# Can Innovative Firms Create Jobs in Conflict-Affected Cities? Evidence from Africa and the Middle East

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- For most types of innovation: The answer is NO.
- Even more disheartening, while innovators are drivers of job creation in non-conflict areas. . .
- . . . these firms are the first to *shed* workers in conflict-affected areas.
- The impact of conflict on employment growth is most severe for innovative firms in Sub-Saharan Africa.
- Exception: *Process* innovators in low and lower-middle income countries exhibit resiliency and are job creators when faced with violence-induced disruption.

# Illustrative Matrix of Technological Capabilities (Lall 1992)

| | | INVESTMENT | | PRODUCTION | | | LINKAGES WITHIN ECONOMY |
|---|---|---|---|---|---|---|---|
| | | Pre-investment | Project Execution | Process Engineering | Product Engineering | Industrial Engineering | |
| DEGREE OF COMPLEXITY | **BASIC:** **Simple Routine** **(Experience-based)** | • Pre-feasibility and feasibility studies<br>• Site selection<br>• Scheduling of investment | • Civil construction<br>• Ancillary services<br>• Equipment erection<br>• Commissioning | • Debugging, balancing<br>• Quality control<br>• Preventive maintenance<br>• Assimilation of process technology | • Assimilation of product design<br>• Minor adaptation to market needs | • Work flow<br>• Scheduling<br>• Time-motion studies<br>• Inventory control | • Local procurement of goods and services<br>• Information exchange with suppliers |
| | **INTERMEDIATE:** **Adaptive, Duplicative** **(Search-based)** | • Search for technology source<br>• Negotiation of contracts<br>• Bargaining terms<br>• Information Systems | • Equipment procurement<br>• Detailed engineering<br>• Training and recruitment of skilled personnel | • Equipment stretching<br>• Process adaptation and cost saving<br>• Licensing new technology | • Product quality improvement<br>• Licensing and assimilating new imported product technology | • Monitoring productivity<br>• Improved coordination | • Technology transfer of local suppliers<br>• Coordinated design<br>• Science and technology links |
| | **ADVANCED:** **Innovative, Risky** **(Research-based)** | | • Basic process design<br>• Equipment design and supply | • In-house process innovation<br>• Basic research | • In-house product innovation<br>• Basic research | | • Turnkey capability<br>• Cooperative R&D<br>• Licensing own technology to others |

- **World Bank Enterprise Surveys (WBES)** conducted over the period 2010 to 2019 in Sub-Saharan Africa (SSA) and the Middle East and North Africa (MENA).
- The sampling design includes quotas for subnational regions, industry, and size to ensure sufficient observations for statistical analysis.
- Subnational stratification is defined in terms of the major cities and administration divisions with the largest commercial presence.
- Two distinct instruments are utilized in the field (based on ISIC Rev.3.1):
  1. Manufacturing (15-37)
  2. Services (45-74)

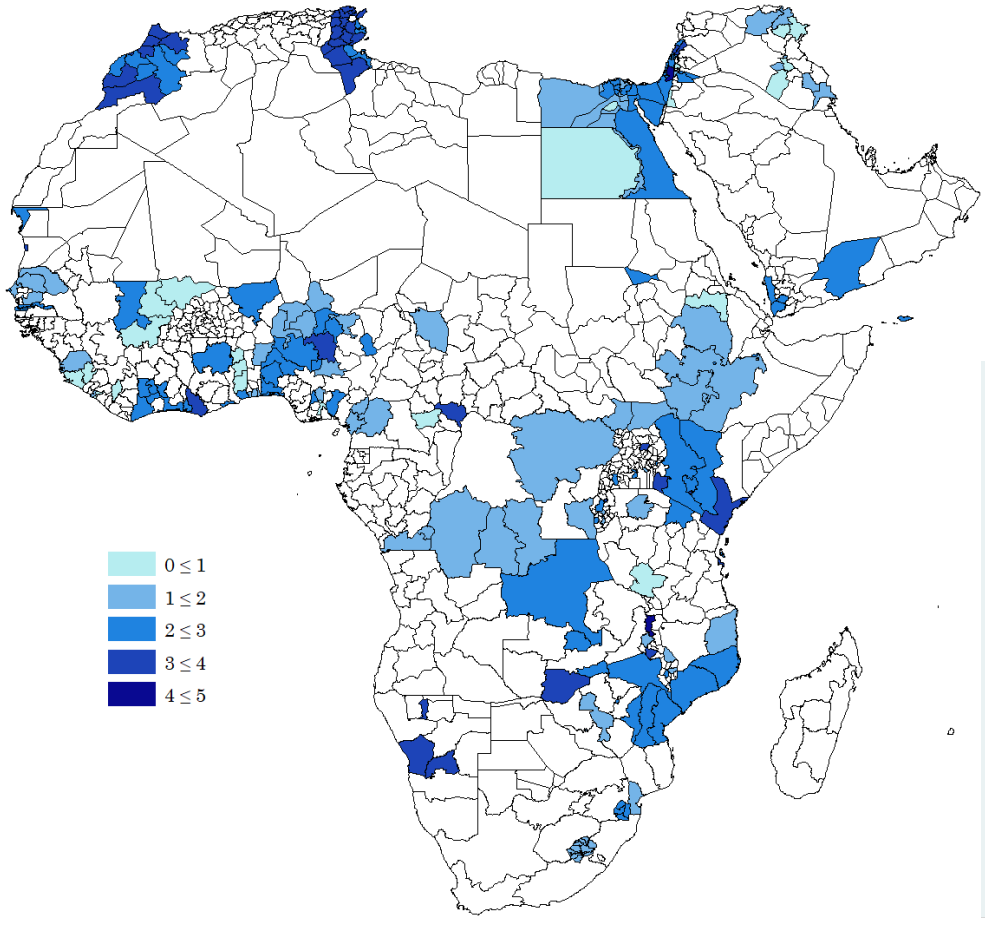
# Technological Capabilities Index (7 Activities)

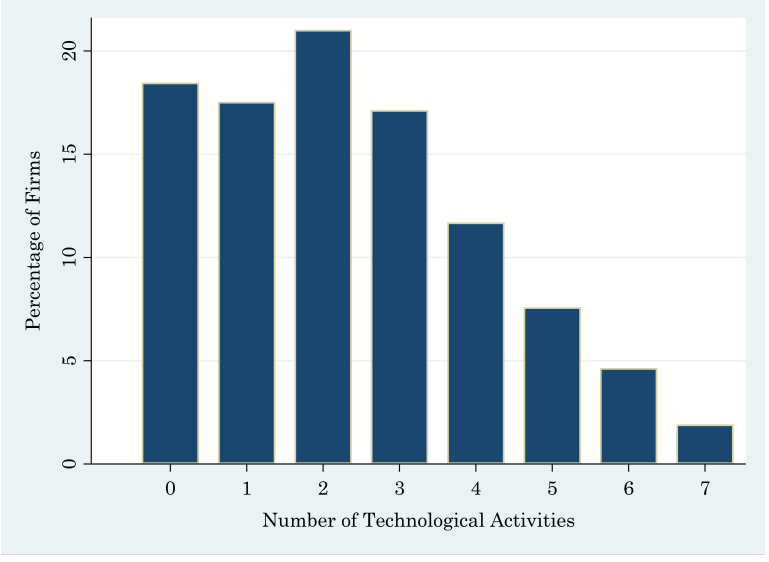
- The paper utilizes two analytical samples determined by the availability of technology and innovation variables.
- The first constructs TCI based on 7 core activities and has the widest coverage:
  - SSA: 13,141 enterprises operating in 125 administrative divisions in 32 countries
  - MENA: 7,560 enterprises operating in 68 administrative divisions in 10 countries
- The lower data requirements allow the regression analysis to exploit the greater variation and heterogeneity that can be found not only across the maximum number of conflict and non-conflict areas but also across income groups: Low vs. Lower-Middle vs Upper-Middle.

# Technological Capabilities Index (7 Activities)

| | | INVESTMENT | PRODUCTION | | | LINKAGES WITHIN ECONOMY |
|---|---|---|---|---|---|---|
| | | | Process Engineering | Product Engineering | Industrial Engineering | |
| DEGREE OF COMPLEXITY | BASIC | • Formal In-house Training<br>• R&D | • Process Innovation | • Product Innovation | • ISO Certification | • Email Customers<br>• Website Ownership |
| | INTERMEDIATE | | | | | |
| | ADVANCED | | | | | |

# Technological Capabilities Index (7 Activities)



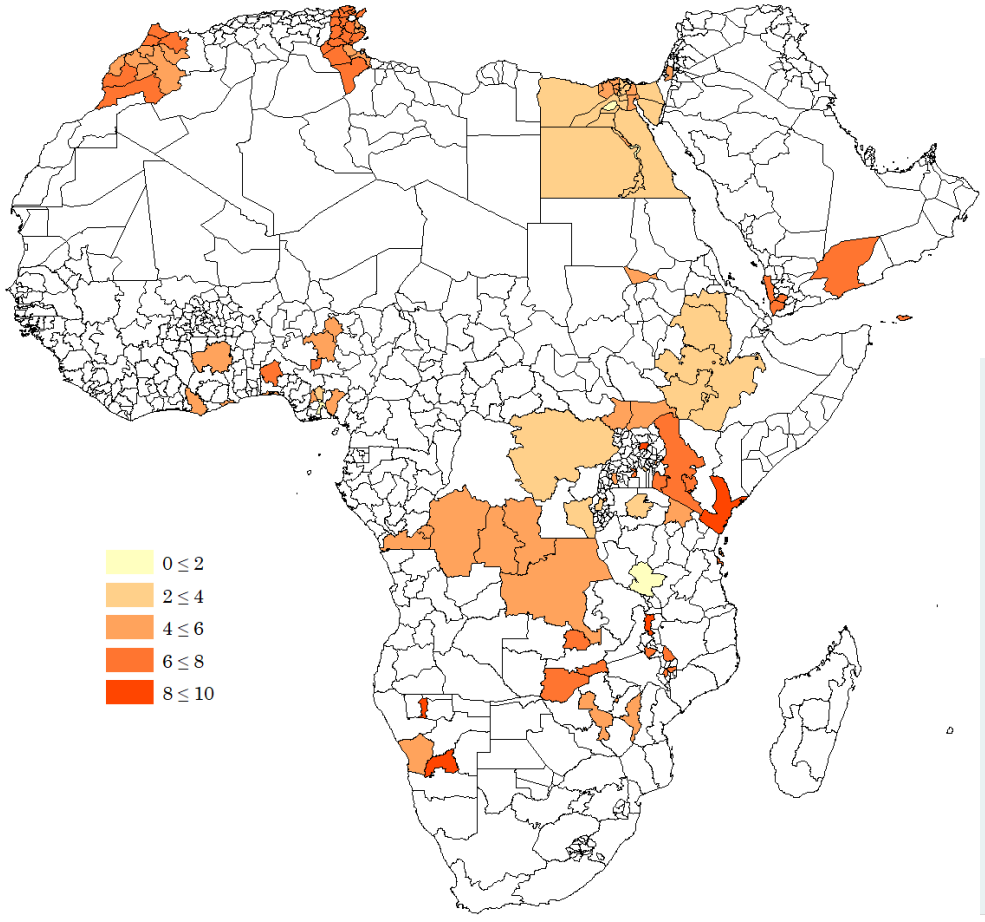
# Technological Capabilities Index (25 Activities)

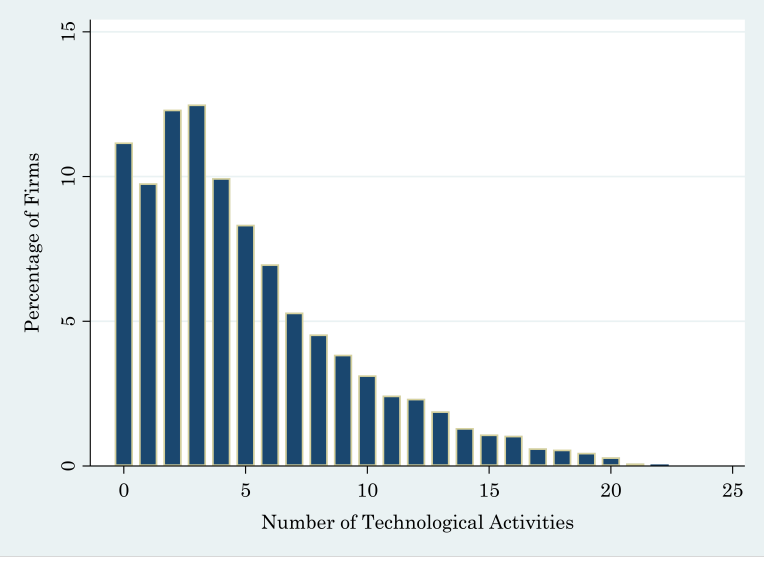
- **WBES Innovation Follow-up Survey** was conducted in 20 of the 32 countries.
- This second analytical sample consists of:
  - SSA: 5,126 enterprises operating in 62 administrative divisions in 14 countries
  - MENA: 3,873 enterprises operating in 37 administrative divisions in 6 countries
- The incorporation of 25 different innovative activities moves much closer to reflecting the complex idea of technological capabilities envisioned by Lall (1992).

# Technological Capabilities Index (25 Activities)

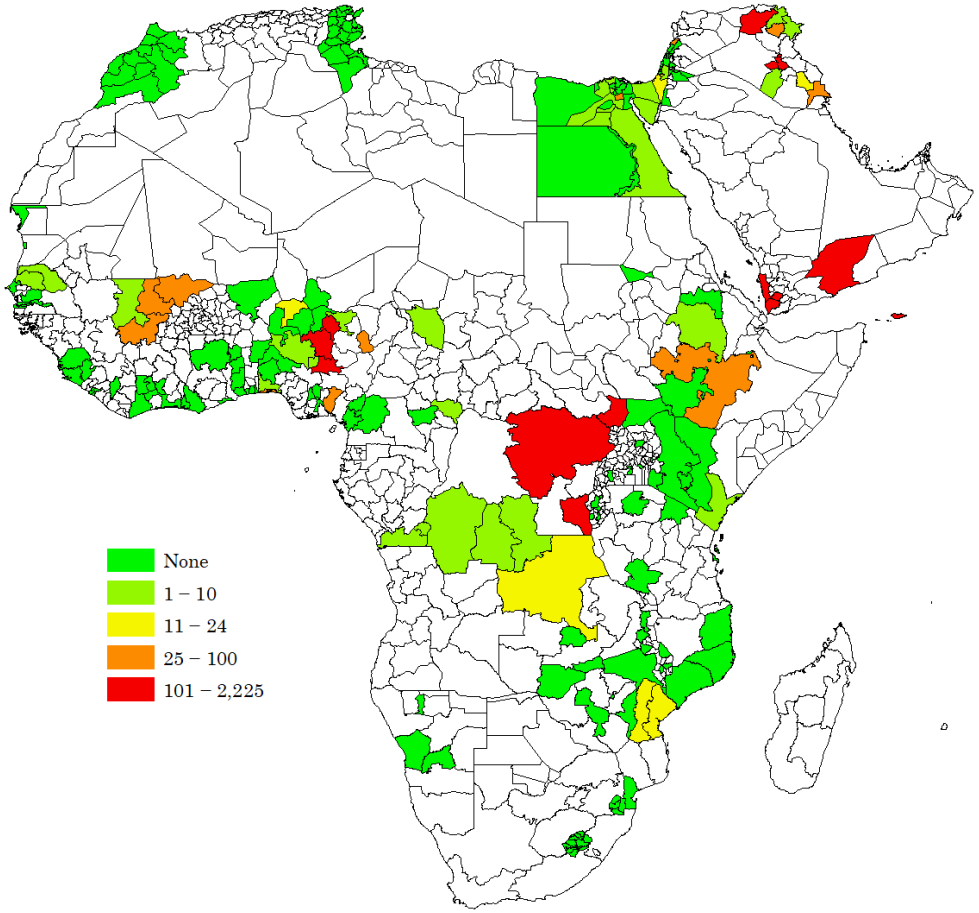
| | | INVESTMENT | PRODUCTION | | | LINKAGES WITHIN ECONOMY |
|---|---|---|---|---|---|---|
| | | | Process Engineering | Product Engineering | Industrial Engineering | |
| DEGREE OF COMPLEXITY | BASIC | • Formal In-house Training<br>• Internal R&D<br>• Training for R&D or Innovation<br>• Purchase New Equipment for Innovation<br>• Purchase or License Patents/ Knowledge for Innovation | • Process Innovation<br>• Two or More Process Innovations<br>• Originated Process Innovative Independently<br>• Process Innovation New to Local Market<br>• Process Innovation New to National or International Market | • Product Innovation<br>• New Product Represents More Than 50 Percent of Sales<br>• Originated Product Innovative Independently<br>• Product Innovation New to Local Market<br>• Product Innovation New to National or International Market | • ISO Certification<br>• Employees Use Computers Regularly for Job<br>• Use Internet to Manage Inventory<br>• Use Internet for Internal Communications<br>• Applied for Patent; Trademark; Utility Model; or Industrial Design | • Email Customers<br>• Website Ownership<br>• External R&D<br>• Most Important Source for Ideas: Suppliers; Consultancy Firms; Business Associations; Government; or Universities<br>• Innovation Funding from Government or NGOs |
| | INTERMEDIATE | | | | | |
| | ADVANCED | | | | | |

# Technological Capabilities Index (25 Activities)



# Total Number of Fatalities




**Uppsala Conflict Data Program (UCDP)** dyad-level data is first aggregated at the level of the first-order subnational administrative division (following ISO 3166-2) where the event took place and then summed over the respective number of WBES growth periods.

# Regression Specification

$$y_i = \alpha + \beta_1 Conflict_r \times Technology_i + \beta_2 Technology_i$$

$$+ \sum_j \beta_{3j} x_{ji} + \lambda_h + \lambda_r \times \lambda_s \times \lambda_t + \varepsilon_i$$

- Adapting the approach of Aterido, Hallward-Driemeier, and Pagés (2011), the regression analysis is based on the OLS estimation of the above equation.

## TCI Components (7 Activities)

Dependent Variable: Employment (Geometric) Growth Rate

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Pooled | SSA | MENA† | Low | Lower Middle | Upper Middle |
| Investment TCI | -0.091 | -0.259 | -0.060 | 0.362 | 0.497 | -6.334*** |
| × Conflict | (1.214) | (1.837) | (1.106) | (2.248) | (1.392) | (1.883) |
| Investment TCI | 1.116*** | 1.107** | 1.237*** | 1.672*** | 0.446 | 1.123*** |
| | (0.362) | (0.472) | (0.397) | (0.546) | (0.593) | (0.520) |
| Production TCI | 0.085 | -0.531 | 0.772 | -1.173 | 0.594 | -4.030** |
| × Conflict | (0.795) | (1.358) | (0.698) | (1.637) | (0.938) | (1.606) |
| Production TCI | 0.827*** | 0.786*** | 0.817*** | 1.142*** | 0.387 | 1.724*** |
| | (0.251) | (0.344) | (0.259) | (0.348) | (0.431) | (0.393) |
| Linkages TCI | -2.143*** | -3.486*** | -1.504** | 0.135 | -2.195*** | 3.255 |
| × Conflict | (0.706) | (1.308) | (0.712) | (0.735) | (0.792) | (2.494) |
| Linkages TCI | 1.147*** | 1.467*** | 0.670* | 1.771*** | 0.888** | 0.631 |
| | (0.298) | (0.411) | (0.353) | (0.457) | (0.448) | (0.514) |
| Observations | 20,701 | 13,141 | 7,560 | 6,769 | 11,714 | 1,766 |
| Number of Clusters | 411 | 273 | 138 | 154 | 211 | 38 |
| Adjusted $R^2$ | 0.126 | 0.110 | 0.153 | 0.156 | 0.116 | 0.127 |

*Notes*: Clustered standard errors are reported in parentheses.

## TCI-25 Components

Dependent Variable: Employment (Geometric) Growth Rate

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Pooled | SSA | MENA | Low | Lower Middle | Upper Middle |
| Investment × Conflict | 0.224 | 0.667 | -0.751 | -0.339 | 0.740 | |
| | (1.245) | (2.169) | (0.615) | (2.312) | (1.392) | |
| Investment | 0.402 | 0.374 | 0.396 | 1.052** | -0.117 | -0.150 |
| | (0.360) | (0.469) | (0.349) | (0.417) | (0.586) | (0.915) |
| Process Engineering | 1.590** | 3.441* | 0.803* | 1.548 | 1.658** | |
| × Conflict | (0.725) | (1.779) | (0.470) | (1.150) | (0.782) | |
| Process Engineering | -0.458 | -0.931** | -0.037 | -0.586 | -0.536 | 0.822* |
| | (0.278) | (0.456) | (0.279) | (0.697) | (0.345) | (0.438) |
| Product Engineering | -1.223** | -3.562** | -0.331 | -0.523 | -1.349** | |
| × Conflict | (0.618) | (1.370) | (0.387) | (0.960) | (0.655) | |
| Product Engineering | 0.465* | 1.077** | 0.079 | 0.597 | 0.644** | -0.296 |
| | (0.238) | (0.435) | (0.188) | (0.664) | (0.268) | (0.460) |
| Industrial Engineering | -0.640 | -1.251 | -0.069 | -0.320 | -0.460 | |
| × Conflict | (0.912) | (1.768) | (0.504) | (1.661) | (1.011) | |
| Industrial Engineering | 0.956*** | 0.862** | 0.981*** | 1.177** | 0.633 | 1.357* |
| | (0.304) | (0.398) | (0.325) | (0.449) | (0.453) | (0.638) |
| Linkages × Conflict | -2.297** | -6.052** | -0.285 | -3.316** | -2.212* | |
| | (1.120) | (2.732) | (0.546) | (1.402) | (1.190) | |
| Linkages | 0.988*** | 1.588*** | 0.274 | 1.788*** | 0.803 | -0.025 |
| Observations | 8,999 | 5,126 | 3,873 | 2,774 | 5,468 | 757 |
| Number of Clusters | 197 | 125 | 72 | 72 | 109 | 16 |
| Adjusted $R^2$ | 0.140 | 0.116 | 0.170 | 0.191 | 0.118 | 0.121 |

*Notes*: Clustered standard errors are reported in parentheses.

## Main Findings

- This paper provides evidence on the central role of technologically-capable enterprises in job creation and how conflict can severely disrupt that vital relationship.
- Results suggest market uncertainty triggered by conflict distorts firm-client, firm-firm, and firm-government transactions, leading to weakened business environments that can neither support collective learning nor create productive jobs.
- However, considerable heterogeneity in the relationship between employment growth and conflict is found across several types of innovative activities.

## Outlook

- Perhaps the most interesting and certainly the most hopeful findings are the signs of resiliency exhibited by process innovators in conflict-affected municipalities and regions of the poorest countries.
- Governments in conflict-prone municipalities and regions should endeavor to provide additional resources and guidance focused on process engineering capabilities, such as equipment stretching, preventative maintenance, and flexible logistics.
- Nonetheless, under normal circumstances, innovation via investment, product and industrial engineering, and linkages capabilities remain the best channels for firms to enhance productivity, innovate, and create jobs.

$$y_i = \alpha + \beta_1 Conflict_r \times Technology_i + \beta_2 Technology_i$$

$$+ \sum_j \beta_{3j} x_{ji} + \lambda_h + \lambda_r \times \lambda_s \times \lambda_t + \varepsilon_i$$

The average annual employment growth rate $y$ for firm $i$ is computed using the following geometric formula:

$$y_i = \left[ \exp \left( \frac{\ln \left( p_n / p_0 \right)}{n-1} - 1 \right) \right] \times 100$$

where $p_n$ and $p_0$ are the last and first observations of total full-time permanent employees in the period, and $n-1$ is equal to the number of growth years.

$$y_i = \alpha + \beta_1 Conflict_r \times Technology_i + \beta_2 Technology_i$$

$$+ \sum_j \beta_{3j} x_{ji} + \lambda_h + \lambda_r \times \lambda_s \times \lambda_t + \varepsilon_i$$

Observations with employment growth rate $y$ greater (less) than the mean plus (minus) three times the standard deviation of their respective peer group (formed by country, year, two-digit ISIC Revision 3.1 industry, and initial size category) are considered outliers and excluded from the analytical sample.

$$y_i = \alpha + \beta_1 \, Conflict_r \times Technology_i + \beta_2 \, Technology_i$$

$$+ \sum_j \beta_{3j} x_{ji} + \lambda_h + \lambda_r \times \lambda_s \times \lambda_t + \varepsilon_i$$

$Conflict_r$ is equal to 1 if the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths within the first-order subnational administrative division $r$ where firm $i$ operates over the duration of the growth period; and is equal to 0 otherwise, aligning with the standard definition established in the literature (Gleditsch et al. 2002; Sundberg and Melander 2013; Croicu and Sundberg 2017).

$$y_i = \alpha + \beta_1 Conflict_r \times Technology_i + \beta_2 Technology_i + \sum_j \beta_{3j} x_{ji} + \lambda_h + \lambda_r \times \lambda_s \times \lambda_t + \varepsilon_i$$

*Technology* is one of 11 different technology specifications for firm $i$ defined based the classification of Lall (1992).

$$y_i = \alpha + \beta_1 Conflict_r \times Technology_i + \beta_2 Technology_i + \sum_j \beta_{3j} x_{ji} + \lambda_h + \lambda_r \times \lambda_s \times \lambda_t + \varepsilon_i$$

$\sum_j x_j$ is a vector of characteristics for firm $i$.

The vector of firm characteristics $\sum_j x_{ji}$ includes:

- initial size dummy variables based on the number of permanent, fulltime workers in year $p_0$ for firm $i$: small (1-19); medium (20-99); and large (100 or more);
- age dummies variables categorized as startup (0-5 years), growing (6-10 years), and mature (more than 10 years);
- an exporter dummy variable indicating if firm $i$ exports any percentage of total sales;
- ownership dummy variables: domestic, foreign, and government;
- an index (with a range of 0 to 5) for the number of credit products that firm $i$ reports to have used: (a) overdraft facility; (b) line of credit or loan; (c) bank financing for working capital; (d) bank financing for investment; and (e) issuance of stock;

The vector of firm characteristics $\sum_j x_{ji}$ includes (*cont.*):

- a dummy variable indicating if firm $i$ has its annual financial statement checked and certified by an external auditor;
- a dummy variable indicating if firm $i$ is a subsidiary of a larger corporation;
- a dummy variable indicating if firm $i$ owns land; and
- a set of legal status dummy variables: (a) sole proprietorship; (b) publicly listed; (c) private limited liability; (d) partnership; and (e) limited partnership.

$$y_i = \alpha + \beta_1 Conflict_r \times Technology_i + \beta_2 Technology_i + \sum_j \beta_{3j} x_{ji} + \lambda_h + \lambda_r \times \lambda_s \times \lambda_t + \varepsilon_i$$

$\lambda_h$ represents a full set of dummies variables for industry defined at the two-digit ISIC Revision 3.1 level ranging from 15 (food products and beverages) to 74 (other business activities); and

$$y_i = \alpha + \beta_1 Conflict_r \times Technology_i + \beta_2 Technology_i + \sum_j \beta_{3j} x_{ji} + \lambda_h + \lambda_r \times \lambda_s \times \lambda_t + \varepsilon_i$$

$\lambda_r \times \lambda_s \times \lambda_t$ represents a full set of dummies variables for clusters formed by region, survey (i.e., manufacturing or services questionnaire), and year.

The number of region-survey-year clusters is 273 for SSA and 138 for MENA.

Standard errors are clustered by these groups.

## Pooled Sample

One additional **product engineering activity** is correlated with

- **Non-Conflict**: 0.5 percentage-point higher employment growth.
- **Conflict**: 0.8 percentage-point *lower* employment growth.

## Sub-Saharan Africa

One additional **product engineering activity** is correlated with

- **Non-Conflict**: 1.1 percentage-point higher employment growth.
- **Conflict**: 2.5 percentage-point *lower* employment growth.

## Pooled Sample

One additional **innovative linkage within the economy** is correlated with

- **Non-Conflict**: 1.0 percentage-point higher employment growth.
- **Conflict**: 1.3 percentage-point *lower* employment growth.

## Sub-Saharan Africa

One additional **innovative linkage within the economy** is correlated with

- **Non-Conflict**: 1.6 percentage-point higher employment growth.
- **Conflict**: 4.5 percentage-point *lower* employment growth.

## Pooled Sample

One additional **process engineering activity** is correlated with

- **Non-Conflict**: Not significant.
- **Conflict**: 1.3 percentage-point *higher* employment growth.

## Sub-Saharan Africa

One additional **process engineering activity** is correlated with

- **Non-Conflict**: 0.9 percentage-point *lower* employment growth (*Fodder for Luddites?*).
- **Conflict**: 2.5 percentage-point *higher* employment growth.

- Additional heterogeneity is revealed when analytical samples are separated by World Bank income groups.
- Innovation via linkages within the economy, such as cooperation with local suppliers or government-funded R&D, are negatively affected by conflict only for firms operating in poorer countries.
- In low-income countries, one additional linkages activity is correlated with 1.8 percentage-point higher employment growth in non-conflict areas, but 1.5 percentage-point lower employment growth for each additional linkages activity in conflict areas.

- Similarly, in lower-middle income countries, one additional linkages activity is correlated with $-1.4$ percentage-point employment growth for each additional linkages activity in conflict areas (no significance in non-conflict areas).
- These findings suggest that the poorest countries are hit the hardest by market uncertainty triggered by conflict, which severely distorts firm-client, firm-firm, and firm-government transactions that are crucial for innovation.

- In contrast, innovation via investment technological capabilities is negatively disrupted by conflict only in upper-middle countries; this relationship is not observed in other income groups.
- An additional investment activity is associated with 5.2 percentage-point lower employment growth in conflicted-affected areas. Specifically, formal in-house training is correlated with 1.4 percentage-point higher growth in non-conflict areas, but 4.1 percentage-point lower growth in conflict areas.
- Lastly, in stark contrast to low and lower-middle income countries, process innovation in upper-middle income countries is correlated with 1.5 percentage-point higher growth in non-conflict areas, but 0.7 percent lower growth in conflict areas.

- This paper develops the analytical tool of a **Technological Capabilities Index (TCI)** by methodologically mapping available data onto the taxonomy of firm-level innovation developed by Lall (1992): one capturing 7 activities and a second with 25.
- The main premise of Lall (1992) centers on the idea that innovation is *tacit*.
- That is, technological knowledge is difficult to embody in hardware or written instructions.

- Lall (1992) argues that firms cannot develop the capabilities needed to handle new technologies overnight.
- Enterprises cannot jump into completely new areas of competence simply by purchasing new machinery or licenses.
- Rather, Lall (1992) identifies three prerequisites for building firm-level technological capabilities.

## Investment

First, firms must proceed in an incremental manner, building on past investments in technological capabilities and moving from simple to complex activities.

## Production

Second, continuous innovation in both products and processes are crucial in achieving greater levels of productivity.

## Linkages

Lastly, firms rarely acquire technological capabilities in isolation, rather interaction and interdependence between economic agents leads to collective learning.

- For the analysis in this paper, both TCI and TCI-25 are necessary to enable a complete investigation into the ability of innovators to create jobs in conflict-affected cities.
- For example, comparison with upper-middle income countries can only be conducted using TCI (no conflict areas in the two upper-income countries that conducted the follow-up survey).
- On the other hand, TCI-25 is necessary in order to identify nuanced differences between process and product engineering across conflict and non-conflict areas.

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