Trade Liberalization, Productivity, and Firm exit in Manufacturing Firms in Ethiopia

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Abstract

This paper uses firm level panel data from 2000 -2009 to study the effect of tariff changes on firm level productivity, firm exit, and industry resource reallocation in Ethiopian manufacturing firms. It uses a new estimation method for production functions to obtain unbiased and efficient estimates of parameters and total factor productivity compared to the "input proxy" approaches, which are common in the empirical trade and productivity literature. We find evidence for increased productivity after liberalization and resource reallocation in several industries as expected from the theoretical literature. However, there are heterogeneous impacts across sectors. We find no evidence for firm exit after tariff reductions due to direct competition effects from lower cost imports but the tariff reductions affect firm decisions to exit via their effect on productivity.

1 Introduction

Ethiopia has pursued a gradual approach to lift protection for its domestic industries beginning in 1993 by reducing import tariffs in different phases over a period of 20 years. Import tariffs have been revised eight times during this period bringing the average tariff rate down from 36.8% to 17.5%. The tariff reduction is unilateral, it is done independently without any negotiation with another country expecting reciprocal liberalization measures, although there was some external pressure from the IMF at the onset in the early 90s. The country remains one of the twenty countries in the world that is not yet a member of the WTO and is still negotiating access to the world market that WTO membership would bring. This paper evaluates the impact of these unilateral tariff reduction measures on the performance of Ethiopia's manufacturing sector using a panel of firm level data.

Micro-oriented trade theories focusing on the behavior of firms in response to trade liberalization, and firm-level productivity are at the center of this investigation. According to these theories, trade liberalization exposes domestic firms to increased competition which forces them to take measures that increase efficiency within plants or lead to reallocation of resources from low to high productive firms resulting from exit of lower productivity firms (Melitz 2003; Syverson 2011). These adjustment mechanisms due to trade exposure will then lead to improvements in aggregate productivity within an industry. We know from these theories that the impact of trade liberalization should differ across firms and depend on the level of their productivity. Melitz's (2003) work, for example, showed that trade liberalization helps productive firms to export more and increase their market share while least productive firms are forced to exit (selection effect). Although some firms exit the industry when exposed to trade competition, others may innovate or invest in high technologies and increase their productivity (within effect). Trade liberalization should in theory increase the aggregate productivity in an industry due to both within and selection effects taking place. There is also documented empirical evidence for increased industry productivity after trade liberalization, for example:- in Chile(Pavcnik 2002), Columbia(Fernandes 2007), and India(Topalova and Khandelwal 2010).

This paper uses a new method of estimating production function developed by Gandhi, Navarro, and Rivers (2011), a techniques that improves on the "input proxy" approach that most empirical trade studies rely on. The method argues that the "input proxy" approach does not exactly identify the production function(and hence productivity) in the presence of flexible inputs. Instead of using flexible inputs as a proxy for productivity, this method makes use of the information contained in the first order conditions with respect to the flexible input to identify input coefficients and productivity(Gandhi, Navarro, and Rivers 2011).

This research uses the gradual nature of trade liberalization policy in Ethiopia for identification in order to study the impact of trade reform on firm productivity using data collected between 2000 and 2009. We observe changes in tariff policy two times during this period. We will also investigate the existence of resource reallocation among firms within an industry after tariff changes to test if the predictions from the Melitz model hold in Ethiopian manufacturing firms. Lastly, we will also explore the channel through which trade liberalization affects firm exit. Do tariff changes affect firm exit directly due to competition from low cost imported goods? or indirectly through its effect on productivity?

We find that there is a high level of heterogeneity in firm productivity within industries where a firm at the 75th percentile distribution of productivity is twice as productive as the firm in a 25th percentile distribution using the same level of inputs. The gap increases to fourfold when we compare the 95th percentile to the 5th percentile. We also found that trade increases the total factor productivity of firms: a 10 percentage point reduction in tariffs increases productivity by approximately 2%. We do not find evidence for a direct effect of tariffs or low cost import competition on firm exit but through its effect on productivity. Aggregate decomposition of industry productivity also reveals evidence for resource reallocation in several of the industries in line with predictions from Melitz's model. However, there are also some sectors where inefficient firms still continue production, especially in industries containing large firms owned by the state.

The rest of the paper is organized as follows. Section 2 reviews related works from the literature, section 3 provides the theoretical framework for estimating production functions, section 4 discusses data and estimation, section 5 presents the results, and finally section 6 concludes.

2 Background and Literature

Firms display significant variation in efficiency — usually measured by Total Factor Productivity rather than the intensity of use of a particular input — in production within an industry. Syverson (2011) presents a simple model to explain why such productivity dispersion is sustained in equilibrium within an industry; and discusses what happens to firms when there is an external common productivity shock to the industry. Those firms that take advantage of the shock will grow bigger while others will shrink or even be no longer profitable. Trade liberalization is one such shock that will expose all firms within an industry in the same way but with different results. This policy change may result in reallocation of factors of production from low to high productive firms(Melitz 2003), create more access for improved technologies that increase efficiency (Grossman and Helpman 1991), or force firms to change managerial organization of the production process to become more efficient (Syverson 2011).

Researchers have empirically investigated the productivity effect of trade liberalization such as the Ethiopian case examined here using firm level micro data. Topalova and Khandelwal (2010) used data from Indian manufacturing firms to show the heterogeneous impact of trade liberalizations across industries, firms, and different economic environments. They showed that the productivity of firms increased after episodes of trade liberalization due to competition from imported goods and access to improved and cheaper intermediate inputs, with the latter having higher impact. Pavcnik (2002) also found evidence of aggregate productivity improvements in Chilean manufacturing firms after liberalization. The study showed that even though there were within plant improvements in productivity in sectors that were exposed to foreign competition, most of the productivity comes from reallocation of resources towards more efficient firms after liberalization. These two studies used methods developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003) to estimate firm level productivity in their analyses.

This study contributes to the literature by using a new and improved method to identify production functions and hence productivity of firms. This method does not rely on strong structural assumptions and does not restrict the functional form of the production technology while estimating productivity(Gandhi, Navarro and Rivers 2011). The estimation of value added production function using intermediate inputs as proxy for firm productivity(Ackerberg, Caves, and Frazer 2006) leads to biased estimates of labor and capital coefficients and also the productivity residual. Since the trade and productivity relationship study relies on the estimate from the production function, it is important to get the first stage estimate as accurate as possible.

There are also limited empirical studies conducted in Africa documenting the productivity effects of trade liberalization using information obtained at firm level. A study of changes in productivity of firms that are engaged in exporting in nine different African countries shows that firms with high productivity self-select into international markets(Van Biesebroeck 2005). This study also finds that firms continue to increase their productivity over time since their credit and contract enforcement constraints are reduced significantly. The reason for post-export growth of productivity may be because the firms can undertake previously prohibitive costly productivity raising activities. A different study, however, that uses firm level data from Ghana, Kenya, and Tanzania could not find similar evidence for post-export growth in productivity (learning-by-exporting) although it finds a positive correlation between exporting and productivity(Bresnahan et al. 2016). Therefore, although there is evidence showing high productive firms self-selecting into export markets, the evidence for learning-by-exporting is not conclusive.

Researches in Ghana, Kenya, Tanzania, and Ethiopia have also found that export destination of the countries matters to how much productivity improves while exporting. Firms that export to other African countries have lower productivity compared to firms that export to the rest of the world. (Mengistae and Teal 1998; Bresnahan et al. 2016).

Studies in Ghana and South Africa, which also including domestic oriented firms, has shown that a 10% decrease in import tariff improves the average Total Factor Productivity by 1.2% and 1.8%, respectively (Ackah, Ernest Aryeetey, and Morrissey 2012; Jonsson and Subramanian 2001).

Bigsten, Gebreeyesus, and Soderbom (2016) also investigated trade liberalization and productivity in Ethiopian manufacturing firms using data from 1997–2005. They estimated input elasticities using average cost share of inputs assuming a two factor Cobb-Douglas production function. This is a non-econometric approach computed from firms' reported expenditures for labor and capital. They concluded that output tariff has no effect on firm productivity(Bigsten, Gebreeyesus, and Soderbom 2016). This paper uses data from 2000 – 2009, a period which covers another round of tariff reductions in 2007, and a new production function estimation technique. It also reaches at a different conclusion about the effect of output tariff liberalization on productivity.

This paper will add to the scanty literature about trade liberalization and productivity relationship in Africa using a longer panel dataset. It will also be, to the best our knowledge, the first paper to measure resource reallocation using dynamic aggregate productivity decomposition for the manufacturing sector in the region.

2.1 Overview of Ethiopia's Trade Liberalization Process

Import substitution industrialization had been pursued as the central policy for growing the manufacturing sector in Ethiopia from the 1960's until 1991. The imperial regime first introduced tariff protections, incentives, and tax relief in the 1960's in order to attract both domestic and foreign firms to establish new industries. In the seventies, a new socialist regime, the Dergue, came to power which continued the import substitution strategies by nationalizing private firms and making industrialization a state-led effort (Zerihun 2008).

In 1991, after the overthrow of the Dergue, a new government started on various economic and trade liberalization measures with the aim of transforming the economy from centrally planned to market oriented; and integrating the country to the world market. It eliminated quantitative restrictions on imports and gradually reduced the level and dispersion of tariff rates. The process of liberalizing the foreign trade regime was conducted more gradually in Ethiopia relative to other African countries that opened their market in the 90s as part of Structural Adjustment Programs and completed their accession to the WTO at the time. The tariff rates for goods in Ethiopia have been reduced and amended eight times in different phases between 1993 and 2014; and the country is still negotiating access to WTO membership. The pre-reform tariff rates were brought down from 0-240 percent to 0-80 percent by 1995. The average unweighted tariff rate was then reduced from 28.9 percent in 1995 to 21.5 percent in 1997, then to 19.5 percent in 1998, and then to 17.5 percent in 2003. Two of the eight tariff reductions fall under our study period of 2000–2009.

We treat tariff reduction as an exogenous policy change although we do not necessarily reject the potential endogeneity of the variable, since tariff reductions could potentially be correlated with firm productivity. There are two reasons, however, to support the treatment of these variable as exogenous in our analysis. These reasons are a) tax revenue consideration instead of the need to continue protecting some sectors of the economy until they build competitiveness; and b) external pressures by IMF and the World bank that forces the government to liberalize markets. The intertemporal and across-industry variation of tariff will also provide us a good identification strategy to study the effect of tariff liberalization.

The gradual nature of tariff reduction, particularly in the 90s, was at least partially due to fiscal considerations related to tax revenues. Macroeconomic stability with prudent fiscal policy was one of the objectives of the structural adjustment program. It was necessary to ensure that tariff reduction was neutral to government revenue with limitations already in place on domestic borrowing for public finances. It was also necessary that gains from a broadening tax base go to strengthening the fiscal position of the government instead of financing tariff reforms(IMF 2001). Therefore, revenue considerations were higher on the agenda than an industrial policy that aims to continue protection or support of industries in response to some form of lobbying or initial productivity conditions.

Table 1: Average Industry Tariff Trends

Industry (2-digit ISIC)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Food and Beverage	46.5	30.1	29.9	24.9	24.7	24.8	24.8	25.4	25.2	25.2
Textile	49.2	32.9	33.0	29.5	29.7	29.8	29.5	29.1	28.7	28.3
Apparel	80.0	40.0	40.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Leather Tanning and footwear	26.7	21.9	21.9	21.8	21.8	21.8	21.8	19.1	19.9	20.1
Wood Products	31.3	10.7	10.7	10.9	10.9	10.9	10.9	10.7	10.7	10.7
Paper and Paper Products	29.5	13.4	13.4	12.9	12.9	12.9	12.9	12.7	12.7	12.7
Publishing and Printing	16.0	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
Chemicals	20.7	14.3	13.3	13.2	12.8	13.9	14.3	14.8	14.9	14.5
Rubber and Platics	20.5	14.4	14.4	14.0	14.0	14.0	14.0	14.5	14.5	14.5
Glass and non-metalic Minerals	46.7	28.1	28.1	23.4	23.5	23.4	23.5	24.3	24.3	24.3
Basic Iron,steel,and casting	6.2	5.5	5.5	6.3	6.3	6.3	6.3	6.8	6.8	6.8
Metal Products	20.9	19.4	18.4	17.6	17.2	17.2	17.0	16.9	15.6	15.0
Machinery and appliances	10.8	9.3	9.3	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Electric motors, cables, and equipments	23.4	18.8	18.8	19.0	19.0	19.0	19.0	18.0	18.0	18.0
Motor vehicles and accessories	28.4	19.2	19.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2
Furniture	37.1	28.0	28.0	27.3	27.3	27.3	27.3	27.3	27.3	27.3
Average	36.8	24.9	24.5	22.1	22.0	20.0	21.0	22.0	22.0	22.6
Minimum	6.2	5.5	5.5	6.3	6.3	6.3	6.3	6.8	6.8	6.8
Maximum	80.0	40.0	40.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0

Table 1 above shows the import tariff rates applied for various industries in the manufacturing sector between 2000 and 2009. We can see from the table that the maximum tariff rate is reduced from 80% to 35%, and the average is reduced by 14.3% percentage points from 36.8% in 2000 to 22.6% in 2009. We observe the largest drop in tariff rates in industries which have the highest protection rate in the first place. We see the largest drop in apparel (45%) followed by food and beverages and textile with about 21% each. We see lowest reduction in tariffs in sectors where there were low tariffs to begin with, such as machinery and appliances (2.6%).

3 Theoretical Framework

Identification and estimation of production functions is a challenge because firm's input decisions are a function of productivity shocks, which is not observable in the data but are known to the firm. This productivity shock may represent different variables like managerial talent or practice, quality of labor input such as training and experience that is not captured by standard input measures, quality of capital input that embodies technology which raises total factor Productivity (TFP), and other factors known to the firm but unknown to the econometrician (Syverson 2011). The optimal choice of input decisions in the production process is going to be correlated with these productivity shocks. Therefore, we employ a production function estimation framework that takes into account this endogeneity problem, and produce unbiased estimates of input coefficients and productivity measures.

We use an estimation framework that improves upon the input control approaches (Olley and Pakes 1996; Levinsohn and Petrin 2003; and Ackerberg, Caves, and Frazer 2006) which use the intermediate input as a proxy for productivity shocks. This approach uses the information contained in the first order condition of intermediate inputs to correctly identify inputs and hence the productivity measure (Gandhi, Navarro, and Rivers 2011), henceforth GNR.

The input-output relationship as developed by GNR (2011) takes the following time varying form:

$$Y_{it} = F_t(K_{it}, L_{it}, M_{it})e^{\nu_{it}}, \tag{1}$$

where: K_{it}, L_{it}, and M_{it} are capital, labor, and intermediate inputs used by firm i at year t, and ν_{it} is a Hicks neutral productivity parameter that can be decomposed into components

$$\nu_{it} = \omega_{it} + \varepsilon_{it}$$

with ω_{it} being a persistent productivity shock for firm i at year t. This is the component of productivity that is known to the firm while making input decisions but not observable to the econometrician. Meanwhile, ε_{it} is an ex-post shock realized after production decisions (not known to the firm and also not observable). Therefore:

$$E[\varepsilon_{it}|L_{it}, K_{it}, M_{it}] = 0.$$

Let's denote $\mathcal{E} = E[e^{\varepsilon_{it}}]$ and let the persistent shock follow a Markovian structure in its evolution. The current productivity shock depends on information from previous period, in the following way:

$$\omega_{it} = h(\omega_{it-1}) + \eta_{it},$$

where: η_{it} is the "innovation" to the firm's productivity and satisfies $E[\eta_{it}|\omega_{it-1}] = 0$. The intermediate input is assumed strictly monotone in ω_{it}

$$m_{it} = \mathcal{M}(\mathcal{I}_t) = \mathcal{M}(L_{it}, K_{it}, \omega_{it})$$

Labor and capital are assumed to be predetermined at or prior to period *t-1*, while the intermediate input is flexibly determined at period *t*. This implies that:

$$E[\eta_{it} + \varepsilon_{it}|L_{it}, K_{it}, L_{it-1}, K_{it-1}, M_{it-1}, \dots] = 0$$

The firm's profit maximization problem with respect to intermediate input will be:

$$\mathcal{M} = arg\,max P_t E[F(K_{it}, L_{it}, M_{it})e^{(\omega_{it}+\varepsilon_{it})}|\mathcal{I}_t] - \rho_{it}M_{it} \tag{2}$$

The first order condition of this problem is

$$P_t \frac{\partial F}{\partial M_{it}}(K_{it}, L_{it}, M_{it})e^{\omega_{it}}\mathcal{E} = \rho_{it} \tag{3}$$

with $\mathcal{E} = E[e^{\varepsilon}_{it}]$. Taking logs of eq. (3) and (1) and taking their difference gives the share of intermediate input in output:

$$s_{it} = ln\mathcal{E} + lnG_t(K_{it}, L_{it}, M_{it}) - \varepsilon_{it}, \tag{4}$$

where: $G_t(K_{it}, L_{it}, M_{it}) = \frac{\partial F(K_{it},L_{it},M_{it})}{\partial M_{it}} \frac{M_{it}}{F(K_{it},L_{it},M_{it}}$ is the elasticity of the production function with respect to intermediate inputs, and $s_{it} = ln(\frac{\rho_{it}M_{it}}{P_{it}Y_{it}})$ is the share of expenditure on intermediate input in total value of output. Equation 4, which GNR call the share regression identifies the elasticity w.r.t inputs upto a constant and the ex-post shock. It forms the basis for the first stage estimation of the production function.

The intermediate input elasticity also defines a partial differential equation that can be integrated up to identify the part of the production function related to the intermediate input and a constant. By the fundamental theorem of calculus we have

$$\int \frac{G_t(K_{it}, L_{it}, M_{it})}{M_{it}} dM_{it} = lnF_t(K_{it}, L_{it}, M_{it}) + \mathscr{C}(K_{it}, L_{it}). \tag{5}$$

Subtracting eq.(5) from the production function and re-arranging we get:

$$\mathscr{R} = lnY_{it} - \int \frac{G_t(K_{it}, L_{it}, M_{it})}{M_{it}} dM_{it} - \varepsilon_{it} = -\mathscr{C}(K_{it}, L_{it}) + \omega_{it}. \tag{6}$$

Notice that $\mathscr{R}$ is observable as it is a function of data and elasticity and ex-post shocks which are recoverable in the first stage.

Applying the Markov Structure on productivity changes forms the basis for the second stage estimation

$$\mathscr{R} = -\mathscr{C}(K_{it}, L_{it}) + h(\mathscr{R}_{it-1} + \mathscr{C}(K_{it-1}, L_{it-1}) + \eta_{it}. \tag{7}$$

To operationalize this estimation procedure GNR show that we need to approximate the non-parametric functional forms of the elasticity expression, the integration component, and the constant of the integration using second order polynomial series approximation. Then we can easily use a standard sieve GMM estimation to identify the labor, capital, and hence productivity using the following moment condition.

$$E[\eta_{it}|K_{it}, L_{it}, K_{it-1}, L_{it-1}, \mathscr{R}_{it-1}] = 0 \tag{8}$$

Our procedure following GNR uses a non-linear least square regression for a log polynomial approximation of equation (4), estimates equation (5) using second order polynomial approximation, and then recover the capital and labor coefficients using the moment condition in equation (8).

4 Data and Estimation Method

4.1 Data

The data used in this study comes from a census of medium and large manufacturing firms in Ethiopia between 2000 to 2009 collected by the Central Statistics Agency (CSA). These are firms that employ 10 or more people. We have 738 firms in 2000 that satisfy this definition, and they increase to 1947 in 2009. Import tariff rates for the manufacturing sector are obtained from the World Integrated Trade Solution (WITS) website at HS 8-digit level, which is later aggregated at 2-digit HS level to match with the firm level data from CSA that categorizes firms using a 4-digit International Standard Industry (ISIC) code.

The firm level dataset contains information on value of output, number of permanent employees, capital (fixed assets), raw material and energy costs that will allow us to estimate the production function using the model we suggested in section 3. It also contains data for different firm characteristics such as ownership (foreign or domestic and private or public), value of export revenue (making it possible to identify exporters), and year of establishment that we make use of to analyze the effect of trade liberalization on firm productivity.

Table 2 below shows the number of firms we have in each industry (2-digit ISIC) across time. The major industries are food and beverage, furniture, glass and non-metallic minerals, metal products, rubber and plastics, leather tanning and footwear, textile, and apparel. We observe more concentration of firms in Food and Beverage, Glass and Non-metallic Minerals, Furniture, and Metal Products. Although we observe a high degree of entry and exit of firms from the data, we have in general a net increase in the number of firms over the years on net basis with the exception of Machinery and Appliances sub-sector where there are fewer firms by the end of 2009 compared to 2000.

The degree of increase in number of new firms entering the market varies by industry, from 33% in Textile to 623% in Glass and Non-metallic Minerals.

Table 2: Total Number of Firms by Industry across time

Industry (2-digit ISIC)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Food and Beverage	213	219	266	272	294	213	334	346	439	484
Textile	33	31	34	36	38	38	42	41	25	44
Apparel	25	24	29	32	35	28	31	32	34	37
Leather Tanning and footwear	52	52	52	56	62	60	60	72	75	80
Wood Products	16	14	21	17	20	18	21	33	49	44
Paper and Paper Products	7	5	7	7	7	9	12	12	19	18
Publishing and Printing	56	46	66	66	66	68	74	81	92	87
Chemicals	39	36	41	45	45	51	52	64	70	69
Rubber and Plastics	27	27	37	39	42	47	63	64	80	82
Glass and Non-metalic Minerals	77	81	96	111	119	66	139	273	454	557
Basic Iron, Steel, and Casting	7	10	11	10	13	13	14	13	14	15
Metal Products	50	50	61	73	73	73	99	57	93	109
Machinery and appliances	13	7	7	9	9	6	8	4	3	4
Motor vehicles and accessories	9	6	6	7	7	8	10	42	14	12
Furniture	113	112	147	157	165	63	190	203	271	304
Total	738	721	882	938	996	762	1150	1338	1733	1947

4.2 Estimation

In order to estimate the impact of trade liberalization on productivity we use a regression difference-in-diffrence framework with time and industry dummies to control for unobserved macro-economic shocks and industry specific characteristics. In a first stage, we estimate productivity ν_{it}using the GNR method described above. Then we analyze how productivity changes due to tariffs. Let productivity be a function of tariffs in the following way:

$$\nu_{it} = \alpha Tariff_{jt} + \delta Time_t + \sigma Ind_j + \varepsilon_{it}. \tag{9}$$

Where ν_{it} is TFP of firm i at year t estimated by the GNR method, $Tariff_{jt}$ is the average tariff rate of industry j at year t, Ind_j is industry dummy which controls for time-invariant industry specific characteristics, and $Time_t$ is a time dummy that controls for unobserved macroeconomic shocks that affect all industries. We estimate equation(9) using panel methods with bootstrapped standard errors since our TFP variable is obtained using estimation.

We also use Quantile Regression (QR) to investigate the impact of tariff changes on three productivity percentile distributions (25th, 50th, and 75th). Given the productivity heterogeneity within an industry, QR is fitting to see how firms at different productivity levels respond to the same policy shock.

To identify the mechanism of firm exit either through direct (competition from cheaper imports) effects of trade liberalization or indirect (competition with domestic firms in improving productivity) effects, we estimate the following probit models,

$$Exit_{it} = \alpha Tariff_{jt} + \beta X_{it} + \varepsilon_{it} \tag{10}$$

$$Exit_{it} = \delta \nu_{jt-1} + \beta X_{it} + \varepsilon_{it} \tag{11}$$

$$Exit_{it} = \alpha Tariff_{jt} + \delta\nu_{jt-1} + \beta X_{it} + \varepsilon_{it} \quad (12)$$

where $Exit_{it}$ is an exit indicator(= 1) if firm i gets out of business at year t and X_{it} is a vector of controls such as firm age and age square, time, and industry dummies.

In order to investigate resource reallocation within industries, we use the dynamic Olley-Pakes productivity decomposition developed by Melitz and Polanec (2015) that takes into account the contribution of survivors, new firm entrants, and exiters to aggregate industry productivity. This decomposition method improves on the cross-sectional method of decomposing industry productivity by Olley and Pakes into a simple unweighted average of productivity and a covariance-term between productivity and market shares that captures resource reallocation among firms(Olley and Pakes 1996).Let the aggregate productivity in an industry ν_t^j be described as follows:

$$\nu_t^j = \bar{\nu}_t^j + cov(s_{it}, \nu_{it}) \quad (13)$$

$$\nu_t^j = \bar{\nu}_t^j + \sum_{i \epsilon j}(s_{it}^j - \bar{s}_t^j)(\nu_{it}^j - \bar{\nu}_t^j)$$

where s_{it}^j is the share of output of firm i at year t in industry j, $\bar{s}_t^j$ is the output share of the average firm at year t and in industry j, ν_{it}^j is productivity of firm i at year t in industry j, and $\bar{\nu}_t^j$ is the average unweighted productivity of industry j and year t.

The aggregate industry productivity at any period time can be written as a function of the aggregate market share and productivity of three groups of firms, namely: survivors, entrants, and exiters (Melitz and Polanec 2015).

$$\nu_t = s_S\nu_S + s_X\nu_X + s_E\nu_E \quad (14)$$

Since the sum of the market shares sum to 1 at any given period, we can re-arrange equation 14 to yield,

$$\nu_t = \nu_S + s_X(\nu_X - \nu_S) + s_E(\nu_E - \nu_S),$$

where s is the aggregate market share of survivors(S), Exiters(X), and Entrants(E). Since market share of entrants in the first period and exiters in the last period is zero, we can write:

$$\nu_1 = \nu_{S1} + s_{X1}(\nu_{X1} - \nu_{S1})$$
$$\nu_2 = \nu_{S2} + s_{E2}(\nu_{E2} - \nu_{S2}).$$

We can then calculate the change in productivity between the two periods as a function of these components and apply the Olley-Pakes decomposition as in equation (13) for the survivors. Since we measure productivity in logs, the difference will give us the percentage change in productivity.

$$\begin{aligned}\Delta\nu &= \nu_{S2} - \nu_{S1} + s_{E2}(\nu_{E2} - \nu_{S2}) + s_{X1}(\nu_{S1} - \nu_{X1}) \\ &= \Delta\bar{\nu}_s + \Delta cov_s + s_{E2}(\nu_{E2} - \nu_{S2}) + s_{X1}(\nu_{S1} - \nu_{X1})\end{aligned} \tag{15}$$

The first line in equation 15 gives the change in aggregate productivity of survivors, exiters, and entrants. The second line follows the decomposition by Olley-Pakes for the surviving groups to calculate the shift in productivity distribution over time (unweighted mean change in productivity) and market share reallocation (covariance term).

5 Results

5.1 Productivity Heterogeneity

As we discussed in the theory section, our production function estimates vary across time and firm, essentially producing a distribution of input elasticity and productivity for each firm. While these are not the main focus of this work, they provide a useful was of demonstrating the heterogeneity of production in Ethiopian manufacturing. Table 3 below shows estimates from the GNR production function estimation. It presents the average elasticity of inputs for firms for selected industries with 2-digit ISIC classifications along with their standard errors. We also show the factor intensity of inputs for each industry, which is a simple ratio of the elasticity of capital to labor, and the sum of elasticities as a measure of returns to scale.

We observe that overall, the manufacturing sector has constant returns to scale but the result varies by sector. The elasticity of capital does not vary by much from sector to sector, which on average is 0.2. Most of the variation across sectors is in the elasticity of labor and intermediate inputs. Labor input elasticities range from a low of 0.37 in Food and Beverage to 0.5 in Textile while the intermediate input elasticity ranges from 0.38 in textile and apparel to 0.47 in Chemicals industry. The capital intensity ratio shows that metal products, food and beverage, chemical, publishing and printing, and rubber and plastics have above industry average capital intensity.

Table 3: Elasticity Estimates

Industry (ISIC 2 digit)	Elasticity	mean	se
Food and Beverage (15)	Labor	0.37	0.12
	Capital	0.18	0.07
	Intermediate	0.45	0.11
	Sum	1.01	0.11
	Capital Intensity (K/L)	0.51	1.22
Textile (17)	Labor	0.50	0.18
	Capital	0.18	0.09
	Intermediate	0.38	0.15
	Sum	1.06	0.14
	Capital Intensity (K/L)	0.39	0.32
Apparel (18)	Labor	0.49	0.14
	Capital	0.19	0.07
	Intermediate	0.38	0.10
	Sum	1.05	0.12
	Capital Intensity (K/L)	0.41	0.18
Basic Iron and steel and casting metals (27)	Labor	0.27	0.14
	Capital	0.18	0.04
	Intermediate	0.60	0.13
	Sum	1.05	0.05
	Capital Intensity (K/L)	0.93	5.36
Furniture (36)	Labor	0.39	0.09
	Capital	0.17	0.06
	Intermediate	0.40	0.08
	Sum	0.96	0.10
	Capital Intensity (K/L)	0.44	0.20
Total	Labor	0.39	0.12
	Capital	0.18	0.06
	Intermediate	0.43	0.11
	Sum	1.00	0.11
	Capital Intensity (K/L)	0.46	3.92

Table 4 below summarizes the productivity(TFP) statistics for each firm the same way we recover the elasticity estimates. We measure productivity dispersion within industry by reporting the ratio of percentiles of the productivity measure. The results show that there is a lot of heterogeneity in productivity across firms within an industry. The firm that is on the 75 percentile distribution of productivity is on average twice as productive than firm on the 25th percentile distribution. The 90/10 ratio varies from a low 2.8 for furniture to a high of approximately 4 in textile. There is a high productivity heterogeneity in both the textile and apparel sector, where the most productive firms can produce 5 or 6 times more than the lower productive firms using the same amount of inputs. The lowest heterogeneity is found in furniture. The ranges of values of this ratios in different sectors also indicates the presence of heterogeneity not only across firms within a sector but also across sectors.

Table 4: Productivity Percentile ratios showing dispersion within industry

ISIC 2 Digit classification	**Productivity Ratio**	**mean**
Food and Beverage (15)	75/25	1.80
	90/10	3.02
	95/5	4.13
Textile (17)	75/25	2.04
	90/10	3.96
	95/5	5.82
Apparel (18)	75/25	1.84
	90/10	3.24
	95/5	5.02
Leather Tanning and footwear (19)	75/25	1.70
	90/10	2.95
	95/5	3.93
Metal Products (28)	75/25	1.79
	90/10	3.31
	95/5	4.85
Furniture (36)	75/25	1.71
	90/10	2.81
	95/5	3.78
Total	75/25	1.79
	90/10	3.05
	95/5	4.21

5.2 Effects of trade liberalization on Productivity

Table 5 below presents the results from estimation of the model in equation (9) for the effects of tariffs on firm productivity. Bootstraped standard errors after 100 replication are reported in parenthesis. The results tell us that tariff reduction is negatively correlated with a firm's productivity as expected from theory: lowering tariff protection increases productivity. The tariff coefficient shows that a 10 percentage point reduction in tariff rates will lead to approximately a 2% improvement in productivity on average across all firms in the sample.[1]

Table 5: Effect of Tariff on productivity(log scale)

	(1)
VARIABLES	Panel Fixed Effect
Tariff	-0.00161*
	(0.000930)
Time Effect	Yes
Industry Effect	Yes
Constant	6.007***
	(0.0294)
Observations	10,289
R-squared	0.105

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Controls: Time and Industry Dummies

In table 6, we report results from a quantile regression specification using three different percentile cutoffs, 25th, 50th, and 75th percentiles. The table contains results from four different specifications which include only tariff, additional time or industry dummies, and both time and industry dummies. This result from all four specifications

[1]Using an estimated dependent variable could potential lead to high variance of estimates which might cast doubt on our inference. We have, therefore, used feasible generalized least squares (FGLS) estimation technique as robustness check of the result we estimated. The result from the FGLS estimation is qualitatively the same and the magnitude of the coefficient on tariff is very close to the above estimate.

Table 6: Quantile Regression: Effect of Tariff on Productivity

VARIABLES	(1) Productivity	(2) Productivity	(3) Productivity	(4) Productivity
q25				
Tariff	-0.000110	-0.00607***	-0.00781***	-0.00552***
	(0.00186)	(0.000840)	(0.000632)	(0.00145)
Time Effect	Yes	Yes		
Industry Effect	Yes			Yes
q50				
Tariff	-0.00243**	-0.00491***	-0.00622***	-0.00724***
	(0.00121)	(0.000681)	(0.000647)	(0.000830)
Time Effect	Yes	Yes		
Industry Effect	Yes			Yes
q75				
Tariff	-0.00284***	-0.00401***	-0.00492***	-0.00686***
	(0.00102)	(0.000657)	(0.000566)	(0.000844)
Time Effect	Yes	Yes		
Industry Effect	Yes			Yes
Observations	10,289	10,289	10,289	10,289

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Time and Industry Dummies
Tariff

and firms in different quantiles of productivity distribution point to the same result we observed in table 5 - that lowering tariff leads to an increase in firm level productivity. Although the direction of the relationship between tariff and productivity is the same for all firms in the specified percentile distributions, the magnitude of the effect is different. Firms in the lower end of the productivity distribution show the most improvement after tariff reduction compared to those firms at the higher end of distribution (column 3) where we look at the simple tariff and productivity relationship. These apparent relationship tends to either decline or disappear for low productivity firms once we control for unobservable industry characteristics or both industry characteristics and macroeconomic shocks. The firms in the upper quantile of distribution experienced more productivity growth when we control for time and industry fixed effects (column 1). It is also interesting to note that the impact on firms at the median is similar to the result we obtained in table 5 which shows the impact of tariff on conditional mean of productivity.

Table 7: Impact of trade liberalization and productivity on firm decision to exit. Marginal effects from probit regression

VARIABLES	(1) Marginal Effect Exit	(2) Marginal Effect Exit	(3) Marginal Effect Exit
lag productivity	-0.0406***		-0.0407***
	(0.0105)		(0.0105)
Tariff		-0.000370	-0.000519
		(0.000965)	(0.000984)
Observations	5,612	6,139	5,612

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Controls Age
Age Square
Time and Industry Dummies

5.3 Effects of trade liberalization on Firm Exit

We estimated a probit model to measure the likelihood of firm exit given the level of firm productivity and the tariff changes. In table 7 above, we report the marginal effects from this probit regression[2]. We controlled for firm level characteristics such as age and its square in addition to unobservable time and industry effects. We found that there is no evidence for a decision by a firm to exit the industry due to changes in tariff per se, implying that increased competition from cheap imported goods is not a factor affecting

[2]We also estimated a linear probability model (LPM) and found qualitatively the same and quantitatively close result. The LPM estimates yield a co-efficient value of -0.033 on lag productivity, a mere 0.07 difference from probit model

firm exit. On the other hand we see that a firm decision to exit is significantly affected by its level of productivity. A 1% increase in productivity reduces the likelihood of exit decision by around 4%. Therefore, competition with domestic firms in adjusting to trade liberalization is more important than competition from cheaper imported goods when it comes to firm's decision to exit.

5.4 Resource Reallocation Within Industries

In order to show resource reallocation within industries, table 8 and 9 below present the aggregate productivity decomposition for the overall manufacturing sector and some selected industries within manufacturing following the model specified by equation (15) in section 3. The tables show the within and between productivity improvement for surviving firms followed by the contributions to aggregate productivity improvement by new firm entrants and exiters. The last column in both tables indicates the aggregate productivity change relative to the base year (2000), which is the sum the contribution by survivors (within and between), entrants, and exiters. Since these productivity changes are reported in logs, they can be interpreted as percentage changes.

Table 8: Aggregate Productivity Decomposition for Overall Manufacturing

Aggregate Productivity Decomposition relative to 2000						
T=1	T=2	Survivors	Covariance Term	Entrants	Exiters	Aggregate
2000	2001	-0.69	-3.81	-1.80	0.01	-6.29
2000	2002	0.39	-2.94	-1.10	-0.03	-3.68
2000	2003	1.16	-0.49	-0.82	0.00	-0.15
2000	2004	2.63	-6.43	-0.46	0.00	-4.26
2000	2005	5.30	-1.56	-0.41	0.00	3.34
2000	2006	4.97	-4.72	-0.04	0.00	0.21
2000	2007	5.63	-7.34	-0.56	-0.01	-2.27
2000	2008	6.19	-3.54	-0.58	0.00	2.07
2000	2009	6.51	10.02	-1.02	0.00	15.52

The aggregate productivity change for the overall manufacturing sector (table 8) registers a decline for the first four years before it starts to rise again and ends up 15.5% higher in 2009 relative to the productivity in 2000. We see a consistent increase in the within productivity improvement among the surviving firms indicating a shift in productivity over time. The covariance term that captures market share reallocations among the surviving firms indicates a negative correlation between market shares and productivity except in the final year. The contribution of new firm entrants to the aggregate productivity is also negative indicating that new firms do not necessarily have higher productivity compare to the surviving firms at the time of entry ($s_{E2}(\nu_{E2} - \nu_{S2})$). Exiters in general have lower productivity compare to survivors but their contribution towards aggregate productivity is approximately zero when the productivity change ($\nu_{S1} - \nu_{X1}$) is weighted by the low aggregate market share of exiters.

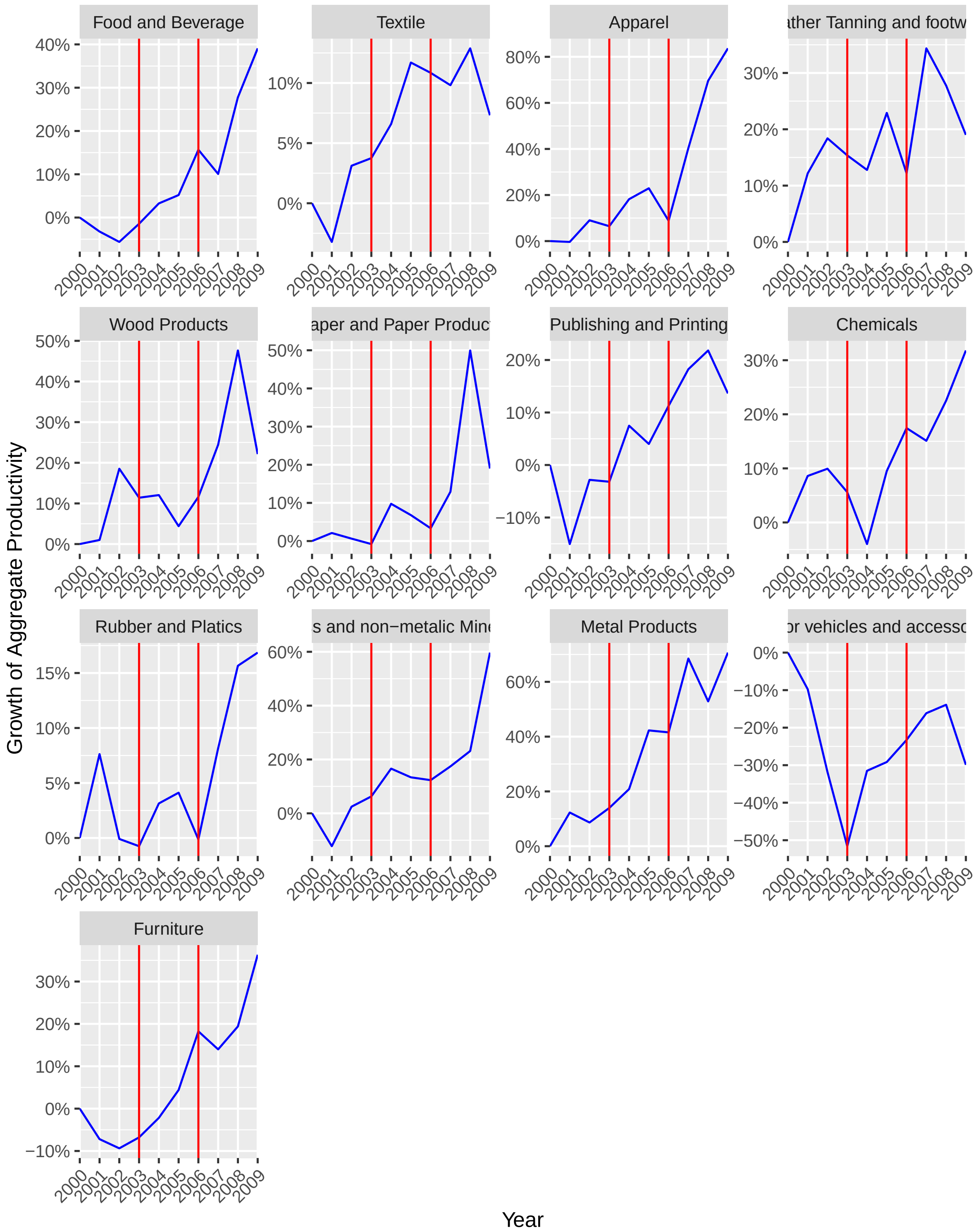
When we look at the data disaggregated by industry within manufacturing, we see some patterns that are similar to the story we see above for the overall manufacturing sector but there are also industries with a different pattern. The within firm improvement in productivity for survivors is also evident in all industries similar to the trend we see in overall manufacturing (table 9). The market share reallocation, however, tell us two opposite stories depending on which industry we are considering. We see a positive correlation between market shares and productivity in Food and Beverages, Apparel, Glass and Non-Metallic Minerals, and others indicating more productive firms producing more of the industry output as predicted by Melitz (2003). On the other hand, for industries such as Textile, Rubber and Plastics, and Furniture a negative covariance term shows that less productive firms still continue to produce more of the industry output. The Textile industry also experiences one of the large drops in tariff rates of approximately 20% between 2000 and 2009, which did not necessarily induce market reallocation among the survivors. The textile sector in Ethiopia still has large state owned enterprises that are not necessarily productive but are able to secure government contracts for part of their market. These state owned firms could be a factor in explaining the negative correlation between productivity and market share reallocation. Aggregate productivity for textile, Rubber and Plastics, and Furniture is also negative due to large negative covariance term for these industries. Figure 1 shows a graph of the overall changes in aggregate productivity for thirteen 2-digit ISIC industries.

Table 9: Aggregate Productivity Decomposition by Industry (2-digit ISIC)

Aggregate Productivity Decomposition relative to 2000							
Industry	T=1	T=2	Survivors	Covariance	Entrants	Exiters	Aggregate
Food and Beverage	2000	2009	10.02	17.74	-2.35	0.00	25.40
Textile	2000	2009	1.32	-12.57	1.69	0.00	-9.56
Apparel	2000	2009	30.07	28.89	1.03	0.00	60.00
Leather Tanning and footwear	2000	2009	6.84	6.43	-0.53	0.00	12.73
Wood Products	2000	2009	7.30	10.06	-3.87	0.00	13.49
Chemicals	2000	2009	14.08	4.85	-0.28	0.00	18.65
Rubber and Plastics	2000	2009	8.75	-18.13	-0.72	0.00	-10.09
Glass and non-metalic Minerals	2000	2009	3.41	33.08	-1.43	0.00	35.06
Furniture	2000	2009	1.88	-32.10	0.46	0.00	-29.76

There are some sectors that experience declines in productivity in early years, but mostly positive growth rates for most of the years. Entrant contributions to aggregate productivity are negative except for textile, apparel, and furniture industries. Exiter contributions are zero although we have evidence that the productivity of firms that are exiting is actually small compared to the surviving ones. Table 9 shows only the values for the beginning and last year of observations. A complete table that shows the trend for each year can be found in the appendix.

Figure 1: Growth rate of Aggregate Productivity
Growth.pdf



6 conclusion

This paper used a new production estimation technique that generates distributions of elasticity and productivity parameters that vary by time and industry to account for the heterogeneous productivity of firms in Ethiopian Manufacturing industry. A dynamic decomposition of aggregate industry productivity shows that we observe a shift in productivity distribution across time among surviving firms across all industries in manufacturing. While we observe reallocation of resources from low to high productive firms in some industries, we find misallocation in others as witnessed by the negative productivity and market share relationship. New firms that join industries also do not necessarily have higher productivity compared to firms that are already operating. Although the contribution of exiting firms towards aggregate industry productivity is negligible due to their lower market share weight, we have evidence that exiting firms have low level of productivity compared to surviving firms. In general, we found both within productivity improvement and selection effect as predicted by trade literature theory.

Trade liberalization in Ethiopia is shown to improve firm productivity, although the effect varies by the level of productivity prior to trade reform. Firms with relatively high level of productivity benefit the most from liberalization suggesting a differential benefit to globalization. Firms' decision to exit does not seem to be impacted directly due to competition from cheaper imports but through the indirect effect of tariff on productivity. We can concluded that domestic competition with other firms due to liberalization is a more important factor for exit decision rather than competition with cheaper imports from abroad.

The results from this paper indicate that trade liberalization measures are successful in improving average industry productivity although they are taken unilaterally without expecting reciprocal measures from trading partners. The existence of sectors where low productive firms produce a larger share of output represents a resource misallocation that needs to be addressed. There are barriers in some industries that prevent free movement of labor and capital which need to be identified.

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7 Appendix A

Table 10: Aggregate Productivity Decomposition by Industry (2-digit ISIC)

Industry	T=1	T=2	Survivors	Covariance	Entrants	Exiters	Aggregate
Food and Beverage	2000	2001	-1.71%	-1.12%	-0.83%	0.00%	-3.66%
	2000	2002	-1.62%	1.53%	-0.79%	0.00%	-0.88%
	2000	2003	-0.15%	2.79%	-0.15%	0.00%	2.49%
	2000	2004	1.78%	3.39%	-0.74%	0.00%	4.43%
	2000	2005	3.09%	3.05%	0.57%	0.00%	5.57%
	2000	2006	4.91%	5.48%	0.90%	0.00%	11.29%
	2000	2007	3.99%	0.31%	-0.51%	0.00%	3.79%
	2000	2008	8.89%	12.46%	-0.81%	0.00%	20.53%
	2000	2009	10.02%	17.74%	-2.35%	0.00%	25.40%
	2000	2001	4.28%	-2.29%	-1.94%	0.00%	0.06%
Textile	2000	2002	8.08%	2.03%	-0.21%	0.00%	9.91%
	2000	2003	9.70%	15.24%	0.51%	0.00%	25.45%
	2000	2004	9.81%	5.90%	-0.02%	0.00%	15.70%
	2000	2005	11.37%	0.24%	0.64%	0.00%	10.50%
	2000	2006	7.40%	-0.03%	0.91%	0.00%	8.28%
	2000	2007	8.12%	-2.29%	0.71%	0.00%	6.53%
	2000	2008	17.81%	1.95%	-1.50%	0.00%	18.26%
	2000	2009	1.32%	-12.57%	1.69%	0.00%	-9.56%
	2000	2001	-4.91%	0.21%	-6.82%	0.18%	-11.34%
Apparel	2000	2002	1.14%	5.58%	-1.86%	0.05%	4.91%
	2000	2003	-8.09%	-15.89%	0.00%	0.00%	-23.98%
	2000	2004	-1.46%	-15.53%	0.27%	0.00%	-16.73%
	2000	2005	8.81%	0.95%	-1.37%	0.00%	6.49%
	2000	2006	-3.55%	-16.61%	0.00%	-0.01%	-20.17%
	2000	2007	23.38%	12.71%	-4.09%	-0.29%	31.72%
	2000	2008	22.13%	10.55%	-4.90%	-0.24%	27.54%
	2000	2009	30.07%	28.89%	1.03%	0.00%	60.00%
	2000	2001	7.22%	11.82%	-3.67%	0.00%	15.37%
Leather Tanning and footwear	2000	2002	12.19%	13.60%	-0.65%	0.08%	25.23%
	2000	2003	8.45%	4.40%	-0.35%	0.01%	12.51%
	2000	2004	7.05%	-0.72%	-0.43%	0.00%	5.89%
	2000	2005	13.42%	16.05%	0.87%	0.00%	28.59%
	2000	2006	4.35%	-0.07%	-1.14%	0.00%	3.13%
	2000	2007	16.75%	17.74%	-0.59%	0.00%	33.91%
	2000	2008	11.66%	11.17%	0.09%	0.00%	22.91%
	2000	2009	6.84%	6.43%	-0.53%	0.00%	12.73%
	2000	2001	0.12%	-7.22%	-0.17%	0.12%	-7.15%
Wood Products	2000	2002	6.35%	0.44%	-3.27%	-1.63%	1.89%
	2000	2003	15.70%	16.11%	-11.58%	0.00%	20.23%
	2000	2004	14.18%	10.97%	-0.12%	0.00%	25.03%
	2000	2005	7.76%	8.15%	0.04%	0.00%	15.86%
	2000	2006	9.90%	9.38%	-3.15%	0.00%	16.13%
	2000	2007	6.48%	11.90%	2.51%	0.00%	20.89%
	2000	2008	5.17%	-2.86%	1.76%	0.00%	4.07%
	2000	2009	7.30%	10.06%	-3.87%	0.00%	13.49%

Table 11: Aggregate Productivity Decomposition by Industry (2-digit ISIC

Industry	T=1	T=2	Survivors	Covariance	Entrants	Exiters	Aggregate
	2000	2001	2.24%	-4.98%	0.00%	0.00%	-2.74%
Paper and Paper Products	2000	2002	0.28%	-16.54%	-1.04%	0.00%	-17.29%
	2000	2003	-1.36%	-29.31%	0.00%	0.00%	-30.67%
	2000	2004	1.95%	-20.76%	5.30%	0.00%	-13.52%
	2000	2005	1.82%	12.39%	2.51%	0.00%	8.06%
	2000	2006	6.16%	-23.94%	-0.22%	0.00%	-18.00%
	2000	2007	7.09%	-11.58%	0.46%	0.00%	-4.03%
	2000	2008	7.36%	6.61%	-0.75%	0.00%	13.22%
	2000	2009	6.43%	-7.87%	-0.04%	0.00%	-1.48%
	2000	2001	-5.19%	-6.14%	-0.14%	0.00%	-11.46%
Publishing and Printing	2000	2002	5.26%	6.80%	-0.63%	0.00%	11.43%
	2000	2003	5.05%	4.53%	-0.54%	0.01%	9.04%
	2000	2004	13.67%	6.80%	-0.02%	0.00%	20.44%
	2000	2005	10.01%	2.31%	0.12%	0.00%	7.82%
	2000	2006	14.68%	1.50%	0.08%	0.00%	16.26%
	2000	2007	17.47%	4.28%	-0.52%	0.00%	21.22%
	2000	2008	17.16%	7.06%	0.29%	0.00%	24.52%
	2000	2009	12.79%	-6.87%	-0.10%	0.00%	5.82%
Chemicals	2000	2001	5.63%	2.15%	2.67%	0.00%	10.45%
	2000	2002	7.03%	8.15%	-1.81%	0.00%	13.37%
	2000	2003	3.71%	4.12%	-0.81%	-0.02%	7.00%
	2000	2004	-0.94%	-12.05%	-0.18%	0.00%	-13.17%
	2000	2005	6.09%	4.25%	0.29%	0.00%	1.55%
	2000	2006	12.69%	2.06%	-0.80%	0.00%	13.95%
	2000	2007	9.72%	-0.92%	-0.47%	0.00%	8.33%
	2000	2008	10.34%	-0.40%	-1.10%	0.00%	8.84%
	2000	2009	14.08%	4.85%	-0.28%	0.00%	18.65%
	2000	2001	5.55%	6.13%	-1.06%	0.00%	10.63%
Rubber and Platics	2000	2002	1.04%	-0.41%	-2.01%	0.00%	-1.37%
	2000	2003	1.04%	-4.82%	-0.22%	0.00%	-4.00%
	2000	2004	1.35%	-20.22%	-1.94%	0.00%	-20.81%
	2000	2005	5.58%	4.19%	1.99%	0.00%	0.60%
	2000	2006	2.73%	-23.62%	-0.42%	0.00%	-21.31%
	2000	2007	7.64%	-14.56%	-0.93%	0.00%	-7.85%
	2000	2008	6.94%	-11.87%	-0.30%	0.00%	-5.23%
	2000	2009	8.75%	-18.13%	-0.72%	0.00%	-10.09%
	2000	2001	-6.69%	-21.94%	-0.34%	0.00%	-28.97%
Glass and non-metalic Minerals	2000	2002	2.00%	-6.12%	-1.50%	0.00%	-5.62%
	2000	2003	7.39%	6.31%	-4.71%	-0.01%	8.98%
	2000	2004	4.53%	-12.91%	-0.33%	0.00%	-8.72%
	2000	2005	3.75%	8.53%	0.09%	0.00%	4.87%
	2000	2006	2.63%	-11.53%	-0.28%	0.00%	-9.18%
	2000	2007	0.37%	-18.43%	-0.54%	0.00%	-18.60%
	2000	2008	0.39%	-18.45%	-0.41%	0.00%	-18.47%
	2000	2009	3.41%	33.08%	-1.43%	0.00%	35.06%

Table 12: Aggregate Productivity Decomposition by Industry (2-digit ISIC)

Industry	T=1	T=2	Survivors	Covariance	Entrants	Exiters	Aggregate
	2000	2001	14.55%	11.84%	0.77%	0.00%	27.16%
Basic Iron, steel, and casting	2000	2002	11.60%	18.21%	-1.67%	0.00%	28.14%
	2000	2003	8.98%	6.61%	-0.46%	0.00%	15.13%
	2000	2004	5.91%	-1.72%	1.44%	0.00%	5.63%
	2000	2005	12.01%	6.94%	2.40%	0.00%	16.55%
	2000	2006	13.83%	4.71%	0.00%	0.00%	18.55%
	2000	2007	15.04%	10.53%	0.00%	0.00%	25.57%
	2000	2008	16.60%	8.50%	-0.58%	0.00%	24.52%
	2000	2009	13.09%	19.09%	-0.93%	0.00%	31.25%
	2000	2001	2.10%	22.25%	0.20%	0.00%	24.55%
Metal Products	2000	2002	-0.52%	21.01%	1.07%	0.00%	21.56%
	2000	2003	2.48%	21.57%	-0.29%	0.00%	23.76%
	2000	2004	3.22%	11.11%	-0.32%	0.00%	14.01%
	2000	2005	8.36%	19.58%	1.13%	0.00%	29.07%
	2000	2006	7.52%	23.85%	-0.35%	0.00%	31.02%
	2000	2007	10.64%	23.16%	7.53%	0.00%	41.32%
	2000	2008	7.61%	37.22%	-0.66%	0.00%	44.16%
	2000	2009	3.10%	23.63%	0.13%	0.00%	26.85%
	2000	2001	-4.78%	-7.24%	0.00%	0.00%	-12.02%
	2000	2002	-13.66%	7.32%	0.86%	0.00%	-5.48%
Machinery	2000	2003	-11.45%	-7.11%	12.85%	0.00%	-5.71%
	2000	2004	3.02%	5.14%	0.00%	0.00%	8.16%
	2000	2005	8.77%	6.78%	0.00%	0.00%	15.56%
	2000	2006	8.62%	0.02%	-0.32%	0.00%	8.32%
	2000	2007	23.58%	6.92%	0.00%	0.00%	30.50%
	2000	2008	21.23%	-9.26%	0.00%	0.00%	11.98%
	2000	2009	20.39%	-8.58%	-0.30%	0.00%	11.52%
	2000	2001	-8.93%	-10.42%	0.00%	-0.01%	-19.36%
	2000	2002	-38.62%	-18.50%	0.00%	0.00%	-57.11%
Motor vehicles and accessories	2000	2003	-60.80%	-46.07%	-0.08%	0.00%	-106.94%
	2000	2004	-32.49%	-39.61%	-0.44%	0.00%	-72.54%
	2000	2005	27.64%	35.44%	0.23%	0.00%	63.30%
	2000	2006	-15.42%	-46.66%	0.00%	0.00%	-62.09%
	2000	2007	-0.85%	-19.66%	-3.83%	0.00%	-24.35%
	2000	2008	-6.25%	-34.27%	-0.32%	0.00%	-40.84%
	2000	2009	-20.59%	-11.21%	-0.04%	0.00%	-31.83%
	2000	2001	-2.42%	-19.94%	-6.70%	0.00%	-29.06%
Furniture	2000	2002	-6.39%	-36.96%	-2.10%	0.00%	-45.45%
	2000	2003	-5.05%	-24.39%	-0.10%	0.00%	-29.54%
	2000	2004	-3.23%	-31.50%	-0.74%	0.00%	-35.47%
	2000	2005	5.54%	46.70%	0.70%	0.00%	-52.94%
	2000	2006	1.09%	-30.21%	-0.60%	0.00%	-29.72%
	2000	2007	0.34%	-33.32%	-2.46%	0.00%	-35.43%
	2000	2008	1.40%	-26.60%	-0.67%	0.00%	-25.87%
	2000	2009	1.88%	-32.10%	0.46%	0.00%	-29.76%