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TECHNOLOGY TRANSFER ACTIVITIES OF NASA/MSFC: ENHANCING THE SOUTHEAST REGION'S PRODUCTION CAPABLIITIES

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Introduction

Although this researcher is not an engineer or science faculty, invaluable knowledge and experience have been gained from this NASA/ASEE Summer Faculty Fellowship. This year's research and activities was related to the previous summer's research; but the experience presented new and varied challenges. This researcher was fortunate to have maximum interaction with NASA colleague, David Cockrell and fellow Summer Faculty Fellow, Christina M. Mastrangelo. It would be both a privilege and honor to continue a relationship with the Technology Transfer Office.

During the past year a Cooperative Agreement between NASA/MSFC and The College of Commerce and Business Administration, Jacksonville State University was instituted. Dean William Fielding of the College of Commerce and Business Administration is anxious to aid the efforts of NASA/MSFC in its technology transfer activities.

The principal benefits gained by this researcher include the opportunity to conduct research in a non-academic, real world environment. In addition, this researcher was able to interact with the excellent professional staff of the Technology Transfer Office. This researcher has gained enhanced respect and understanding of the staff and facilities of Marshall Space Flight Center.

Preparation of a Simple Model of Production Possibility Frontier

This researcher was charged with the task of developing a simplified model to illustrate the impact of how NASA/MSFC technology transfer activities contribute to shifting outward the Southeast region's and the nation's productive capacity. What follows is a background report of the impact of technological growth on the nation's production possibility frontier (ppf).[1]

The production possibility frontier (ppf) illustrates scarcity and choice in an economy by using a simple model of an economy in which only two goods can be produced. The ppf is called a frontier since it represent the limits of output possibilities given the current level of resources and technology. The frontiers of knowledge and capability are able to expand and the ppf is no exception. Over time, as resources are accumulated and new technologies are applied, the ppf will expand outward.

Recent developments in growth theory have made rates of technology change and/or population growth an intregal part of the model of growth.[3] Technology change includes changes in technological knowledge (*eg.* ways to employ robots in the production process), as well as new knowledge (*eg.*

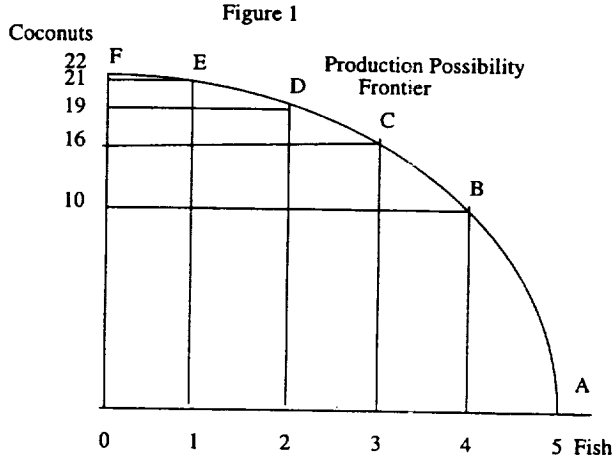
Managerial strategies). According to estimates of Edward F. Denison, during the period 1920 - 82, technology change accounted for 28 percent of the growth in the U.S., and is the most important influence on labor productivity.[2]

Simple Model of Two-Product Economy

Suppose a two-product economy located on a remote island inhabited only by Joe Six-pack. The island provides for all his material needs, but he must spent time to feed himself. His options are to catch fish or harvest coconuts. He values both of these foods in his diet and can spend up to eight hours a day to obtain them. This can be illustrated by means of a simple ppf for Joe's economy.

The relationship between Joe's options are shown in Figure 1. For instance, the basic message of the ppf is that as more fish are caught, fewer coconuts can be collected. The inverse relationship between fish and coconuts illustrates the opportunity cost to Joe using his limited resource, time.

Figure 1



As Joe increases his catch from zero to a maximum of five, we see the number of coconuts he collects drops off at a nonlinear rate. In other words, the opportunity cost of the first fish is only one coconut, but as he spends more time fishing, he gathers less coconuts. This illustrates the concept of the *theory of increasing costs*, which states that as an economy adds to its production of any one good, the marginal (extra) opportunity cost of that good will tend to rise. This explains why the ppf appears bowed outward.

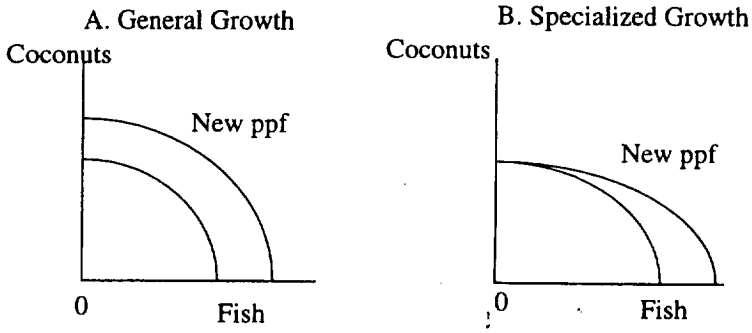
Returning to Joe's island, each working hour of the day he must choose between fishing or gathering coconuts. The most productive fishing occurs at certain hours of the day when fish are biting; while all hours are equally well suited to gathering coconuts. Joe knows that the number of coconuts gathered per hour declines as he spends more hours fishing, thus he gathers the most accessible

coconuts first. In the beginning he can reduce hours of coconut gathering allowing more time to catch fish at a cost of relatively few coconuts. However, adding more hours to his fishing time leads to less incremental productivity in fishing while taking away productive hours gathering coconuts. This illustrates the law of increasing costs.

Technological Improvements

Technological improvements can increase productivity in an economy generally, as has been the case with better information flows made possible by modern computers and telecommunications. Often however, technological improvements are specific to an industry. For instance, a biotechnological advance might improve crop yields for agriculture but have no effect on, say, the steel industry. Figure 2 illustrates the difference between general growth in an economy and specialized growth, when the economy starts from the original ppf. In the case of general growth shown in Figure 2A, productivity of all goods and services are increased, as in the case with improved computers and telecommunications. In the case of specialized growth shown in Figure 2B, productivity increases in a particular sector, say, agriculture.

Figure 2



Production possibilities depend upon how much of each resource the economy has, as well as the technology that is available to make use of those resources. As resources increase or technology improves, production possibilities grow. On the other hand, a natural disaster or exhaustion of a natural resource tends to cause the economy's resource base to shrink, thus causing the production possibility frontier to shrink (*eg.* shift the ppf curve inward).

Let's return to Joe Six-pack's island. Suppose Joe were to take some time to construct some netting to use in catching fish and some additional netting to collect the coconuts as they fall from the trees. The nets are capital goods that

embody technological improvements, allowing Joe to catch more fish and collect more coconuts per hour. These improvements shift Joe's ppf outward (Figure 2A) allowing Joe to have both more fish and coconuts than before.

Transferring NASA/MSFC technology to private industry contributes to improvements in both industrial production techniques and improved products and services for the entire economy. In the case of NASA/MSFC technology transfer activities, the outward shift in the production possibility frontier may be either specialized (*eg*, improved healthcare) or more generalized (*eg*, improvements in computers). In either case, the productive capacity of the Southeast region and the U.S. is enhanced as NASA/MSFC technology is adapted to the private sector.

Technology Transfer Activities of NASA/MSFC

Let's turn to some specifics regarding the technology transfer activities of NASA at Marshall Space Flight Center (MSFC). The activities involve a broad cross section of businesses, both large and small, throughout the United States. For instance, a small clothing manufacturer, Apparel Manufacturing Company, is using computer simulation developed by NASA/MSFC and the University of Alabama. The Modular Manufacturing and Simulation Data Package allows multiple clothing items to be made simultaneously with a rapid turn-around time for orders. The company indicates that it cut operating costs up to 20 percent, increased sales by $1.5 million; and added over 30 employees.

NASA/MSFC technology transfer aids small, medium and large firms alike. For instance, various divisions of Pratt & Whitney (United Technologies) that have served as prime contractors on the Space Shuttle Program have successfully commercialized several adapted NASA technologies. These include the application of water jet stripping technology as an environmentally friendly way of cleaning vital jet engine parts on major airline planes, as well as for use on ships, boats, barges and floating dry docks.

Medical science and meteorology have also benefited from NASA/MSFC technology transfer activities. A vision screening system developed at NASA/MSFC is helping the Vision Research Corporation of Birmingham, AL detect vision abnormalities and diseases in hundreds of thousands of children across the United States. The system involves photographing the children's eyes and analyzing the patterns reflected from them. Different eye abnormalities and diseases cause the eyes to reflect light in different ways. Each abnormality has a reflection "signature," thus permitting immediate diagnosis.

Meteorology has also benefited from NASA/MSFC technology transfer activities. The system provides a storm projection system that allows electric utilities and emergency management officials to plot dangerous storm's projected movements. Baron Services developed a means of changing the computer generated data into audio data for transmission by radio station sub-carriers for reception by clients through an antenna, and decoded by computer display. Surely, all of these instances of transferring NASA/MSFC technologies to the private industry helped to push outward our nation's production possibility frontier.

This researcher worked closely with fellow researcher, Christina Mastrangelo in developing a methodology for analyzing technology assistance data for evidence of economic impact on the SE region. Actual survey results from leading SIC codes in manufacturing and service industries in the SE region are compared to the U.S. Department of Commerce values. These data, although tentative, do lend support to our contention that technology assistance of NASA/MSFC contributes to shifting outward the ppf; at least in the eleven major industries studied.

Conclusions and Recommendations

This researcher has gained a great deal of insight into the operations of the Technology Transfer activities of NASA/MSFC over the three summers spent as a Summer Faculty Fellow. It is the desire of this researcher to continue as a consultant to the Technology Transfer Office in the future.

Based upon the experiences and background gained over the past three years, several recommendations are listed briefly below.
(1) Continue integration of technology assistance data of NASA/MSFC with comparative data from the U.S. Department of Commerce to demonstrate the impact of NASA/MSFC technology spin-offs on the primary industries assisted.
(2) Add several questions to the TTA questionnaire instrument sent out by TecMasters, Inc., and continue collecting and refining data from the Southeast Alliance technology assistance surveys.
(3) Continue to develop success stories in cooperation with business partners, but concentrate on stories illustrating human interest factors, as well as jobs and productivity improvements.

References

[1] Collinge and Ayers, Economics by Design, (Prentice Hall, 1997), pp. 42 - 47.
[2] Dennision, E.F., Trends in American Growth 1929 - 82, (Washington, D.C., The Brookings Institution, 1985), p. 15ff.
[3] Romer, Paul "Capital Accumulation and Long-Run Growth", in R. J. Barro, Modern Business Cycle Theory, (Cambridge, Mass., Harvard University Press, 1989).