Do firms benefit from quality-related training activities?

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Research question and key findings

Research question

What is the impact of attending quality-related training activities / investing in quality control services, on firms’ certification status, exporter status and performance outcomes?

Key findings

1. Treatment helps firms acquire and retain internationally recognised quality certifications (IRQCs)

2. Treatment helps firms acquire and retain their exporter status

3. Larger firms are more likely to see positive outcome 1

4. Treatment improved firms’ sales and increased their size, however, had no effect on productivity, capacity utilization or export values
A refresh on the role of standards in trade
A refresh on the role of standards in trade

Standards are essential to international trade and value chains

Plenty of literature points to benefits of holding quality certificates:

Terlaak & King, 2006:
- Certified facilities in value chains grow faster than non-certified facilities
- Effect is bigger in advertising intensive industries

Otsuki, 2011:
- ISO certification increased the share of exports in sales by 45%

Goedhuys & Sleuwenagen 2016:
- Certified firms are more likely to export, and to export on a larger scale
  - Increased productivity
  - Reduced transaction costs
    - Stronger effect in counties with weak institutions
A refresh on the role of standards in trade

• But, getting certified is no easy job:
  1. Select standard;
  2. Implement required changes;
  3. Prove compliance; and;
  4. Pay for the certificate.

• Quality trainings and quality management services can help
  ➢ Global ISO certification market valued at $12 billion
  ➢ Global market for all types of certifications is likely to be much higher

• But, how effective are such services?
  ➢ No empirical evidence showing that quality-related trainings effectively increase firms’ probability to become certified or to start exporting
The data and our model specification
The data

Source: World Bank Enterprise Surveys

Panel data: 2006 & 2010
Countries: 14
Size of dataset: 19,646 obs.
- 10,430 obs. in 2006 surveys
- 9,216 obs. in 2010 surveys
✓ 6,226 obs. in 2006 & 2010 surveys

3,113 firms
Defining treatment

“Over the last three years, did this establishment use any services or programs to improve quality control or training to obtain quality certification?”

(World Bank Enterprise Surveys, 2010)

Treatment = Participation in quality-related business trainings between 2007 and 2009

\[
\begin{align*}
    \text{Treat}_i = 1 & \quad \text{if the firm participated} \\
    \text{Treat}_i = 0 & \quad \text{if the firm did not participate}
\end{align*}
\]
DiD OLS regression model

Testing the effect of being treated on several outcome variables:

\[ Y_{it} = \alpha + \beta_1 Treat_i + \beta_2 Time_t + \beta_3 (Treat_i * Time_t)_{it} + \beta_4 X_{it} + \gamma_j + \gamma_s + \varepsilon_{it} \]

Where:
- \( Y_{it} \) is the binary outcome variable which states whether a firm holds an IRQC or is an exporter.
- \( Treat_i \) is the treatment dummy which controls for time-invariant differences between the treated and non-treated groups.
- \( Time_t \) is the time dummy which gives the time evolution of the control group.
- \( Treat_i * Time_t \) is the average effect of treatment on the treated group.
- \( X_{it} \) is a vector of firm level controls set to 2006 values.
- \( \gamma_j, \gamma_s \) are country and sector fixed effects.
The Results
## Regression results

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Certification status (Gain certification)</th>
<th>Certification status (Retain certification)</th>
<th>Export status (Become exporter)</th>
<th>Export status (Remain exporter)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
<td>Model 4</td>
</tr>
<tr>
<td>Treat</td>
<td>0.000 (0.000)</td>
<td>0.000 (0.000)</td>
<td>0.000 (0.000)</td>
<td>0.000 (0.000)</td>
</tr>
<tr>
<td>Time</td>
<td>0.031*** (0.009)</td>
<td>-0.612*** (0.066)</td>
<td>0.060*** (0.008)</td>
<td>-0.428*** (0.039)</td>
</tr>
<tr>
<td>Treat*Time</td>
<td>0.250*** (0.019)</td>
<td>0.380*** (0.060)</td>
<td>0.057*** (0.018)</td>
<td>0.211*** (0.034)</td>
</tr>
<tr>
<td>Ln(Firm size) (2006)</td>
<td>-0.000 (0.004)</td>
<td>0.023 (0.021)</td>
<td>0.017*** (0.006)</td>
<td>0.004 (0.010)</td>
</tr>
<tr>
<td>Ln(sales) (2006)</td>
<td>0.006 (0.004)</td>
<td>-0.003 (0.011)</td>
<td>-0.001 (0.004)</td>
<td>0.008 (0.006)</td>
</tr>
<tr>
<td>Manager’s Experience (2006)</td>
<td>-0.001** (0.000)</td>
<td>0.000 (0.001)</td>
<td>-0.000 (0.000)</td>
<td>-0.001 (0.001)</td>
</tr>
<tr>
<td>Locality (2006)</td>
<td>0.011 (0.007)</td>
<td>0.009 (0.025)</td>
<td>-0.009 (0.010)</td>
<td>-0.049* (0.027)</td>
</tr>
<tr>
<td>Firm age (2006)</td>
<td>-0.000 (0.000)</td>
<td>-0.001 (0.000)</td>
<td>-0.000* (0.000)</td>
<td>-0.000 (0.000)</td>
</tr>
<tr>
<td>Exporter status (2006)</td>
<td>0.037*** (0.013)</td>
<td>0.059*** (0.021)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Certification status (2006)</td>
<td>-</td>
<td>-</td>
<td>0.027** (0.013)</td>
<td>0.026 (0.021)</td>
</tr>
<tr>
<td>Sector effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Country effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>0.000 (0.000)</td>
<td>1.000 (0.000)</td>
<td>0.000 (0.000)</td>
<td>1.000 (0.000)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,788</td>
<td>940</td>
<td>3,728</td>
<td>1,022</td>
</tr>
<tr>
<td>R2</td>
<td>0.2133</td>
<td>0.3017</td>
<td>0.1927</td>
<td>0.3253</td>
</tr>
</tbody>
</table>
Regression results - Graphically

Gaining certification

- Control: % certified
  - 3.1% at time 0
  - 28.1% at time 1

- Treated: % certified
  - 3.1% at time 0
  - 25.0% at time 1

Becoming exporter

- Control: % exporters
  - 6.0% at time 0
  - 11.7% at time 1

- Treated: % exporters
  - 6.0% at time 0
  - 5.7% at time 1

Retaining certification

- Control: % certified
  - 38.8% at time 0
  - 38.0% at time 1

- Treated: % certified
  - 38.8% at time 0
  - 38.8% at time 1

Remaining exporter

- Control: % exporters
  - 57.2% at time 0
  - 78.3% at time 1

- Treated: % exporters
  - 57.2% at time 0
  - 21.1% at time 1
The effectiveness of treatment as a function of firm size

As firm size increases, the probability that treatment results in the acquisition of an IRQC rises from about 15% to 40%

\[ y = 0.058 \ln(x) + 0.050 \]

\[ R^2 = 0.803 \]
Performance results
DiD OLS regression model

Testing the effect of being treated on several outcome variables:

\[ Y_{it} = \alpha + \beta_1 \text{Treat}_i + \beta_2 \text{Time}_t + \beta_3 (\text{Treat}_i \times \text{Time}_t)_{it} + \beta_4 X_{it} + \gamma_j + \gamma_s + \epsilon_{it} \]

Where:
- \( Y_{it} \), The natural logarithm of annual sales in thousands / the natural logarithm of the number of full-time employees
- \( \text{Treat}_i \), Treatment dummy which controls for time-invariant differences between the treated and non-treated groups
- \( \text{Time}_t \), Time dummy which gives the time evolution of the control group
- \( \text{Treat}_i \times \text{Time}_t \), The average effect of treatment on the treated group
- \( X_{it} \), A vector of firm level controls set to 2006 values
- \( \gamma_j, \gamma_s \), Country and sector fixed effects
### Regression results – Performance variables

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Model 1 (Sales (ln) No filtering)</th>
<th>Model 2 (Employment (ln) No filtering)</th>
<th>Model 3 (Sales (ln) Gained certification)</th>
<th>Model 4 (Sales (ln) Retain certification)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treat</td>
<td>0.032</td>
<td>0.035**</td>
<td>0.035</td>
<td>0.109</td>
</tr>
<tr>
<td>Time</td>
<td>0.420***</td>
<td>0.063</td>
<td>0.392***</td>
<td>0.712**</td>
</tr>
<tr>
<td>Treat*Time</td>
<td>0.197***</td>
<td>0.138***</td>
<td>0.257**</td>
<td>-0.149</td>
</tr>
<tr>
<td>Ln(Firm size) (2006)</td>
<td>0.229***</td>
<td>0.857***</td>
<td>0.223***</td>
<td>0.229***</td>
</tr>
<tr>
<td>Ln(sales) (2006)</td>
<td>0.783***</td>
<td>0.051***</td>
<td>0.791***</td>
<td>0.758***</td>
</tr>
<tr>
<td>Manager’s Experience (2006)</td>
<td>-0.001</td>
<td>-0.000</td>
<td>-0.001</td>
<td>-0.001</td>
</tr>
<tr>
<td>Locality (2006)</td>
<td>0.017</td>
<td>0.024</td>
<td>-0.007</td>
<td>0.160</td>
</tr>
<tr>
<td>Firm age (2006)</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Exporter status (2006)</td>
<td>-0.022</td>
<td>-0.032</td>
<td>-0.024</td>
<td>-0.007</td>
</tr>
<tr>
<td>Certification status (2006)</td>
<td>0.116**</td>
<td>0.029</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sector effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Country effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>0.705***</td>
<td>0.204***</td>
<td>0.711***</td>
<td>0.867***</td>
</tr>
<tr>
<td>Observations</td>
<td>4,860</td>
<td>5,146</td>
<td>3826</td>
<td>1,032</td>
</tr>
<tr>
<td>RMSE</td>
<td>0.864</td>
<td>0.875</td>
<td>0.844</td>
<td>0.841</td>
</tr>
</tbody>
</table>
The values in this plot were calculated by executing quantile regressions between percentiles of 0.05 and 0.95, in steps of 0.01. The solid line is the value of the DiD coefficient, transformed into a percentage sales increase. The dashed lines are the one standard deviation errors.
The values in this plot were calculated by executing quantile regressions between percentiles of 0.1 and 0.90, in steps of 0.05. The solid grey line is the value of the DiD coefficient, transformed into a percentage employment increase. The dashed grey lines are the one standard deviation errors. The solid red line is the value of the number of additional full-time employees due to treatment.
Robustness checks
PSM robustness checks

Idea of matching
• Matching groups of treatment and control group observations, based on a combination of their observable characteristics, allows one to calculate the counterfactual change in the treatment group if there were no treatment

Propensity Score Matching
• PSM collapses a vector of pre-treatment characteristics, $X$, into a single variable (i.e. the propensity score), and uses this as the matching estimator.
• By combining covariates into a single score, it can balance treatment and non-treatment groups without losing a large number of observations.

Propensity Score

$$T_{it} = \begin{cases} 1 \text{ if } \beta \cdot X_{it-1} + \gamma_j + \gamma_s + \epsilon_{it} > 0 \\ 0 \text{ otherwise} \end{cases}$$

Where:
• $T_{it}$ is a binary variable that defines whether firm $i$ received a quality-related training at time $t$
• $X_{it}$ is a vector of controls
• $\gamma_j$ and $\gamma_s$ are included as fixed effects
PSM robustness checks

Average effect of the treatment on the treated (ATT):

\[
\overline{\text{ATT}}(S) = \sum_{i \in T \cap S_P} \frac{1}{N^T} \left[ (Y(1)_{it} - Y(0)_{it-1}) - \sum_{j \in C \cap S_P} \omega_{ij} (Y(0)_{jt} - Y(0)_{jt-1}) \right]
\]

Where:
- \(Y(1)_{i}\) is the treatment outcome for treated firms, \(i\)
- \(Y(0)_{j}\) is the non-treatment outcome for unit \(j\) (comparison group)
- \(t\) is time
- \(T, C\) denotes the set of control units
- \(N^T\) is the number of treated firms
- \(S_P\) denotes the region of common support (e.g. the matching radius)
- \(\omega_{ij}\) is the weight used in the matching method (e.g. Kernel matching)

Matching methods:
- *Nearest Neighbour Estimation* uses only those control group observations that are closest to treated units
- *Kernel Matching* uses all control group observations, but weights each observation according to its distance from the treated unit. We use an epanechnikov weighting function.
PSM - Results

- For the first two specifications, PSM provides complementary evidence.
- For the last two, the errors are large, meaning that it neither confirms nor denies our regression based results.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Nearest Neighbour (1)</th>
<th>Nearest Neighbour (2)</th>
<th>Kernel (epanechnikov)</th>
<th>Bandwidth (epanechnikov)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaining an IRQC (t-stat)</td>
<td>0.24±0.02</td>
<td>0.23±0.02</td>
<td>0.25±0.02</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>(11.3)</td>
<td>(11.4)</td>
<td>(13.6)</td>
<td></td>
</tr>
<tr>
<td>Retaining an IRQC (t-stat)</td>
<td>0.40±0.07</td>
<td>0.41±0.06</td>
<td>0.39±0.05</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(6.1)</td>
<td>(6.8)</td>
<td>(7.3)</td>
<td></td>
</tr>
<tr>
<td>Becoming an exporter (t-stat)</td>
<td>0.024±0.021</td>
<td>0.026±0.0.018</td>
<td>0.036±0.015</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td>(1.1)</td>
<td>(1.45)</td>
<td>(2.3)</td>
<td></td>
</tr>
<tr>
<td>Remaining an exporter (t-stat)</td>
<td>0.060±0.064</td>
<td>0.071±0.057</td>
<td>0.079±0.054</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td>(0.9)</td>
<td>(1.25)</td>
<td>(1.5)</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions
Recap of main findings

Programmes to improve quality control or quality-related trainings help firms to:

- acquire IRQC (8.1 times more likely)
- retain their IRQC (2.1 times more likely)
- transition from non-exporter to exporter status (2.0 times more likely)
- retain their exporter status (37% more likely)
- larger firms are better able to translate treatment into positive outcomes
- increase sales, especially for smaller firms
- increase employment
Implications for managers

- Firm managers who choose to invest in quality management are more likely to see sales rise, as well as the size of their company expand.

- No indication on whether that investment was ‘worth it’.

- No evidence that treatment increased capacity utilization or productivity.

  - This may indicate that treatment mostly helped firms attract new customers or secure larger orders from existing ones.

- Presumably, the acquisition or retention of an IRQC is the main mechanism behind the increase in sales, not the training *per se*.
Implications for policymakers

• Investments in quality control and quality-related trainings lead to a variety of beneficial outcomes for these firms.

• However, treatment was much less effective for smaller firms. Why?
  - Lower absorptive capacities?
  - Limited financial resources?
  - Lower quality treatments?
  - Cheaper treatments selected?

• Policymakers may want to direct resources towards these firms with tailored quality management programmes and implementation support.
## Description of variables - 1

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Mean</th>
<th>Std. dev</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certification status</td>
<td>A binary variable equal to (1) if the firm had an internationally-recognized quality certificate, and (0) if it did not.</td>
<td>0.22</td>
<td>0.42</td>
</tr>
<tr>
<td>Export status</td>
<td>A binary variable equal to (1) if the firm is an exporter, and (0) if it is not. A firm is considered an exporter in our sample if 1% or more of its sales come from direct export.</td>
<td>0.22</td>
<td>0.41</td>
</tr>
<tr>
<td><strong>Independent variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat</td>
<td>A treatment dummy which controls for time-invariant differences between the treated and non-treated firms. The question asked was, “Over the last three years, did this establishment use any services or programs to improve quality control or training to obtain quality certification?”</td>
<td>0.44</td>
<td>0.50</td>
</tr>
<tr>
<td>Time</td>
<td>A time dummy which controls for time-variant differences between 2006 and 2010.</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Treat*Time</td>
<td>An interaction between the treatment and time dummies, which isolates the effect of being treated over time on an outcome variable. Put differently, the resulting coefficient can be interpreted as the average effect of being treated for the treated group.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Fixed effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sector</td>
<td>A two-step categorical variable indicating the sector the firm was operating in, in 2006: (1) is equal to manufacturing and (2) to services.</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### Description of variables - 2

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Mean</th>
<th>Std. dev</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Firm-level controls</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm size (2006)</td>
<td>The natural logarithm of the number of full-time employees in 2006.</td>
<td>3.46</td>
<td>1.39</td>
</tr>
<tr>
<td>Sales (2006)</td>
<td>The natural logarithm of annual sales for 2006 in thousands. Sales were converted from local currency to USD using the real annual exchange rate.</td>
<td>7.02</td>
<td>2.10</td>
</tr>
<tr>
<td>Firm age (2006)</td>
<td>A continuous variable, defined simply by the age of the firm in 2006.</td>
<td>26.1</td>
<td>20.6</td>
</tr>
<tr>
<td>Manager’s experience</td>
<td>A continuous variable, defined simply by the number of years of management experience the top manager has.</td>
<td>20.6</td>
<td>10.6</td>
</tr>
<tr>
<td>Size of locality</td>
<td>A binary variable indicating if the firm is situated in the capital city or a city of 1 million people or more (1), or a smaller locality (0).</td>
<td>0.76</td>
<td>0.43</td>
</tr>
<tr>
<td>Certification status</td>
<td>A binary variable equal to (1) if the establishment had an internationally-recognized quality certificate in 2006, and (0) if it did not.</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>Exporter status (2006)</td>
<td>A binary variable equal to (1) if the establishment is an exporter in 2006, and (0) if it was not. A firm is considered an exporter in our sample if it 1% or more of its sales come from direct export.</td>
<td>0.22</td>
<td>0.42</td>
</tr>
</tbody>
</table>