©The Pakistan Development Review
52:2 (Summer 2013) pp. 97–126

The End of Multi-Fibre Arrangement and Firm Performance in the Textile Industry: New Evidence

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Using a sample of 321 textile and clothing companies for the years 1992 to 2010, this paper analyses the effect of quota phase-outs on firm-level efficiency in Pakistan following the end of the Multi-Fibre Arrangement (MFA). It highlights sectoral heterogeneity within the manufacturing industry as a result of MFA expiration. The empirical methodology uses the structural techniques proposed by Olley and Pakes (1996), and Levinsohn and Petrin (2003) in order to take care of endogeneity in the estimation of production functions. The results differ for the two industries: MFA expiration lead to an increase in the average productivity of textile producing firms but a significant reduction in the mean productivity of clothing producers. We offer a number of explanations for this outcome, such as a change in the input and product mix, entry by non-exporters in the clothing sector, and sectoral differences in quality ladders. A number of crucial policy lessons can be drawn from the findings of this study.

JEL Classification: F13; F14; D24; C14; O19
Keywords: Multi-Fibre Arrangement, Trade Liberalisation, Productivity, Firm Heterogeneity, Simultaneity and Production Functions, Endogeneity of Protection

1. INTRODUCTION

The Multi-Fibre Arrangement (MFA) was the outcome of a decade-and-a-half of previous short-term agreements on the trade of textile and clothing (T&C) products amongst the developed and developing countries. Signed in 1974, the MFA enforced restrictions on exports by T&C exporters to developed countries by means of bilaterally negotiated quotas on textile products. Moreover, T&C products were excluded from multilateral trade negotiations under the General Agreement on Tariffs and Trade (GATT) and the World Trade Organisation (WTO). An important development of the

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Author's Note: An earlier draft of this paper was presented at the 8th annual Pacific Conference on Development Economics (PAC-DEV), hosted by the Centre of Evaluation for Global Action (CEGA), at the University of California, Berkeley, on March 12, 2011. We thank our discussants and other conference participants for their comments. An older version of the paper was also presented at the University of Guelph, Department of Economics and Finance seminar series, on May 11, 2012. The author would like to thank Jeffery Nugent, John Strauss, and Robert Dekle for their extremely useful suggestions. The author would also like to thank Abid Burki for sharing the Balance Sheet Data of Pakistani Listed and Non-Listed Companies (BSDPC). Excellent research assistance in updating the BSDPC data set was provided by Rai Ghulam Mustafa, Muhammad Umair Mustafa, Sidra Ilyas and Turab Hassan. Any opinions, findings, and recommendations expressed are those of the author.

Uruguay Round (1994) was signing of the Agreement on Textile and Clothing (ATC) which put to an end the MFA. The ATC commenced the practice of integrating T&C products into GATT/WTO. The integration occurred over a period of ten years and across four phases starting from 1 January 1995. Importing countries were to include a certain portion of all T&C products covered by the ATC in each phase.[1] The expiration of these quotas was expected to bring about a considerable reallocation of production and exports across countries. This paper evaluates the impact of the end of MFA on Pakistan's T &C industry under the ATC. More specifically, it evaluates the impact of quota relaxation and removal on firm productivity and total output in these industries. The goal of the study is to use the adjusted quota base within a given industry on the right-hand side of a regression with either firm productivity or firm output as the dependent variable. The paper argues that the quota changes can be seen as exogenous from the firm's perspective. Naturally, the topic is of general interest as well as from Pakistan's point of view. The T&C industries are important in many developing countries, including Pakistan, and the ATC was one of the most important negotiated trade reforms for developing countries in the past 30 years. The end of quota system, together with the mounting significance of the industry in its domestic market, leads us to analyse the efficiency issues related to Pakistan's textile industry.

What is of interest in the paper is the central issue of the relationship between these quota phase-outs and firm output and productivity. Unlike most other studies in the literature, this paper investigates the liberalisation episode in a developed country, i.e. the United States in our case, and its consequences for firms in Pakistan. Furthermore, it highlights sectoral heterogeneity within the manufacturing industry of a developing country as an effect of MFA expiration. The textile sector is an important industry in Pakistan in terms of output, export value, foreign exchange earnings and employment.[2] Tables 1 and 2 demonstrate the export value in millions of U.S. dollars of several cotton and cotton manufactures from 1993 to 2011. Pakistan is the fourth largest producer of cotton in the world and does not have to rely on other countries for its raw materials. Moreover, labour costs in Pakistan are among the lowest in the world.[3] T&C make up roughly 74 percent of total export value. Tables 3 and 4 show the production and export of yarn and cloth, respectively, from 1971 to 1991. Government had taken steps to ensure competitiveness of its product even prior to the MFA expiration.[4]

[1]The particular products integrated in each phase were specific to importing countries but were determined by two rules [Brambilla, *et al.* (2007)]. To begin with, the products retired in each phase had to consist of goods from all four key textile and clothing segments: Yarn, Fabrics, Made-Up textile products, and Clothing. Moreover, the selected products had to correspond to an agreed fraction of each country's 1990 T&C imports by volume. The U.S. postponed the removal of quotas on sensitive products until Phase III. Of the 4,839 ten-digit Harmonized System (HS) product codes that the U.S. retired over the four phases, 62 percent were retired in 2005. HS codes are the group of T&C products governed by the ATC and imported by the U.S.

[2]The spinning sector was the most privileged by investment. It received 47 percent of the $4 billion investment in the T&C industry between 1999 and 2003. After China and India, Pakistan has the third-largest capacity of short-staple spindles for spun yarn in the world ("Textiles and Apparel: Assessment of the Competitiveness of Certain Foreign Suppliers to the U.S. Market." Investigation No. 332-448, U.S. International Trade Commission, 2004).

[3][International Comparison of the Hourly Labour Cost in the Primary Textile Industry (2012)].

[4]The private and public sectors together formed the National Textile Institute (Faisalabad) in 1959. The government proposed Textile Vision 2005, which involves giving loans to upgrade equipment, interest rate and tax policy reforms, and promotion of product and market diversification.

Table 1

Exports of Cotton and Cotton Manufactures in Millions of US Dollars

Period	Cotton Yarn	Cotton Cloth	Tent and Canvas	Cotton Bags	Towels	Bed Wear
1993-94	1259.3	820.6	29.1	17.3	129.2	285.6
1994-95	1528.1	1081.4	38.2	19.1	144.8	340.2
1995-96	1540.3	1275.9	39.5	24.6	174.1	422.2
1996-97	1411.5	1262.4	36.2	27.6	194.1	456.3
1997-98	1159.5	1250.3	58.1	23.1	200.1	508.8
1998-99	945.2	1115.2	40.8	20.8	177.7	611.0
1999-00	1071.6	1096.2	52.9	19.2	195.6	709.9
2000-01	1076.6	1035.0	50.0	19.0	243.0	734.9
2001-02	942.3	1132.7	47.4	18.2	269.8	918.5
2002-03	928.3	1345.6	73.2	18.2	374.8	1329.0
2003-04	1127.0	1711.7	75	18.0	404	1383
2004-05	1057.0	1863	67	0	520	1450
2005-06	1383.0	2108.0	39.0	13.7	588.0	2038.0
2006-07	1428.0	2027.0	69.0	11.4	611.0	1996.0
2007-08	1,301.0	2,011	71.0	10.4	613.0	1904.0
2008-09	1114.8	1955.3	56.2	8.4	642.9	1735.0
2009-10	1,433.1	1,800.1	61.5	5.3	668.2	1,744.3
2010-11	2,201.4	2,623.2	47.0	10.3	762.3	2,088.9

Source: All Pakistan Textile Mills Association (APTMA).

Table 2

Exports of Cotton and Cotton Manufactures in Millions of US Dollars

Period	Other Made-ups	Garments	Hosiery	Thread	Cotton Manufacture	Total Export
1993-94	129.4	612.2	509.1	4.0	3795.8	6802.5
1994-95	163.5	641.7	688.5	1.9	4647.5	8137.2
1995-96	179.1	648.5	703.4	1.5	5009.1	8707.1
1996-97	208.7	736.4	688.9	1.7	5023.8	8320.3
1997-98	245.8	746.5	696.7	1.8	4890.7	8627.7
1998-99	255.3	651.2	742.1	1.5	4560.8	7779.3
1999-00	307.6	771.7	886.7	1.3	5112.7	8568.6
2000-01	328.2	827.5	910.3	1.0	5225.5	9224.7
2001-02	351.3	882	841.5	–	5404	9123.6
2002-03	359.7	1092.6	1146.6	–	6668.0	11160.2
2003-04	417.0	993	1459	–	7587.7	1231.3.
2004-05	466	1088	1635	0	8146	14391.0
2005-06	418.0	1310	1751	0.3	9649	16451.0
2006-07	514.0	1547.0	1798.0	0.2	10001.6	16976.0
2007-08	537.0	1452.0	1732.3	0.2	9631.9	19052.0
2008-09	480.1	1230.0	1740.8	–	8963.5	17688.0
2009-10	537.2	1,269.3	1,744.3	–	9,263.3	19,290.0
2010-11	625.0	1,773.7	2,305.6	–	12,437.2	24,810.4

Source: All Pakistan Textile Mills Association (APTMA).

Table 3

Production and Export of Yarn in Thousands of Kilograms (1971–1991)

Year	Production	Exports		Year	Production	Exports	
		Quantity	% of Production			Quantity	% of Production
1971-72	335,702	130,158	38.77	1991-92	1,188,270	505,863	42.57
1972-73	376,122	184,404	49.03	1992-93	1,234,539	555,294	44.98
1973-74	379,460	100,564	26.50	1993-94	1,498,948	578,648	38.60
1974-75	351,200	78,365	22.31	1994-95	1,413,648	522,091	36.93
1975-76	349,653	112,182	32.08	1995-96	1,505,244	535,889	35.60
1976-77	282,640	64,294	22.75	1996-97	1,530,855	508,188	33.20
1977-78	297,895	59,955	20.13	1997-98	1,540,720	461,919	29.98
1978-79	327,796	97,929	29.87	1998-99	1,547,632	421,481	27.23
1979-80	362,862	99,834	27.51	1999-00	1,678,536	512,971	30.56
1980-81	374,947	95,232	25.40	2000-01	1,729,129	545,134	31.59
1981-82	430,154	95,621	22.23	2001-02	1,818,345	539,500	29.67
1982-83	448,430	134,100	29.90	2002-03	1,924,936	525,130	27.28
1983-84	431,580	101,805	23.59	2003-04	1,938,908	514,279	26.52
1984-85	431,731	125,855	29.15	2004-05	2,290,340	520,782	22.74
1985-86	482,186	157,895	32.75	2005-06	2,216,605	691,492	31.20
1986-87	586,371	259,668	44.28	2006-07	2,727,566	699,259	25.64
1987-88	685,031	210,950	30.79	2007-08	2,809,383	594,936	21.18
1988-89	767,434	291,953	38.04	2008-09	2,862,411	526,246	18.38
1989-90	925,382	374,976	40.52	2009-10	2,880,970	612,413	21.26
1990-91	1,055,228	501,072	47.48	2010-11	3,016,972	549,947	18.23

Source: All Pakistan Textile Mills Association (APTMA).

Table 4

Production and Export of Cloth in Million Square Meters (1971–1991)

Year	Production	Exports		Year	Production	Exports	
		Quantity	% of Production			Quantity	% of Production
1971-72	1350.67	409.81	30.34	1991-92	3238.99	1196.12	36.93
1972-73	1238.11	517.98	41.84	1992-93	3360.00	1127.58	33.56
1973-74	1828.72	353.02	19.30	1993-94	3378.00	1046.79	30.99
1974-75	1827.08	440.81	24.13	1994-95	3100.75	1160.66	37.43
1975-76	1503.36	463.84	30.85	1995-96	3706.00	1323.09	35.70
1976-77	1445.30	416.84	28.84	1996-97	3781.20	1257.43	33.25
1977-78	1573.07	453.47	28.83	1997-98	3913.70	1271.27	32.48
1978-79	1487.10	531.53	35.74	1998-99	4386.79	1355.17	30.89
1979-80	1720.02	545.77	31.73	1999-00	4987.16	1574.88	31.58
1980-81	1834.00	500.90	27.31	2000-01	5591.40	1736.00	31.05
1981-82	2200.44	584.35	26.56	2001-02	5653.09	1957.35	34.62
1982-83	2048.77	605.33	29.55	2002-03	5650.52	2005.38	35.49
1983-84	2165.98	664.38	30.67	2003-04	6833.12	2412.87	35.31
1984-85	2000.00	687.62	34.38	2004-05	6480.67	2751.56	42.46
1985-86	1985.40	727.35	36.63	2005-06	8524.26	2633.98	30.90
1986-87	2009.85	693.42	34.50	2006-07	8694.92	2211.84	25.44
1987-88	2230.82	848.61	38.04	2007-08	9005.44	2035.14	22.60
1988-89	2250.00	845.33	37.57	2008-09	9015.26	1898.54	21.06
1989-90	2734.77	1017.87	37.22	2009-10	8949.77	1753.12	19.59
1990-91	2854.00	1056.53	37.02	2010-11	9018.32	2297.49	25.48

Source: All Pakistan Textile Mills Association (APTMA).

Fig. 1. Mean Productivity of Textile and Clothing Firms—Levinsohn and Petrin Productivity Measure

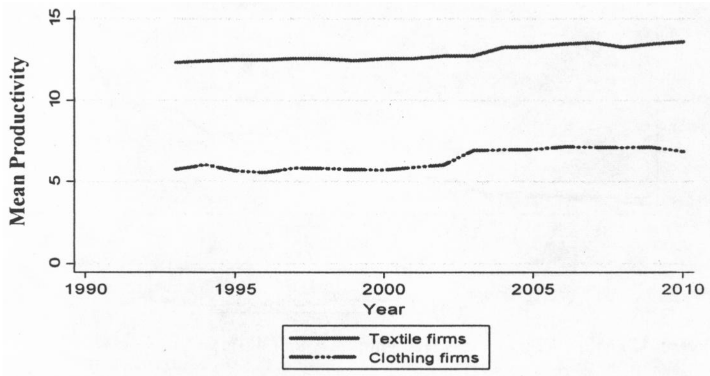
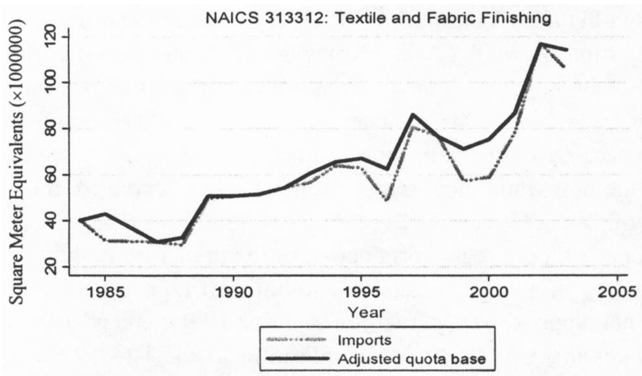


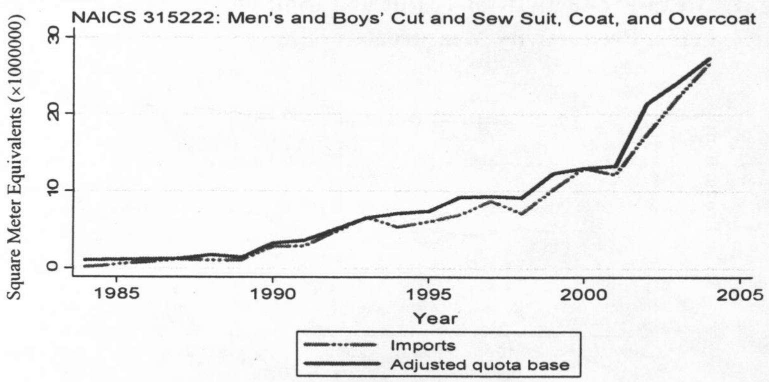
Figure 1 shows the evolution of mean productivity of the sample of T&C firms used in the paper. It is computed using Levinsohn and Petrin productivity measure (which we explain later in the paper). For the time period under consideration, textile firms have a much higher mean productivity than clothing firms. Furthermore, we notice an upward trend in the mean productivity of both types of firms. The focus of this paper is on the exports of T&C products by Pakistan to the U.S. only. The reason why this is an interesting case to consider is because the United States is the most important trading partner of Pakistan for a sizeable majority of T&C products. In fact, for most of the clothing products exported, the U.S. captures more than 90 percent of total market share.[5] Moreover, the fill rates for nearly all T&C products are very close to one hundred, indicating that quotas imposed by the U.S. were usually binding.[6]

Fig. 2. Level of Imports and Adjusted Quota Base (Examples)



[5]This was verified using the statistical database of the All Pakistan Textile Mills Association (APTMA).

[6]Fill rate is defined in the literature as total imports as a percentage of adjusted base quota. Even though the adjusted base quotas can exceed base quotas, fill rates cannot exceed 100 since they are defined as imports over adjusted base. Evans and Harrigan (2005) define a binding quota as one in which the fill rate exceeds 90 percent.



Source: US MFA/ATC Database [Brambilla, *et al.* (2007)].

Let us look at two examples.[7] Figure 2 exhibits total imports into the U.S. from Pakistan and adjusted quota base from 1984 up to 2004 for two T&C products, one from the textile and clothing industries each. For Textile and Fabric Finishing as well as Men's and Boys' Cut and Sew Suit, Coat, and Overcoat, the actual number of imports closely followed the adjusted quota base. In the light of the phasing out of MFA, this evidence makes the case of Pakistan-U.S. trade in T&C industry all the more interesting for closer study.

The paper is organised as follows: in the next section, we present a brief literature review of the topic. In Section 3, we describe a methodology that can be used to measure the effect of liberalisation on firm efficiency, and the data used in our analysis. Empirical results are presented and discussed in Section 4. The main conclusions and policy implications are summarised in Section 5.

2. LITERATURE REVIEW

A variety of studies look into the efficiency of manufacturing industries as a result of trade liberalisation [Pavcnik (2002); Krueger and Baran (1982); Bernard, *et al.* (2006); Sasidaran and Shanmugam (2008)]. Many developing countries have embarked on programmes of trade and financial liberalisation. In the old trade theory, welfare gains from trade are because of specialisation in line with the comparative advantage. On the other hand, in the new trade theory, these welfare gains accrue from economies of scale and expansion of product varieties [Bernard, *et al.* (2007)]. Empirical analyses at the firm level offer evidence for aggregate productivity growth driven by the contraction and exit of low-productivity firms and expansion and entry of high productivity firms. Pavcnik (2002) finds that approximately two-thirds of the 19 percent increase in aggregate productivity following Chile's trade liberalisation in the late 1970s is because of the relatively longer survival and growth of high-productivity plants. Another study by Krueger and Baran (1982) estimates the rates of total factor productivity (TFP) growth for two-digit manufacturing industries in Turkey during 1963–1976. The paper shows that periods of slower productivity growth coincided with periods of stringent trade

[7]Table A.1 in Appendix A displays the adjusted quota base, level of imports and fill rates for a sample of OTEXA (US Office of Textile and Apparel) categories.

regimes. These findings are not confined to developing countries. The effects of a reduction in U.S. trade costs are examined by Bernard, *et al.* (2006).

These studies focus on liberalisation that primarily comprised reduction in tariff rates or a fall in trade costs. There is limited evidence, for example, on the effect of a liberalisation regime mainly featuring an increase in the amount of quota, as in the case of MFA expiration that a sizeable number of studies examine on the reallocation of production and exports across countries. Using a time series of product-level data from the U.S. on quotas and tariffs that comprise the MFA, Evans and Harrigan (2005) analyse how MFA affected sources and prices of U.S. apparel imports, with a particular focus on East Asian exporters during the 1990s. Brambilla, *et al.* (2007) examine China's experience under the U.S. apparel and textile quotas. These studies pertain to the macroeconomic outcomes of the end of MFA, and do not consider the impact on textile producing firms. Using Bangladeshi garment exporters' data, Demidova, *et al.* (2006) model and present evidence for the pattern of exports and performance of heterogeneous firms in response to variations in trade policy in diverse product and export destinations. A study by Sasidaran and Shanmugam (2008) attempts to empirically investigate the implications of the end of MFA on firm efficiency in Indian textile industry. By employing stochastic frontier analysis, they estimate the overall and input specific efficiency values for 215 sample firms during 1993 and 2006. The results of the analysis illustrate that average efficiency dropped over the years. However, their empirical methodology does not utilise the actual number of quotas imposed by the developed countries on the import of T&C products from India, and instead models the end of MFA by introducing a dummy variable for each of the four phases. Our paper, on the other hand, uses an exceptional database initially used by Brambilla, *et al.* (2007), which traces U.S. trading partners' exports to the U.S. in addition to the actual amount of quota under the regimes determined by MFA (1974–1995) and the succeeding ATC (1995–2005). This source of data is combined with a unique company-level data set which is a compilation of annual reports of a representative sample of T&C companies in Pakistan. Hence, the paper merges micro-level data of firms with the data on quotas at the industry level in order to answer an essential question which has been the centre of debate in the new trade theory.

A large number of papers that analyse the impact of trade liberalisation on firm performance are repeatedly criticised for endogeneity inherent in either the estimation of productivity or in the principal regression model used to regress the performance variable on a proxy for trade liberalisation, such as the tariff rate [Goldberg and Pavcnik (2005); Grossman and Helpman (1994); Mobarak and Purbasari (2006)]. Hence, the relationship between openness and performance cannot be taken to imply causality. This is usually the case because liberalisation is more often a part of a broader package of reforms; and improvement in firm efficiency cannot be traced to trade reforms specifically. Moreover, even if trade reforms do not come as a part of a package of reforms, there is always a possibility of lobbying by firms in order to circumvent these reforms whenever these are feared to harm them. This is widespread in the case of developing countries. There is literature that argues that a selection of industries have political power to lobby governments for protection [Grossman and Helpman (1994)]. Mobarak and Purbasari (2006) find that political connections do not affect tariff rates in Indonesia: it is hard for governments in developing countries to offer favours since they are under the close scrutiny of international organisations.[8] The potential bias is also diminished as the estimates include fixed effects. If time-varying industry characteristics could, at the same time, affect both productivity and tariffs, the bias may persist. Just like Goldberg and Pavcnik (2005), they use the 1991 levels of tariffs as instruments for changes in tariffs.[9] Because of the regression specification used in the paper, whereby we regress the change in *firm* productivity on the adjusted level of quotas at the six-digit NAICS *industry* level, we can rule out the possibility of lobbying by firms. This is because it is not viable for an individual firm to influence the amount of textile quota at the industry level. Consequently, the MFA expiration can be thought of as a 'natural experiment.' This methodology has been used in order to avoid the potential problem of endogeneity of the trade proxy that is used in the empirical estimation of the effect of elimination of import quotas. Even if the actual amount of quota, that is obtained by each individual firm, were available, including that in the basic regression as a control variable, it would have been problematic due to the endogeneity of the firm's ability to obtain the quota license in a regression where the firm's efficiency is the dependent variable. Due to the availability of a considerable amount of highly disaggregated NAICS industry level quota data, the employment of this methodology allows us not only to overcome the potential endogeneity, but also to introduce sufficient amount of variation in the control variable used.

Last but not least, we use the structural techniques proposed by Olley and Pakes, and Levinsohn and Petrin in order to take care of endogeneity in the estimation of production functions. We notice that the results vary across textile and clothing industries; MFA expiration lead to an increase in the average productivity of textile producing firms but a significant reduction in the mean productivity of clothing and garment producers. Finally, in order to measure the effect of quotas directly on firm's output, we regress output on the adjusted level of quotas and trade costs. In the textile sector, an increase in the adjusted level of quotas leads to a significant rise in the firm's output. Nevertheless, this result is not statistically significant for the clothing sector.

In short, the most important contribution of this paper is that it is one of the very few studies that investigate the effect of liberalisation in the form of phasing out of quotas on firm-level productivity in the textile and clothing industry. Unlike most other studies in the literature which mainly analyse the impact of trade liberalisation in a developing country, for example, in the form of a reduction in average tariff rates, this paper investigates the liberalisation episode initiated by the U.S. by means of eliminating import quotas on textile and clothing products exported by developing countries to the U.S. It underlines cross-sector disparity in the effect of MFA expiration in the developing country and that trade reforms may influence different sectors heterogeneously even within the manufacturing industry of Pakistan.

[8]Mobarak, A. M. and D. Purbasari (2006). Corrupt Protection for Sale to Firms: Evidence from Indonesia. (Unpublished).

[9]The instruments that they use are: 1991 levels of output tariffs, 1991 levels of input tariffs, an interaction between the 1991 input tariffs and a firm-level indicator equal to one if the firm was an importer in all years, a dummy indicator for product codes that consisted of at least one nine-digit HS code that was barred from the commitment to cut bound tariffs to 40 percent, and the share of skilled workers at the five-digit industry level.

3. EMPIRICAL METHODOLOGY

In this section, we discuss the empirical methodology used to measure the impact of the end of MFA on firm performance in the textile and apparel industries of Pakistan from 1992 to 2010. We will then describe the data set used in the paper. To determine the effect of trade liberalisation on firm performance, we first need to find a measure of productivity for the firms in our sample. This measure is then related to an index of openness using a simple regression equation.

There are quite a few ways of measuring the productivity change in response to a change in policy. An econometric issue facing the estimation of production functions is the likelihood that some of these inputs are unobserved. If the observed inputs are chosen as a function of these unobserved inputs, then there is an endogeneity problem [Ackerberg, *et al.* (2005)]. A second endogeneity problem appears because of sample selection. There is a group of contemporary techniques alongside the dynamic panel data literature and the methods introduced by Olley and Pakes (1996), and Levinsohn and Petrin (2003). The Olley and Pakes methodology (OP) is derived from dynamic optimisation of firms, whereby it is assumed that unobserved productivity follows a first order Markov process and capital is accumulated by means of a deterministic dynamic investment process.[10] Levinsohn and Petrin (LP) adopt a similar approach to solving the endogeneity problem. Instead of using an investment demand equation, they use an intermediate input demand function. In this section, we use structural techniques proposed by Levinsohn and Petrin.[11]

Consider a firm with a Cobb-Douglas production function:

$$Y_{ijt} = A_{ijt}(\tau)L_{ijt}^{\beta_l}M_{ijt}^{\beta_m}K_{ijt}^{\beta_k} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (1)$$

where output of firm i in six-digit industry j at time t, Y_{ijt}, is a function of labour, L_{ijt}, capital, K_{ijt}, and materials, M_{ijt}. We want to test if productivity of firm i is a function of trade policy, denoted by τ. Taking natural logs, denoted by small letters, we get:

$$y_{ijt} = \beta_0 + \beta_l l_{ijt} + \beta_m m_{ijt} + \beta_k k_{ijt} + e_{ijt}. \quad \dots \quad \dots \quad \dots \quad \dots \quad (2)$$

The output of firm i is computed using the firm's total revenue which is the only proxy for total production that is available in our data. Therefore, the total revenue of the firm is deflated by two-digit industry-level producer price indices to obtain y_{ijt}. The real labour, l_{ijt}, is taken to be the total number of employees, and the amount of material inputs, m_{ijt}, is retrieved using total material expenditure.[12] Although domestic and

[10]Profit maximisation generates an investment demand function that is determined by two state variables, capital and productivity. If the investment demand function is monotonically increasing in productivity, it is feasible to invert the investment function and get an expression for productivity as a function of capital and investment.

[11]See Olley and Pakes (1996), and Levinsohn and Petrin (2003) for a complete explanation of the method. A brief review is also given in Appendix B.

[12]Additional units of both labour and material inputs are assumed to be equally productive, and hence, deemed to be of equal marginal productivity.

imported inputs should be adjusted by separate deflators, the balance sheet data does not provide information on the share of imported inputs. Hence, all material inputs are deflated with a two-digit producer price deflator.[13] Productivity is then computed using LP, and the change in firm productivity is regressed on the change in the adjusted level of quotas and trade costs:

$$\Delta tfp_{ijt} = \beta_0 + \beta_1 \Delta \log(AdjQuota)_{jt} + \beta_2 \Delta \log(Cost)_{jt-1} + X_{ijt} + \delta_t + \delta_j + \varepsilon_{ijt}, \quad (3)$$

where $\log(AdjQuota)_{jt}$ is the logarithm of adjusted level of quotas, and $\log(Cost)_{jt-1}$ is the logarithm of industry trade costs at date *t*-1. δ_t and δ_j are time and industry fixed effects, respectively, and ε_{jt} is the error term. Following Bernard, *et al.* (2006), we define industry variable trade costs as the sum of ad valorem duty and ad valorem freight and insurance rates.[14] The inclusion of non-tariff barriers (NTBs) such as quotas in the regression equation, unlike Bernard, *et al.* (2006), is an added advantage of this empirical methodology since NTBs are a vital source of trade distortions. X_{ijt} includes other control variables: a dummy variable for the city in which the firm is located, size, age and capital intensity of the firm, whether or not the firm is ISO certified, whether or not the firm is multinational and, lastly, the Herfindahl index of the industry at the six-digit level. Size is measured by the number of workers; capital intensity is the ratio of capital to number of employees; firm age is the number of years since establishment; the Herfindahl index is an indicator of the amount of competition.

In order to quantify the impact of quotas directly on the firm's output, we regress output on the level of quotas:

$$\begin{aligned} y_{ijt} = \beta_0 + \beta_1 m_{ijt} + \beta_2 k_{ijt} + \beta_3 l_{ijt} + \beta_4 \log(AdjQuota)_{jt} \\ + \beta_5 \log(Cost)_{jt-1} + X_{ijt} + \delta_t + \delta_j + \varepsilon_{ijt} \quad \ldots \quad \ldots \quad \ldots \quad (7) \end{aligned}$$

[13]Amiti and Konings (2007) show that domestic and imported input prices normally move together, provided they are substitutes. Their results are robust to deflating both domestic and imported material inputs by the same five-digit domestic materials deflators.

[14]Bernard, *et al.* (2006) define variable trade costs ($Cost_{jt}$) for industry *j* in year *t* as the sum of ad valorem duty (d_{jt}) and ad valorem freight and insurance (f_{jt}) rates:

$$Cost_{jt} = d_{jt} + f_{jt} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

The ad valorem duty rate is duties collected ($duties_{jt}$) corresponding to free-on-board customs value of imports (fob_{jt}):

$$d_{jt} = \frac{duties_{jt}}{fob_{jt}} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Likewise, the ad valorem freight rate is the markup of the cost-insurance-freight value (cif_{jt}) over fob_{jt} relative to fob_{jt}:

$$f_{jt} = \frac{cif_{jt}}{fob_{jt}} - 1 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

The rate for industry *j* is the weighted average rate across products in *j*, using the import values from the source countries as weights. This measure of trade costs has several advantages. It includes information concerning both trade policy and transportation costs, and it varies across industries and time. For a complete discussion of the advantages and disadvantages of this measure, see Bernard, *et al.* (2006).

This paper uses Balance Sheet Data of Pakistani Listed and Non-Listed Companies (BSDPC) which is a survey of a representative sample of 321 T&C companies in Pakistan for the years 1992 to 2003. The surveys encompass a wide range of topics.[15] The data set is an unbalanced panel data and it covers almost all large and medium-sized formal manufacturing enterprises. However, the coverage of the industrial sector is not complete since informal enterprises are excluded, and small formal firms are under-represented. The core survey is organised into four parts: Balance Sheet, Profit & Loss Account, Cash Flow Statement, and Accounts Section. For each company and year, we observe the sales revenue, input use, investment, wage bill, and all other costs, as well as industry codes and firm identity codes that allow us to track establishments over time. However, several observations are either not available or are reported as missing for different variables, such as, wages and sales. We test whether these values are systematically missing for particular types of firms, industries, or years but find that this was not the case.

The literature talks about a sample selection problem stemming from the possible association between TFP and plant exit; the unbalanced nature of our panel deals with this potential challenge to some extent. Entering and exiting firms are detected in the data by comparing firm identity codes overtime. Whenever there were gaps in the time-series data for a firm, we interpolated one- and two-year gaps in employment and sales variables and excluded the firm altogether if there was a larger gap in the data. To estimate Equations (3) and (7) using a panel of firms, we needed data on real output, capital stock, labour, raw materials, and their respective shares in real output. Nominal output deflated by sectoral price deflators gave the real output.[16] Real labour was found by deflating the total wage bill by industry wage rate.[17] Materials were also deflated using two-digit sectoral price deflators.[18] The real capital stock was calculated by deflating net fixed assets by sectoral investment deflators. Table 5 provides summary statistics for the balance sheet data used.

[15]They are carried out in cooperation with the Lahore University of Management Sciences (LUMS), Pakistan. The survey is completed by managing directors and accountants of the company. The data compiled by LUMS only covers the period 1992 to 2003. We updated the dataset to add seven more years of data on sales revenue, input use, investment, and so forth. The paper, therefore, uses data from 1992 to 2010. This was done in order to compute firms' productivity during the final phase of MFA expiration as well, since we know that the initial phases of ATC were not very severe for producers in developed countries.

[16]*The Economic Survey of Pakistan*, which is published annually by the Ministry of Finance, Government of Pakistan, provides price indices at the two-digit industry level for output and intermediate inputs which are used as deflators.

[17]Real labour is taken to be the total number of employees, and not the number of hours worked, since the hourly wage rate is not known. Many firms list the number of employees directly so there is no need to deflate the wage bill by the industry wage rate.

[18]Ideally, material inputs should be deflated by separate price indices for each different type of material used in the production of the final good. However, the balance sheet data only lists the total material expenditure. Harrison (1994) shows that the estimates based on deflating the material inputs using the Input-Output table for each sector are not very different from those computed using the two-digit sectoral price deflators.

Table 5

Summary Statistics

Variable	Observations	Mean	Standard Deviation
Ln(Sales)	4717	19.24889	3.725365
Ln(Fixed Assets)	4718	11.5004	9.505546
Ln(Labour)	4718	16.36191	1.92692
Ln(Raw Materials)	4718	18.70915	3.581584
Ln(Net Profit)	4718	12.99495	10.32405
Ln(Investment)	4813	4.016176	7.223366
Productivity (Levinsohn and Petrin)	4717	10.55175	5.720158
Productivity (Olley and Pakes)	4717	1.870537	3.044538
Age	2895	23.78066	16.09899
Ln(Age)	2846	2.9679	.8172853
Ln^2(Age)	2846	9.476151	4.306341
Ln(Capital to Labour Ratio)	4407	.733027	.5847288
Herfindahl Index	4813	.8199503	.6192361
ISO Certified	4606	.6743378	.4686726
Multinational	4606	.09835	.2978196
Share of Foreign Ownership	4436	.2193417	.4138473
Exporting Firm	4606	.8790708	.3260804
Importing Firm	4606	.4240122	.4942458
Ln(Cost of Imports)	2385	.1535817	.108629
Ln(Adjusted Base New)	3980	29.10755	16.11072
Ln(Adjusted Base)	2499	16.72591	1.134198
Ln(Imports)	1544	16.43371	2.013854
Average Fill Rate	2143	.806451	.1900999

This paper is based on a panel of firms instead of industry data. Accordingly, we can be fairly specific about the sources of productivity change. It tracks a single firm through time, eliminating the obscuring firm-specific effects. The paper utilises the data initially used by Brambilla, *et al.* (2007) that traces U.S. trading partners' performance under the quota regimes determined by MFA and ATC. The database is assembled from U.S. trading partners' Expired Performance Reports, which were used by the U.S. Office of Textile and Apparel (OTEXA) to supervise trading partners' fulfilment with the MFA/ATC quotas. Provided by Ron Foote of the U.S. Census Bureau, they record imports, base quotas and quota adjustments by OTEXA category and the year for all countries with which the U.S. negotiated a bilateral quota arrangement.[19] The negotiated quota for any given category is stated in terms of square meter equivalents (SME) of fabric.[20] The data on trade costs is taken from Bernard, *et al.* (2006) which provides data on free-on-board customs value of imports, *ad valorem* duty and *ad valorem* freight and insurance rates for the underlying four-digit product-level U.S. import data.[21] The next section discusses the estimation results.

4. ESTIMATION RESULTS

To determine the effect of trade liberalisation on firm efficiency, we first need to find a measure of productivity for the firms in our sample. We estimate the production function coefficients for firms in each sector separately using a Cobb-Douglas production function and the structural techniques proposed by Levinsohn and Petrin. These estimates are used to work out the log of measured TFP of firm i at time t for each six-digit industry j. The change in firm productivity is then regressed on the change in adjusted level of quotas, allowing for time and industry fixed effects. Table 6 reports the production function estimates for T&C firms using LP. Robust standard errors corrected for clustering at the firm level are stated in parentheses. The regression results are illustrated in Tables 7 to 8.

Table 6

Production Function Estimates for Textile and Clothing Firms—Levinsohn and Petrin

	Textile	Clothing
	(1)	(2)
Employment	0.246***	0.285***
	(0.0313)	(0.0327)
Fixed Assets	0.0312***	0.0340**
	(0.00805)	(0.0152)
Raw Materials	0.125	0.171
	(0.116)	(0.160)
No. of Observations	3274	1443

Notes: Robust standard errors corrected for clustering at the firm level in parentheses. *** Significant at, or below, 1 percent. ** Significant at, or below, 5 percent. * Significant at, or below, 10 percent.

[19]The base quota is the initially negotiated quota level decided at the beginning of an agreement term. Adjusted base quotas indicate the use of 'flexibilities', which allowed countries to go over their base quota in a particular period by borrowing unexploited base quota, across categories within a year and across years within a category, up to a specified percentage of the receiving category.

[20]In addition, when the quotas are completely removed in Phase IV, the adjusted quota base is essentially equal to infinity. There are a number of possible ways of handling it. For example, we could assume a 'very large' value of the adjusted level of quotas, and vary that value to test if our results are sensitive to this hypothetical value of the adjusted level of quotas. Another possible way is to predict the adjusted quota level using the past values of the fill rates. A number of these methods were used in order to prove that the results are robust to functional form differences.

[21]The data on trade costs is available only for the years 1992-2004.

Table 7

Effect of Elimination of Quota-Restrictions on Textile Firm Productivity—Levinsohn and Petrin

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Adjusted Quota	0.0238***	1.277**	1.266**	1.250**	1.192**	1.567*	1.692**
	(0.00520)	(0.534)	(0.530)	(0.557)	(0.535)	(0.875)	(0.850)
Cost of Imports		–0.126	–0.124	–0.120	–0.122	0.0965	0.0971
		(0.225)	(0.225)	(0.223)	(0.237)	(0.175)	(0.173)
Herfindahl Index		0.0619	0.0602	0.0596	0.0673	0.0924*	0.0971*
		(0.0509)	(0.0507)	(0.0509)	(0.0501)	(0.0547)	(0.0566)
Multinational			0.410*	0.215	0.149	0.0126	0.162
			(0.234)	(0.206)	(0.200)	(0.192)	(0.261)
ISO Certified				0.830***	0.827***	1.020*	0.839
				(0.176)	(0.169)	(0.578)	(0.574)
K/L (–1)					–0.0333	–0.0709	–0.0696
					(0.158)	(0.0823)	(0.0883)
Size (–1)					0.0474*	–0.0246	–0.0273
					(0.0282)	(0.0203)	(0.0198)
Age						0.118	0.117
						(0.206)	(0.222)
Age^2						0.0262	0.0346
						(0.0430)	(0.0510)
Constant	11.47***	–12.03	–11.80	–12.47	–11.96	0	0
	(0.305)	(10.03)	(9.973)	(10.50)	(10.20)	(0)	(0)
Industry Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
City Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*Yes*
No. of Observations	2767	1570	1570	1570	1567	996	996

Notes: Robust standard errors corrected for clustering at the firm level in parentheses. (–1) denotes lagged variables. *** Significant at, or below, 1 percent. ** Significant at, or below, 5 percent. * Significant at, or below, 10 percent.

Table 8

Effect of Elimination of Quota-Restrictions on Clothing Firm Productivity—Levinsohn and Petrin

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Adjusted Quota	–0.972***	–1.003***	–0.998***	–1.069***	–1.692***	–0.753***
	(0.246)	(0.248)	(0.248)	(0.255)	(0.327)	(0.195)
Cost of Imports (–1)	–8.697	–8.787	–8.793	–9.737*	–11.70	–11.22
	(6.040)	(6.041)	(6.051)	(5.796)	(7.886)	(8.823)
Herfindahl Index (–1)		–0.155**	–0.155**	–0.192**	–0.241***	–0.182**
		(0.0719)	(0.0720)	(0.0765)	(0.0879)	(0.0782)
Multinational			–0.773	–0.749	–4.371***	–2.368
			(1.546)	(1.572)	(1.538)	(1.981)
ISO Certified				0.403	1.097	1.719
				(1.148)	(1.943)	(2.174)
K/L (–1)				0.946*	0.969	0.807
				(0.563)	(0.659)	(0.700)
Size (–1)				0.0885*	0.117**	0.0716
				(0.0458)	(0.0536)	(0.0572)
Age					0.669	0.104
					(0.490)	(0.513)
Age^2					–0.0968	0.277
					(0.196)	(0.248)
Constant	0	0	14.13***	16.59***	26.45***	0
	(0)	(0)	(4.739)	(4.371)	(6.223)	(0)
Industry Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
City Effects	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*Yes*
No. of Observations	503	503	503	502	315	315

Notes: Robust standard errors corrected for clustering at the firm level in parentheses. (–1) denotes lagged variables. *** Significant at, or below, 1 percent. ** Significant at, or below, 5 percent. * Significant at, or below, 10 percent.

4.1. Effect on Productivity

Tables 7 and 8 report the estimation results for the effect of elimination of quota restrictions on textile and clothing firm productivity, respectively. The results vary across the two types of industries: an increase in adjusted level of quotas, on average, brings about a significant increase in the productivity of firms in the textile industry (see Table 7) and a reduction in mean productivity in the clothing industry (refer to Table 8). These estimation results are derived after controlling for the firm's size, capital intensity, age, whether or not the firm is ISO certified, whether or not the firm is a multinational, Herfindahl index of the industry at the six-digit level, and lastly, the city in which the firm is located. Although trade costs do not seem to have a significant impact on textile firms, there is clearly a negative relationship between trade costs and the productivity of garment producers; the productivity of clothing firms goes up, on average, if trade costs go down, and the estimates are significantly different from zero in a number of cases as can be seen in Table 8. As far as trade costs coefficient for textile firms is concerned, the estimates take both positive and negative values, and none of the values are statistically significant. The positive coefficient of trade cost for textile producers might be indicative of a selection effect for these types of firms, as is highlighted in the literature on the new trade theory [Pavcnik (2002)]. This suggests that as a consequence of a rise in variable trade cost, coupled with exposure to international competition, only the most productive firms are able to survive. As a result, an upsurge in trade cost will cause the mean productivity of textile producers to go up.

Let us look at other control variables in Tables 7 and 8. Again, as far as capital intensity of the firm is concerned, the two types of firms display disparate results. Higher capital intensity has a significantly positive impact on productivity of clothing firms but not on the productivity of textile producers. For most of the different specifications shown in Table 7, the coefficient for size is negative for textile firms. However, the only case where it is significant is when it takes a positive value. On the other hand, it is always positive and significant for clothing firms (see Table 8).

Another intriguing point to be noted is that the sign of Herfindahl index coefficient is positive and significant for only textile firms; on the other hand, it is negative and highly significant for clothing firms, as can be seen in Tables 7 and 8. This indicates that higher concentration in the industry results in lower productivity for clothing firms but not for textile firms. One would generally expect that greater degree of concentration in an industry leads to greater market power for firms in that industry and, hence, lowers their productivity growth. This is not the case for textile producers. One possible explanation for this result is that, although there might be a small number of firms with a lot of market power, there is an intense competition amongst them which forces them to become more productive in order to capture an even bigger market share. That is why higher concentration in the textile industry would imply that textile producers are, on average, more productive than if there were a large number of firms capturing an almost similar market share. While this explanation is plausible, another explanation could be related to returns to scale. The textile industry is dominated by a few capital intensive firms with higher returns to scale. With the expansion of quotas, these firms might be capable of ramping up their output, and productivity, rapidly because of their already large capital investment. Within the textile industry, sub-industries with more of these large firms (concentrated sub-industries) will be better able to ramp up output and productivity. On the contrary, the lower returns to scale and lower capital intensity of the clothing industry may restrict the output and productivity expansion.

Textile multinational firms, on average, tend to have higher productivity compared to non-multinational textile firms (see Table 7). This is not the case for clothing producers: the multinational clothing firms have a significantly lower mean productivity compared to non-multinational clothing firms (see Table 8). Older textile firms, which are also likely to be bigger in size, appear to be much more productive than their younger counterparts.

For most of the above-mentioned control variables, we have seen that the results are different across two types of firms. The only case where it is indistinguishable is in the case of ISO certified T&C firms. ISO certification affects firm efficiency positively: a firm certified for its quality management system has a higher productivity, on average, than a firm that is not certified (see Tables 7 and 8). These estimation results are arrived at after controlling for industry, time and city fixed effects. The city fixed effects take into account the fact that some firms are located in more developed areas compared to others. There may be differences in infrastructural facilities in different parts of the country which are taken care of by regional fixed effects.

Furthermore, we run this regression separately for the MFA period (1992-1994) and post-MFA period (1995-2010), along with each of the four phases individually.[22] Table 9 demonstrates the estimation results for the four phases. In all the phases, an increase in the adjusted level of quotas brings about a significant reduction in the clothing firm's productivity and an increase in the productivity of firms in textile industry. This is also true for post-MFA period as a whole. Only in Phase IV do we observe that the productivity of clothing firms is positively related to the level of the quotas. Nevertheless, the positive coefficient is not statistically significant. For a majority of control variables described above, we do not observe a noticeable change in either the sign or the magnitude of coefficients (see Table 9).

4.2. Effect on Output

In order to measure the effect of quotas directly on the firm's output, we regress output on the adjusted level of quotas and trade costs. The results are shown in Table 10. There are a number of interesting points to be examined here. First of all, the results vary for both types of industries. In the textile sector, an increase in the adjusted level of quotas leads to significant rise in the firm's output. For the clothing sector, however, this result is not statistically significant. Since quotas are measured by quantity and not value, under a given quota, producers try to manufacture high value products. Consequently, MFA expiration is expected to bring about a shift in the production of lower-value products. There is a significant reduction in output if trade costs go up in the textile sector. This, in contrast, is not true for clothing firms: an increase in trade costs, on average, results in an increase in output in clothing industry and the estimates are significantly different from zero in nearly all the cases (see Table 10).

[22]The estimation results for the MFA and post-MFA periods alone are not shown here but can be made available upon request.

Table 9

Effect of Elimination of Quota-Restrictions on Firm Productivity—Levinsohn and Petrin

	Phase 1		Phase 2		Phase 3		Phase 4	
Variable	Textile	Clothing	Textile	Clothing	Textile	Clothing	Textile	Clothing
Adjusted Quota	0.862	–0.466	0.845	–1.424**	6.039***	–2.291*	0.0546	0.0200
	(0.539)	(0.362)	(0.673)	(0.682)	(0.890)	(1.230)	(0.108)	(0.155)
Cost of Imports	0.00578	4.801	–6.675	5.707	2.009	–1.788	–	–
	(0.289)	(3.895)	(4.732)	(5.436)	(6.765)	(8.671)	–	–
Age	0.364	1.524*	–0.193	0.00114	2.098	0.0364	4.530	–4.135
	(0.449)	(0.840)	(1.007)	(0.283)	(2.655)	(0.867)	(3.088)	(3.293)
Age^2	–0.00151	–0.171	0.0873	0.0409	–0.319	0.0312	–0.629	1.279
	(0.0870)	(0.380)	(0.188)	(0.240)	(0.411)	(0.433)	(0.457)	(0.859)
Size (–1)	0.0271	0.106*	0.0196	0.119	0.0985	0.122***	0.0348*	0.0370
	(0.0328)	(0.0642)	(0.0284)	(0.0737)	(0.0645)	(0.0372)	(0.0188)	(0.0293)
K/L (–1)	–0.256**	0.618	0.0456	0.163	0.0513	2.254***	–0.252**	0.0254
	(0.116)	(0.579)	(0.121)	(0.205)	(0.236)	(0.779)	(0.102)	(0.0816)
Herfindahl Index	0.0734	–0.101	0.00460	–0.162*	0.190	0.0704	–0.0418	–0.00690
	(0.0600)	(0.0741)	(0.0477)	(0.0857)	(0.167)	(0.107)	(0.0504)	(0.0539)
ISO Certified	0.00166	–0.0829	1.099	0.647	0.789	–1.939	1.713	–0.972
	(0.241)	(5.173)	(0.826)	(2.137)	(0.793)	(2.815)	(1.071)	(8.757)
Multinational	–0.217	–0.557	0.429	–0.712	0.154	0.666	–0.528	–5.204
	(0.309)	(1.888)	(0.300)	(1.859)	(0.256)	(3.135)	(0.401)	(3.246)
Constant	0	0	2.036	15.17	–106.2***	0	0	0
	(0)	(0)	(14.52)	(12.41)	(17.02)	(0)	(0)	(0)
Industry Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
City Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
No. of Observations	298	89	405	139	202	61	645	192

Notes: Robust standard errors corrected for clustering at the firm level in parentheses. (–1) denotes lagged variables. *** Significant at, or below, 1 percent. ** Significant at, or below, 5 percent. * Significant at, or below, 10 percent.

Table 10

Effect of Elimination of Quota-Restrictions on Output

	(1)	(2)	(3)	(4)	(5)	(6)
Variable		Textile			Clothing	
Raw Materials	0.264***	0.285***	0.132***	0.0816**	0.0344	0.0102
	(0.0629)	(0.0741)	(0.0503)	(0.0393)	(0.0286)	(0.0269)
Labour	0.0907***	0.0711***	0.0597***	0.114**	0.0315	0.0167
	(0.0232)	(0.0246)	(0.0200)	(0.0458)	(0.0353)	(0.0456)
Fixed Assets	0.0550*	0.0448	0.0764*	0.0936**	0.122**	0.0712
	(0.0329)	(0.0390)	(0.0453)	(0.0410)	(0.0533)	(0.0539)
Adjusted Quota Level	0.137	1.523**	2.409**	0.494	0.420	0.975*
	(0.246)	(0.702)	(1.049)	(0.334)	(0.353)	(0.509)
Cost of Imports (–1)		–0.287	–0.422*		7.774*	11.71*
		(0.210)	(0.232)		(4.265)	(6.185)
Multinational		0.379*	0.386		–1.981	–3.538
		(0.200)	(0.285)		(2.074)	(3.479)
ISO Certified		0.770***	0.979		1.709***	2.512***
		(0.191)	(0.676)		(0.421)	(0.896)
Age			–0.0135			2.699
			(0.249)			(1.925)
Age^2			0.0652			–0.493
			(0.0574)			(0.428)
Constant	8.567*	0	–32.82	6.674	3.331	0
	(4.752)	(0)	(20.00)	(6.044)	(6.514)	(0)
Industry Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
City Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
No. of Observations	1811	1461	929	648	503	316

Notes: Robust standard errors corrected for clustering at the firm level in parentheses. (–1) denotes lagged variables. *** Significant at, or below, 1 percent. ** Significant at, or below, 5 percent. * Significant at, or below, 10 percent.

Another remarkable point is that a textile multinational firm has, on average, a significantly higher output compared to a textile firm that is not a multinational company, whereas, the corresponding coefficient for clothing firms is negative. On average, older textile firms produce lesser output, but this is not true for clothing firms. Both, the ISO certified textile as well as clothing firms have a higher output compared to a textile or clothing firm that is not ISO certified, and this finding is statistically significant. To sum up, MFA expiration led to an increase in output of T&C firms in Pakistan. However, for a majority of specifications that we consider, this result is statistically significant only for the textile firms (refer to Table 10).

4.3. Discussion and Limitations of Analysis

The above analysis highlights cross-sector variation in the effect of MFA expiration. As is frequently emphasised in the new trade theory literature, trade reforms often influence different sectors heterogeneously even within the manufacturing industry. However, what seems intriguing is that in our case the outcome differs within what is typically lumped together as the textile industry. A liberalisation episode such as phasing of quotas may generate divergent changes in productivity levels of different categories of products even within an industry. MFA expiration will potentially boost competition, both between and within countries, weakening tendencies toward oligopolies, thereby resulting in technological advancement and productivity growth. We see this happening in the textile sector. Pakistan has had a relatively better textile sector historically. The textile industry is labour intensive and the primary input is cotton. The country has a high production of cotton and a sizeable labour force that confirms its strong revealed comparative advantage in the production of textile goods. On the other hand, clothing industry still faces the challenge of obsolete machinery. Energy outages, workforce development, product standards, fabric finishing, styles and patterns, customs and port procedures, and security are other factors that shape productivity growth. One reason why TFP may decline after the end of MFA for garment firms is competition from foreign sellers of garments in the Pakistani market. Since TFP confounds the effect of efficiency if its market share declines, it may result in depressing its measure. Any form of liberalisation like this has two opposing effects: market stealing of imports lowers sales for domestic firms and leaves less money available to invest in productivity improvements, and higher competition spurs some lagging firms to work harder and improve productivity in order to survive. The balance of these two effects might work out differently in both sectors, for example, because the initial level of competition may differ. Some theory papers incorporate asymmetric effects of liberalisation in the productivity level of firms. If non-exporting firms become exporters, we may see a decline in mean industry productivity because new exporters may need time to adapt to the new environment.

The difference in results across textile and garment firms is related to the structure of production, namely, the type of raw materials used by garment firms after the end of MFA. However, the data does not provide information about types of raw materials used and it is, therefore, hard to determine if this was the case. Another possible explanation is a change in product mix, for instance, a shift to the most productive production lines in textiles, and expansion into new products for which there is still some learning to do in the garment industry. Since MFA expiration, Pakistan has been changing the composition of its textile exports, from a broader category that benefitted from the MFA without much weight of Rules of Origin (RoO), to a narrower category focused on specific markets that offer Pakistan preferential access through bilateral trade agreements with strict Rules of Origin. If this is the case, one would expect a fall in productivity as the mix of inputs utilised by firms would no longer be dictated by rationally choosing the optimal input-mix given market prices. If the composition of exports has changed in the stated way, one should attempt to decompose the TFP between RoO-affected and non-RoO-affected exports. Another aspect is that the country may have found it harder to compete with other countries in the garments sector because clothing is relatively more labour intensive than textiles; firms in Pakistan could have responded to, say, China's competition by upgrading the quality of Pakistani textiles but may not have done so in the garment sector because it is harder to upgrade quality in that sector. These cross-sector differences in quality ladders could play a crucial role under these circumstances.

4.4. Robustness Check: Alternative Measure of Productivity

This section provides an alternative measure of productivity to determine whether or not results derived so far are sensitive to empirical methodology used to estimate firm efficiency. The OP methodology can be used to account for simultaneity between input choices and productivity shocks, in addition to sample selection bias. Table 11 illustrates the estimation results when change in firm productivity is regressed on change in adjusted level of quotas using the OP productivity measure. We note that the results are not very different from LP regression estimates. As before, an increase in adjusted level of quotas brings about a significant reduction in the firm's mean productivity in clothing industry but not in the textile sector. Moreover, the sign and magnitude of most of the control variables' coefficients remain the same as under LP (see Table 11).

Table 11

Effect of Elimination of Quota-Restrictions on Textile and Clothing Firms' Productivity—Olley and Pakes

Variable	(1)	(2) Textile	(3)	(4)	(5) Clothing	(6)
Adjusted Quota	1.087**	1.969***	2.047***	–1.170***	–1.647***	–0.646
	(0.539)	(0.752)	(0.727)	(0.306)	(0.353)	(0.575)
Cost of Imports (–1)	–0.146	0.124	0.103	0.110	–4.953	–5.612
	(0.238)	(0.223)	(0.225)	(6.915)	(10.55)	(11.24)
Herfindahl Index (–1)	0.110*	0.149*	0.162**	–0.189	–0.186	–0.113
	(0.0604)	(0.0760)	(0.0800)	(0.153)	(0.220)	(0.224)
Multinational	0.0807	0.0483	0.234	–2.523	–4.167	–3.935
	(0.173)	(0.139)	(0.200)	(2.181)	(3.770)	(3.583)
ISO Certified	0.362**	0.767*	0.583	0.773	1.292	2.066*
	(0.152)	(0.460)	(0.459)	(0.618)	(0.936)	(1.087)
K/L (–1)	–0.198	–0.169*	–0.187*	0.781	0.214	–0.00531
	(0.122)	(0.0912)	(0.107)	(0.486)	(0.755)	(0.777)
Size (–1)	–0.0156	–0.082***	–0.076***	0.115*	0.108	0.0278
	(0.0278)	(0.0259)	(0.0280)	(0.0590)	(0.0818)	(0.0837)
Age		–0.0244	–0.00227		3.653**	3.530*
		(0.267)	(0.281)		(1.841)	(2.100)
Age^2		0.0282	0.0372		–0.822**	–0.691
		(0.0496)	(0.0574)		(0.365)	(0.484)
Constant	–17.73*	0	0	11.77*	20.57***	0
	(10.05)	(0)	(0)	(6.369)	(7.319)	(0)
Industry Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
City Effects	*Yes*	*No*	*Yes*	*Yes*	*No*	*Yes*
No. of Observations	1567	996	996	502	315	315

Notes: Robust standard errors corrected for clustering at the firm level in parentheses. (–1) denotes lagged variables. *** Significant at, or below, 1 percent. ** Significant at, or below, 5 percent. * Significant at, or below, 10 percent.

5. CONCLUSION AND POLICY IMPLICATIONS

The elimination of quotas has been the most important event in the global textile and garment industry in the past two decades. The textile sector is a key industry in Pakistan in terms of output, export value, foreign exchange earnings and employment. Along with the cost advantage in terms of proximity to a raw material base in cotton and man-made fibres, as well as the availability of cheap labour, what appears to be a crucial determinant of competitiveness in this industry is the ability to respond to rapidly changing consumer demands. This, in turn, requires greater investment in research and development to ensure greater mobility and adaptability of the production process to changes in fashion trends. Although the need to invest in cost-saving production methods is vital for the textile industry as well, it plays a greater role in the clothing industry owing to the nature of the finished good and its global price sensitivity. The sectoral heterogeneity in the effect of MFA expiration further corroborates this notion. The finding that mean productivity fell for the clothing firms as a result of the phasing out of quotas, points to the inability of these firms to shift to a more efficient composition of inputs as well as the product range of output produced in response to a more competitive world market. For example, according to a report by the World Bank's Poverty Reduction and Economic Management Sector Unit, compared to its competitors, Pakistani garment industry labour is cheaper but the least productive: limited training in productivity, design, and other product related skills are the major constraints to raising productivity, and clothing firms have been unable to tailor products particularly for their customers, deliver fast and within multiple fashion cycles in one season [Pakistan Growth and Export Competitiveness (2006)]. Even though several institutions for training and skills upgradation are present, in general, the country has an insufficient number of institutes that offer support services to garment firms. According to the report, higher efficiency at the firm level is necessary in order to compensate for the time costs associated with greater distance to the U.S. market. APTMA has been seeking duty-free access to the U.S. market for a large number of finished items. If the duty-free facility is provided, Pakistan can increase its export tremendously. More recently, the textile and clothing industry has faced an acute energy crisis. Energy shortages are forcing the textile industry to operate at almost half the capacity. If continuous gas and power supply are not guaranteed to the textile firms, exporters would not succeed to complete their orders on time, threatening total disintegration of Pakistani textile exports.

The most important contribution of this paper is that it is one of the few studies to empirically investigate the effect of liberalisation in the form of phasing out of quotas on firm-level productivity in the textile and clothing industry. The existing studies pertain to macroeconomic outcomes of the end of MFA, and do not consider the effect on textile firms. The studies that do attempt to evaluate the impact of lifting a quota at the firm level do not utilise the actual number of quotas imposed by developed countries on imports from developing countries. This paper, on the other hand, uses the database that traces U.S. trading partners' exports to the U.S. along with the actual amount of quota under the regimes determined by the MFA. Because of the nature of data and empirical methodology used, it effectively takes care of the endogeneity problem that is often challenging for analyses to estimate the effect of liberalisation on firm performance. We observe that MFA expiration led to an increase in average productivity of textile producing firms but a significant reduction in mean productivity of clothing and garment producers. The paper draws attention to cross-sector variation in the impact of MFA expiration and to trade reforms that often influence different sectors heterogeneously even within the manufacturing industry. It proposes various explanations for this outcome, for example, a change in product mix, entry by non-exporters in clothing sector, cross-sector differences in quality ladders, and so forth.

The competitiveness of T&C industry hinges on numerous factors: labour cost, production costs (energy, water, production inputs, for example, cotton, polyester and chemicals), transport and distribution, and macroeconomic environment (domestic interest rates, corporate taxes, exchange rate, property rights, and political stability). The private sector in Pakistan appears to benefit from domestic raw material base in cotton and synthetic fibres, low labour costs, and large-scale investment in the last number of years. Clearly, the T&C industry has benefited from complimentary trade agreements with the US and EU since 2001 in relation to the fight against terrorism. The government is promoting diversification in terms of input use and products to lessen the concentration in low value-added products. It has been promoting progress in the weaving sector through implementation of standards and loan programmes to upgrade to auto looms. On the other hand, the industry faces the challenge of obsolete machinery, energy shortages and export concentration in low value-added products. The declining efficiency of clothing firms points to the failure of these firms to fight competition. MFA expiration is a chance for them to trim down their input usage which can help reduce export prices in the world market, yielding the desired competitive edge over other exporters.

APPENDIX A

Table A.1

Sample OTEXA Categories—Adjusted Base, Imports and Fill Rates

Year	MFA Root	OTEXA Category Description	Native Units	Adjusted Base (SME)	Imports (SME)	Fill Rate
1993	219	Duck Fabric	M2	5500000	5500000	1
1994	219	Duck Fabric	M2	5885000	3983780	0.676938
1995	219	Duck Fabric	M2	5606114	2842510	0.507038
1996	219	Duck Fabric	M2	6818078	6058734	0.888628
1997	219	Duck Fabric	M2	8777010	8454310	0.963234
1998	219	Duck Fabric	M2	7200397	5611143	0.779283
1999	219	Duck Fabric	M2	7758895	3621719	0.466783
2000	219	Duck Fabric	M2	8736258	7030377	0.804736
2001	219	Duck Fabric	M2	1.08E+07	6753098	0.625608
2002	219	Duck Fabric	M2	1.16E+07	10054596	0.87003
2003	219	Duck Fabric	M2	1.30E+07	11025657	0.845117
2004	219	Duck Fabric	M2	1.67E+07	11393881	0.68291
1993	314	Cotton Poplin & Broadcloth Fabric	M2	3529200	3419602	0.968945
1994	314	Cotton Poplin & Broadcloth Fabric	M2	4750800	1882077	0.39616
1995	314	Cotton Poplin & Broadcloth Fabric	M2	3323319	1206620	0.363077
1996	314	Cotton Poplin & Broadcloth Fabric	M2	4958603	2935625	0.592027
1997	314	Cotton Poplin & Broadcloth Fabric	M2	6383279	6148264	0.963183
1998	314	Cotton Poplin & Broadcloth Fabric	M2	5577228	5577228	1
1999	314	Cotton Poplin & Broadcloth Fabric	M2	6944831	4895780	0.704953
2000	314	Cotton Poplin & Broadcloth Fabric	M2	6646990	6646990	1
2001	314	Cotton Poplin & Broadcloth Fabric	M2	9103492	9103492	1
2002	314	Cotton Poplin & Broadcloth Fabric	M2	9619245	9582178	0.996147
2003	314	Cotton Poplin & Broadcloth Fabric	M2	1.09E+07	10430209	0.960494
2004	314	Cotton Poplin & Broadcloth Fabric	M2	1.23E+07	9637755	0.786177
1991	315	Cotton Print Cloth Fabric	M2	5.16E+07	51576942	1
1992	315	Cotton Print Cloth Fabric	M2	5.44E+07	54413674	1
1993	315	Cotton Print Cloth Fabric	M2	6.06E+07	56601311	0.933711
1994	315	Cotton Print Cloth Fabric	M2	6.56E+07	63840951	0.973061
1995	315	Cotton Print Cloth Fabric	M2	6.70E+07	62885763	0.938984
1996	315	Cotton Print Cloth Fabric	M2	6.25E+07	48527274	0.77664
1997	315	Cotton Print Cloth Fabric	M2	8.60E+07	80625620	0.937126
1998	315	Cotton Print Cloth Fabric	M2	7.64E+07	76408847	1
1999	315	Cotton Print Cloth Fabric	M2	7.11E+07	57271284	0.805458
2000	315	Cotton Print Cloth Fabric	M2	7.52E+07	58815757	0.782006
2001	315	Cotton Print Cloth Fabric	M2	8.67E+07	78064295	0.90072
2002	315	Cotton Print Cloth Fabric	M2	1.17E+08	1.17E+08	1
2003	315	Cotton Print Cloth Fabric	M2	1.14E+08	1.06E+08	0.927237
2004	315	Cotton Print Cloth Fabric	M2	1.47E+08	78932440	0.537423

Source: US MFA/ATC Database [Brambilla, *et al.* (2007)].

Table A.1

Sample OTEXA Categories—Adjusted Base, Imports and Fill Rates (Continued)

Year	MFA Root	OTEXA Category Description	Native Units	Adjusted Base (SME)	Imports (SME)	Fill Rate
1994	317/617	MMF Twill And Sateen Fabric	M2	2.30E+07	17201696	0.7479
1995	317/617	MMF Twill And Sateen Fabric	M2	1.93E+07	12039372	0.622763
1996	317/617	MMF Twill And Sateen Fabric	M2	2.66E+07	19048809	0.714866
1997	317/617	MMF Twill And Sateen Fabric	M2	3.43E+07	34302672	1
1998	317/617	MMF Twill And Sateen Fabric	M2	2.99E+07	29901543	1
1999	317/617	MMF Twill And Sateen Fabric	M2	3.31E+07	21604068	0.652369
2000	317/617	MMF Twill And Sateen Fabric	M2	3.84E+07	32280324	0.840262
2001	317/617	MMF Twill And Sateen Fabric	M2	4.52E+07	33642099	0.744576
2002	317/617	MMF Twill And Sateen Fabric	M2	5.70E+07	55857219	0.979842
2003	317/617	MMF Twill And Sateen Fabric	M2	5.84E+07	56259003	0.964072
2004	317/617	MMF Twill And Sateen Fabric	M2	6.59E+07	56710278	0.860839
1991	331/631	Cotton & MMF Gloves & Mittens	DPR	4149613	4149612.9	1
1992	331/631	Cotton & MMF Gloves & Mittens	DPR	4298328	4298327.8	1
1993	331/631	Cotton & MMF Gloves & Mittens	DPR	5225211	5225211.3	1
1994	331/631	Cotton & MMF Gloves & Mittens	DPR	5947642	5925369.9	0.996255
1995	331/631	Cotton & MMF Gloves & Mittens	DPR	6430591	6430590.5	1
1996	331/631	Cotton & MMF Gloves & Mittens	DPR	7114654	7114654.1	1
1997	331/631	Cotton & MMF Gloves & Mittens	DPR	7355412	7355412.1	1
1998	331/631	Cotton & MMF Gloves & Mittens	DPR	7784920	7730324.1	0.992987
1999	331/631	Cotton & MMF Gloves & Mittens	DPR	9120778	9120778.4	1
2000	331/631	Cotton & MMF Gloves & Mittens	DPR	1.06E+07	10561745	1
2001	331/631	Cotton & MMF Gloves & Mittens	DPR	1.06E+07	10267923	0.973166
2002	331/631	Cotton & MMF Gloves & Mittens	DPR	2747715	1508812	0.549115
2003	331/631	Cotton & MMF Gloves & Mittens	DPR	3962053	1456208.9	0.367539
2004	331/631	Cotton & MMF Gloves & Mittens	DPR	3716657	1421849.7	0.382561
1992	334/634	Other M&B cotton and MMF coats	DOZ	6541200	6541200	1
1993	334/634	Other M&B cotton and MMF coats	DOZ	7115729	5373409.5	0.755145
1994	334/634	Other M&B cotton and MMF coats	DOZ	7426539	5997514.5	0.807579
1995	334/634	Other M&B cotton and MMF coats	DOZ	9241412	6963307.5	0.75349
1996	334/634	Other M&B cotton and MMF coats	DOZ	9362300	8715907.5	0.930958
1997	334/634	Other M&B cotton and MMF coats	DOZ	9205704	7121214	0.773565
1998	334/634	Other M&B cotton and MMF coats	DOZ	1.23E+07	10242740	0.829831
1999	334/634	Other M&B cotton and MMF coats	DOZ	1.30E+07	13010882	1
2000	334/634	Other M&B cotton and MMF coats	DOZ	1.33E+07	12151176	0.914748
2001	334/634	Other M&B cotton and MMF coats	DOZ	2.14E+07	17412737	0.813117
2002	334/634	Other M&B cotton and MMF coats	DOZ	2.42E+07	22245428	0.920172
2003	334/634	Other M&B cotton and MMF coats	DOZ	2.73E+07	26630447	0.975774
1992	336/636	Cotton & MMF Dresses	DOZ	1.00E+07	9381917.6	0.935222
1993	336/636	Cotton & MMF Dresses	DOZ	1.21E+07	8639039.7	0.715614
1994	336/636	Cotton & MMF Dresses	DOZ	1.54E+07	11835526	0.770508
1995	336/636	Cotton & MMF Dresses	DOZ	1.41E+07	13226721	0.939638
1996	336/636	Cotton & MMF Dresses	DOZ	1.73E+07	15759919	0.912777
1997	336/636	Cotton & MMF Dresses	DOZ	1.73E+07	16131567	0.933601
1998	336/636	Cotton & MMF Dresses	DOZ	1.88E+07	17240824	0.915346
1999	336/636	Cotton & MMF Dresses	DOZ	1.84E+07	7362984.6	0.399599
2000	336/636	Cotton & MMF Dresses	DOZ	2.33E+07	19182251	0.823895
2001	336/636	Cotton & MMF Dresses	DOZ	2.56E+07	17012590	0.665267
2002	336/636	Cotton & MMF Dresses	DOZ	3.16E+07	26824559	0.847631
2003	336/636	Cotton & MMF Dresses	DOZ	2.98E+07	21127582	0.708673
2004	336/636	Cotton & MMF Dresses	DOZ	4.11E+07	32319945	0.786017

Source: US MFA/ATC Database [Brambilla, *et al.* (2007)].

Table A.1

Sample OTEXA Categories—Adjusted Base, Imports & Fill Rates (Continued)

Year	MFA Root	OTEXA Category Description	Native Units	Adjusted Base (SME)	Imports (SME)	Fill Rate
1992	338	M&B Knit Shirts, Cotton	DOZ	2.58E+07	25822104	1
1993	338	M&B Knit Shirts, Cotton	DOZ	2.45E+07	21908160	0.893081
1994	338	M&B Knit Shirts, Cotton	DOZ	2.79E+07	27890238	1
1995	338	M&B Knit Shirts, Cotton	DOZ	3.13E+07	31344468	1
1996	338	M&B Knit Shirts, Cotton	DOZ	3.17E+07	31693164	1
1997	338	M&B Knit Shirts, Cotton	DOZ	3.17E+07	31718982	1
1998	338	M&B Knit Shirts, Cotton	DOZ	3.41E+07	33052386	0.970578
1999	338	M&B Knit Shirts, Cotton	DOZ	3.68E+07	36774354	1
2000	338	M&B Knit Shirts, Cotton	DOZ	4.03E+07	40276782	1
2001	338	M&B Knit Shirts, Cotton	DOZ	4.44E+07	44392812	1
2002	338	M&B Knit Shirts, Cotton	DOZ	5.17E+07	51688488	1
2003	338	M&B Knit Shirts, Cotton	DOZ	5.64E+07	56447706	1
2004	338	M&B Knit Shirts, Cotton	DOZ	5.88E+07	58810998	1
1992	339	W&G Knit Shirts/Blouses, Cotton	DOZ	5965572	5965572	1
1993	339	W&G Knit Shirts/Blouses, Cotton	DOZ	6383160	5891052	0.922905
1994	339	W&G Knit Shirts/Blouses, Cotton	DOZ	7121862	7121862	1
1995	339	W&G Knit Shirts/Blouses, Cotton	DOZ	6753414	6753414	1
1996	339	W&G Knit Shirts/Blouses, Cotton	DOZ	8352198	8352198	1
1997	339	W&G Knit Shirts/Blouses, Cotton	DOZ	7526706	7440906	0.988601
1998	339	W&G Knit Shirts/Blouses, Cotton	DOZ	9045354	8537808	0.943889
1999	339	W&G Knit Shirts/Blouses, Cotton	DOZ	1.07E+07	10733376	1
2000	339	W&G Knit Shirts/Blouses, Cotton	DOZ	1.22E+07	12219480	1
2001	339	W&G Knit Shirts/Blouses, Cotton	DOZ	1.11E+07	10820190	0.972356
2002	339	W&G Knit Shirts/Blouses, Cotton	DOZ	1.59E+07	14536554	0.91195
2003	339	W&G Knit Shirts/Blouses, Cotton	DOZ	1.70E+07	16717866	0.982085
2004	339	W&G Knit Shirts/Blouses, Cotton	DOZ	1.80E+07	16278546	0.905849
1994	342/642	Cotton & MMF Skirts	DOZ	2571174	1685279.4	0.655451
1995	342/642	Cotton & MMF Skirts	DOZ	3619448	2781412.8	0.768463
1996	342/642	Cotton & MMF Skirts	DOZ	4401907	2625439.6	0.596432
1997	342/642	Cotton & MMF Skirts	DOZ	2780534	1119422.1	0.402593
1998	342/642	Cotton & MMF Skirts	DOZ	1275127	1275127.1	1
1999	342/642	Cotton & MMF Skirts	DOZ	5826571	2450260.3	0.420532
2000	342/642	Cotton & MMF Skirts	DOZ	5640335	3453909.4	0.612359
2001	342/642	Cotton & MMF Skirts	DOZ	7464006	3887454.7	0.520827
2002	342/642	Cotton & MMF Skirts	DOZ	7867513	3826543.5	0.486373
2003	342/642	Cotton & MMF Skirts	DOZ	8881696	2981951.9	0.335741
2004	342/642	Cotton & MMF Skirts	DOZ	1.13E+07	3799351	0.336536
1992	347/348	Cotton Trousers/Slacks & Shorts	DOZ	8402825	8402825.2	1
1993	347/348	Cotton Trousers/Slacks & Shorts	DOZ	8251858	8251858.4	1
1994	347/348	Cotton Trousers/Slacks & Shorts	DOZ	1.08E+07	9960694.7	0.924569
1995	347/348	Cotton Trousers/Slacks & Shorts	DOZ	1.16E+07	9468190.1	0.81285
1996	347/348	Cotton Trousers/Slacks & Shorts	DOZ	1.26E+07	12137749	0.963777
1997	347/348	Cotton Trousers/Slacks & Shorts	DOZ	1.36E+07	13165104	0.966842
1998	347/348	Cotton Trousers/Slacks & Shorts	DOZ	1.50E+07	13742717	0.916263
1999	347/348	Cotton Trousers/Slacks & Shorts	DOZ	1.65E+07	1621045.5	0.09812
2000	347/348	Cotton Trousers/Slacks & Shorts	DOZ	1.91E+07	19057681	1
2001	347/348	Cotton Trousers/Slacks & Shorts	DOZ	2.00E+07	19970932	1
2002	347/348	Cotton Trousers/Slacks & Shorts	DOZ	2.42E+07	24176427	1
2003	347/348	Cotton Trousers/Slacks & Shorts	DOZ	2.73E+07	27292881	1
2004	347/348	Cotton Trousers/Slacks & Shorts	DOZ	2.94E+07	29448628	1

Source: US MFA/ATC Database [Brambilla, *et al.* (2007)].

Table A.1

Sample OTEXA Categories—Adjusted Base, Imports & Fill Rates (Continued)

Year	MFA Root	OTEXA Category Description	Native Units	Adjusted Base (SME)	Imports (SME)	Fill Rate
1992	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	5277116	2973660	0.563501
1993	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	9276158	8252167.5	0.889611
1994	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	1.10E+07	9732690	0.883391
1995	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	1.14E+07	9906820.5	0.872117
1996	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	1.26E+07	11851097	0.938869
1997	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	1.35E+07	13277810	0.985685
1998	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	1.48E+07	14312109	0.964565
1999	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	1.63E+07	15460640	0.945955
2000	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	1.90E+07	19012371	1
2001	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	1.99E+07	19932657	1
2002	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	3.06E+07	26602512	0.86802
2003	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	3.59E+07	35853266	1
2004	351/651	Cotton & MMF Nightwear & Pajamas	DOZ	4.05E+07	40474967	1
1992	352/652	Cotton & MMF Underwear etc.	DOZ	4645995	4255873.8	0.916031
1993	352/652	Cotton & MMF Underwear etc.	DOZ	6092056	4878458.6	0.80079
1994	352/652	Cotton & MMF Underwear etc.	DOZ	7180246	4580138.6	0.63788
1995	352/652	Cotton & MMF Underwear etc.	DOZ	7483515	7414257.7	0.990745
1996	352/652	Cotton & MMF Underwear etc.	DOZ	8091173	7608504.7	0.940346
1997	352/652	Cotton & MMF Underwear etc.	DOZ	8413573	7877422.1	0.936276
1998	352/652	Cotton & MMF Underwear etc.	DOZ	9970725	9210810.8	0.923786
1999	352/652	Cotton & MMF Underwear etc.	DOZ	9412245	8220331.9	0.873366
2000	352/652	Cotton & MMF Underwear etc.	DOZ	1.29E+07	12293112	0.953438
2001	352/652	Cotton & MMF Underwear etc.	DOZ	1.36E+07	13600364	1
2002	352/652	Cotton & MMF Underwear etc.	DOZ	1.72E+07	16746916	0.972925
2003	352/652	Cotton & MMF Underwear etc.	DOZ	2.02E+07	19128188	0.944741
2004	352/652	Cotton & MMF Underwear etc.	DOZ	2.29E+07	22856951	1
1991	360	Cotton Pillowcases	NO	1391385	1391384.7	1
1992	360	Cotton Pillowcases	NO	1659218	1574308.8	0.948826
1993	360	Cotton Pillowcases	NO	1592996	1592996.4	1
1994	360	Cotton Pillowcases	NO	1924688	1902252.6	0.988344
1995	360	Cotton Pillowcases	NO	2080972	2073618.9	0.996467
1996	360	Cotton Pillowcases	NO	3680633	3378957.3	0.918037
1997	360	Cotton Pillowcases	NO	4413190	4187838.6	0.948937
1998	360	Cotton Pillowcases	NO	4840267	4840266.6	1
1999	360	Cotton Pillowcases	NO	5736731	5736731.4	1
2000	360	Cotton Pillowcases	NO	6014405	6014404.8	1
2001	360	Cotton Pillowcases	NO	6624866	6624865.8	1
2002	360	Cotton Pillowcases	NO	7668605	7668604.8	1
2003	360	Cotton Pillowcases	NO	9081286	9081286.2	1
2004	360	Cotton Pillowcases	NO	9454337	9454337.1	1
1991	361	Cotton Sheets	NO	1.15E+07	11460452	1
1992	361	Cotton Sheets	NO	1.30E+07	12950309	1
1993	361	Cotton Sheets	NO	1.24E+07	12433444	1
1994	361	Cotton Sheets	NO	1.45E+07	14460732	1
1995	361	Cotton Sheets	NO	1.56E+07	15634939	1
1996	361	Cotton Sheets	NO	2.29E+07	18597389	0.811838
1997	361	Cotton Sheets	NO	2.78E+07	25280960	0.909474
1998	361	Cotton Sheets	NO	3.44E+07	33095868	0.962913
1999	361	Cotton Sheets	NO	3.85E+07	38541344	1

Source: US MFA/ATC Database [Brambilla, *et al.* (2007)].

Table A.1

Sample OTEXA Categories—Adjusted Base, Imports & Fill Rates (Continued)

Year	MFA Root	OTEXA Category Description	Native Units	Adjusted Base (SME)	Imports (SME)	Fill Rate
2000	361	Cotton Sheets	NO	4.04E+07	40406844	1
2001	361	Cotton Sheets	NO	4.45E+07	44508136	1
2002	361	Cotton Sheets	NO	5.01E+07	50126669	1
2003	361	Cotton Sheets	NO	5.62E+07	56164092	1
2004	361	Cotton Sheets	NO	6.01E+07	60097534	1
1991	363	Cotton Terry & Other Pile Towels	NO	1.17E+07	11689698	1
1992	363	Cotton Terry & Other Pile Towels	NO	1.47E+07	14710422	1
1993	363	Cotton Terry & Other Pile Towels	NO	1.38E+07	13844720	1
1994	363	Cotton Terry & Other Pile Towels	NO	1.54E+07	15357094	1
1995	363	Cotton Terry & Other Pile Towels	NO	1.62E+07	16230249	0.998919
1996	363	Cotton Terry & Other Pile Towels	NO	1.76E+07	17588729	1
1997	363	Cotton Terry & Other Pile Towels	NO	1.86E+07	18594367	1
1998	363	Cotton Terry & Other Pile Towels	NO	1.98E+07	19793857	1
1999	363	Cotton Terry & Other Pile Towels	NO	2.10E+07	20999250	1
2000	363	Cotton Terry & Other Pile Towels	NO	2.25E+07	22521696	1
2001	363	Cotton Terry & Other Pile Towels	NO	2.42E+07	24154519	1
2002	363	Cotton Terry & Other Pile Towels	NO	2.64E+07	26403174	1
2003	363	Cotton Terry & Other Pile Towels	NO	2.88E+07	28834247	1
2004	363	Cotton Terry & Other Pile Towels	NO	2.97E+07	29271308	0.984514
1991	369	Shop Towels Only	KG	3688660	3688660	1
1992	369	Shop Towels Only	KG	4165145	4165144.5	1
1993	369	Shop Towels Only	KG	4456703	4456703	1
1994	369	Shop Towels Only	KG	4456703	4256052	0.954978
1995	369	Shop Towels Only	KG	5155888	4682446	0.908175
1996	369	Shop Towels Only	KG	5675884	5675883.5	1
1997	369	Shop Towels Only	KG	6144047	6144046.5	1
1998	369	Shop Towels Only	KG	6780552	6780552	1
1999	369	Shop Towels Only	KG	7363168	733167.5	0.099572
2000	369	Shop Towels Only	KG	8096709	8096709	1
2001	369	Shop Towels Only	KG	8918523	8918523	1
2002	369	Shop Towels Only	KG	1.01E+07	10080558	1
2003	369	Shop Towels Only	KG	1.14E+07	11379970	1
2004	369	Shop Towels Only	KG	1.21E+07	12131115	1
1991	615	MMF Print Cloth Fabric	M2	1.42E+07	14187864	1
1992	615	MMF Print Cloth Fabric	M2	1.49E+07	14935279	1
1993	615	MMF Print Cloth Fabric	M2	1.76E+07	13794085	0.78531
1994	615	MMF Print Cloth Fabric	M2	2.00E+07	13475023	0.673025
1995	615	MMF Print Cloth Fabric	M2	1.78E+07	10141540	0.569823
1996	615	MMF Print Cloth Fabric	M2	1.94E+07	14184923	0.730959
1997	615	MMF Print Cloth Fabric	M2	2.56E+07	22730616	0.889082
1998	615	MMF Print Cloth Fabric	M2	2.56E+07	25632933	1
1999	615	MMF Print Cloth Fabric	M2	2.87E+07	26963151	0.940312
2000	615	MMF Print Cloth Fabric	M2	2.83E+07	26330205	0.929341
2001	615	MMF Print Cloth Fabric	M2	3.79E+07	37853501	1
2002	615	MMF Print Cloth Fabric	M2	3.83E+07	36837156	0.962278
2003	615	MMF Print Cloth Fabric	M2	3.77E+07	27696697	0.735485
2004	615	MMF Print Cloth Fabric	M2	4.90E+07	25816627	0.527164

Source: US MFA/ATC Database [Brambilla, *et al.* (2007)].

Table A.1

Sample OTEXA Categories—Adjusted Base, Imports & Fill Rates (Continued)

Year	MFA Root	OTEXA Category Description	Native Units	Adjusted Base (SME)	Imports (SME)	Fill Rate
1991	638/639	MMF KN Shirts & Blouses	DOZ	1796113	626356.8	0.348729
1992	638/639	MMF KN Shirts & Blouses	DOZ	981007.2	981007.2	1
1993	638/639	MMF KN Shirts & Blouses	DOZ	1517175	1219419.4	0.803743
1994	638/639	MMF KN Shirts & Blouses	DOZ	520253.3	520253.28	1
1995	638/639	MMF KN Shirts & Blouses	DOZ	1429216	1429215.8	1
1996	638/639	MMF KN Shirts & Blouses	DOZ	976212	976212	1
1997	638/639	MMF KN Shirts & Blouses	DOZ	1228789	1228789.4	1
1998	638/639	MMF KN Shirts & Blouses	DOZ	2448157	860764.32	0.351597
1999	638/639	MMF KN Shirts & Blouses	DOZ	3260684	3252.96	0.000998
2000	638/639	MMF KN Shirts & Blouses	DOZ	4240629	4240628.6	1
2001	638/639	MMF KN Shirts & Blouses	DOZ	2368803	1903253.8	0.803467
2002	638/639	MMF KN Shirts & Blouses	DOZ	4843048	3232677.6	0.667488
2003	638/639	MMF KN Shirts & Blouses	DOZ	6378536	6378536.2	1
2004	638/639	MMF KN Shirts & Blouses	DOZ	8429119	6944680.8	0.823892
1996	666	MMF Pillowcases ex. Bolsters	KG	7456867	7456867.2	1
1997	666	MMF Pillowcases ex. Bolsters	KG	1.13E+07	11178763	0.991541
1998	666	MMF Pillowcases ex. Bolsters	KG	1.24E+07	12432586	1
1999	666	MMF Pillowcases ex. Bolsters	KG	1.47E+07	14678395	1
2000	666	MMF Pillowcases ex. Bolsters	KG	1.24E+07	12418099	1
2001	666	MMF Pillowcases ex. Bolsters	KG	1.70E+07	17020152	1
2002	666	MMF Pillowcases ex. Bolsters	KG	1.56E+07	15551554	1
2003	666	MMF Pillowcases ex. Bolsters	KG	1.85E+07	18517118	1
2004	666	MMF Pillowcases ex. Bolsters	KG	1.99E+07	19867450	1
1996	666	MMF Sheets	KG	3.43E+07	34322674	1
1997	666	MMF sheets	KG	5.74E+07	54240566	0.944143
1998	666	MMF Sheets	KG	6.68E+07	66772613	1
1999	666	MMF Sheets	KG	6.89E+07	68866315	1
2000	666	MMF Sheets	KG	7.72E+07	77178125	1
2001	666	MMF Sheets	KG	7.25E+07	72539179	1
2002	666	MMF Sheets	KG	8.94E+07	89401234	1
2003	666	MMF Sheets	KG	9.80E+07	98031859	1
2004	666	MMF Sheets	KG	1.02E+08	1.02E+08	1

Source: US MFA/ATC Database [Brambilla, *et al.* (2007)].

APPENDIX B

REVIEW OF OLLEY AND PAKES AND LEVINSOHN AND PETRIN

This section provides a review of the techniques of Olley and Pakes and Levinsohn and Petrin. Consider the following Cobb-Douglas production function:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \epsilon_{it}. \qquad \text{(B.1)}$$

y_{it} is the log of output, k_{it} is the log of capital input, and l_{it} is the log of labour input. The OP methodology allows the error term to have two components, a white noise component and a time-varying productivity shock. There are two terms in this equation that are unobservable to the econometrician, ω_{it} and ϵ_{it}. ϵ_{it} represents shocks that are not observable by firms before making their input decisions. On the contrary, ω_{it} represents shocks that are potentially expected by firms when they make input decisions. ϵ_{it} can also represent measurement error in the output variable. We will refer to ω_{it} as the 'productivity shock' of firm *i* in period *t* [Ackerberg, *et al.* (2005)]. It is assumed that ω_{it} follows a first order Markov process and capital is accumulated by means of a deterministic dynamic investment process:

$$p(\omega_{it+1} | I_{it}) = p(\omega_{it+1} | \omega_{it}),$$

where I_{it} is firm *i*'s information set at *t*. Current and past realisations of ω, i.e. (ω_{it}, ..., ω_{i0}) are assumed to be a part of I_{it}. OP assumes that labour is a non-dynamic input. This investment adds to future capital stock deterministically:

$$k_{it} = \kappa(k_{it-1}, i_{it-1}).$$

In view of the fact that k_{it} is decided at *t−1*, the above assumptions entail that it must be uncorrelated with the unexpected innovation in ω_{it} between *t−1* and *t*. This orthogonality will be used to form a moment to spot β_k. Unlike capital, l_{it} is decided at *t* and, consequently, correlated with the innovation component of ω_{it}. Considering the firm's dynamic decision of investment level, i_{it}, OP state conditions under which a firm's optimal investment level is strictly an increasing function of their current productivity, ω_{it}, i.e.

$$i_{it} = f_t(\omega_{it}, k_{it}). \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \text{(B.2)}$$

Profit maximisation generates an investment demand function that is determined by two state variables, capital and productivity. The reason *f* is indexed by *t* is the assumption that variables such as input prices, are allowed to vary across time but not across firms [Ackerberg, *et al.* (2006)]. If the investment demand function is monotonically increasing in productivity, it is feasible to invert the investment function and get an expression for productivity as a function of capital and investment [Pakes (1994)]:

$$\omega_{it} = f_t^{-1}(i_{it}, k_{it}). \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \text{(B.3)}$$

The heart of OP is to make use of this inverse function to control for ω_{it} in the production function:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + f_t^{-1}(i_{it}, k_{it}) + \epsilon_{it}. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \text{(B.4)}$$

The first stage of OP is to estimate this equation. *f* is the solution to a complex dynamic programming problem. To avoid the computationally demanding assumptions, OP treats f_t^{-1} non-parametrically [Ackerberg, *et al.* (2006)]. Given this non-parametric treatment, direct estimation of (B.4) does not identify β_k, as k_{it} is collinear with the non-parametric function. Nevertheless, one does find an estimate of the labour coefficient β_l, and of the composite term $\beta_k k_{it} + f_t^{-1}(i_{it}, k_{it})$, which we denote by $\widehat{\Phi}_{it}$. By the timing assumptions regarding capital, we can write:

$$\omega_{it} = E[\omega_{it} | I_{it-1}] + \xi_{it} = E[\omega_{it} | \omega_{it-1}] + \xi_{it},$$

where ξ_{it} is orthogonal to k_{it}, i.e. $E[\xi_{it} | k_{it}] = 0$. This is the moment which OP uses to identify the capital coefficient. To operationalise this process by GMM, given a guess at the capital coefficient β_k, one can 'invert' out the ω_{it}'s in all periods:

$$\omega_{it}(\beta_k) = \widehat{\Phi}_{it} - \beta_k k_{it}.$$

Given these $\omega_{it}(\beta_k)$'s, one can compute ξ_{it}'s in all periods by non-parametrically regressing $\omega_{it}(\beta_k)$'s on $\omega_{it-1}(\beta_k)$'s and taking the residual, i.e.

$$\xi_{it}(\beta_k) = \omega_{it}(\beta_k) - \widehat{\psi}(\omega_{it-1}(\beta_k)),$$

where $\widehat{\psi}(\omega_{it-1}(\beta_k))$ are predicted values from the non-parametric regression. Treating the regression of ω_{it} on ω_{it-1} non-parametrically allows for ω_{it} to follow an arbitrary first-order Markov process. These $\xi_{it}(\beta_k)$'s can subsequently be used to establish:

$$\frac{1}{T}\frac{1}{N}\sum_t \sum_i \xi_{it}(\beta_k) \cdot k_{it}$$

In a GMM procedure, β_k would be estimated by setting this empirical analogue as close as possible to zero [Ackerberg, *et al.* (2005)]. LP adopts a similar approach to solving the endogeneity problem. Instead of using an investment demand equation, they use an intermediate input demand function to invert out ω_{it}. In the real data, investment is often lumpy. This may not be in line with the strict monotonicity assumption regarding investment. Also, OP procedure can cause efficiency loss in a data with zero investment. Given that the intermediate input demands normally exhibit a lesser tendency to have zeros, the strict monotonicity condition is expected to hold in the LP methodology. LP considers the following production function:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \omega_{it} + \epsilon_{it},$$

where m_{it} is an intermediate input, such as electricity. LP considers the following intermediate input demand function:

$$m_{it} = f_t(\omega_{it}, k_{it}). \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \text{(B.5)}$$

First, the intermediate input at *t* is chosen as a function of ω_{it}. Secondly, l_{it} is also taken to be a 'perfectly variable' input. If l_{it} was chosen before m_{it}, then it would influence the firm's optimal choice of m_{it}. Under the assumption that intermediate input demand (B.5) is monotonic in ω_{it}, we can invert:

$$\omega_{it} = f_t^{-1}(m_{it}, k_{it}). \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \text{(B.6)}$$

And substitute this in the production function to get:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + f_t^{-1}(m_{it}, k_{it}) + \epsilon_{it}. \qquad \ldots \quad \ldots \quad \ldots \text{(B.7)}$$

The first step of the LP estimates β_l using the above equation, treating f_t^{-1} non-parametrically. Once more, β_k and β_m are not identified as k_{it} and m_{it} are collinear with the non-parametric term. One also obtains an estimate of the composite term, in this case $\beta_k k_{it} + \beta_m m_{it} + f_t^{-1}(m_{it}, k_{it})$. In the second stage, there is one more parameter to estimate, β_m. LP uses the same moment condition as OP to identify the capital coefficient [Ackerberg, *et al.* (2005)]. $\xi_{it}(\beta_k, \beta_m)$ can be constructed as the residual from a non-parametric regression of $(\omega_{it}(\beta_k, \beta_m) = \widehat{\Phi}_{it} - \beta_k k_{it} - \beta_m m_{it})$ on $(\omega_{it-1}(\beta_k, \beta_m) = \widehat{\Phi}_{it-1} - \beta_k k_{it-1} - \beta_m m_{it-1})$. They include a further moment to identify β_m, i.e. the condition that $\xi_{it}(\beta_k, \beta_m)$ is orthogonal to m_{it-1}. This results in the following moment condition:

$$E[\xi_{it}(\beta_k, \beta_m) | \begin{matrix} k_{it} \\ m_{it-1} \end{matrix}] = 0$$

ξ_{it} is not orthogonal to m_{it} because ω_{it} is observed at the time that m_{it} is chosen, and ξ_{it} should be uncorrelated with m_{it-1}, as m_{it-1} was chosen at t–1 [Ackerberg, *et al.* (2006)].

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