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ANY PEER COMPETITORS OUT THERE? AN ECONOMIC
PERSPECTIVE TO THE GROWTH OF POTENTIAL PEER
COMPETITORS

by

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Abstract

This paper attempts to determine whether or not a peer competitor nation will arise within the next 25 years by examining a nation's potential for economic growth. An econometric model is used to assist in the formulation of this forecast. This model develops a linear regression to relate national indicators such as levels of investment, population growth, education and energy production to gross domestic product (GDP) growth. The use of the model is limited to that of "bracketing" possible rates of GDP growth. Using this model, China's potential for reaching peer status is examined in detail. Through this examination it is determined that China does not have the potential to reach peer competitor status within the next 25 years. China faces too many obstacles in terms of developing its energy production infrastructure and providing the necessary means to stop the erosion of its environment. These tasks will necessitate the investment of large sums of money which will compete with investments into the commercial and industrial sectors. As such, it is unlikely that China will accelerate its rate of GDP growth to levels above the phenomenal growth rates that it experienced during the decade 1980-1990. Plausible rates of growth will not support the build-up of a military force which could present itself as a peer competitor to the forces of the United States.

Chapter 1

Peer Competitors

Peer Competitor Defined

During the next 25 years the United States will face unknown challenges in terms of its national security. These could range all the way from peacekeeping operations to full scale, conventional warfare. For all of these scenarios, the United States must be prepared to protect its interests, whether they be economic or political. The question addressed in this paper is whether or not the United States will see the emergence of a threat at the high end of the threat spectrum, a “peer competitor.” This paper will discuss the likelihood of the emergence of a peer competitor from an economic and energy resource perspective.

What is a peer competitor? In Jeffrey Barnett’s book, *Future War*, the author discusses the possible threats that the United States may face within the next 25 years from a peer competitor nation that would rival the United States in terms of military strength. The peer competitor would be capable of fielding multiple major military systems and providing support for them. Historic examples of peer competitors include the Soviet Union and Nazi Germany. The author refines the definition of a peer competitor’s military capabilities by presenting a framework of five attributes of weapons

systems. These attributes are information; command and control; penetration; precision; weapons of mass destruction; and size of force. The peer competitor will have an indigenous information infrastructure dedicated to military purposes. Its command and control system will provide near real time control of his assets. Its penetration abilities will allow strikes on targets in near real time through an automated delivery system. The precision of its weapons will allow the nation to strike targets with multiple, different weapon systems. The peer competitor will have not only weapons of mass destruction but also have the ability to reach the United States with these systems. Lastly, the peer competitor would be able to field forces of roughly the equivalent size as those forces of the United States.¹

Relevance to the United States

The emergence of a peer competitor to the United States will have implications for the force structuring of the U. S. military. As a peer competitor will have forces based on high-end technology, the United States should find itself continuing to keep its technological edge. On the other hand, if no peer competitors are likely to emerge, then the United States could reform its force structure to handle contingencies that do not involve a peer competitor. In this case it could continue to pursue technological developments but could focus most of its efforts on the acquisition of resources to meet contingencies of a lesser scale.

The tradeoff between the development and procurement of the F-22 versus the procurement of more C-17 aircraft illustrates this discussion. The F-22, with its stealth characteristics, would serve to meet the threat of a peer competitor. On the other hand,

increasing the buy of C-17 aircraft would greatly improve the ability of the global reach of the armed services to handle a wide range of military operations. This type of tradeoff will become important as financial resources for military procurements become limited during the next twenty-five years.

Many factors can contribute to the emergence of a peer competitor. They include both the will of a nation and its sources of power: economic, diplomatic, moral, and military. The thesis of this work is that no peer competitor will arise to challenge the United States within the next 25 years because the economic growth rates of countries will not support the development of military forces equivalent to those of the United States.

This paper will develop a framework with which to analyze the potential of nations to reach peer competitor status. This framework will then be used to analyze the potential of China to reach peer competitor status. China presents the strongest potential to arise to peer status because of its large population and resources. A second choice for examination might be Japan. However, the economy of Japan is tightly linked to that of the US. Japan benefits from a strong relationship with the US in two ways. First, the close military relationship that Japan shares with the US affords Japan security with respect to the potential development of a hostile China or other Asian nation. Secondly, Japan is strongly linked economically with the US. Our markets account for roughly 30 percent of Japan's exports.² Japan's energy demands require that it import 84 percent of its energy sources.³ Of this, the US provides large amounts of coal for steam generation and metallurgical purposes. For these reasons, Japan is not examined in this analysis. Instead, China is examined in detail as the next potential peer competitor..

Notes

¹ Jeffery R. Barnett, *Future War An Assessment of Aerospace Campaigns in 2010*, (Maxwell Air Force Base Alabama: Air University Press, Alabama, 1996): xviii-xx.

² The Europa World Yearbook, Vol. 1, (London: Europa Publications Limited, 1996), 1752.

³ The World Resources Institute, *World Resources 1994-1995*, (New York: Oxford University Press, 1994), 335.

Chapter 2

Methodology

Comparing Military Power

The military power of a nation is comprised of many factors including its relationship to the civilian leadership, internal leadership, training and equipment. This paper concentrates on potential peer competitors' abilities to equip their forces. The size of a nation's gross domestic product (GDP) is one of the best measures of a nation's sources of wealth which it may use to support a military force. Figure 1. National Economic Processes shows a rough flow of resources within a nation.

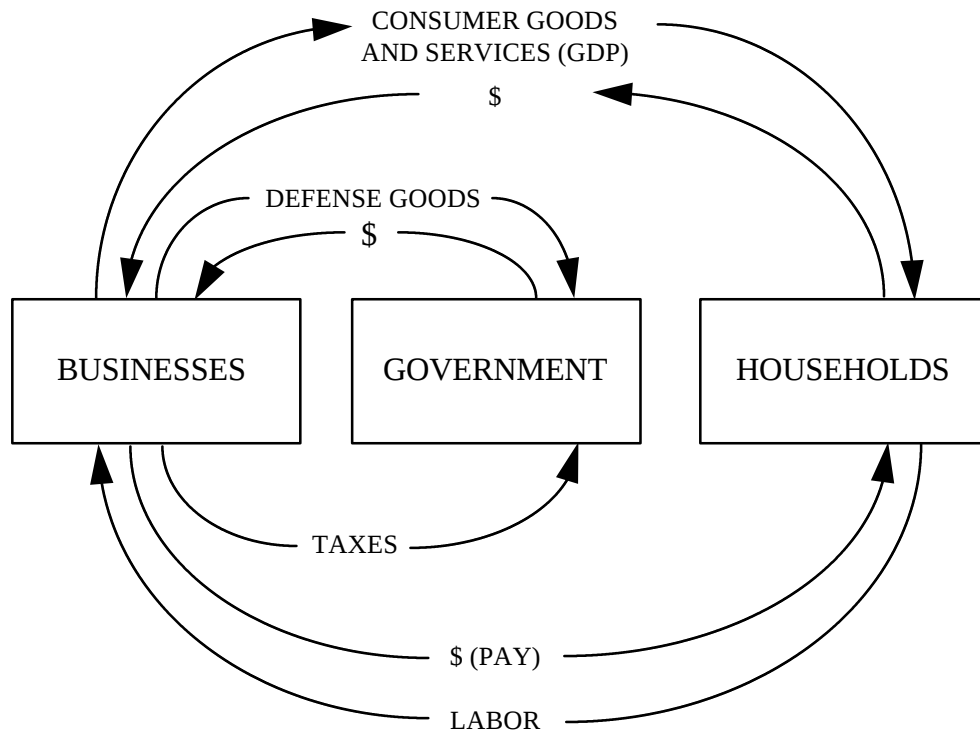


Figure 1. National Economic Processes

To determine how many defense goods a country may purchase, we must first estimate the size of the GDP. Once a GDP is estimated, the next step is to look at the effects on the GDP from allocating funds for defense requirements. The heavy spending on war materials during World War II provides a good example of how the GDP can be influenced. Nearly every country involved in World War II saw the growth of its GDP decline either during or immediately after the World War.¹ This may have been attributable in part to the large amounts of money that had to be diverted to the government to support war efforts which contributed no value added to nations.

The object of this paper is to develop methodologies and rationales to project the GDP growth of several nations so that an economic comparison can be made between the United States and potential peer competitors. The analysis will concentrate on the status

of each country's energy resource availability and process of development, its demographics, and its economic status.

GDP Growth Estimation Model

A regression analysis is used to develop sensitivity parameters between different national statistics (independent variables) and the GDP or the growth rate of the GDP (dependent variables). A least squares regression using data from a large cross section of countries compares a single statistical parameter to another national indicator (for example, investment as a percentage of GDP, to the rate of change of the GDP). The intent is to find sensitivities to changes in these parameters to the rate of change of GDP over a number of countries to see if correlations do exist between statistical parameters and GDP growth. This does not attempt to find a causal relationship between parameters, but rather a correlation. The results of the correlations will be the “bracketing” of nations in their patterns of growth.

Equation represents a theoretical relationship:

$$\begin{aligned} \text{GDP growth rate} = & b_i (\text{investment}) + \\ & b_p (\text{population growth}) + \\ & b_e (\text{education factor}) + \\ & b_g (\text{government spending as portion of GNP}) \end{aligned}$$

Equation 1

Where $b_i, b_p, b_e,$ and b_g are sensitivity coefficients of their respective variables. The results of the cross country regression analysis were based on analysis using up to 43 nations, listed in Appendix A, each with populations over 15 million. The results are

shown in Table 1. Sensitivity Coefficients, for statistical data of countries from 1980-1990. Standard deviations are shown in parentheses below each sensitivity parameter.

Table 1. Sensitivity Coefficients

Sensitivity Coefficient	Statistic	Standard Deviation	Confidence that Relation Exists	Validity
$b_i = .111$	Investment as percent of GDP to GDP Growth	.047	>99%	Robust
$b_g = -.021$	Government Spending as % of GDP to GDP Growth	.031	<75%	Fragile
$b_p = .024$	Population Growth Rate to GDP Growth	.344	<75%	Fragile
$b_e = .01$	Percent enrolled in secondary education (average 1965-1989) to GDP Growth	.01	<75%	Fragile

Source: World Bank, *World Development Report 1992*, (Oxford: Oxford University Press, 1992), Table 2, Table 9, Table 11, Table 26, Table 29.

Many other national indicators were analyzed to look for correlations to the growth of the GDP. However, none of these statistics showed a strong correlation to the rate of growth of the GDP; all showed a less than 75 percent confidence that a correlation existed.

Investment

Investment as a percent of GDP and population growth showed over a 99% confidence that a relation does exist between investment and the growth of the GDP. These relationships are depicted in Figure 2, Sensitivity of GDP Growth to Investment. The relationship between investment and GDP growth also follows from the Cobb-Douglas equation:

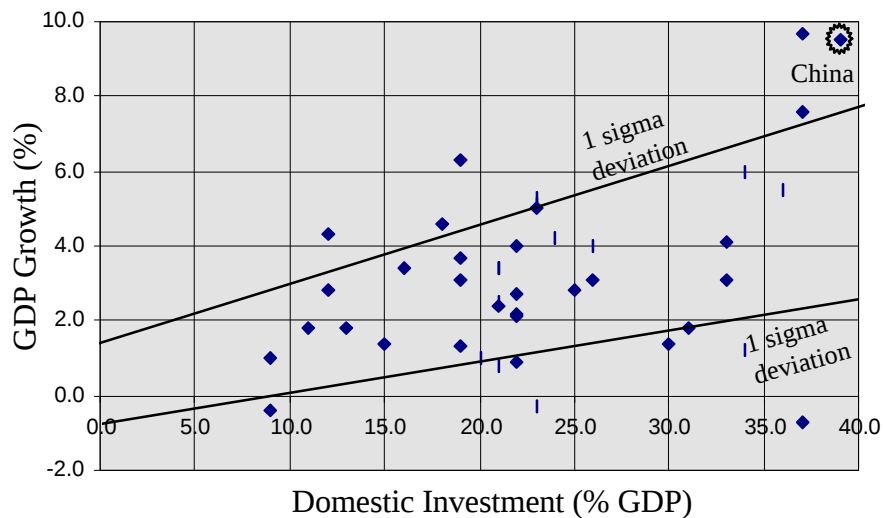
$$\text{GDP} = (\text{Labor})^{(1-a)} (\text{Capital})^a (\text{total productivity factor})$$

Taking the derivative with respect to time leads to:

$$\begin{aligned} \text{GDP Growth/GDP} = & (1-a) (\text{Growth of Labor})/(\text{Labor}) + \\ & (a) (\text{Growth of Capital})/(\text{Capital}) + \\ & (\text{Growth of total productivity factor})/(\text{total productivity factor}) \end{aligned}$$

Equation 2 Cobb-Douglas Relationship

Where “a” is the proportion of GDP allocated to capital. One can see that the rate of growth of GDP is proportional to the growth of capital. The growth of capital requires investment. Therefore, countries with high levels of investment showed significant rates of growth. This result is corroborated by the work of other



economists.²

Source: World Bank, *World Development Report 1992*, (Oxford: Oxford University Press, 1992), Table 2, Table 9.

Figure 2. Sensitivity of GDP Growth to Investment

Demographics

On the other hand, the model showed little correlation between population growth and growth of the GDP as would be expected from the Cobb-Douglas Equation cited above. It appears that growth of a labor force is not purely related to the growth of a

nation's population when all of the countries were considered. However, if a smaller subset consisting of the less developed nations is used for the analysis, a mild negative correlation between the rate of population growth and the rate of GDP growth exists as shown in Figure 3 below. This trend may be accounted for by the fact that many of the lesser developed countries still have large agrarian sectors. While the increase in human capital is contributing to overall output, it is not contributing as much as an increase in human capital would contribute if it were in the industrialized sector. Measures to control population growth in lesser developed countries may assist nations in improving their overall prosperity. On the other hand, little correlation was found to exist between population growth rate and GDP growth in the industrialized nations.

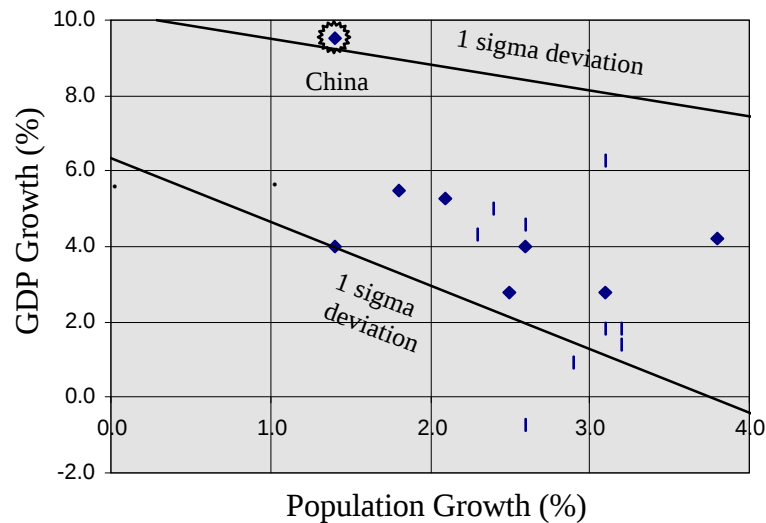


Figure 3. Sensitivity of GDP Growth to Population Growth in 17 Poor Countries

Little correlation exists between the level of education and the growth of a nation's GDP when all countries were examined. This lack of a strong relationship was shown in Table 1 above. However, Figure 4 below, which is derived from analysis using the 15 poorest countries shows a strong positive correlation between educational levels and

growth. Not only does education support correlate to the growth rate, it is also correlated to the GDP of a nation. Figure 6 below shows a logarithmic relationship between the percent of the population who attended secondary to the gross domestic product. The same logarithmic relationship exists between tertiary education and the GDP as also shown in Figure 6. Increasing percentages of education are necessary to perform the complex tasks associated with productivity within industrialized societies.

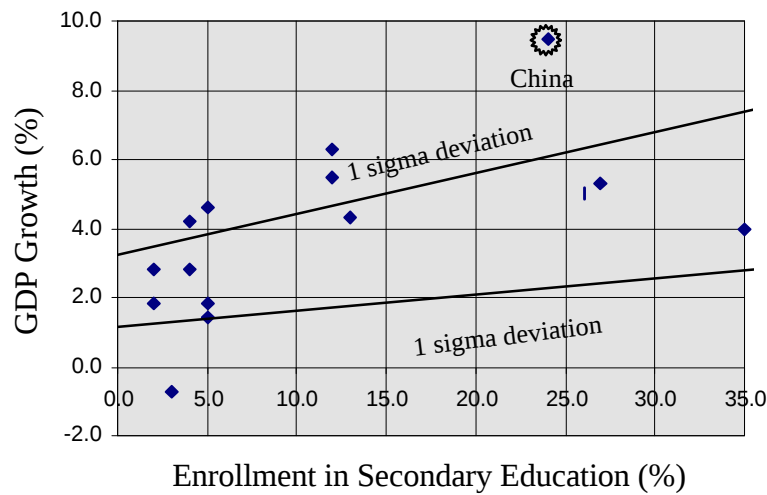


Figure 4. Sensitivity of GDP Growth to Education in 15 Poorest Countries

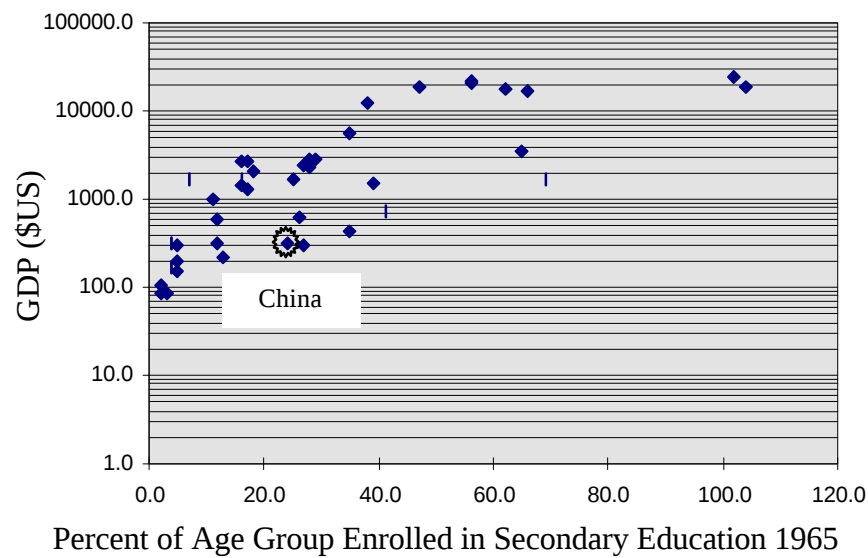


Figure 5. Secondary Education and GDP

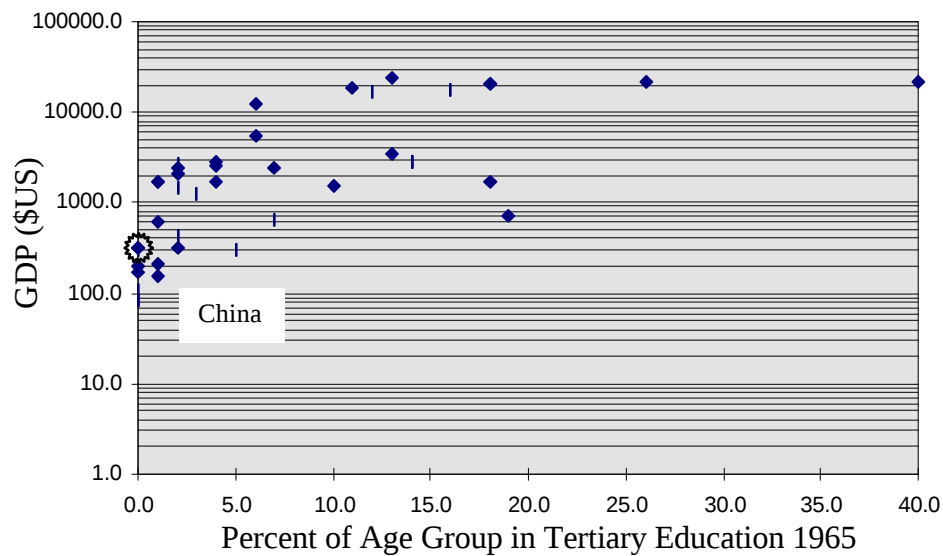


Figure 6. Tertiary Education and the GDP

Government Spending

The last national statistic that is presented is government spending and its relationship to GDP growth. As presented in Table 1, government spending appears to have little correlation to the growth of the GDP. This is likely because governments vary

greatly in their efficiency, levels of corruption and abilities to provide services to their respective countries.³

Correlation Summary

Table 2 below summarizes the significant correlations between country parameters. These parameters will be referred to in the next chapter to assist in analyzing Chinese economic growth.

Table 2. Sensitivity Coefficient Summary

Sensitivity Coefficient	Statistic	Standard Deviation	Confidence that Relation Exists	Validity
$b_i = .111$	Investment as percent of GDP to GDP Growth (all countries)	.047	>99%	Robust
$b_p = -1.84$	Population Growth Rate (poor countries only)	.74	>97%	Robust
$b_e = .079$	Percent enrolled in secondary education (average 1965-1989), 15 poorest countries	.034	>97%	Robust
Not Applicable to Log Function	Secondary Education to per capita GDP (all countries)		From visual inspection	Robust
Not Applicable to Log Function	Tertiary Education to per capita GDP (all countries)		From visual inspection	Robust

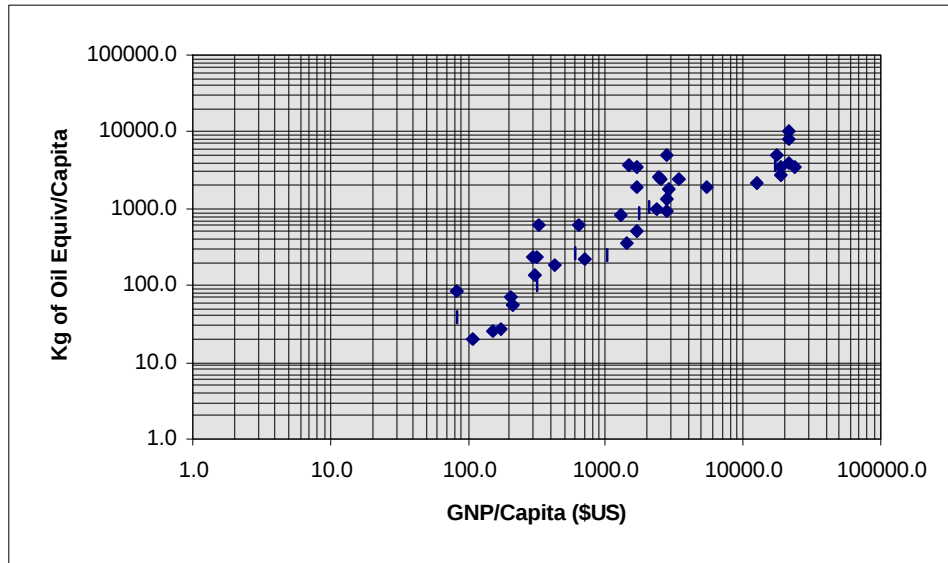
Source: World Bank, *World Development Report 1992*, (Oxford: Oxford University Press, 1992), Table 2, Table 26, Table 29.

Detractors from GDP Growth

Energy Requirements

As nations move from agrarian intensive economies to industrial-based economies, they increase their reliance on energy. Energy is used to transform raw materials into

finished goods and services. The relationship between energy consumption can be seen by examining Figure 7. Energy Consumption per Capita vs GNP per Capita. This table shows that the elasticity of energy growth to GDP growth is roughly 0.5. While industrialization requires more energy as shown by this elasticity, nations are able to increase their efficiency of energy consumption as their economies grow. This would account for the fact the elasticity is less than one. As countries increase their wealth, their demand for energy increases and must be met by either domestic production or importation.



Source: World Bank, *World Development Report 1992*, (Oxford: Oxford University Press, 1992), Table 3, Table 5.

Figure 7. Energy Consumption per Capita vs GNP per Capita

How can countries with no energy resources expand their economies? Japan, Korea, and Singapore are excellent examples of countries with limited energy resources that have demonstrated strong economic growth. Each of these countries is highly dependent upon other countries for coal or oil fuels. It appears that in industrial nations the cost of energy to make products is small in comparison to the value of the final products themselves. For

example, an energy intensive product, steel, requires only 314 pounds of coal for production of a ton.⁴ In current prices, the ton of steel is worth about \$460 while the coal required for production costs only \$10.⁵ While the cost of the energy is almost insignificant, a country must first have the ability to gain access to raw energy resources and to convert raw resources into useful forms such as electricity. For this, countries must develop their conversion and distribution infrastructures by either domestic or foreign investment. Either of these investment activities may result in decrease GDP growth: every dollar invested in energy production development subtracts a dollar that could be invested in other commercial or industrial sectors. If foreign investors pay for the fixed assets necessary to develop energy extraction, conversion and distribution infrastructure, the growth of the GDP may still suffer because foreign investors will demand a portion of the profits from the sale of energy resources. This profit will leave the country and not be available for further investment. However, this reduction in the growth of the GDP is offset by the growth of industry that is enabled by the development of the energy sector. The overall result is that the GDP will grow as the energy sector grows, but not as fast as it could have grown if the energy sector were previously in place.

Defense Expenditures

In a similar manner to the above discussion of energy, it is assumed that defense expenditures do not contribute to the overall GDP in a tangible sense. Therefore, money invested into the defense establishments of nations does not result in a “return on the investment” to the GDP. Therefore, money spent on defense subtracts from resources that otherwise would have been available for investment. This approach is supported by history; large military expenditures do have an adverse effect on economies. The former

Nazi Germany prior to World War II and the United States during World War II offer examples of nations who expended large portions of their GDPs on defense spending.

Nazi Germany increased its spending on armaments from 15 percent of national income in 1934 to an amount that exceeded national income in 1941. The only way the German economy stayed afloat was through the acquisition of forced labor from newly occupied territories.⁶

The US increased its military spending to 41 percent of the gross national product (GNP) by 1944.⁷ The rate of growth of the GNP per capita decreased from nearly eight percent per year in 1941 to less than zero in 1945.⁸ Clearly, increased military expenditures do have deleterious effects on the growth of a nation's wealth.

Notes

¹ W. W. Rostow, *The World Economy History and Prospect*, (Austin and London: University of Texas Press, 1978): 375-550.

² Ross Levine and David Renelt, "Sensitivity Analysis of Cross Country Growth Regression," *American Economic Review*, Vol. 82, (Sep 92), 942-963.

³ Levine and Renelt, "Sensitivity Analysis," 949.

⁴ Vaclav Smil, *China's Environmental Crisis An Inquiry into the Limits of National Development*, (Armonk, New York: M. E. Sharpe, 1993), 124.

⁵ Knight-Ridder Financial Commodity Review, *The CRB Commodity Yearbook 1996*, (New York: John Wiley and Sons, Inc., 1996): 145. The price for hot-rolled steel is \$0.23/pound which equates to \$460 per English ton. The costs of coal to produce a ton of steel is calculated as follows: (450 kilowatt-hours energy per tonne) (.432 kg coal per kilowatt-hour) (\$50 per English ton). Energy figures from Smil, "China's Environmental Crisis," 124. Coal price from article *When Will Prices Ignite on the Spot Market?*, *Journal of Commerce and Commercial*, September 13, 1995, Vol. 405, no. 28558, 1C.

⁶ Otto Nathan, *Nazi War Finance and Banking*, (New York: National Bureau of Economic Research, 1944): 96,97.

⁷ Henry C. Murphy, *The National Debt in War and Transition*, (New York: McGraw-Hill, 1950): 58.

⁸ W. W. Rostow, "The World Economy History and Prospect," 388.

Chapter 3

United States Outlook

To economically compare another country to the United States, it is necessary to define the future budget for the United States military. It is assumed that the military spending will continue to be proportionate to discretionary spending. The future size of discretionary spending is a subject of intense debate within Congress and the White House. Although both the parties have differing views as to the actions necessary to balance the budget, both parties agree that the budget must be brought into balance. However, balancing the budget within the next decade and in the long term requires the solutions to two significant problems.

First, the U.S. debt as of 1995, has grown to 51% of the gross national product. If the debt continues to increase, interest on this debt will consume a larger and larger portion of the GNP. Secondly, the first “baby-boomers’ will reach retirement in 2008 and start a major change in the demographics of the U.S.

The Congressional Budget Office estimates that if no action is taken to change the spending policies of the United States, there is a 15 percent probability that the national debt will rise above 200% of the GNP in the year 2020. This probability will increase to 40 percent by the year 2030. An economy with a debt this high is not sustainable.¹

A sustainable strategy that precludes a spiraling increase of debt is proposed whereby discretionary spending is limited to current spending levels and Medicaid is limited to grow at the same rate as the economy. In this way, the national debt and deficits can be contained to sustainable levels. This means a likely scenario for military spending is one where military spending continues at the current level (about \$251 billion in 1996) and increases only with the rate of inflation.²

Notes

¹ The Congress of the United States, *The Economic and Budget Outlook: Fiscal Years 1997-2006*, (Washington, D.C.: Government Printing Office, Washington, 1996): xxiv.

² The Congress of the United States, "The Economic and Budget Outlook," (Washington, D.C.: U.S. Government Printing Office, 1996): 1996, 92. *Defense 96*, (Washington, D.C.: U.S. Government Printing Office: September, 1996): 11.

Chapter 4

China

Overview

Will China grow economically large enough to become a peer competitor within the next twenty-five years? If it is to do so, it faces many challenges. Although it has shown a miraculous growth of its GDP of over nine percent during the last decade, it is questionable whether it can sustain this rate of growth over the next two decades because it has grown quickly without making the necessary investments in its infrastructure and its people. China's emphasis on industrial growth has placed great strains on its energy production and distribution infrastructure and caused increased environmental degradation. It has overheated the economy resulting in a corresponding rise in inflation, placed economic growth in front of education, and resulted in increased regionalism amongst the provinces. For these reasons, there is little room to significantly increase the military budget to bring Chinese forces to "peer" status.

Economic Status and Prospect

Status

Figure 2, Sensitivity of GDP Growth to Investment one sees that China's growth significantly exceeds the growth rate that the regression analysis would predict for the level of investment in China. Secondly, one sees that the level of investment, 39 percent of GDP, is the highest level of investment of all countries examined. This excellent growth rate and level of investment are the results of several factors.

First, China dramatically restructured its economic system towards an open market, capitalist system. After the disastrous effects of the Great Leaps Forward in 1958-1961 and Cultural Revolution in 1976-1978 where 30 million died, China's leadership was forced to relinquish much of its economic power to the provinces. This failure of centralized planning during the Cultural Revolution forced provinces to develop local distribution systems and small and medium size enterprises. Although state owned enterprises still existed, China was able to reallocate large segments of its agrarian work force to the developing non-state owned sector of the economy. China was able to increase its total productivity factor because it was able to transfer a significant amount of its agrarian labor force to the industrial sector.¹ Now that the shift of labor from agriculture to industry has occurred, it remains to be seen whether or not China can continue to increase its total factor productivity. If it cannot, it is likely that China's relationship between GDP growth and investment would compare more closely to the rest of the countries of the world.

Coupled with the changes brought by these reforms, China has sustained a high level of investment. Unlike other countries in transition from economies with centralized planning, China did not have a severe external debt. China has maintained this low debt to GNP ratio; it was only 1.5 percent of GNP in 1990. Therefore prior to 1988, China did not have to implement austerity programs and so heavy investment was possible.

Prospects

Will investment remain as strong? Although much of this investment is from household savings in the state owned banks, there were also large amounts of investment from foreign sources. In 1992, \$45 billion was invested by foreign investors, seventy percent of which was from Hong Kong and Macao. These two entities have served as economic bridges between China and the rest of the world. It remains to be seen if Hong Kong can serve in this same capacity after its incorporation into China.

This British Colony is guaranteed a separate status for the first 50 years after its incorporation into China. In spite of this, the Chinese government may adversely affect Hong Kong's investment by levying taxes on Hong Kong. Its per capita GNP of more than \$10,000 (1990) would be an easy target for taxation.

Much of China's high rate of growth is mainly attributable to increased industrialization along the eastern coast. In Shanghai, the GNP per capita is 3.75 times the national average. The industrial provinces have flourished sometimes at the expense of the other provinces. This has created tensions between the industrial provinces and those which supply raw materials. As an example, coal pricing until recently was managed by the state.² As a consequence, the state run coal company has operated at a loss. At the same time, this allowed industrial areas, such as Shanghai, to profit by

utilizing relatively cheap energy. As China allows more and more of its energy resources to fluctuate with the market, it may see more productivity and growth in energy producing provinces at the expense of the industrial provinces. This may alleviate some inter-regional tensions but also reduce industrial growth.

In some cases, the disparity in economies has led to the use of military force. In 1993, the Guangdong province with its superior purchasing power, offered to buy goods from suppliers in the Hunan province at prices above those set by the Hunan leadership. Hunan actually used troops to prevent the shipment of these goods to Guangdong.³ This is not an isolated case as commodity wars exist between provinces over items including rice, wool, soy beans, tobacco, coal, and steel.⁴

Not only are there economic difficulties at the provincial level, but also at the state level. China's 9-10 percent GDP growth during the 1980s has been miraculous in that China was able to control inflation. However, in the early nineties inflation steadily increased and the yuan has become devalued against the dollar. Inflation rose to 24 percent in 1994. A significant factor leading to this high rate of inflation is the Chinese government's continued support of state owned enterprises.

China still has many state owned enterprises and it is estimated that 40 percent of these operated at a loss during 1994. This is down from 60 percent in 1993, but still represents a sizable portion. These enterprises have continued to receive loans from the Chinese central banking system to pay-off their debts even as their productivity continues to decline. The Chinese central banking system has in turn printed more money to provide the needed funds. As such, the general measure of money, M2, has grown an average of 29 percent a year from 1990 to 1994.⁵ However, it wasn't until 1994 that inflation rose

significantly to 24 percent. In spite of this significant rate of inflation, the Chinese central bank continues to provide loans at artificially low rates to stimulate economic activity and keep state owned enterprises from declaring bankruptcy. The result is that China is falling further into debt.

As China's center finds itself further in debt, it also has found itself pressed to collect domestic revenue to payoff some of this debt. Since the reforms began, local entities and provinces have retained larger and larger shares of tax revenues for themselves. In 1978, fiscal revenues collected were 31 percent of the GDP. As a result, China's infrastructure is being developed by the provinces. By 1993, this revenue had fallen to 13 percent with about half of this revenue going to local governments.⁶ In 1995, China instituted tax reforms which included a 17 percent value added tax of which 75 percent was to be collected by the central government.⁷ This will go a long ways towards bringing money back to the federal coffers but will also dampen investment as the public will have less money with which to invest.

Therefore, the prospect for continued strong economic growth is dampened. China will not see another appreciable gain in total productivity factor due to a shift from an agrarian work force to an industrial work force. Investment levels could fall if Hong Kong and Macao are not allowed to continue to operate as they have in the past. Investment may also fall as China is forced into regulating inflation by tightening the money supply. China will need to increase its tax revenues instead of printing money. Additional taxation would also dampen investment. It is not foreseeable that the growth rate of the GDP will accelerate.

Demographic Status

China has successfully slowed its rate of population growth to 1.5 percent a year and it is projected to slow even further to .78% per year. As this rate of growth continues to slow, China could see a slight increase in the rate of GDP growth according to the model derived in Chapter 2. According to the sensitivity found in Table 1. Sensitivity Coefficients, a decrease in population growth of .72 percent will lead to an increase in GDP growth rate of .18 percent.

In terms of human labor, China is increasing its efforts in education. Because of the anti-intellectualism of the Maoist period, only 25 percent of the eligible age group were enrolled in secondary education in 1965. In spite of this moderate level of education during this time period, China still was able to create a climate for economic growth during the 1980s. The percentage of eligible population enrolled in 1989 has grown to 44 percent. This increase in the “investment” in human capital will manifest itself by increased productivity within the next 20 years as the individuals who benefit from education apply themselves to economic endeavors. Using Table 2. Sensitivity Coefficient Summary as a guide, this increase from 25 percent to 44 percent will result in an increase in GDP growth of over one percent.

However, China still lags other industrial nations in tertiary education: only two percent of its age group eligible for tertiary education were enrolled in 1989. The industrial nations average 22% enrollment in tertiary education of those eligible. This lack of tertiary education will likely manifest itself as a lack of a strong scientific and engineering sector.⁸ If China hopes to increase its economic wealth, it will need to invest

more heavily in its education. This investment will require significant amounts of funds to be diverted from commercial investment to education.

Energy

China contains much of the world's energy reserves. Most of these reserves are in the form of coal which, at China's current rate of consumption, could support China's energy needs for hundreds of years.⁹ Therefore, in China's case, it is not a question of whether or not China has sufficient reserves to fuel its needs. Instead, we must ask how fast China can expand its energy resource extraction, energy production and energy distribution infrastructure to support its current rate of growth.

How fast must China increase its production capability? A linear regression to find the elasticity between energy usage and GDP in Table 3 of the preceding section results in an elasticity of approximately .5. Over the last decade China has demonstrated a growth in its energy consumption that is consistent with this figure. This is because China's inefficient systems from the Soviet Union and Eastern Europe are being replaced with more modern and efficient systems from the West.¹⁰ If China's growth is to continue at 9-10 percent, then its energy requirements will need to grow at nearly five percent per annum. From 1980 to 1990, China's energy consumption grew at a rate of three percent per year.¹¹ This is slightly below what should be required to maintain a strong economic growth. However, to China's credit, its coal production is increasing at a favorable rate. It grew from 714 million metric tonnes in 1983 to over 1,200 million metric tons in 1994.¹² This is an increase in production of nearly 5 percent per year. Yet, this is still not sufficient to meet China's energy needs. In 1992, coastal factories were operating at 75

percent capacity because of power outages.¹³ Additionally, 120 million Chinese have no electrical power at all.

Why is there a shortage of power while raw energy production continues to rise? The answer lies in China's need to improve its distribution infrastructure. Much of China's coal reserves lie in the North and most of China's hydroelectric generating stations lie in the South while the east coast has become the center of industrialization. Either coal must be converted to electricity near the extraction sites in the north, or the coal must be transported for conversion to electricity in the industrial provinces. Either of these options leads to additional costs.

Only a limited amount of coal can be converted to electricity near extraction locations because limited water exists for power generation purposes. For instance, in the Shanxi province where a large portion of the coal is extracted, there are only 7.8 billion cubic meters of water available. However, the Chinese current plan to produce 20 to 24 gigawatts of power within the province by the year 2000 will require 12 million cubic meters of water. This clearly exceeds the resources available.¹⁴

Therefore, ways must be found to transport coal to locations for conversion to energy that are not located close to the mining operations. Unfortunately, the transport of coal already takes up 40 percent of China's rail traffic.¹⁵ China is only spending 1.4 percent of its GNP for railway maintenance and improvement. This is less than one half of the proportion spent by either India or Brazil to improve rail traffic.¹⁶ China officially stated that it would spend \$28 billion over the next five years to upgrade the rail system but has yet to explain from where the money will come.¹⁷

China is pursuing other alternatives to rail transport of coal. A U.S.-Hong Kong consortium will develop a 500 mile slurry pipeline to transport coal from northern China to the coast. This \$900 million project will be completed in 3 years and carry 15 million tons of coal per year. Coal will be cleaned at the mine mouth to remove impurities which account for up to one third of the weight of coal transported by rail traffic. Large amounts of water will be required to form the slurry. Additionally, by cleaning the coal it can be burned near to industrial centers and create significantly less pollution. Taking this as an example of the investment required to bring coal to use, one can calculate that at least \$4 billion will be required each year for transport to meet the required energy growth of 5 percent per year.¹⁸

Not only does coal extraction and distribution require investment, but power generation also requires extensive investment. Western analysts believe that China's power production could grow at a rate as low as 3 percent per year.¹⁹ Official Chinese projections show a growth rate of 8 percent per year.²⁰ At a typical capital cost of \$1536/kilowatt generating capability using fossil fuels, this will require an annual investment ranging from \$6 billion to \$21 billion per year.²¹ Even if this money is available, foreign firms find it difficult to initiate projects. In 1994, out of 50 power plant projects that were proposed, only two projects were approved. Firms express concern that China bureaucrats intentionally delay contracts to discredit other bureaucrats as part of political power struggles.²² As well, China has recently started to limit the amount of profit that foreign firms can realize on their investments. Some firms have decided to look for other countries in which to do business.²³

Significant investments in China's energy extraction, distribution and conversion infrastructure are required to sustain China's economic growth. In the recent past, these investments have marginally met the needs of the country as evidenced by the power outages of China's coastal regions mentioned above. Additionally, coal and electrical power production will continue to place further demands on China's limited water supplies. For these reasons, it is likely that increased investment in China's energy infrastructure will be required. These investments may "crowd-out" investments in other sectors and thereby slow economic growth.

Environment

One must also consider other costs associated with China's growing energy production. Only twenty percent of the coal burned in China is cleaned before combustion. As a result, large quantities of sulfur gases are released into the atmosphere. The daily average for cities in the northern zones is 600 micrograms/meter. This is six times the sulfur content of the air over American cities.²⁴ The problem has become so immense that much of China's pollution now drifts to the airspace above Japan.

Air pollution is not the only environmental effect that has resulted from the increase in energy production. The development of hydrostations has led to the loss of arable land. During the 1980s, every 100 gigawatt-hour of generation capacity led to a loss of 50 hectares of land and the displacement of 560 people. If this trend continues, by the end of the 1990s approximately 1 million people could be displaced.²⁵

The Chinese have estimated the loss due to environmental deterioration to be extensive. Just in the years 1988 and 1989, the losses were \$7.4 billion and \$10.1 billion

respectively. Yet the Chinese only spent roughly \$25 million to protect the environment during the entire 1980s.²⁶ The Chinese government estimates between \$6 billion to \$9 billion per year will be required to recover and protect the environment of China. If funds diverted to clean-up subtract from the amount that is available for investment in commerce, the GDP growth rate may slow by 0.2 percent according to the model of Chapter 2.²⁷ Other sources project a decrease in GDP growth by as much as 1.5 percent.²⁸

Outlook

Economic

China will have to overcome severe financial obstacles if it wishes to divert a significantly greater portion of its budget to military expenditures during the next 25 years. Large investments will continue to be needed in the areas of infrastructure, environmental protection, and human capital. Industrial growth has outpaced infrastructure growth. As the infrastructure is crucial to continued growth, China will be forced to bring the infrastructure up to support its industrial growth. It can ill afford to reallocate large sums of money to its military forces. At the very best, China could continue to grow at the same rate of 9-10 percent that it saw during the last decade.

Other factors, however, may eclipse this growth rate. As mentioned before, China saw a large increase in its total productivity as labor was shifted from the agriculture sector to the industrial sector after 1978. This shift of labor from agriculture to industry may slow during the next decade.²⁹ Secondly, Chinese economy has shown “stop-go”

swings in growth as inflation increased significantly during 1988 and 1994. In each case, the Chinese government used austerity measures to slow growth and inflation.

Military Forces

If China can sustain a 9 percent rate of growth over the next twenty-five years, its GDP could be as high as \$5-6 trillion. At its current level of military expenditures, this would extrapolate to defense spending of \$77 to 92 million per year.³⁰ This is a significant amount, but it is significantly less than the projected budget for the United States (today's budget growing with inflation). And one must look at where the Chinese forces are today in terms of size and quality of equipment.

China's military is a contradiction. Although it is perhaps the world's largest with roughly 3 million personnel, the quality of its forces varies greatly. While it possesses some state-of-the-art equipment such as Soviet Su-27 Flanker fighter aircraft, a large portion of the Army is equipped with 1950s vintage articles.³¹ Additionally, Deng Xiaoping changed the focus of the military by instructing it to be productive and to develop technology that also serves the civilian economy.³² As such, the Chinese Army has turned into the world's first entrepreneurial force. Some units have bragged about how many pigs they have produced rather than about their warfighting skills.³³ Certainly units that spend a portions of their time working in agrarian activities are not going to be as well trained as the units of countries which occupation their time with only training activities. A large gap exists between an entrepreneurial, agrarian army and the forces of the United States.

However, one may argue that the gap may be shortened if one takes into account the actual purchasing power of the Chinese economy. One may argue that the actual

purchasing power parity of the Chinese economy would be as much as six times as great.³⁴ However, the purchasing power within the international arms market still would be based on the exchange rate of the Chinese yuan. Thus, China would be faced with the two choices: purchasing fewer arms from foreign sources or trying to develop domestic production facilities using a more favorable level of purchasing power parity.

Foreign sources may continue to sell arms to China as long as they perceive that it does not have hostile intentions. If foreign sources of military arms perceive that China is a potential threat, they may be reluctant to sell arms. As an example, Russia recently decided that it would not sell China the means to locally produce Su-27 Flanker aircraft for security and commercial reasons.³⁵

If China decides to equip its forces through domestic sources, it will undoubtedly face the same development times that the U.S. faces for weapon systems acquisitions. Even with a large industrial complex in place, U.S. aircraft require up to fifteen years from inception to initial operating capability. China could face even longer lead times if it desires to domestically produce state-of-the-art weapon systems.

Lastly, China's lack of investment in human capital will manifest itself in yet another form. The operation of complex weaponry requires unique skills and knowledge that are founded on education. A significant increase in education programs will be required to form a basis to adequately train individuals to operate complex weaponry.

Because it is unlikely that China can divert larger sums of money to bolster its defense, it is unlikely that China will arise as a peer military competitor within the next twenty-five years.

Notes

¹ Eduardo Borensztein and Jonathan D. Ostry, "Accounting for China's Growth Performance," *American Economic Review*, Vol. 86, No. 2, May 96, 227.

² "State Run Firm to Sell More Coal at Market Prices," *Journal of Commerce and Commercial*, October 5, 1993, Vol. 398, no. 28076, 7b.

³ "Cut Along the Dotted Lines," *The Economist*, June 26, 1993, Vol. 327, no. 7817, 35.

⁴ David S. Goodman, *China Deconstructs*, ed. David S. Goodman, (New York: Routledge, 1994): 7.

⁵ "Quick, Quick, Slow," *The Economist*, March 18, 1995, Vol. 334, no. 7906, c6-c15.

⁶ "China Feels the Heat," *The Economist*, January 23, 1993, Vol. 326, no. 7795, 31.

⁷ "Quick, Quick, Slow," c15.

⁸ Smil, "China's Environmental Crisis," 92.

⁹ The World Resources Institute, *World Resources 1994-1995*, (New York: Oxford University Press, 1994), 332-337. China has 286,400 million metric tonnes of anthracite, bituminous, subbituminous, and lignite coal. In 1991, China consumed 27,345 petajoules of energy. At this rate, these reserves would last for 306 years. This calculation does not take into account variations in coal quality.

¹⁰ Mark D. Levine, et. al., *Energy Efficiency, Developing Nations, and Eastern Europe*, Report to the U.S. Working Group On Global Energy Efficiency, June 1991, 11.

¹¹ Vaclav Smil, "China's Environmental Crisis," 123.

¹² Peter Hannan, "China to Get World's Largest Coal Pipeline," *Journal of Commerce and Commercial*, Vol. 401, No 28293, (August 19, 1994): 10b. Vaclav Smil, *Energy in China's Modernization Advances and Limitations*, (Armonk, New York, M.E. Sharpe, 1988), 218. 1983 production figure taken from *Energy in China's Modernization*, 1994 production figure projected from "China to Get World's Largest Coal Pipeline."

¹³ "China's Powerless Growth," *The Economist*, Vol. 325, (November 28 1992): 32.

¹⁴ Vaclav Smil, "Energy in China's Modernization," 218.

¹⁵ "China's Powerless Growth," 32.

¹⁶ "China's Powerless Growth," 32.

¹⁷ Josephine Bow, "Making Tracks in China," *Distribution*, October 1995, Vol. 94, no. 11, 24.

¹⁸ A five percent increase of 1.2 gigatons of coal results in 60 million metric tonnes increase per year. This is roughly four times the capacity of the proposed slurry pipeline.

¹⁹ Mark D. Levine, et. al., "Energy Efficiency," Figure 8, 31.

²⁰ Kari Haus, "Gridlock Anyone?," *Far Eastern Economic Review*, Vol. 157, November 10, 1994, 56.

²¹ U.S. Congress, Office of Technology Assessment, "Fueling Development: Energy Technology for Developing Countries," OTA-E-516 (Washington DC: U.S. Government Printing Office, April 1992), Table A-2, 291.

²² Haus, "Gridlock Anyone?," 56.

²³ Haus, "Gridlock Anyone?," 56.

²⁴ Smil, "China's Environmental Crisis," 117.

²⁵ Smil, "China's Environmental Crisis," 114.

Notes

²⁶ Smil, "China's Environmental Crisis," 196,249.

²⁷ Alice H. Amsden, Dongyi Liu, and Xiaming Zhang, "China's Macroeconomy, Environment, and Alternative Transition Model," *World Development*, Vol. 24, no. 2, 283. Analysis based on Table 6 for environmental costs using exchange rate of \$1 = 6.37 rmb (1992). \$6-9 billion is roughly 1.2 to 1.8 percent of the GDP. (1.2 to 1.8) (0.11 from Table 1 of this work) = (.13 to .19 percent reduction in GDP growth).

²⁸ Amsden, Liu and Zhang, , "China's Macroeconomy, Environment, and Alternative Transition Model," 284. The authors estimate a reduction in GDP growth by as much as 1.5 percent.

²⁹ Eduardo Borenzstein and Jonathan D. Ostry, "Accounting for China's Growth Performance," *American Economic Review*, Vol. 86, no. 2, May 96, 227.

³⁰ World Bank, *World Development Report 1992*, (Oxford: Oxford University Press, 1992), 222. Figured by combining the GDPs of China and Hong Kong of 1990 and chainlinking the growth at 9 percent. Projected spending for Chinese defense in 1997 is \$12 million, or roughly 1.6 percent of the extrapolated GDP of 1997.

³¹ Patrick E. Tyler, "China's Military Stumbles Even As Its Power Grows," *The New York Times*, December 3, 1996, Vol. CXLVI, no. 50630, A1.

³² Carol Lee Hamrin, "China and the Challenge to the Future Changing Political Patterns," (Boulder: Westview Press, 1990): 139.

³³ Patrick E. Tyler, "China's Military Stumbles Even As Its Power Grows," *The New York Times*, December 3, 1996, Vol. CXLVI, No 50630, A1.

³⁴ World Bank, *World Development Report 1992*, (Oxford: Oxford University Press, 1992), 219,223,276. The International Comparison Program suggests that the purchasing power of the GDP per capita is 9.1 percent of that of the U.S. This translates to a per capita purchasing power of \$1962 or a GDP of \$2.2 trillion. Some authors such as Vaclav Smil suggest that this amount is too high. See Vaclav Smil, "How Rich is China?," *Current History*, September 1993, Vol. 92, no. 575, 266.

³⁵ Forecast International/DMS, August, 1996, s. v. China Section (Force Structure), 1.

Chapter 5

Conclusions

Modeling

The use of cross country analysis to predict economic growth has limited application. Yet, the model used can give a prediction of the change in economic growth given a change in other economic and demographic indicators. The most dominant factor is investment level. Other factors such as changes in population growth or education levels may correlate to changes in economic growth, but these changes are small in comparison. As such, economic growth is difficult to predict because investment may vary greatly as governments tighten or loosen their money supplies either to prevent excessive inflation or to stimulate their economies. However, the model can still be used to approximate changes in the rate of growth. For instance, the model could predict the decrease in economic growth that corresponds to a decrease in investment. This decrease in investment could be caused by the diversion of moneys for non-productive purposes such as environmental clean-up or support of military forces.

Peer Competitor?

China is beset with an array of problems which it must overcome. These include control of inflation and growth of its energy infrastructure, environmental clean-up, and

the modernization of its armed forces. Tight monetary policies which may further dampen investment policies are likely as China tries to control inflation. As well, these problems point towards a reduction in levels of investment in the commercial sectors as funds are diverted to fix shortfalls in infrastructure development and to effect environmental clean-up. For these reasons, the growth at the rate China saw over the last decade is a plausible, best case estimate of its growth in the future. Yet even given this growth rate, China still will not possess sufficient economic resources to match those of the United States and thus qualify as a peer competitor.

Appendix A

Countries Used in Cross Country Analysis

Source: World Bank, <i>World Development Report 1992</i> , (Oxford: Oxford University Press, 1992), Table 2, Table 9. Figure 2. Sensitivity of GDP Growth to Investment	Figure 3. Sensitivity of GDP Growth to Population Growth in 17 Poor Countries	Figure 4. Sensitivity of GDP Growth to Education in 15 Poorest Countries	Figure 6. Tertiary Education and the GDP, Secondary Education	Figure 6. Tertiary Education and the GDP, Tertiary Education	Figure 7. Energy Consumption per Capita vs GNP per Capita
Mozambique	Mozambique	Mozambique	Mozambique	Mozambique	Mozambique
Tanzania	Tanzania	Tanzania	Tanzania	Tanzania	Tanzania
Ethiopia	Ethiopia	Ethiopia	Ethiopia	Ethiopia	Ethiopia
Nepal	Nepal	Nepal	Nepal	Nepal	Nepal
Bangladesh	Bangladesh	Bangladesh	Bangladesh	Bangladesh	Bangladesh
Zaire	Zaire	Zaire	Zaire	Zaire	Zaire
Uganda	Uganda	Uganda	Uganda	Uganda	Uganda
Nigeria	Nigeria	Nigeria	Nigeria	Nigeria	Nigeria
India	India	India	India	India	India
China	China	China	China	China	China
Kenya	Kenya	Kenya	Kenya	Kenya	Kenya
Pakistan	Pakistan	Pakistan	Pakistan	Pakistan	Pakistan
Sri Lanka	Sri Lanka	Sri Lanka	Sri Lanka	Sri Lanka	Sri Lanka
Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia
Egypt	Egypt	Egypt	Egypt	Egypt	Egypt
Philippines	Philippines		Philippines	Philippines	Philippines
Morocco	Morocco		Morocco	Peru	Morocco
Peru			Peru	Colombia	Peru
Colombia			Colombia	Thailand	Colombia

Source: World Bank, <i>World Development Report 1992</i> , (Oxford: Oxford University Press, 1992), Table 2, Table 9. Figure 2. Sensitivity of GDP Growth to Investment	Figure 3. Sensitivity of GDP Growth to Population Growth in 17 Poor Countries	Figure 4. Sensitivity of GDP Growth to Education in 15 Poorest Countries	Figure 6. Tertiary Education and the GDP, Secondary Education	Figure 6. Tertiary Education and the GDP, Tertiary Education	Figure 7. Energy Consumption per Capita vs GNP per Capita
Thailand			Thailand	Turkey	Thailand
Turkey			Turkey	Romania	Turkey
Romania			Romania	Poland	Romania
Poland			Poland	Algeria	Poland
Algeria			Algeria	Malaysia	Algeria
Malaysia			Malaysia	Argentina	Malaysia
Argentina			Argentina	Iran	Argentina
Iran			Iran	Mexico	Iran
Mexico			Mexico	South Africa	Mexico
South Africa			Venezuela	Venezuela	South Africa
Venezuela			Brazil	Brazil	Venezuela
Brazil			Yugoslavia	Yugoslavia	Brazil
Yugoslavia			Czechoslova kia	Czechoslova kia	Yugoslavia
Czechoslova kia			Korea	Korea	Czechoslova kia
Korea			Spain	Spain	Korea
Spain			United Kingdom	United Kingdom	Spain
United Kingdom			Italy	Italy	United Kingdom
Italy			Australia	Australia	Italy
Australia			France	France	Australia
France			Canada	Canada	France
Canada			Germany	United States	Canada
United States			Japan	Japan	United States
Germany					Germany
Japan					Japan

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