# The Division of Labor, Coordination Costs, and Knowledge

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## 1 Division of Labor Among Tasks

The rate of production from the $s$th task ($Y(s)$) equals the product of the working time devoted to $s$ ($T_w(s)$) and the productivity of each hour($E(s)$):

$$Y(s) \quad = \quad E(s)T_w(s)$$

- A worker who does not specialize and performs all the tasks himself allocates his working time and investments in specific human capital among tasks to maximize the common output on each one
- However, it is possible for workers to do better by specializing in subsets of tasks, and then combining their outputs with that of other workers who specialize in other tasks.
- The increasing returns from concentrating on a narrower set of tasks raises the productivity of specialist above that of jack-of-all-trades. For example, a doctor who specializes in surgery is more productive than one who performs an occasional operation because surgical skills are honed by operating

A group of workers who cooperate to produce $Y$ by performing different tasks and functions a team. Instead of assuming that workers have intrinsic comparative advantages, the paper assume that workers are intrinsically identical. Specialization is what produces most comparative advantages; they do not arise at birth or childhood. The paper further assumes that all tasks are equally difficult and have the same degree of interdependence with other tasks. Therefore, each of the identical members of an efficient team concentrates on an equal set of tasks, $w = 1/n$, when $n$ is the team size. Output on each tasks depends on the size of the set and also the general knowledge($H$) available:

$$Y \quad = \quad Y(H, w), Y_h > 0, Y_w < 0$$

Output per member is equals

$$y \quad = Y/n \quad = B(H, n)$$

- The division of labor is limited by market size. If you have$n$ workers, the maximum division of tasks you can have is $n$
- Conflict among members generally grows with the size of the team because members have greater incentive to shirk when they get a smaller share of output
- Efforts to extract rents by "holding up" other members also grows as the number of members performing complementary tasks increases
- The chances of breakdown in production(due to poor coordination or miscommunication) also increase as number of separate specialists grows

The net output per member is then

$$\begin{aligned} y &= B(H,n) - C(n), B_n > 0, C_n > 0 \\ C(n) &= \text{Total Coordination cost per member} \end{aligned}$$

The FOC condition is then

$$B_n - C_n \geq 0 \tag{1}$$

- The division of labor is also limited by coordination costs.

# 2 Coordination Costs

A few example that clarify the relation between coordination cost and specialization

1. If each historian specialized in the events of only a few years, they would become more expert on development during these short periods. But since events over a few years are not isolated from those in prior and subsequent years, each one would have to coordinate research with several other specialists. Such coordination cost can be greatly reduced by specialization in larger and more self-contained periods
2. For economists and lawyers working on relation between law and economics, coordination costs are reduced if economists also become lawyers and vice versa. Hence, we can observe the increasing number of persons who take advanced degrees in both fields. Yet joint degree between law and economics are more common than that of economics and health, since the later require a higher investment

- Altruism among family members lowers the coordination cost of division of labor among family members
- Companies are less "vertically" integrated when it is cheaper to coordinate specialized team members through market transactions. This is why companies are more specialized when they can economize on transactions costs by locating near each other-as computer industry locates in Silicon Valley and automobile industry in Detroit
- Entrepreneurs play the role of coordinating different types of labor and capital. This is why economic systems that encourage entrepreneurship would have lower costs coordination, and presumably a widespread division of labor among workers and firms. By the same token, centralized economies are more vertically integrated since they discourage entrepreneurship.
- Centrally planned economies do not make effective use of market and prices raise coordination costs, and thereby reduce incentives for investment in specialized knowledge

# 3 Knowledge and Specialization

The paper assumes that increase in knowledge embodied in the human capital of workers not only raises the average product per team member, but also marginal product of a larger team:

$$\frac{d}{dH} \quad (\tfrac{dB}{dn}) \quad = B_{nh} > 0 \tag{2}$$

By differentiating FOC (1) that maximizes income per worker w.r.t. H, one gets

$$\begin{aligned} \frac{dn}{dH} &= \frac{B_{nh}}{C_{nn} - B_{nn}} > 0 \\ B_{nn} - C_{nn} &< 0 \text{ (Second-order Condition)} \end{aligned} \tag{3}$$

The inequality in (2) signs these derivatives.

- Equation (3) implies that teams get larger and workers become more specialized and expert over a smaller range of skills as human capital and technology grow. Note that division labor leads to greater knowledge at the same time greater general knowledge leads to more extensive division of labor and task-specific knowledge.
- Jack-of-all-trades is less useful than the specialists in economies with more advanced technologies and extensive human capital base since a typical workers commands a very small share of the total knowledge.
- It is the extensive cooperation among highly specialized workers that enables advanced economies to utilize a vast amount of knowledge.
- An efficient allocation assigns workers whose productivity is least affected by coordination costs to high-cost sectors. This implies that workers with low human capital would be assigned to the high-cost sectors if greater coordination costs lower the marginal product of human capital
- Earnings are usually higher in large cities even after adjusting for observable measures of human capital-such as years of schooling and experience-because unobserved human capital is also attracted to cities by the lower coordination costs

# 4 Extent of the Market

- Adams Smith argues that division of labor is limited by the extent of the market while this paper argues that division of labor is limited by coordination costs
- The division of labor may be greater in cities than in small towns not because markets are larger in the cities, but because it is easier to coordinate specialists in more densely populated areas
- The division of labor cannot be limited mainly by the extent of the market when many specialists in the same city provide essentially the same skills.
- Why didn't several pin factories in Smith's England combine their activities, and get a larger scale and market, and specialize more within each market? The answer is that cost of coordinating between factories exceeded the gain from a greater division of labor, then specialization is limited by coordination cost and not by extent of the market. Again, if each factory produce different quality pins or cater to different local markets, the factory would not combine.
- Interpretation of enormous growth in specialization as countries develop. The paper claim that huge increase in scientific and other knowledge and decline in coordination costs raised the benefits from greater specialization. The alternative view suggested by Smith's approach is that declines in transportation costs raised the effective size of the markets

# 5 The Growth in Specialization and Knowledge

- There is no one-way correlation between knowledge and the division of labor, but mutual determination
- Knowledge is not subject to diminishing returns in the same obvious way as is physical capital because greater knowledge raises productivity of further investment in knowledge. However, as knowledge continue to grow, limited human capacities tend to make it harder to pack more knowledge into a person without running into diminishing returns
- Greater specialization enables workers to adsorb knowledge more easily, which offsets to some extent the tendency toward diminishing returns from the accumulation of knowledge

- Rates of investment in knowledge depend on cost of coordinating specialized workers. Countries with lower coordination costs due to stabler and more efficient laws, not only have higher outputs but also tend to grow faster because lower costs stimulate investments in knowledge by raising the advantages of a more extensive division of labor

# 6 The Division of Labor Between Sectors: Teachers and Workers

- Workers become specialized to particular sectors partly because they become skilled at the tasks specific to a sector

The teachers of workers in period $j$ were students in period $j-1$, their teachers were students in period $j-2$, and so on, continuing backward until one comes to the persons in the initial period who indirectly taught the workers $j$. The paper defines the $j$ th lineage as this sequence of teachers and students in successive periods that ends in period $j$ because students in $j$ become workers then. A lineage is a "team" of teachers, students, and workers in different periods. Human capital of workers in later periods produced with more "roundabout" methods, and hence has longer lineages, than the human capital of workers in the earlier periods.

- The negative effect on production of human capital from having an additional student in a lineage would would exactly cancel the positive effect of subsequently having an additional teacher.
- It is efficient to provide students who are further removed from becoming workers with more extensive training, so that teacher-student ratios would be higher in the more roundabout lineages.
- Since more roundabout lineages have greater human capital, the analysis in Section I of the effects of human capital on the degree of specialization implies that members of the more roundabout sectors tend to specialize in narrower tasks.
- An efficient economy has a finely etched division of labor, where teachers have more human capital than workers, and teachers in higher-order lineages-in more roundabout production-have greater human capital than teachers in lower ranges.
- Inequality in the distribution of human capital at any moment expands over time because human capital of sectors with greater human capital grows faster. However, the inequality would fall over time because the sectors with the least human capital are culled out and eliminated.

# 7 T/F/U Questions

1. It is efficient for pediatricians in a city to specialized in a particular childhood disease. **ANS:** False. There is no doubt they would learn more about a disease through specialization, but the additional knowledge require greater expenses in coordinating their care with that of other pediatricians. For parents who often do not know what is wrong with their children, and would need to see several pediatricians to get adequate care if each were highly specialized.
2. (Revision to Q253 in Encyclopedia) Real wages appear to be higher in larger than in smaller cities in most, if not all countries. This is because the division of labor and efficiency of production is greater in large cities. **ANS:**True.
   (a) Division of labor is likely to be greater in cities because it is easier to coordinate 'specialists' in more densely populated areas. When labor specialize in certain types of tasks, they would become more productive in that specified tasks which lead to more efficient production. Since their output increase, they are paid a higher real wage.

(b) In larger cities where more types of firms are located near to each other, coordination cost with other companies as a result of each firm specializing in specified tasks is greatly reduce. Take for instance an advertisement company in a small town and a large city. It is more likely that there is a web design firm locate in the large city compare to a small town. Hence, the advertisement company in the large city can easily outsource and coordinate its web-designing portion of its projects with the web-designing compare to the advertisement company in the small town; the later would have to find a web-designing company(if it plan to outsource the web-designing task) in another town which incurred additional search cost. The low coordination costs would lead to greater division of labor. Efficiency would increase from the division of labor since firms won't encourage division of labor in the first place if it is not efficient to do so. Higher output per unit labor due to increase efficiency would imply higher real wages.