PRELIMINARY AND INCOMPLETE
What do managers do?

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where $R(.)$, $\widetilde{z}$, and $\widetilde{\omega}_i$ denote revenue, firm specific productivity, and wage of type i employee respectively.

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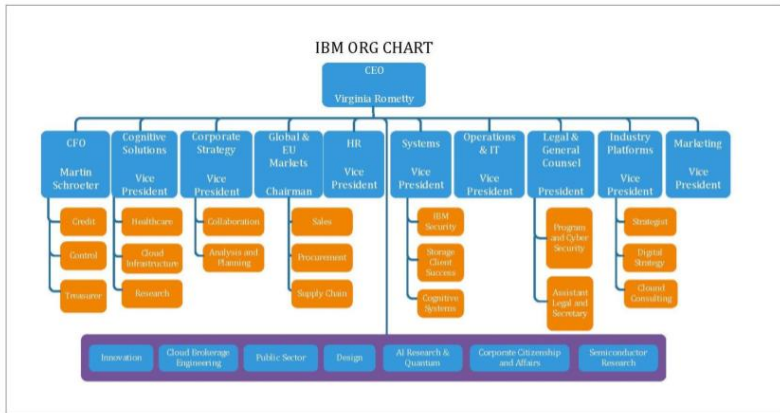 - The types of skills and earnings employees at different levels of the hierarchy have.

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Table 1: **Summary Statistics CPS 2011-2018**

		Workers			Managers	
	N	mean	s.d.	N	mean	s.d.
Panel A: Share in Each Role	396,585	0.90		46,196	0.10	
Panel B: Demographics						
Female	396,585	0.44	0.50	46,196	0.41	0.49
Bachelors Deg.	396,585	0.30	0.46	46,196	0.57	0.49
ln.Earnings	389,295	10.48	0.75	44,700	11.06	0.68
Age | female	172,536	40.68	12.06	18,889	42.61	10.94
Age | male	224,049	40.52	11.99	27,307	44.11	10.43

BLS model of earnings determination

- The US BLS uses four factors from its *National Compensation Surveys, NCS*, to characterize jobs and predict their earnings.

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- Occupational knowledge, supervision received, and communication outside the supervisory chain characterize job skills and the last factor characterizes job amenities.

- Reduced form empirical strategies cannot explain the use of these skill factors to determine earnings.

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Based on that coordination role, we propose that:

- One manager cannot supervise and coordinate all the tasks which are aggregated into final production. The pyramidal structure arises endogenously. The bottom levels of the hierarchy are workers. All higher levels are managers who manage other manages and at the bottom levels, workers.

Managers coordinate specialization within the firm

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- Managers coordinate specialization with their own subordinates and other managers in product design committees (i.e. meetings).

- Managers hire, train, allocate, coordinate and supervise subordinates, and coordinate activities with other managers.

How do managers coordinate specialization?
*** Lots of potential research topics to investigate ***

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- Hierarchical comparative advantage.
    - Occupation specific knowledge falls relative to communication skills as the level of the hierarchy increases.

Literature review

- Chandler (1977): the role of managers is to coordinate specialization. Workers are at the bottom of the hierarchy and managers occupy all higher levels. He took a historical and institutional approach.
- Garicano (2000) and his co-authors have an analytic framework where access to managers are arranged to economize on within firm communication costs. Also see McCann, et. al. (2015).
- Deming and co-authors (2017, 2020, 2023) show the importance of communication and allocative skills, occupational mobility due changing job skills. Cortes, et. al. (2023) show gender differences in social skills in high paying occupations.
- Using data from a large multinational, Minni (2022) showed:
    - Good managers are more successful in matching workers with jobs.
    - Suitably matched, the resulting gains to the worker are persistent.
    - A major role of managers is to assign workers to jobs.
- Kohlhepp (2023), "The Inner Beauty of Firms", UCLA manuscript, shows that a salon with more specialized workers, communicate more with each other, charge higher prices and are more profitable.

Building block: Two-level hierarchies (2H)

- A two-level hierarchy, hereafter 2H, consists of a manager and their subordinates. The span of control is determined by the communication skill of the manager. Figure 1 shows the smallest

Figure 1: 2-Level Hierarchy

M : Manager
$\underline{S}_j$: Subordinate j
: Link between manager and subordinate

2H

Two non-mutually exclusive roles for a 2H

- (PH) Multiple plants/branches produce/sell many units of the same good. All subordinates do the same task, i.e. they are in the same occupation. The manager, who also has the same occupational knowledge, is responsible for hiring, training and supervising the subordinates. There need not be communication between plants/branches/retail chain stores.

- (DH) In a division hierarchy, the manager assign different subordinates, in different occupations, to different tasks. The manager hires trained subordinates if she cannot train them. The manager has to coordinate the task outputs between the subordinates including those who may know more about their task outputs than she does.

Figure 2: 3-Level Hierarchies

(a) MPH: Multi-plant Hierarchy

(b) DH: Multi-division Hierarchy
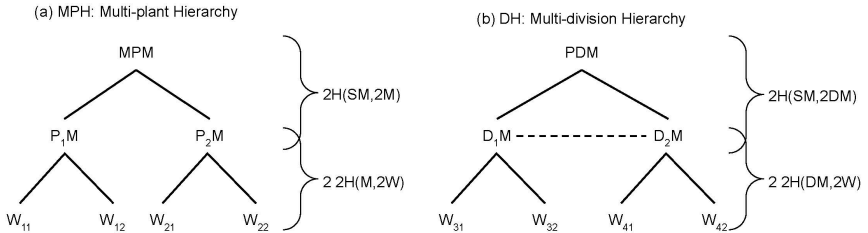
MPM: Multi-plants Manager
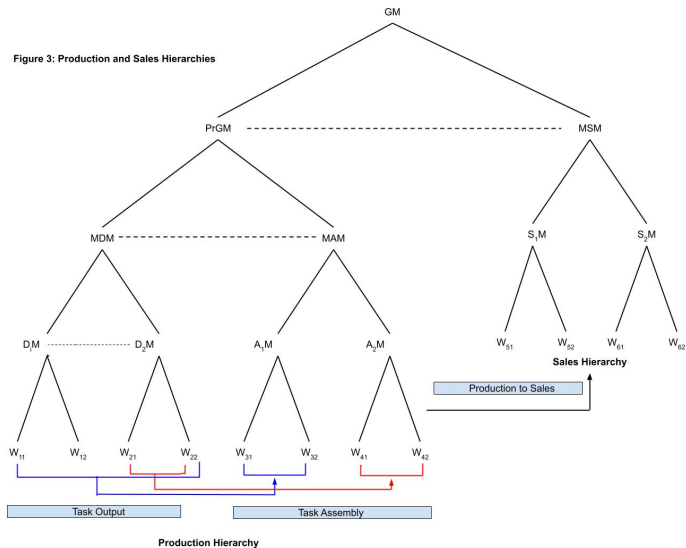MDM: Multi-divisions Manager
P_iM: Manager of Plant i
W_{ij}: Worker j of unit i
—: Link between manager and subordinate
- -: Communication link between two managers
D_iM: Manager of Division i

Figure 3: Production and Sales Hierarchies

Complex hierarchies

- More complex hierarchical firms are constructed by concatenating 2Hs.
- Figure 2a applies to plant and or retail branches. Figure 2b applies to firms, universities and sports teams.
- A firm with multiple hierarchies. Figure 3 is an example of a multi-product firm. In different plants, the assembly hierarchy assembles different products using different combinations of task outputs. The sales hierarchy operates separately.
- Workers are at the bottom level of each hierarchy, production, assembly or sales.
- Managers are at higher levels of the hierarchies (Chandler; Garicano).
- Higher level managers communicate with managers from other occupations.

- Every employee posses two skills. A new entrant into the labor market applies to be a worker in a specific occupation. Using their base cognitive skill, the individual learns the task specific knowledge for that occupation.

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  - Vertical communication:

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    - Upward communication: Each subordinate has to communicate with one direct manager.

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- Because higher level managers often have to supervise and communicate with others with different occupational skills in product design committees, the occupational specific knowledge of higher level managers are less important. Horizontal communication skill become more important.

Sketch of a J+1 levels hierarchical firm

- There are $J + 1$ levels hierarchies in this firm, managers in levels 1 to J with a CEO in level J, and workers in level 0.

- For analytic convenience, we treat all managers and workers at the same level in the same firm symmetrically although generally they are in different occupations.

- All labor market participants have different amounts of three skills, vertical communication skill, c, horizontal communication skill, h, and occupational specific skill, k.

- The wage of a participant with skills (c, h, k) is $w(c, h, k)$. This wage is independent of the hierarchy level or firm assignment.

Labor force of the firm

- Consider a manager of skills (c_j, h_j, k_j) in level j, $j > 0$. This manager hires l_{j-1} supervisees, each of skill $(c_{j-1}, h_{j-1}, k_{j-1})$.
- Because of specialization, each manager in level j is in a different occupation from other managers in the same level.
- Each level 1 manager supervises l_0 workers in the same occupation as the manager. Each worker has skills (c_0, h_0, k_0).
- Including the CEO, $l_J = 1$, the firm hires

$$\sum_{j=0}^{J} \prod_{i=j}^{J} l_i$$

workers.

- The firm's wage bill is

$$\sum_{j=0}^{J} w(c_j, h_j, k_j) \prod_{i=j}^{J} l_i$$

Value added by a manager in level j

- Because each manager's decisions affect others, we use a value added approach to construct the optimization problem of the firm.
- Let x_j be the shadow value of output which a manager at level j delivers to the firm. It may be based on a physical output such as a plant, or a non-physical output such as a task assignment or plan, etc..
  - A manager gets a transfer price, p_j, per unit of level output which she produces. Her inputs are her subordinates, l_{j-1}, whom she hires and the level output immediately below, x_{j-1}.
  - Her wage from the firm is equal to the value added she produces for the firm:

  $$w(c_0, k_0, h_0) = p_0 x_0$$
  $$w(c_j, k_j, h_j) = p_j x_j - p_{j-1} x_{j-1} l_{j-1}, \ j = 1..J-1$$

  which may also be written as:

  $$p_j x_j = w_j + \sum_{k=1}^{j} w_{j-k} \left[\prod_{m=1}^{k} l_{j-m} \right], \ j = 1,..J$$

- x_j evolves as follows:

$$x_j = v(g(c_j, c_{j-1}), \gamma(k_j, k_{j-1}), \rho(h_j, h_{j-1}, l_{j-1}), x_{j-1}) \qquad (1)$$

- $g(c_j, c_{j-1})$: effective communication by the level j manager and her subordinates. c_j is the manager's vertical communication skill and c_{j-1} is chosen by the manager.
- $\gamma(k_j, k_{j-1})$: k_{j-1}, occupational skill of the supervisee is chosen by the manager.
- $\rho(h_j, h_{j-1}, l_{j-1})$: l_{j-1} is the number of subordinates which the manager hires. h_{j-1} is the horizontal skill chosen by the manager of each subordinate.
- $x_0 = 0$.

- Given c_j, k_j, h_j and x_{j-1}, the objective of a level j manager is to solve:

$$\max_{c_{j-1}, k_{j-1}, h_{j-1}, l_{j-1}} p_j x_j - p_{j-1} x_{j-1} l_{j-1} \qquad (2)$$

subject to (1).

- Total profits of the firm:

$$\pi_J = x_J - w_J - \sum_{j=1}^{J} (w_{j-1} l_{j-1}) \prod_{i=j}^{J} l_i$$

where the CEO charges his market wage to the firm.

Compare: Reduced form model of firm z with K occupations:

$$\widetilde{\pi}(\widetilde{l}_1, .., \widetilde{l}_K, z) = R(\widetilde{l}_1, .., \widetilde{l}_K, z) - \sum_{j=1}^{K} w_k \widetilde{l}_k$$

Reduced form earnings determination for i in occ k and firm z:

$$w_{ijz} = f(z, s_k, s_i, \varepsilon_{ijk})$$

$\quad s_k$: skill index (e.g. communication skill) for occupation k

$\quad s_i$: individual characteristics such as educational attainment

Occupational choice (Supply side of labor market)

- An individual with occupational knowledge k, vertical and horizontal communication skills c and h respectively, will earn $w(c, h, k)$ in the labor market.
- Given her occupational knowledge, assume that she chooses occupation k.
- For analytic convenience, we have assume that different occupations have the same impact on producing x_j. So in (1), vertical communication skills and occupational knowledge enters symmetrically which raises the question as to whether they could be separately identified. With occupational codes, workers in different occupations will be differentiated in an empirical analysis and thus vertical communcation skills will be differentiated from occupational knowledge. For analytic convenience, we assume that different occupations have the same impact on producing x_j. So in (1), vertical communication skills and occupational knowledge enters symmetrically which raises the question as to whether they could be separately identified. With occupational codes, workers in different

Labor market equilibrium

Let $H(c, h, k)$ be the continuous distribution of individual skills in the labor market. Assume that every CEO is the owner of their firm. Equilibrium in the labor market is a wage function $w(c, h, k)$ such that:

1. A labor market participant with skills (c, h, k) earns $w(c, h, k)$.
2. A participant can be an employee or a CEO of their own firm.
3. All managers, including the CEOs, choose their preferred subordinates to solve (2).
4. Zero profit condition: The total profit of each firm is equal to its wage bill which includes the CEO's opportunity cost as an employee elsewhere.
5. Market clearing: The supplies of labor market participants by skills are equal to the demands by firms for those participants. The number of firms is equal to the number of CEOs.

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2. The principle of hierarchical comparative advantage predicts the kinds of skills which are best matched at each level of the hierarchy. Explains depreciation of STEM skills and occupational mobility in Deming and Noray (2020).

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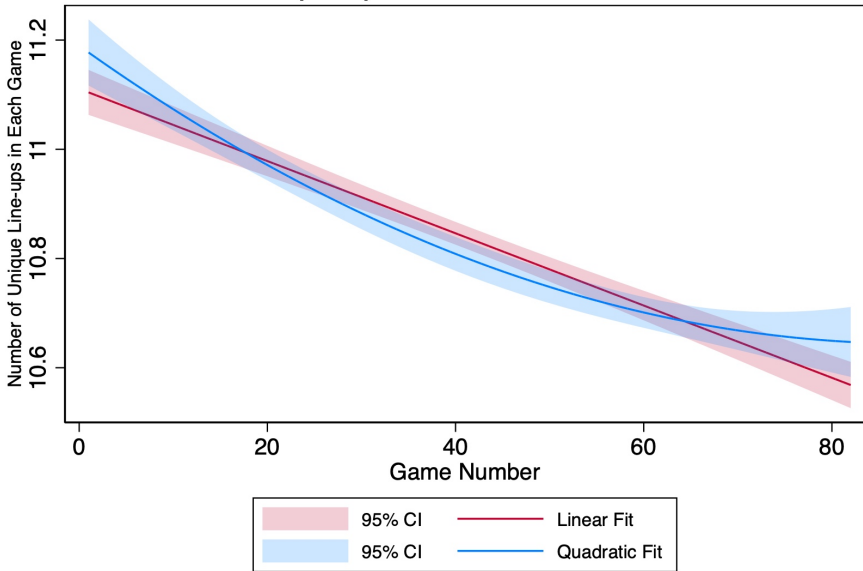3. Make faster assignment decisions with "same" subordinates than "other" subordinates with other occupations.

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3. Make faster assignment decisions with "same" subordinates than "other" subordinates with other occupations.
   - Conditional on the draft rank and separated, "other" players will be separated slower than "same" players. I.e. coaches decide faster on fit of "same" players.
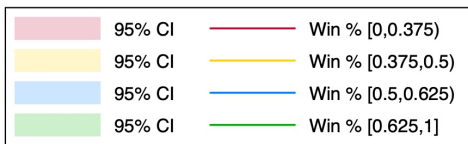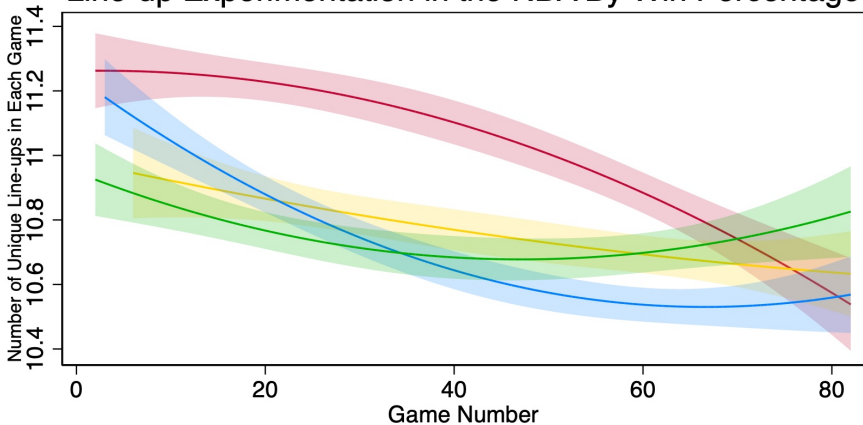
A firm specific human capital activity: choosing who works with whom

- Firm specific capital is the increase in productivity of a worker firm match as it persists. It is lost when the pair separates. What activities constitute FSHC?

- A major task of managers is to optimally match heterogenous employees to heterogenous tasks (Minni). There is no team independent individual productivity.

- The optimal assignments for team members have to be discovered on the job. Some members may be replaced. This is a natural extension of Jovanovic.

- Explains experimentation in team composition by sports teams at beginning of season. When more new members join in the same season, it will take longer to arrive to at an optimal composition.

- Evidence from NBA team lineups (ongoing with Grant Benjamin).

Line-up Experimentation in the NBA

Number of Unique Line-ups in Each Game (y-axis)

Game Number (x-axis)

	95% CI		Linear Fit
	95% CI		Quadratic Fit

Line-up Experimentation in the NBA By Win Percentage

Legend:
- 95% CI — Win % [0,0.375)
- 95% CI — Win % [0.375,0.5)
- 95% CI — Win % [0.5,0.625)
- 95% CI — Win % [0.625,1]

Y-axis: Number of Unique Line-ups in Each Game
X-axis: Game Number

Conjectures on promotions with hierarchical comparative advantage

- In addition to the head coach, professional football employ position coaches such as quarterback, offensive and defensive coaches. Hypothesis: The higher the level of the coach is negatively correlated with their draft rank as a player.

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Gender differences in promotion rates

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- Workers are in the same occupations as their managers who hire and train them.
- When managers and workers are in the same occupation, occupation knowledge is valued relatively more than communication in promotions of workers to managers.
- In higher levels of the hierarchies, communication skills are valued more than occupational specific knowledge in promotions.

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- Conjecture: The promotion rate of men will be higher than the promotion rate of women in low managerial levels. The sex ratio (ratio of men to women) in promotion rates will be decreasing as the managerial level increases.
- The above hypothesis is complementary to Sheryl Sandberg's "lean in" hypothesis.

- Consider a worker working on a specific task. She comes across a problem which she is unable to resolve. If the problem is unresolved, her task fails.

- Her manager instructs her to ask him for assistance when she gets stuck. Her manager also says that she is not to ask a higher level manager for help without his permission.

- A manager has to divide his time between coordinating with other managers, and also managing his own subordinates. If lower level workers who are not his direct subordinates, have direct access to him, they may use up his time and not leave enough time for him to deal with his main activities.

- On the other hand, it is important for him to deal with some issues experienced by those lower level workers. The insight is that his subordinates and their subordinates should do the screening for him.

- Applies to who should speak up in a conference discussion.

Ignore efficient suggestions by workers (Dessain Wouters)

- At the beginning of the year, a firm has to design a new model for sale for Christmas of the next year.
- Using Figure 3, at the beginning of the year, the general manager will call a series of product design meetings for the product design committee, between himself, other high level managers and staff.
- Changes in one task output may directly affect the final product and also affect the performances of the other task outputs, and therefore again the final product.
- Due to lengthy build and sell, the final product design has to be completed well before Christmas of next year.
- A worker, Mary, is asked to brief the product design committee on the state of the art options for producing her task output. The product design committee decides to choose option X. Later, Mary discovers a new option X' which is more efficient. There is enough time to redesign and prototype using X'. If the firm agrees to the redesign, other workers may also propose new options. This continual redesign will lead to insufficient time to produce and deliver a new product.

Learning about demand

- As demand preferences change, demanders will convey those changes in preferences as new requests to the sales and client service workers. Workers with low communication skills will ignore these new requests. Workers with higher communication skills will recognize these new requests and pass on the new requests to their managers.
  - Communicating profitable new demand requests to your supervisor is a way to be promoted. Superstar move: Present your supervisor with a potential internal team, which requires his or her consent, which can implement this new request. I.e. hand your supervisor a complete, turnkey, potential new profit opportunity.
- Compare online sales with in person sales. Tradeoff between scale versus eliciting demanders' requests (customization).