# Going Deeper on Technology

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# Motivation

- Technology is central to most important economic issues
- Yet, much of our understanding is limited by measurement
- Traditional approach to measure technology (Ryan and Grossman, 1943, and Griliches, 1957) reflect the presence of a few (typically one) advanced technologies in the establishment.
- Three limitations
  - How do establishments produce if they do not have the advanced technology?
  - Small number of technologies relative to those involved in production
  - Ignores the intensive margin.

# Three steps to overcome these limitations

1. The Grid

2. The FAT dataset

3. Measures of technology sophistication

# GRID: General Business functions

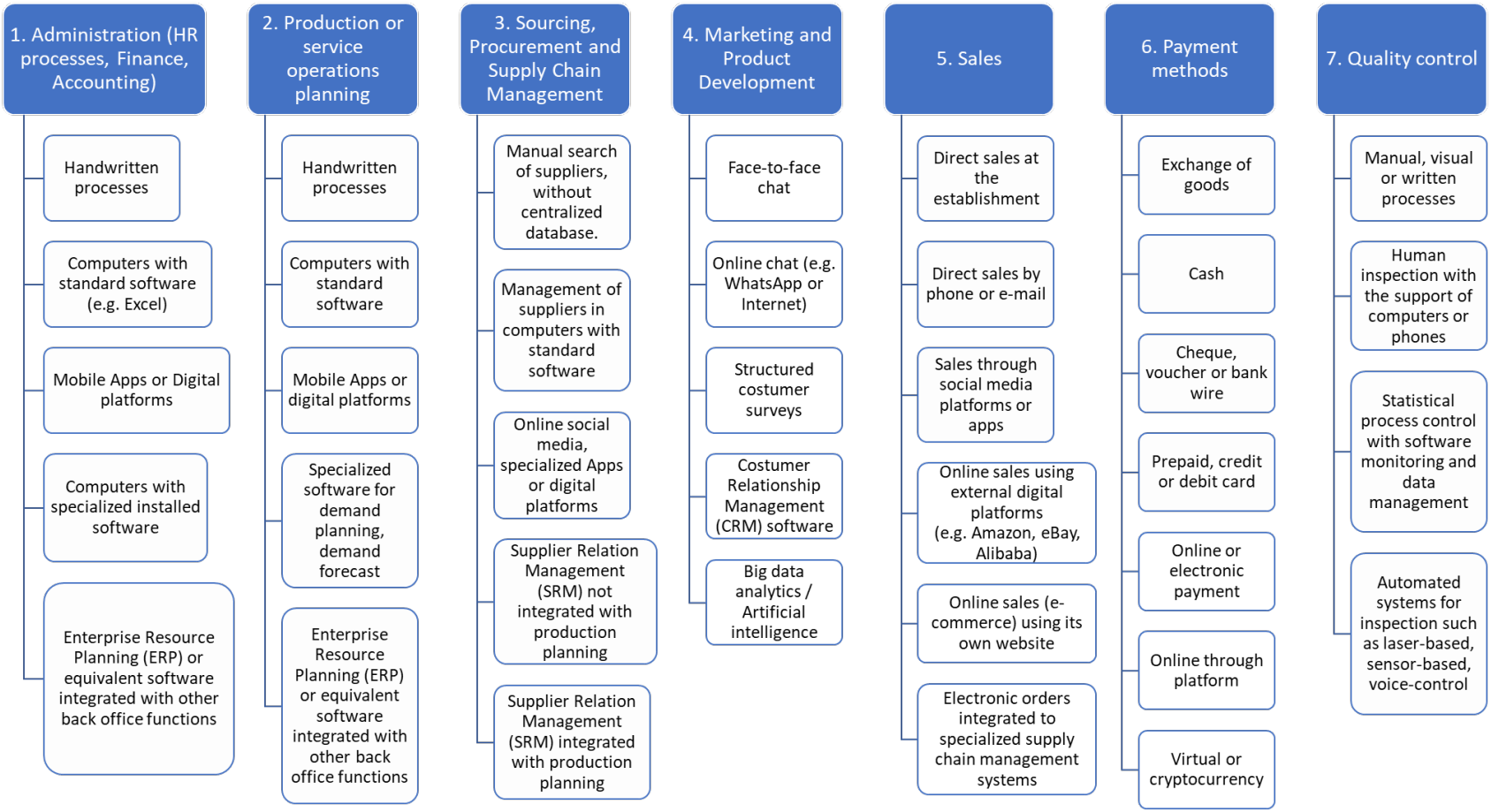
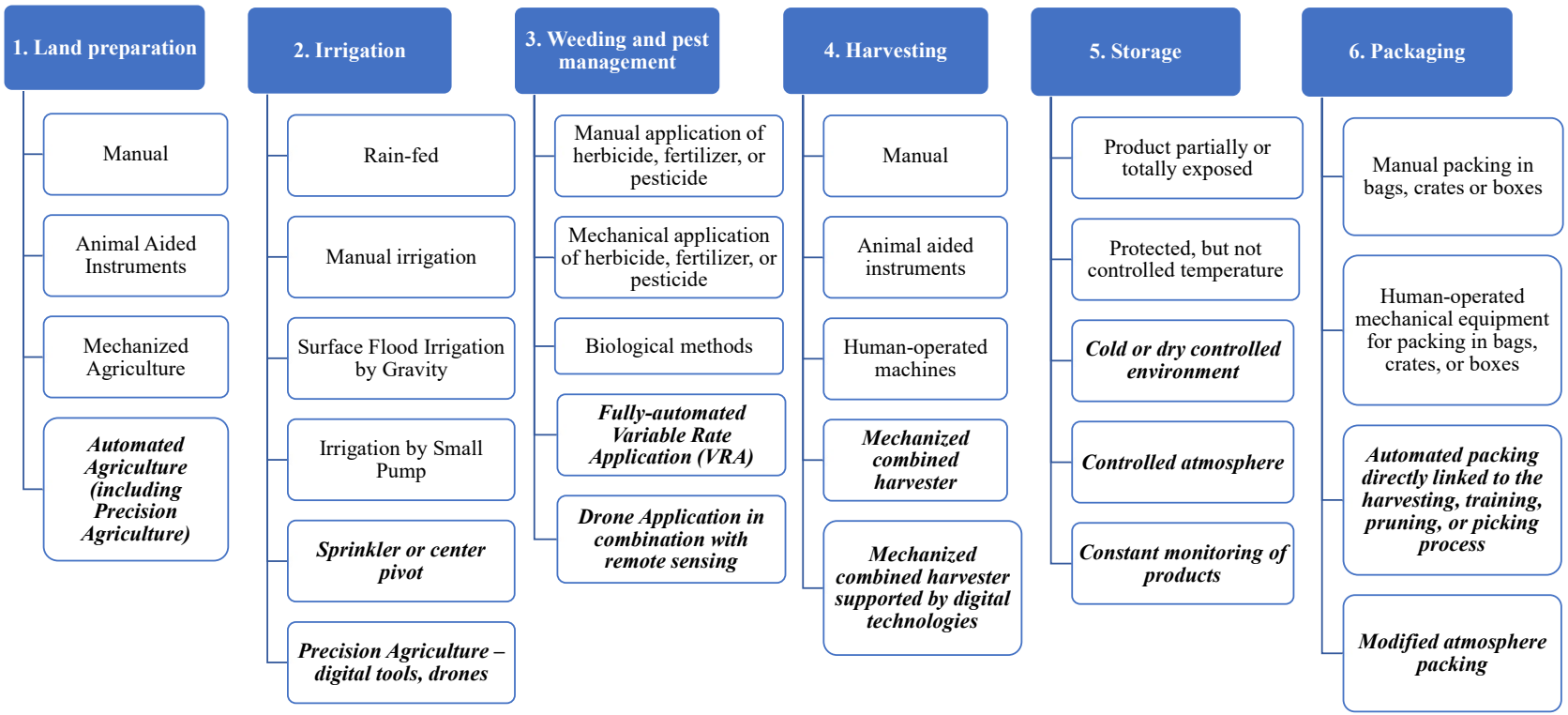



Figure 1: General Business Functions and Their Technologies

# GRID: Agriculture farming



# FAT Dataset

- Embed the GRID in a survey (FAT)
- Administered in representative samples of 14 countries (South Korea, Poland, Chile, Brazil, Georgia, Vietnam, India, Ghana, Bangladesh, Kenya, Cambodia, Senegal, Ethiopia, and Burkina Faso)
- In total cover over 20,000 establishments.
- Questions:
  - For each business function, which of the technologies in the grid uses
  - Of those, Which one is most widely used

# Technology sophistication measures

- Technologies in a BF can be ranked based on their sophistication, $\hat{r}_{f,j}$.

- $MOST_{f,j} = 1 + 4 * \hat{r}_{f,j}^{MOST}$
- $MAX_{f,j} = 1 + 4 * \hat{r}_{f,j}^{MAX}$
- $MOST_j = \frac{\sum_f MOST_{f,j}}{N_j}$; $MAX_j = \frac{\sum_f MAX_{f,j}}{N_j}$
- $\overline{S}_j = \frac{MAX_j + MOST_j}{2}$

# $MAX_{f,j}$ vs $MOST_{f,j}$

- On average $MAX_{f,j} - MOST_{f,j} = 0.61$
- In 63% of BFs where $NUM_{f,j} > 1$, $MAX_{f,j} > MOST_{f,j}$
- Different relation with $NUM_{f,j}$
- They account for very small fraction of each other's variation
- MAX and MOST reflect different dimensions of technology adoption

# MAX, MOST and NUM

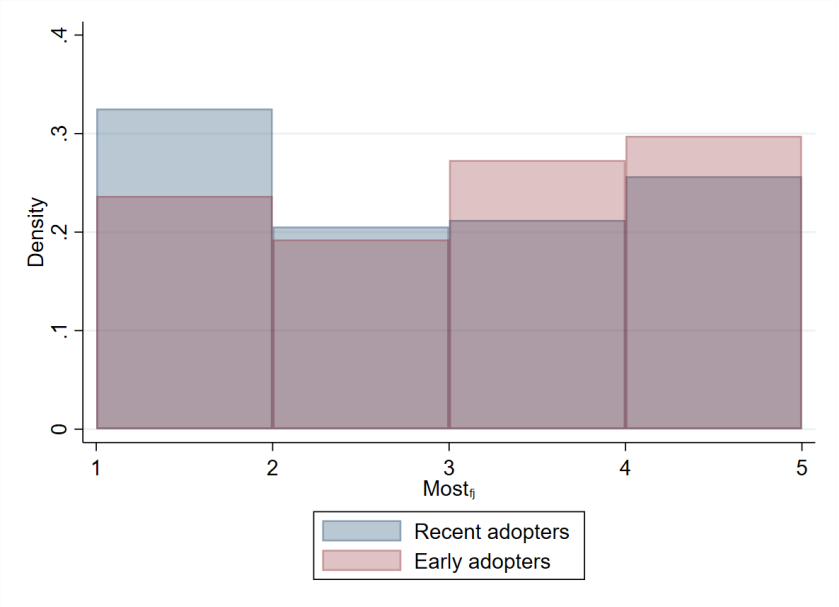
Table 5: Relationship between technology measures

| | $MOST_{f,j}$ | $MAX_{f,j}$ | $MOST_{f,j}$ |
|---|---|---|---|
| $MAX_{f,j}$ | $0.55^{***}$ | | |
| | (0.01) | | |
| $NUM_{f,j}$ | | $0.85^{***}$ | $0.25^{***}$ |
| | | (0.01) | (0.01) |
| N | 186503 | 186503 | 186503 |
| R-squared | 0.66 | 0.75 | 0.51 |
| BF FE | Y | Y | Y |
| Firm FE | Y | Y | Y |
| Variation Explained | 0.35 | 0.46 | 0.05 |

# Is the gap between MAX and MOST transitory?

| | % functions with $MAX_{f,j} > MOST_{f,j}$ |
|---|---|
| Size : Medium | -0.057*** |
| | (0.006) |
| Size : Large | -0.038*** |
| | (0.011) |
| Age: 6 - 10 Years | -0.014** |
| | (0.007) |
| Age : 11 - 15 Years | -0.055*** |
| | (0.007) |
| Age : 16+ years | -0.026*** |
| | (0.006) |
| Multi-establishment | 0.006 |
| | (0.006) |
| Foreign Owned | 0.017** |
| | (0.008) |
| Exporter | -0.060*** |
| | (0.007) |
| Constant | 0.621*** |
| | (0.033) |
| N | 18322 |
| R-squared | 0.107 |
| 2-Dig. Sector FE | Yes |

# Is the gap between MAX and MOST transitory?




- How long ago establishment adopted MAX technology in the business function does not explain the gap between MAX and MOST.

# Technology and productivity

# Key questions

- How relevant is technology sophistication for productivity?
- Does the relevance of technology sophistication for productivity differ across sectors?
- What dimensions of technology sophistication are more relevant?
- Is technology sophistication complementary to management?
- Is technology appropriate to use in all economies?

# Productivity and technology sophistication

Table 1: Productivity and technological sophistication

| | Sales per worker | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| $K_j$ | 0.234*** | 0.266*** | 0.223*** |
| | (0.007) | (0.007) | (0.007) |
| $H_j$ | 0.191*** | 0.585*** | 0.150*** |
| | (0.040) | (0.042) | (0.040) |
| $\overline{S}_j$ | 0.493*** | 0.631*** | 0.504*** |
| | (0.019) | (0.020) | (0.019) |
| N | 13046 | 13046 | 13046 |
| R-squared | 0.407 | 0.234 | 0.435 |
| Sector FE | Yes | Yes | |
| Country FE | Yes | No | |
| Sector X Country FE | | | Yes |

# The agricultural productivity gap

Table 2: Productivity and technological sophistication - Sectoral

| | Sales per worker | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $K_j$ | 0.342*** | 0.442*** | 0.234*** | 0.281*** | 0.218*** | 0.244*** |
| | (0.023) | (0.024) | (0.008) | (0.009) | (0.011) | (0.012) |
| $H_j$ | 0.507** | 0.825*** | 0.164*** | 0.604*** | 0.165*** | 0.586*** |
| | (0.227) | (0.236) | (0.061) | (0.063) | (0.058) | (0.060) |
| $\overline{S}_j$ | 0.648*** | 1.023*** | 0.584*** | 0.701*** | 0.458*** | 0.587*** |
| | (0.088) | (0.086) | (0.023) | (0.025) | (0.030) | (0.030) |
| N | 825 | 825 | 6032 | 6032 | 6189 | 6189 |
| R-squared | 0.716 | 0.577 | 0.480 | 0.327 | 0.382 | 0.186 |
| Sector FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Country FE | Yes | No | Yes | No | Yes | No |
| Data | Agri. | Agri. | Manu. | Manu. | Serv. | Serv. |

# MOST vs. MAX

Table 4: Productivity and dimensions of technology sophistication

| | Sales per worker | |
|---|---|---|
| | (1) | (2) |
| $K_j$ | 0.235*** | 0.267*** |
| | (0.007) | (0.007) |
| $H_j$ | 0.233*** | 0.633*** |
| | (0.041) | (0.042) |
| $MAX_j$ | 0.084*** | -0.037 |
| | (0.023) | (0.023) |
| $MOST_j$ | 0.433*** | 0.740*** |
| | (0.025) | (0.027) |
| N | 13046 | 13046 |
| R-squared | 0.410 | 0.250 |
| Sector FE | Yes | Yes |
| Country FE | Yes | No |

# Policy implications

MOST and MAX are distinct dimensions of technology adoption

- Typically policies are aimed at increasing MAX
- But those are unlikely to affect MOST, which is more relevant for establishment productivity
- What can drive MOST?
  - Fraction of high value-added output
  - Cost of training workers
  - Cost of capital that embodies it

# Taking stock

- Technology sophistication is a key driver of productivity, within and across countries
- Critical to explain the agricultural productivity gap
- Technology sophistication is complementary to management
- MOST is much more relevant than MAX, especially in developing countries.
- Technology is appropriate to use in all economies