tables from the Chinese National Bureau of Statistics computed by the OECD for 18 manufacturing industries.
Input tariffs (US IO) (industry-level)	MFN applied tariffs using as weights input shares based on US Input-Output tables for 18 manufacturing industries.	US input-output tables from the OECD for 18 manufacturing industries.
ETCR (energy, transport, communication and regulation) Index (industry-level)	Upstream regulation weighted by the proportion of non-manufacturing inputs used by each 2-digit industry from the energy, transport and communication sector.	OECD Product Market Regulation indicators database. Weights are constructed using input-output tables for China computed by the OECD for 18 manufacturing industries.
ETCR Index (US IO) (industry-level)	Upstream regulation indexes weighted by the proportion of non-manufacturing inputs used by each 2-digit industry from the energy, transport and communication sector.	OECD Product Market Regulation indicators database. The weights are constructed using US input-output tables computed by the OECD for 18 manufacturing industries.
IMF financial reform (industry-level)	IMF financial reform index weighted by the proportion of inputs from the banking sector used by each 2-digit industry considered.	Financial reform index from IMF (Abiad *et al.*2010). Weights are constructed using input-output tables for China computed by the OECD for 18 manufacturing industries.
IMF financial reform RZ (industry-level)	IMF financial reform index weighted by the proportion of inputs from the banking sector used by each 2-digit industry considered.I	The weights are constructed using the external dependence measure developed by Rajan and Zingales (1998) based on 18 US manufacturing industries.
Capital intensity (industry-level)	Median value of the distribution of capital to employment ratios across all firms with available information in a 2-digit industry.	ORBIS dataset provided by Bureau van Dijk.
Herfindhal index (industry-level)	Concentration of revenues in each 2-digit industry.	ORBIS dataset provided by Bureau van Dijk.
Firm's initial size	(Logarithm of) employment in 2002 (trade reform specifications) or 2001 (product market and financial reform specifications).	ORBIS dataset provided by Bureau van Dijk.
Productivity of the frontier(s) (industry-level)	Firm with the highest productivity level in a 2-digit industry.	ORBIS dataset provided by Bureau van Dijk.
Proximity to frontier (2dig) (t-1) (industry-level)	(Logarithm of) the ratio of productivity of firm i relative to productivity level of the industry frontier.	ORBIS dataset provided by Bureau van Dijk.

21. Simple statistical inspection of the data reveals an increase in average labour productivity over the period. Figure 1 plots the distribution of firm-level labour productivity for three representative manufacturing industries: food and beverages, chemicals and textile, clothing and footwear. For each year and industry, the figure shows the distribution between the 5th and the 95th percentile of labour productivity, where the upper bound of the grey bar represents the 75th percentile, the lower bound the 25th percentile and the middle line the median. All industries display substantial and somewhat growing productivity dispersion, signalling within-industry heterogeneity in firm performance. These patterns should be interpreted with care, though, due to the unbalanced nature of the dataset. In particular, the increase in the dispersion of firm productivity levels could reflect firm entry and exit, an issue which ORBIS data limitations do not allow this study to address (see below).

Figure 1. Productivity dispersion in selected industries



Note: The figures exclude the 5th and 95th percentiles of the productivity distribution.

3.2. Policy indicators

3.2.1. Input trade policy

22. Input tariffs at the 2-digit industry level are constructed for 18 manufacturing industries as the weighted average of tariffs on the intermediate goods used in the production of final goods in that industry. The tariff measures are Most Favourite Nation (MFN) tariffs applied by China from the WTO-TRAINS database. Since China's accession to WTO took place in December 2001 and tariff information is missing for the year 2002, the analysis of input-trade policy is restricted to the period 2003-08.[18] Input tariffs for each manufacturing industry s and year t, $\tau_{s,t}$, are computed as:

18. MFN tariff measures for China are available from the World Bank on the WITS web site at the 2-digit industry level: http://wits.worldbank.org/wits/.

$$\tau_{s,t} = \sum_{z} \alpha_{z,s} \tau_{z,t}$$

where $\alpha_{z,s}$ is the value share of input *z* in the production of output in the 2-digit industry *s* and $\tau_{z,t}$ is the tariff on input z in period t. For example, in an industry that uses three different intermediate goods facing tariffs of 5, 10 and 15%, and value shares of 0.10, 0.30 and 0.60, respectively, the input tariff would be 12.5% (5 x 0.10 + 10 x 0.30 + 15 x 0.60). In order to reduce endogeneity concerns, value shares are based on the (pre-reform) 2000 Chinese input-output matrix. The robustness tests reported in section 6 rely on an alternative set of weights based on US input-output matrices.

23. China experienced significant reductions in input tariffs over the period 2003-08 – after its accession to WTO – with an average reduction in (unweighted) input tariff of 1.9 percentage points (p.p) across all manufacturing industries[19]. Largest declines were observed in motor vehicles (5.3 p.p), food (3.7 p.p) and textile (2.7 p.p). Despite substantive liberalisation over the period, the level of import restrictions implied by input tariffs in China remained quite high, in particular in food and motor industries (Table 2).

Table 2. Input-trade tariffs: China versus OECD average

Industry	China		OECD	
	2003	2008	2003	2008
Food, beverages and tobacco	17.9	14.2	4.5	3.5
Textiles	12.8	10.1	3.4	3.0
Wood	7.4	5.2	2.8	1.9
Pulp, paper, paper products	5.9	4.9	1.3	0.7
Coke, refined petroleum products	7.7	6.1	2.7	2.1
Chemicals	9.1	6.6	3.1	2.2
Rubber and plastics products	9.8	7.4	3.5	2.7
Other non-metallic mineral products	8.2	7.2	3.5	2.8
Iron and steel	6.3	4.7	2.8	1.7
Fabricated metal products	6.3	5	3.0	2.1
Machinery	7.2	5.7	2.9	2.3
Electrical machinery	7.2	5.9	3.1	2.4
Medical instruments	7.2	6.2	2.7	2.2
Motor vehicles	17.3	12	4.8	4.5
Transport equipement	5.8	4.9	2.6	2.1
Manufacturing of furniture and NEC	9.4	7.5	3.1	2.2
Office and computing machinery	4.8	4.4	2.0	1.6
Radio, TV and communication	5.9	5.4	2.7	2.2

19. Input tariffs for OECD countries are computed using specific input-output tables from OECD for 18 manufacturing industries. The output tariffs are MFN tariff measures for each OECD country from the World Bank on the WITS web site at the 2-digit industry level.

3.2.2. Product market regulation in non-manufacturing sectors

24. The product market regulation analysis (PMR) relies on OECD PMR indicators in non-manufacturing industries as described in Conway and Nicoletti (2006). For the present paper, new data measuring regulation in energy, transport and communications (ETCR) indicators were constructed for China, covering major policy areas, in line with the standard OECD approach.[20] For each downstream manufacturing industry, an industry-specific regulation indicator is derived by weighting each upstream industry sub-component of the ETCR indicator by the downstream industry's reliance on those upstream industries' (namely energy, transport and communication). The latter is measured in the initial year, based on input-output matrices. The ETCR indicator itself is a weighted average of each upstream industry sub-indicator (referred to as $\text{upstream-reg index}_{jt}$ below). The ETCR indicator for each manufacturing industry *s* and year *t* is then given by:

$$\text{ETCR index}_{s,t} = \sum_{j} \alpha_{j,s} \text{upstream-reg index}_{jt}$$

where $\alpha_{j,s}$ is the value share of energy, transport and communication inputs used in the production of the goods of 2-digit manufacturing industry *s*. Since the ETCR indicator for China is constant between 2004 and 2009 – in practice implying that there were no significant reforms within the regulatory areas covered by the corresponding policy indicator – the period under consideration for product market regulation is 2001-04. Reforms of domestic network and energy sectors were rather narrow compared with the progressive opening to import competition induced by the accession to WTO. However, as described in the previous section and reflected in the changes of the policy indicators, some steps towards liberalisation took place in two essential providers of upstream services, namely electricity and telecommunications (Table 3).

Table 3. Product and financial market regulation in upstream industries: China versus OECD average

Upstream regulation indexes	China		OECD	
	2001	2004-05	2001	2004-05
Airlines	4,7	4,7	2,1	1,7
Telecom	4,6	3,8	2,1	1,5
Electricity	6,0	5,0	3,1	2,2
Gas	5,3	5,3	3,7	2,7
Post	4,2	4,2	3,5	2,9
Rail	6,0	6,0	4,2	3,7
IMF Financial reform index	7,25	10,25	19	20

Note: product market regulation is measured by $\text{upstream-reg index}_{jt}$ in each upstream industry j. The aggregate $\text{ETCR index}_{s,t}$, defined as a weighted average of the sub-indexes (see above), varies between 1.2 and 5.1, with an average of 2.7 and a standard deviation of 0.83 (across OECD countries, India, China and Brazil over 2001-05). Higher values signal more stringent regulation. Financial market regulation is measured by the $\text{IMF financial reform index}_{t}$. The index varies between 7 and 21, with an average of 16 and a standard deviation of 3.5 (across 91 OECD and non OECD countries over 2001-05.).

20. Details on Indicators of Product Market regulation can be found on the associated Indicators of Product Market Regulation Homepage and details on ETCR indicators on the associated Indicators of regulation in energy, transport and communications (ETCR) sub-page. See OECD (2011).

3.2.3. Financial market regulation

25. Financial market regulation is captured by the IMF financial reform index (Abiad *et al.* 2008). It is composed of eight sub-indices covering the following policy areas: credit controls, reserve requirements, aggregate credit ceilings, interest rate liberalisation, entry barriers in the banking sector, capital account transactions, banking privatisation, securities markets and banking sector supervision. The index is then weighted by the proportion of banking inputs used by each manufacturing sector, based on the last available – pre-reform year– input-output matrix. While this approach has been already used in previous works (*e.g.* Bourlès *et al.*, 2010), it must be recognised that input-output banking weights may not accurately measure financing costs. In order to further reduce potential endogeneity issues, some sensitivity analysis is performed based on US industries' financial dependence data initially developed by Rajan and Zingales (1998) and subsequently updated by Braun (2002). The impact of financial market regulation is restricted to the period 2001-05 because the IMF financial reform index is available until 2005 only. The IMF financial reform index for each industry *s* and year *t* is given by:

$$\text{IMF financial reform index}_{s,t} = \alpha_{banking,s}\,\text{IMF financial reform index}_{t}$$

where $\alpha_{banking,s}$ is the value share of banking inputs used in the production of the goods of 2-digit manufacturing industry *s*. An *increase* in the reform index value signals financial market *liberalisation*. Similarly to what was observed in the case of product market reforms, financial market reforms were relatively timid and bank credit remains far from being allocated by the market (Table 3).

4. Empirical approach

26. The empirical approach is based on recent models of endogenous growth (*e.g.* Acemoglu *et al.*, 2006; Aghion and Howitt, 2006) in which the aggregate impact of (domestic or foreign) competition on productivity can be non-linear and depends on the characteristics of incumbent firms (*e.g.* on the degree of firm heterogeneity). In these models, two counter-acting effects shape productivity dynamics in each market, namely the "escape competition" or "escape entry" effect on the one hand and the Schumpeterian or "discouragement" effect on the other. Which of this set of effects prevails is determined, among other things, by the average distance to technological frontier of firms in the market. In particular, the positive "escape competition" or "escape entry" effects on incumbents' efforts to improve productivity are likely to be stronger where more firms are neck-and-neck and close to frontier than in markets where a large proportion of firms have a wide technological shortfall to fill (Aghion *et al.*, 2004; Aghion *et al.*, 2006). As a result, anticompetitive regulations can have differential aggregate effects on productivity in different countries and industries depending on specific technological and market factors, such as the average distance to frontier of firms.

27. This theoretical approach is implemented in the data by estimating a model in which the effects of upstream competition vary with firms' distance to the industry-level frontier. This paper applies the Aghion and Howitt (1998) neo-Schumpeterian growth framework, as already done among others by Nicoletti and Scarpetta (2003); Aghion *et al.* (2004); Griffith *et al.* , 2006), and Bourlès *et al.* (2010). While this method has been widely applied to industry-level data as way to provide evidence of the nonlinear impact of regulation across countries, it has been rarely applied to firm-level data.[21] The following equation is estimated for a panel of firms in 18 manufacturing industries over 2003-08 for the

21. See below a brief review of relevant papers. Cross-country regressions based on industry-data include *e.g.* Bourlès *et al.* (2010) while firm-level evidence is scarce, Aghion *et al.* (2004) being an exception.

trade policy analysis, 2001-05 for the financial liberalisation analysis and 2001-04 for product market regulation analysis:[22]

$$A_{i,s,t} = \alpha + \theta A_{F,s,t} + \vartheta\left(\frac{A_{i,s,(t-1)}}{A_{F,s,(t-1)}}\right) + \beta\ policy_{s,t} + \sigma\ policy_{s,t} * \left(\frac{A_{i,s,(t-1)}}{A_{F,s,(t-1)}}\right) + \lambda\ k_{s,t} + \chi\ H_{s,t} + \gamma_i + \gamma_t + \varepsilon_{i,s,t}(I)$$

where $A_{i,s,t}$ is the logarithm of firm-level labour productivity (measured by revenues over total employment) in firm *i* in (2-digit industry) *s* in year *t*, and $policy_{s,t}$ is the policy variable under consideration, respectively trade, product market and financial market policy. $A_{F,s,t}$ corresponds to the logarithm of the productivity of the frontier and is measured by the highest productivity level in the 2-digit industry considered.[23] $\frac{A_{i,s,(t-1)}}{A_{F,s,(t-1)}}$ is the logarithm of the ratio of the productivity level of firm *i* to that of the most productive firm in industry *s* in year *t-1,* and measures the proximity of firm *i* to the industry technological frontier.

28. The identification strategy relies on the exogenous differential impact of each policy across manufacturing industries, based on each industry's reliance on locally-produced or imported inputs. The estimated β coefficient provides the effect of each policy on the level of productivity for the average downstream manufacturing firm. The estimated coefficient on the interaction term between the policy indicator and the proximity to the technological frontier (σ) measures the differential impact of policies depending on firms' distance to the technological frontier. In the case of input tariffs and product market policy, a negative (positive) coefficient value would imply that the productivity gains from a reduction in input tariffs or a deregulation of product market in upstream industries are larger (smaller) for firms that are closer to the technological frontier. For financial liberalisation, a positive (negative) coefficient value would imply that the productivity gains from the reform are larger (smaller) for firms that are closer to the technological frontier. To be able to compare the coefficients throughout the different specifications and interpret β as the average effect of policies on firm productivity, all variables are centered at the sample mean values.

29. The specification includes a number of time-varying industry-level control variables that could in principle be correlated with policy changes and are therefore introduced to reduce endogeneity bias: *i)* capital intensity ($k_{s,t}$) at the 2-digit industry level, measured by the median ratio of the capital stock to total employment; *ii)* a measure of industrial concentration, namely the standard Herfindhal index ($H_{s,t}$); *iii)* finally, in the analysis of trade policy, output tariffs in industry *s* are controlled for. γ_i denote firm level fixed effects, while γ_t denote time fixed effects.[24] Standard errors are robust and in the last column of all

22. The period under analysis differs for each policy due to policy data constraints. Since China's accession to WTO took place in December 2001 and tariff information is missing for the year 2002, the analysis of input-trade policy is restricted to the period 2003-08. In the case of product market reforms the analysis is restricted to the period 2001-04 since the ETCR index is available from 2001 and it is constant after 2004. The IMF financial reform index computed by Abiad *et al.* (2008) is only available until 2005.

23. The empirical findings reported in this paper are robust to alternative definitions of the productivity of the frontier, *e.g.* using the average productivity of the best firms in each 2-digit industry (the best firms being defined as firms with a productivity level higher than the 95th percentile of the productivity distribution).

24. An additional bias can arise insofar as firms in downstream manufacturing industries experiencing productivity gains were also able to lobby for deregulation in upstream industries. Controlling for industry concentration might partially reduce this potential bias.

tables clustered at the industry-year level to correct for potential correlation of the residuals within *industries*. Because clustering when the number of clusters is relatively small can generate biased estimates (see Wooldridge, 2005, for a technical discussion), this approach is not adopted in the baseline specification

30. As the above specification makes clear, this paper investigates the impact of structural policies on *within-firm* productivity growth and does not address the issue of industry-level productivity growth arising from reallocation effects across firms. This is a limitation of the paper given the important literature, both theoretical and empirical, suggesting that one of the channels through which policies – in particular trade and product market policies – affect productivity *via* entry and exit of firms and subsequent reallocation effects (Melitz, 2003, see Arnold *et al.* 2008 for a survey on the impact of product market regulation on productivity). Because the ORBIS dataset does not allow identifying properly entry and exit, the focus is on within-firm productivity growth, which has been consistently shown to drive the bulk of industry-level productivity growth in practice (Bartelsman *et al.* (2004); Foster *et al.* (2000); Melitz and Polanenc (2009)). In turn, productivity gains at the firm level may be channelled through innovation (Costantini and Melitz, 2007) – potentially spurred by product market liberalisation (Arnold *et al.,* 2008) – or adoption of foreign technology embodied in imported inputs potentially fostered by trade liberalisation (Kasahara and Rodrigue, 2008). Lack of account for reallocation effects implies that the estimates presented below could either under-estimate (if productivity-enhancing reallocation of resources is quick) or over-estimate (if reallocation takes time and induce temporary waste of resources) the actual short-term gains from reforms at the sectoral level.

5. Results and robustness analysis

5.1 Results

31. The empirical analysis delivers clear evidence that anticompetitive regulations in upstream sectors curb firm productivity downstream, implying that liberalisation of upstream sectors spurred manufacturing productivity growth in China over the last decade. Column 1 of Tables 4 to 6 reports within (firm) estimates, which show a significant negative productivity effect of respectively input tariffs, anticompetitive product and financial market regulations.[25] Ge *et al.* (2011) is one of the few papers which similarly look at the effects of input trade liberalisation on firm productivity in China. Associated results are not really comparable with the ones presented here, given the use of different data and empirical approach, but they are qualitatively in line with the present findings.

32. The results remain stable and robust when including other industry-level control variables, such as capital intensity and concentration in revenues, whose changes might potentially be correlated with changes in policies (Columns 2 and 3 of Tables 4 to 6). The estimated input tariff coefficient is robust to the inclusion of MFN tariffs for final goods (output tariffs) in Column 2, implying that the impact of input tariff changes is not picking up the effect of changes in output tariffs.

33. The neo-Schumpeterian specification allows shedding light on non linearities and highlights the heterogeneous effects of policies across firms within the same industry (Column 4). The estimates suggest that input tariffs and anticompetitive regulation in upstream industries have negative effects on productivity that decrease with distance to frontier. The last column shows that the results are robust to clustering standard errors at the industry-year level. This finding is in line with the view that the "escape competition" effect dominates close to the frontier, while it is weakened by a "discouragement" effect far from the frontier (Aghion and Howitt, 2006; Aghion *et al.*, 2006). The latter result is consistent with

25. Increases in the product and trade policy indicators signal more restrictive regulation while the reverse holds for the financial market indicator.

previous empirical evidence – none of which covering China though: on trade liberalisation, *e.g.* Aghion *et al.* (2006) based on industry-level data for India, on product market liberalisation *e.g.* Bourlès *et al.* (2010) based on cross-country industry-level data for OECD countries. Interestingly, though, while strict financial market regulation is found to depress labour productivity, in line with *e.g.* Rajan and Zingales, 1998 and Berger *et al.* (2009), distance to frontier estimates suggest that such depressing effects increase with distance to frontier: hence, financial repression is more damaging for laggard firms within industry. This result is new and would need to be further investigated but could tentatively suggest that access to credit is more binding for firms that are relatively more distant to the industry frontier.

Table 4. The impact of input trade policy (2003-08)
Dependent Variable: individual firm productivity level

	(1)	(2)	(3)	(4)	(5)
Productivity of the frontier	0.005***	0.006***	-0.002**	-0.004***	-0.004
	(0.001)	(0.001)	(0.001)	(0.001)	(0.011)
Input tariffs	-1.458***	-5.310***	-2.506***	-8.437***	-8.437**
	(0.163)	(0.442)	(0.439)	(0.677)	(4.231)
Proximity to frontier (2dig) (t-1)	0.181***	0.181***	0.179***	0.177***	0.177***
	(0.001)	(0.001)	(0.001)	(0.004)	(0.024)
Proximity to frontier (2dig) (t-1) x Input tariff				-1.152***	-1.152*
				(0.086)	(0.605)
Proximity to frontier (2dig) (t-1) x Output tariff				1.135***	1.135***
				(0.048)	(0.310)
Output tariffs		2.296***	1.899***	9.069***	9.069***
		(0.248)	(0.248)	(0.368)	(2.116)
Capital intensity			0.806***	0.768***	0.768***
			(0.015)	(0.015)	(0.102)
Herfindhal index			0.005***	-0.000	-0.000
			(0.001)	(0.001)	(0.006)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1031733	1031733	1031733	1031733	1031733
R-squared	0.214	0.214	0.219	0.222	0.222

Note: The table reports estimates of equation (1) where the dependent variable is the logarithm of labour productivity in firm *i* in (2-digit industry) *s* in year *t*. The *productivity of the frontier* variable corresponds to the logarithm of the highest productivity level in the 2-digit industry considered in year *t*. Proximity to frontier (2dig)(t-1) is the logarithm of the ratio of the productivity level of firm *i* to that of the most productive firm in industry *s* in year *t-1*. Tariff variables are defined at the 2-digit industry level corresponding to the main industry in which firm i operates. Capital intensity is defined at the 2-digit industry level and measured by the median ratio of the capital stock to total employment. Herfindhal index is also defined at the 2 digit industry level and computed using firm revenues. Heteroskedasticity-robust standards errors are shown in parentheses. Errors are corrected for clustering at the industry-year level in column (5). ***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

Table 5. The impact of product market regulation in non-manufacturing sectors in China (2001-04)

Dependent Variable: individual firm productivity level

	(1)	(2)	(3)	(4)	(5)
Productivity of the frontier	0.005*	0.013***	0.013***	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.015)
ETCR Index	-21.27***	-20.60***	-21.48***	-21.83***	-21.83***
	(1.038)	(1.039)	(1.050)	(1.045)	(2.960)
Proximity to frontier (2dig) (t-1)	0.146***	0.145***	0.145***	0.217***	0.217***
	(0.003)	(0.003)	(0.003)	(0.005)	(0.024)
Proximity to frontier (2dig) (t-1) x ETCR Index				-0.198***	-0.198***
				(0.011)	(0.050)
Capital intensity		0.337***	0.340***	0.279***	0.279**
		(0.026)	(0.026)	(0.026)	(0.112)
Herfindhal index			0.006***	0.006***	0.006**
			(0.001)	(0.001)	(0.002)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	537800	537800	537800	537800	537800
R-squared	0.122	0.122	0.122	0.124	0.124

Note: The table reports estimates of equation (I) where the dependent variable is the logarithm of labour productivity in firm *i* in (2-digit industry) *s* in year *t*. The ETCR index is computed for each 2-digit industry level corresponding to the main industry in which firm i operates. Higher values of the ETCR index signal stronger product market regulation. The other variables are defined in table 1 and the footnote of table 3. Heteroskedasticity-robust standards errors are shown in parentheses. Errors are corrected for clustering at the industry-year level in column (5). ***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

Table 6. The impact of financial market regulation in China (2001-05)

Dependent Variable: individual firm productivity level

	(1)	(2)	(3)	(4)	(5)
Productivity of the frontier	0.007***	0.007***	0.004	0.007**	0.007
	(0.003)	(0.003)	(0.003)	(0.003)	(0.019)
IMF financial reform Index	0.079***	0.075***	0.009	-0.497***	-0.497**
	(0.016)	(0.016)	(0.018)	(0.039)	(0.193)
Proximity to frontier (2dig) (t-1)	0.125***	0.125***	0.126***	0.176***	0.176***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.019)
Proximity to frontier (2dig) (t-1) x IMF financial reform				-0.063***	-0.063***
				(0.004)	(0.019)
Capital intensity		0.097***	0.112***	0.123***	0.123
		(0.025)	(0.025)	(0.025)	(0.146)
Herfindhal index			-0.013***	-0.020***	-0.020**
			(0.001)	(0.001)	(0.010)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	571.938	571.938	571.938	571.938	571.938
R-squared	0.115	0.115	0.116	0.117	.117

Note: The table reports estimates of equation (I) where the dependent variable is the logarithm of labour productivity in firm i in (2-digit industry) s in year t. The IMF financial reform index is computed for each 2-digit industry level corresponding to the main industry in which firm i operates. Higher values of the IMF Financial reform index signal less stringent basic financial regulation. The other variables are defined in Table 1 and the footnote of Table 3. Heteroskedasticity-robust standards errors are shown in parentheses. Errors are corrected for clustering at the industry-year level in Column (5). ***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

5.2. Size heterogeneity

34. Recent literature (Melitz, 2003; Bernard *et al.*, 2003) found robust evidence of firm heterogeneity within industries. The findings reported in the previous section suggest that liberalisation of trade and product market boosts firm productivity the closer the firm is to the industry leading technological frontier. This section exploits other sources of firm heterogeneity *e.g.* it provides new evidence on the differential effect of each policy depending on initial firm size. The baseline specification is modified to incorporate an interaction term between each policy variable and firms' initial size, which is measured by the logarithm of firm employment in 2002 (trade reform specifications) or 2001, the initial year in the firm level dataset (product market and financial reform specifications).

35. Tables 7 to 9 present detailed estimation results for each policy. As predicted by the theory, the estimated coefficients presented in Table 7 suggest that input tariff reductions are associated with a greater increase in firm productivity for initially bigger firms. Results presented in Table 8 imply that product market liberalisation delivers higher gains for (initially) larger firms. Similar to what could be inferred in the case of trade liberalisation and product market policies, Table 9 suggests that financial deepening is more beneficial to bigger firms relative to smaller ones.

Table 7. The impact of input trade policy: size heterogeneity (2003-08)

Dependent variable: individual firm productivity level

	(1)	(2)	(3)	(4)	(5)
Input tariffs	-1.146***	-0.802	1.240**	1.529**	1.529
	(0.201)	(0.629)	(0.621)	(0.620)	(2.036)
Input tariffs x initial size	-3.628***	-3.629***	-3.744***	-3.748***	-3.748***
	(0.100)	(0.100)	(0.100)	(0.100)	(0.225)
Output tariffs		-0.205	-0.157	-0.393	-0.393
		(0.362)	(0.360)	(0.362)	(1.059)
Capital intensity			0.929***	0.924***	0.924***
			(0.023)	(0.023)	(0.091)
Herfindhal index				-0.007***	-0.007
				(0.002)	(0.005)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	594.397	594.397	594.397	594.397	594.397
R-squared	0.154	0.154	0.160	0.160	0.160

Note: The dependent variable is the logarithm of labour productivity in firm *i* in (2-digit industry) *s* in year *t*. Initial size is measured by the logarithm of firm employment in 2002. The other variables are defined in table 1 and the footnote of table 3. Heteroskedasticity-robust standards errors are shown in parentheses. Errors are corrected for clustering at the industry-year level in column (5). ***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

Table 8. The impact of product market regulation in non-manufacturing sectors in China (2001-04)

Dependent variable: individual firm productivity level

Size heterogeneity

	(1)	(2)	(3)	(4)
ETCR index	-0.524***	-0.433***	-0.428***	-0.428
	(0.102)	(0.101)	(0.101)	(0.306)
ETCR index x Initial size	-1.841***	-1.841***	-1.841***	-1.841***
	(0.055)	(0.055)	(0.055)	(0.149)
Capital intensity		0.228***	0.218***	0.218**
		(0.035)	(0.035)	(0.090)
Herfindhal			-0.006***	-0.006**
			(0.001)	(0.002)
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	313.156	313.156	313.156	313.156
R-squared	0.042	0.043	0.043	0.043

Note: The dependent variable is the logarithm of labour productivity in firm *i* in (2-digit industry) *s* in year *t*. Initial size is measured by the logarithm of firm employment in 2002. The ETCR index is computed for each 2-digit industry level corresponding to the main industry in which firm i operates. Higher values of the ETCR index signal stronger product market regulation. The other variables are defined in table 1 and the footnote of table 3. Heteroskedasticity-robust standards errors are shown in parentheses. Errors are corrected for clustering at the industry-year level in column (5).
***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

Table 9. The impact of financial market regulation in China: size heterogeneity (2001-05)

Dependent variable: individual firm productivity level

	(1)	(2)	(3)	(4)
IMF financial reform index	0.153***	0.142***	0.139***	0.139***
	(0.019)	(0.019)	(0.019)	(0.042)
IMF financial reform index x Initial size	0.441***	0.440***	0.440***	0.440***
	(0.009)	(0.009)	(0.009)	(0.019)
Capital intensity		0.347***	0.344***	0.344***
		(0.032)	(0.032)	(0.093)
Herfindhal			-0.005***	-0.005**
			(0.001)	(0.003)
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	402.989	402.989	402.989	402.989
R-squared	0.063	0.064	0.064	0.064

Note: The dependent variable is the logarithm of labour productivity in firm *i* in (2-digit industry) *s* in year *t*. Initial size is measured by the logarithm of firm employment in 2002. The IMF financial reform index is computed for each 2-digit industry level corresponding to the main industry in which firm i operates. Higher values of the IMF Financial reform index signal less stringent basic financial regulation. The other variables are defined in table 1 and the footnote of table 3. Heteroskedasticity-robust standards errors are shown in parentheses. Errors are corrected for clustering at the industry-year level in column (5). ***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

5.3. Robustness analysis

5.3.1. Endogeneity

36. Endogeneity bias might arise as a direct consequence of the way the policy variables are computed. These are indeed based on input-output interlinkages. Industry productivity might affect input weights, in which case the policy variables would be endogenous. For example, if more productive industries rely relatively more on energy, the cross-industry variation in the ETCR index might reflect the cross-industry variation productivity. Another potential source of endogeneity arising from the use of Chinese input-output weights is that the latter can be a function of domestic policies. If, for example some upstream sector is heavily affected by tariff changes, it could end up representing a low share of input in downstream sectors.

37. To address these issues, as reported above, the baseline estimates rely on input-output matrices in the "initial" period (before the policy variables are defined). Still, endogeneity risk cannot be ruled out if there is persistence in productivity growth over time. One way of dealing with this is to use an alternative set of weights which are not correlated with Chinese firm productivity growth. Therefore, this section presents a series of robustness checks using US input-output matrices to construct an alternative set of input weights for input tariffs and the ETCR index. In the case of financial market reforms, sensitivity analysis is based on US (rather than domestic) industries' financial dependence data developed by Rajan and Zingales (1998) and updated by Braun (2002).

38. These sensitivity tests confirm the robustness of the results. Table 10 presents the estimates for input trade policy and tables 11 and 12 for product and financial market policies. Column (1) reports the estimates of the distance to frontier specification and column (2) of the size heterogeneity specification.

Table 10. Input-trade policy and firm productivity: robustness checks using US I-O matrix

Dependent Variable: individual firm productivity level

	(1)	(1)	(2)
Input tariffs (US IO)	-0.755*	-0.319	0.467
	(0.422)	(0.417)	(0.528)
Proximity (2dig) (t-1) x Input tariff (US IO)		-0.531***	
		(0.079)	
Proximity (2dig) (t-1) x Output tariff (US IO)		0.804***	
		(0.044)	
Input tariff (US IO) x Initial size			-4.041***
			(0.107)
Productivity of the frontier		-0.004***	
		(0.001)	
Proximity (2dig) (t-1)		0.190***	
		(0.001)	
Output tariffs	0.185	1.531***	0.137
	(0.232)	(0.229)	(0.293)
Capital intensity	0.940***	0.780***	0.925***
	(0.016)	(0.015)	(0.023)
Herfindhal	-0.007***	0.002	-0.007***
	(0.001)	(0.001)	(0.002)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	1,208,370	1,031,733	594.397
R-squared	0.219	0.221	0.160

Table 11. Product market regulation and firm productivity: robustness checks using US I-O matrix

Dependent Variable: individual firm productivity level

	(1)	(1)	(2)
ETCR Index (US IO)	-0.818***	-50.923***	-0.265
	(0.183)	(5.558)	(0.191)
Proximity to frontier (2dig) (t-1) x ETCR Index(US IO)		-0.140***	
		(0.007)	
ETCR Index (US IO) x Initial size			-2.696***
			(0.072)
Productivity of the frontier		-0.027***	
		(0.004)	
Proximity to frontier (2dig) (t-1)		0.151***	
		(0.003)	
Capital intensity	0.054***	-0.036***	0.011
	(0.007)	(0.008)	(0.007)
Herfindhal	0.003***	0.001	-0.007***
	(0.001)	(0.001)	(0.001)
Firm fixed effects	Yes	Yes	Yes
Year Fixed effects	Yes	Yes	Yes
Observations	537.800	537.800	313.156
R-squared	0.111	0.122	0.045

Table 12. Financial market regulation and firm productivity: robustness checks using Rajan-Zingales (RZ)

Dependent variable: individual firm productivity level

	(1)	(1)	(2)
IMF financial reform index RZ	0.212***	0.332***	0.253***
	(0.047)	(0.053)	(0.067)
Proximity (2dig) (t-1) x IMF financial reform RZ		-0.109***	
		(0.021)	
IMF financial reform RZ x Initial size			1.733***
			(0.049)
Productivity of the frontier		0.010***	
		(0.004)	
Proximity (2dig) (t-1)		0.140***	
		(0.003)	
Capital intensity	0.533***	0.354***	0.392***
	(0.023)	(0.026)	(0.033)
Herfindhal	-0.005***	-0.001	-0.007***
	(0.001)	(0.001)	(0.001)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	799869	534885	377308
R-squared	0.112	0.122	0.058

5.2.2. Additional robustness analysis

39. Additional sensitivity analysis is carried out by introducing simultaneously several policy variables in the same equation. Due to data constraints, this test can however be only conducted for product and financial market policies.[26] This is clearly a limitation because political economy considerations would suggest a correlation between trade and product market policies; however (disregarding the non coincidence of the time coverage), simple statistical analysis suggests that this may be not be a concern in practice.[27] Table 13 presents the results. When including in the same specification the ETCR index and the IMF financial reform index, the findings remain robust and stable. Product market regulation in upstream industries has a negative effect on firm productivity that is decreasing with distance to the frontier, while the negative effect of strict financial regulation increases with distance to the technological frontier (Column 1). These findings are robust when including in the same specification observable industry level characteristics in Column (2) and when clustering standard errors at the industry-year level in Column (3).

Table 13. Other robustness checks

Dependent variable: individual firm productivity level

	(1)	(2)	(3)
Proximity to frontier (2dig) (t-1) x ETCR Index	-0.139***	-0.131***	-0.131**
	(0.012)	(0.013)	(0.054)
Productivity of the frontier	-0.002	0.008**	0.008
	(0.003)	(0.004)	(0.016)
ETCR Index	-25.408***	-22.568***	-22.568***
	(14.470)	(15.923)	(60.516)
Proximity to frontier(2dig)(t-1) x IMF financial	-0.061***	-0.065***	-0.065***
reform Index	(0.005)	(0.005)	(0.020)
IMF financial reform index	-0.120***	-0.072**	-0.072
	(0.023)	(0.031)	(0.114)
Proximity to frontier (2dig)	0.155***	0.153***	0.153***
	(0.003)	(0.003)	(0.012)
Capital intensity		0.319***	0.319***
		(0.027)	(0.114)
Herfindhal		0.000	0.000
		(0.001)	(0.005)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	537,800	537,800	537,800
R-squared	0.125	0.126	0.126

26. Since China joined WTO in December 2001 and MFN tariff data are not available for 2002, the input tariff policy analysis is restricted to the period 2003-08. The ETCR index has no variation after 2005 and the IMF financial index is available till 2005.

27. Regressing input tariffs on the ETCR index and year dummies suggest that trade and product market policies are uncorrelated (with a statistically insignificant estimated coefficient of -0.11). Similarly, regressing input tariffs on the IMF financial reform index and year dummies yields a statistically insignificant coefficient of -0.020.

6. Policy simulations

40. The empirical results are illustrated by calculating the productivity gains in the manufacturing sector from adopting the level of trade, product market and financial market regulation observed on average in upstream sectors in OECD countries. The methodology is adapted from Bourlès *et al.* (2010) who use a similar approach on industry-level data. To calculate the potential gains from adopting OECD level regulations, empirical estimates of Column 5 in Tables (3) to (5) are used respectively for trade, product and financial market reforms. Specifically, dynamic productivity gains are computed over the 2003-07 period from adopting in each upstream industry the level of input tariffs observed on average across OECD countries in 2007 while comparable calculations are done over 2001-05 for product and financial market reforms (in which case the simulation assumes adopting 2005 OECD regulation).

41. The indicators of regulatory burden are based on domestic input-output matrix, as appropriate for the purpose of the simulations. Each firm-industry is projected dynamically: the productivity impact of deregulation results from the initial decrease in the indicator of regulatory burden obtained by adopting OECD practice regulation in upstream sectors and on the subsequent reductions in distance to frontier that this initial policy shock sets off over the projection period. For each downstream manufacturing industry, Figures 2-4 present the level of input tariffs (as of 2007) and anticompetitive product and financial market regulations (as of 2005) for China and the average OECD countries

Figure 2. Input tariffs levels in downstream industries in 2007: China vs. average OECD.

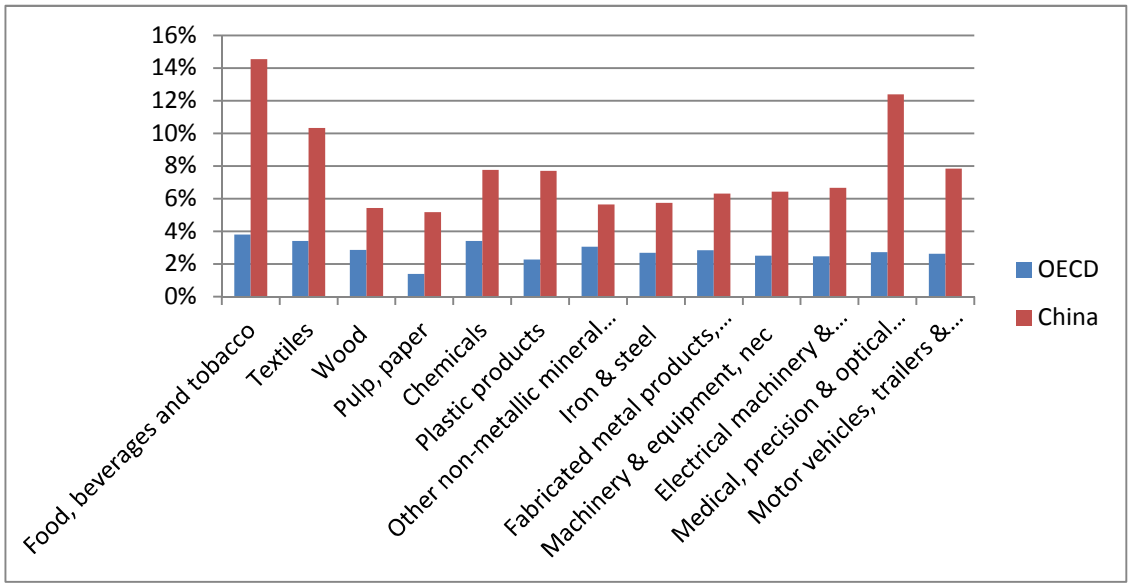
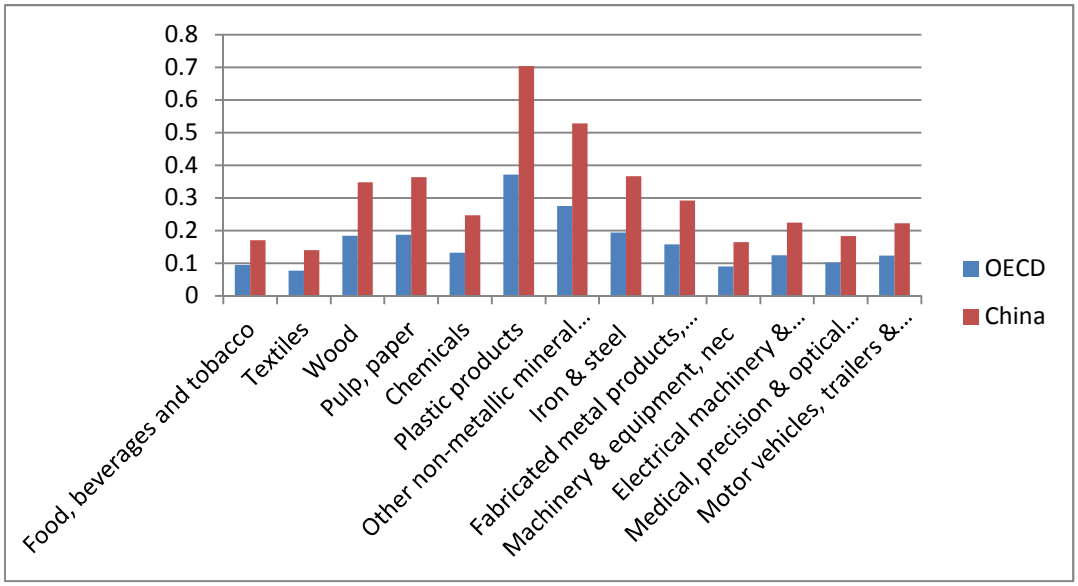
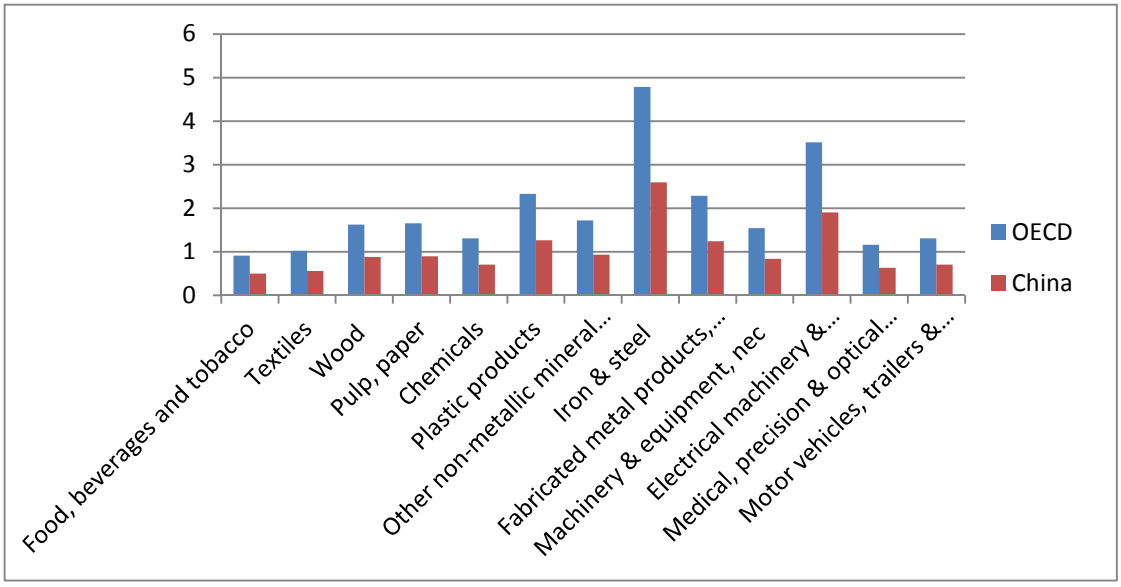


Figure 3. Anticompetitive product market regulation in downstream industries in 2005: China vs. average OECD.



Note: Higher values of the ETCR index signal stronger product market regulation.

Figure 4. Anticompetitive financial market regulations in downstream industries in 2005: China vs. average OECD.



Note: Higher values of the IMF Financial reform index signal less stringent basic financial regulation.

42. Tables 14 to 16 present respectively the impact of trade, product and financial market reforms, both at the aggregate manufacturing level (relying on industries' revenue weights) and at the industry level (relying on firms' revenue weights).[28] First, taken at face value, such policy simulations would imply substantive productivity gains in China: product market reforms would deliver the biggest gains (9% after five years), followed by financial market reforms (6.5% after five years) and trade reforms (4% after five years). Such ranking can be explained by the relatively more stringent policy stance in the two former areas compared to the latter, as discussed in the first section of the paper. Annual gains from product market reforms, in the order of 2% on aggregate, are comparable with calculations by Bourlès *et al.* (2010) for the most regulated OECD countries (the closest comparison since the latter paper does not cover China).[29] The highest productivity gains are observed between the first and second year (2001-02) after the introduction of the policy reform. The subsequent decline in annual gains reflects the contraction of productivity gap set off by deregulation, which implies a declining catch-up effect, as well as, to a smaller extent, the reduction of regulatory burdens during the 2001-05 period in the baseline simulation. The dynamic pattern of adjustment is mainly presented for comparative purposes with Bourlès *et al.* (2010) and needs to be interpreted with great caution as the analysis relies on the strong assumption that the speed of adjustment to policy reform corresponds to the general pace of convergence to best practice.

43. These simulations shed light on the importance of heterogeneity and non linearities associated with the effects of structural reforms. Indeed, cross-industry differences in productivity gains reflect four factors: *i)* the excess regulatory burden relative to best practice in each upstream sector, *ii)* the intensity of downstream intermediate consumption of products from regulated upstream sectors, *iii)* the initial distance to frontier of productivity in downstream sectors, *iv)* a composition effect due to the weights of each firm in the industry. The larger the excess regulatory burden and intermediate consumption of regulated products, the stronger the gains in productivity from aligning regulations in upstream sectors on international practice; conversely, the smaller the distance to frontier, the stronger the gains from deregulation. The industry-level calculations reflect these opposing forces. Since the first two factors vary across policy areas, a different cross-industry pattern is found for each policy simulation, as suggested in Tables 14 to 16:[30]

- The industries that benefit most from trade reforms are motor vehicles (8.6% after five years), food, beverages and tobacco (7.9% after five years) and medical instruments (3.9% after five years). These industries exhibit the highest input tariffs in comparison to the OECD average.
- The industries that benefit most from product market reforms are non-metallic products (20% after five years), chemicals (16% after five years) and iron and steel (14% after five years). These industries are heavy consumers of energy inputs, and therefore an alignment of Chinese electricity and gas regulation to OECD levels would be most beneficial to them.
- The industries that benefit most from financial market reforms are metal products (16% after five years), machinery (11% after five years) and non-metal mineral products (10.1% after five years). Being capital-intensive, these industries depend more on external finance, hence on intermediate services from the banking sector.

28. The absence of gains in the first year (2001 for product and financial reforms or 2003 for trade liberalization) is due to the assumption that policies affect productivity with one year lag.

29. More precisely, the gains computed in this paper are slightly lower, which is to be expected given the relatively high level of regulation in China compared to OECD countries, including the most restrictive ones.

30. More precisely, the non overlapping nature of the data for the different estimations makes it likely that even the last two factors would vary across policy calculations, but eventually relatively less if the distribution of firms' productivity remains relatively stable over time.

Table 14. Productivity gains in the Chinese manufacturing sector from adopting in 2003 average OECD input tariffs observed in 2007 in the upstream sectors

	2004		2005		2006		2007	
	Annual	Cumul	Annual	Cumul	Annual	Cumul	Annual	Cumul
Aggregate manufacturing	**0.6**	**0.6**	**0.6**	**1.2**	**0.7**	**1.9**	**0.8**	**2.7**
Food, beverages and tobacco	1.6	1.6	1.9	3.5	2.0	5.5	2.4	7.9
Textiles	0.6	0.6	0.7	1.3	0.7	2.0	1.3	3.2
Wood	0.4	0.4	0.5	0.9	0.4	1.3	0.5	1.7
Pulp, paper	0.6	0.6	0.5	1.1	0.4	1.5	0.4	1.9
Chemicals	0.7	0.7	0.6	1.3	0.7	2.0	0.5	2.5
Plastic products	1.0	1.0	0.8	1.8	0.7	2.5	0.9	3.4
Non-metallic mineral	0.4	0.4	0.7	1.1	0.8	1.9	0.7	2.6
Iron and steel	0.1	0.1	0.3	0.5	0.4	0.9	0.4	1.2
Metal products	0.1	0.1	0.3	0.4	0.0	0.4	0.0	0.4
Machinery	0.1	0.1	0.2	0.3	0.3	0.5	0.3	0.9
Electrical machinery	0.6	0.6	0.5	1.1	0.6	1.7	0.8	2.5
Medical inst.	0.8	0.8	0.9	1.7	1.1	2.8	1.1	3.9
Motor vehicles, trailers	2.2	2.2	1.9	4.1	2.2	6.3	2.2	8.6

Table 15. Productivity gains in the Chinese manufacturing sector from adopting in 2001 average OECD product market regulation observed in 2005 in the upstream sectors

	2002		2003		2004		2005	
	Annual	Cumul	Annual	Cumul	Annual	Cumul	Annual	Cumul
Aggregate manufacturing	**2.8**	**2.8**	**2.3**	**5.1**	**2.1**	**7.2**	**2.2**	**9.4**
Food, beverages and tobacco	1.3	1.3	1.3	2.6	1.1	3.7	1.2	4.9
Textiles	1.1	1.1	1.0	2.2	0.9	3.1	1.0	4.0
Wood	3.0	3.0	2.5	5.5	1.8	7.3	1.7	9.0
Pulp, paper	3.4	3.4	3.0	6.4	2.7	9.1	2.7	11.8
Chemicals	4.9	4.9	4.2	9.1	3.6	12.6	3.7	16.4
Plastic products	2.2	2.2	2.0	4.1	1.7	5.8	1.8	7.6
Non-metallic mineral	6.5	6.5	5.6	12.0	4.4	16.4	4.4	20.8
Iron and steel	4.4	4.4	3.7	8.0	3.0	11.0	3.0	14.0
Metal products	3.2	3.2	1.4	4.6	2.5	7.1	2.7	9.8
Machinery	2.5	2.5	2.3	4.8	1.9	6.8	2.1	8.8
Electrical machinery	1.4	1.4	1.3	2.7	1.1	3.8	1.2	5.0
Medical inst.	1.8	1.8	1.7	3.5	1.4	4.9	1.6	6.5
Motor vehicles, trailers	1.5	1.5	1.3	2.8	1.2	4.0	1.4	5.5

Table 16. Productivity gains in the Chinese manufacturing sector from adopting in 2003 average OECD financial market regulation observed in 2005 in the upstream sectors

	2002		2003		2004		2005	
	Annual	Cumul	Annual	Cumul	Annual	Cumul	Annual	Cumul
Aggregate manufacturing	**2.3**	**2.3**	**1.9**	**4.2**	**1.3**	**5.6**	**0.9**	**6.5**
Food. beverages and tobacco	1.4	1.4	1.2	2.6	0.9	3.4	0.6	4.0
Textiles	1.7	1.7	1.4	3.1	1.0	4.2	0.8	5.0
Wood	2.5	2.5	1.8	4.3	1.0	5.4	0.7	6.1
Pulp, paper	2.3	2.3	1.9	4.3	1.5	5.7	1.2	6.9
Chemicals	2.6	2.6	2.0	4.6	1.5	6.1	1.1	7.2
Plastic products	2.0	2.0	1.5	3.5	1.2	4.7	0.9	5.6
Non-metallic mineral	4.1	4.1	3.1	7.1	1.7	8.9	1.2	10.1
Iron and steel	2.8	2.8	2.2	5.0	1.3	6.2	0.9	7.1
Metal products	8.3	8.3	2.7	11.0	3.2	14.2	1.8	15.9
Machinery	4.1	4.1	3.3	7.4	2.1	9.5	1.4	10.9
Electrical machinery	2.4	2.4	1.9	4.3	1.4	5.7	1.0	6.7
Medical inst.	3.3	3.3	3.3	6.6	1.9	8.5	1.1	9.6
Motor vehicles, trailers	1.8	1.8	1.3	3.1	0.9	4.0	0.8	4.8

7. Conclusions

44. This paper presents novel insights on the effects of input-trade liberalisation, product market deregulation and financial reform in upstream sectors on firm-level productivity in the manufacturing sector in China, a fast-growing and fast-reforming country. The analysis suggests that these reforms boost firm productivity. Input tariff cuts and deregulation of upstream sectors such as networks and energy provision have a larger effect on firms that are closer to the industry technological frontier. By contrast, financial liberalisation seems to benefit more firms that are further away from the industry frontier, and thereby to speed up the catch-up process.

45. The findings presented in this work suggest that removing remaining restrictions in upstream industries could bring substantive productivity gains and benefit not only firms producing in these industries but also those that use inputs from these industries. Despite progress in liberalising trade, services and financial sectors, the reform process in China is not complete yet. The recent decision by the Chinese monetary authorities to allow greater freedom for banks to set their own interest rates might be a first step towards interest rate deregulation and could signal a beginning process of financial liberalisation. The analysis undertaken in this paper suggests that such reforms could yield very high gains; taken at face value, the estimates would imply that adopting OECD regulation in the financial sector could boost manufacturing productivity by 6.5% after five years. Such findings come with a number of limitations, not least related to data availability and in particular to the representativeness of the firm-level dataset used in this study. As more and higher-quality firm-level data become available, further work should be carried out on the effects of reforms and the mechanisms through which these impact productivity.

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