Gender, Vocational Education, and Economic Development: The Japanese Experience

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Abstract: Economic development in Japan prior to World War II involved the expansion of labor intensive manufacturing industries that employed a large proportion of women. This was accompanied by the growth in vocational education for women as well as for men. Was the growth in vocational education, especially of women, a result of the economic expansion or a cause? In the postwar period vocational education for women grew slightly, while that for men declined. Was this caused by continued economic growth or did vocational education, especially for women, play a causal role in postwar economic growth? This paper attempts to address these questions using a recently available data set and utilizing the vector error correction methodology. The results indicate that vocational education, especially of females, played a causal role. Thus vocational education may be important in the early stages of growth for today's developing nations.

Key Words: vocational education, gender, Japanese growth

JEL Classification: 010, 053

Modern development economics gives great importance to the role of education in the process of economic development. However, little work has been done in terms of looking at the role of vocational education. One would expect or hypothesize that hands-on, technical training would be a key factor in promoting the transfer of new techniques and technology. This would seem to be especially true for those nations which are producing manufactured goods at the low end of the technology ladder.

It will be the purpose of this paper to empirically analyze the role of vocational education, broken down by gender, on economic growth in prewar and postwar Japan. This topic is of special interest in light of the path breaking efforts of Yoshihisa Godo and Yujiro Hayami (1999). They have constructed measures of average years of schooling broken down by gender and educational level for Japan for the years 1897 to 1940 and 1951 to 1995. Given the existence of this data, it will be possible to examine the experience of a country, which transformed itself from a less developed to a developed state. Godo and Hayami's data show that the average years of vocational education of the labor force (aged fifteen to sixty four) in Japan showed an increasing trend in the years preceding the war, with data on vocational education ranging from 1898 to 1940. However, in the years following the war, these numbers started falling with the drop being more dramatic for Japanese males in the labor force. Enrollment data for roughly the same period (Benavot, 1983) show similar trends for the region of Asia as a whole. This paper will address whether or not the changing trends in vocational education in Japan, particularly with reference to males and females in the labor force, were a cause or an effect (or both) of Japan's economic expansion.

The importance of the gender aspect to vocational education can be understood by looking at the characteristics of early Japanese industrialization. In prewar Japan the textile

industry accounted for the largest share of factory employment. Specifically, of the 2.3 million factory workers in Japan in 1934, 41 percent were engaged in textile production. Of these workers 80 percent or more were women in the pre-World War II period. Thus it appears that the early Japanese labor force was more predominately female than that of other developed or developing nations at that time (Francks 1992).

In many of today's developing countries, one notices trends similar to those found in Japan. That is, initially manufacturing growth is most rapid in textiles and other labor-intensive commodities. In addition, women make up a large share of the unskilled labor force in these countries. Thus women seem to play an important role in the early process of development. However, they are generally prevented, in one way or another, from partaking in the formal educational process. Given their role in labor intensive manufacturing the question naturally arises concerning the role of vocational education for women. Is this likely to promote growth in the early stages of development? It is argued here that the experience of Japan will be useful in shedding light on this question.

The next section of this paper will discuss vocational education in Japan. The time series evidence for male and female vocational education will be examined. In addition, correlations between male and female education and, the growth of per capita GDP and the growth of the capital to labor ratio will be examined. Section two will discuss the causality methodology used in this paper in some detail. Section three will discuss the empirical results. Finally, section four will summarize the paper and discuss some policy implications.

I. Introduction

At the end of the nineteenth century Japan was emerging from a long period of self-imposed isolation. Although it had managed to develop an extremely sophisticated commercial

economy based upon agricultural production, it had fallen far below the technological frontier, as represented by the then developed nations. As part of an effort to rapidly catch up, the Meiji government invested heavily in education.

Most importantly, for the purposes of this paper, there was a heavy emphasis on vocational education. Vocational education included vocational courses at girl's high schools, supplementary courses at ordinary primary schools, supplementary courses in higher primary school, vocational middle school, vocational supplementary school, apprentice's school, young men's training institutes, young men's training schools, vocational courses at senior high schools, and technical colleges. The average number of years of vocational schooling increased dramatically before World War II. More importantly, the share of vocational education in post primary education rose from 3% in 1900 to 45% in 1940. The female to male ratio of average schooling at the vocational level varied from 27% (1920) to 39% (1940). In the postwar period the share of vocational education in post primary education fell to 16% (1990). However, the female to male ratio increased from 43% (1950) to 69% (1990). The average schooling measure mentioned above represents the average number of years of vocational schooling per person in the working population (male, female). This number for the entire population (male and female) rose from .008 in 1900 to 0.88 in 1940 and fell from 1.13 in 1950 to .89 in 1990 (Godo and Hayami, 1999).

The most significant policy factor in the prewar growth of vocational education was the Law for Subsidizing Vocational Education Expenses from the National Treasury, which was put in force on September 1, 1894. Although the amount of the subsidy was initially quite small, it had a significant impact on the advancement of vocational education. As a result of this policy, vocational education for both males and females grew relatively rapidly in the prewar period.

Figure 1 presents the average years of vocational education, broken down by gender, for the prewar period, and is based on the data set constructed by Godo and Hayami (1999). Examining the figures one can see that average years of vocational education attained by males grew faster than that for females, but both increased rapidly.

In the postwar period, Japanese government policy emphasized other types of education and this is illustrated in the data presented in Figure 2. Average years of attainment for males falls, while there appears to be a modest increase for women, at least up until the mid 1980s. Moreover, Figure 3 presents mainstream education (primary, secondary, and tertiary cumulatively) of males and females along with the vocational education of both genders to allow the reader a comparative view of the respective data series.

The correlations in Tables 1 and 2 give an intuitive understanding about the relations that existed between the Japan's growth and the growth in vocational education of both genders. Table 1 presents the correlations between economic growth as measured by the rate of change in per capita GDP, the rate of change in the physical capital to labor ratio, the rate of change in the average number of years of vocational education by gender, and the rate of change of mainstream education by gender.

[Table 1 Here]

As one can see, from examining the table, in the prewar period there is positive correlation between the growth in male and female vocational education, the growth in mainstream education, and growth in GDP per capita. However the correlations with female vocational education and female mainstream education and growth are relatively weaker. Growth of vocational education is also positively correlated with the growth in the physical capital per labor during this period. Additionally, the growth of mainstream education itself has a positive

correlation with the growth in vocational education during this period. These correlations indicate that vocational education develops in response to the industrialization process a country is undergoing which generates a requirement for a technically efficient labor force (Blaug, 1968, 1969; Machlup, 1970). It also appears to support two hypotheses tested by Benavot (1983) that the higher the amount of regular or mainstream education, the more one should expect to see a growing emphasis on vocational education. The next table presents the postwar correlations for the same variables.

[Table 2 Here]

The first difference to be noted is the relatively stronger correlations between per capita GDP growth and the growth in all the education variables in the postwar period compared to the prewar, particularly for males. However, it needs to be remembered that the growth rate of male vocational education is negative in the postwar period. That is, in the postwar period, when the Japanese economy starts booming, there appears to be a positive correlation between the falling vocational education and rising mainstream education of males. Moreover the correlation between growth of the physical capital to labor ratio and the growth of mainstream education is negative in this period as well.

Of course, the correlations discussed above really do not imply anything about causality or the direction of causality. That is, does vocational education, broken down by gender, cause economic growth? Or perhaps, does the causation run in the opposite direction? Does economic growth cause changes in vocational education? Perhaps when a country initially industrializes, it needs technically trained individuals via vocational education. However, once a certain level of industrialization is achieved, the degree of skills provided by vocational or technical schools is no longer enough. Instead there is a need for more mainstream education, especially that of a

tertiary nature. Or, alternatively, perhaps vocational education, along with mainstream education causes the rate of growth, especially of manufacturing. In this case industrialization and economic growth are the result of increased vocational and mainstream education. All of these questions can be asked separately for each gender.

Additionally, this paper is also interested in analyzing the role of gender and vocational education on capital growth in Japan. Figure three shows that Japan's output growth and the growth in the capital to labor ratio were almost at par in the pre-war period, with the latter growth marginally higher than GDP growth. However, in the post-war period the capital to labor ratio grew much faster than output (See Figure 4). This paper attempts to determine how much of a role was played by vocational education in causing the growth of the capital to labor ratio and vice versa. Since the manufacturing sector played a significant role in Japan's growth process and the hypothesis here is that vocational education had a role in promoting the manufacturing sector, especially for women, it is very possible that this impact might have been apparent through the growth in the physical capital stock, which might, in turn, have an impact on growth. With this in mind, the correlation analysis presented above is a starting point, a tool to provide some initial intuition about the existing relationships. However, correlation does not imply causality or its direction. It is this issue that the next section addresses.

II. Data and Methodology

The discussion in the previous sections tells us that the emphasis on vocational education, especially the education of women, may have played a key role in the Japanese growth process. Utilizing annual data recently developed by Godo and Hayami (1999) for the pre and postwar periods this proposition is tested here. The initial step is to test for possible causal relationships between the industrialization of Japan and the vocational education of males and females aged

fifteen to sixty four. In order to examine these causal relationships the vocational education variables include the growth in the average years of vocational education of males and females. The other explanatory variables of interest included are the growth of per capita GDP (1990 dollars), the growth of the physical capital stock per unit of labor (1990 dollars per person), and the growth of mainstream education (primary, secondary, and tertiary cumulatively). Because the measures of vocational education are also included in the measures of secondary education, whenever mainstream and vocational education are included in the same regression, secondary education is measured net of vocational education (that is the average years of vocational education are subtracted from the average years of secondary education). Two models are tested for each gender with the second (more complete model) also including an additional control variable.[1] For the prewar period this variable is the agricultural productivity of the Japanese economy while for the postwar period this variable is the degree of openness of the Japanese economy.

The reason behind including agricultural productivity as an additional control variable arises from its importance in the literature relating to this period. A number of theorists (Johnston and Kilby, 1975) have argued that prewar Japanese economic development and growth were driven by the growth of productivity in its agricultural sector. In particular, productivity growth in the agricultural sector was thought to have allowed labor to be released to the manufacturing sector, stimulated the demand for newly created manufacturing industries, and perhaps provided the critical foreign exchange necessary to import the capital necessary for industrialization (Johnston and Mellor, 1961). Given the above ideas, a measure of agricultural productivity (output divided by all inputs utilized) developed by Yamada and Hayami (1979) is added as a robustness check and a control variable for the prewar period. For the postwar period, however,

agricultural productivity is replaced with the openness variable. In the postwar period, many analysts have argued that Japanese economic growth was outward oriented. That is, Japan sought to emphasize trade as a mechanism for stimulating economic growth. In order to account for this, an openness variable (exports plus imports, the total divided by GDP) was constructed for the postwar period and included.

This paper utilizes a VAR technique to estimate the model. The VAR approach models all endogenous variables in the system as functions of the lagged values of all endogenous variables in the system and thereby sidesteps problems arising out of an endogeneity bias in the system. By adding additional lagged variables of the dependent variable, this estimation process also takes care of serial correlation between the disturbances. It was pointed out by Engle and Granger (1987) and Granger (1988) that a VAR model in levels may lead to spurious results if the variables are non-stationary and a VAR in first differences may be misspecified in case these non-stationary variables are co-integrated. The Granger representation theorem (1987) was introduced as a solution to such problems and led to the Vector Error Correction Model (VECM). In the VECM, the changes in the dependent variable are a function of both the explanatory variables as well as the error-correction term (ECT), which captures the level of disequilibrium in the co-integrating relationship.

Granger (1988) pointed out that there were two channels of causality using Vector Error Correction (VEC). One is through the lagged values of the variables and the other through the coefficient associated with the ECT, if it is found to be significant. The VECM has the additional advantage over standard Granger causality by being able to distinguish between the short-run and long-run forms of Granger causality. While the joint F-tests on the coefficients are utilized to test the short-run causality, t-tests on the coefficients of the lagged ECTs are utilized to

determine the long-run causal relationships since these are derived from the co-integrating relations between the relevant variables.

In order to test whether vocational education had a causal effect on economic growth the VECM is given by,

$$\Delta \ln y_t = a_0 + \sum_{j=1}^{m1} a_{1j}\Delta \ln y_{t-j} + \sum_{j=1}^{m2} a_{2j}\Delta \ln voc(m)_{t-j} + \sum_{j=1}^{m3} a_{3j}\Delta \ln voc(f)_{t-j} + \sum_{j=1}^{m4} a_{4j}\Delta \ln mainstream(m)_{t-j} + \sum_{j=1}^{m5} a_{5j}\Delta \ln mainstream(f)_{t-j} + \sum_{j=1}^{m6} a_{6j}\Delta \ln c_{t-j} + \sum_{j=1}^{m7} a_{7j}\Delta \ln k_{t-j} + \delta EC_{t-1} + e^{y}_{t} \quad (1)$$

and to test whether vocational education had a causal effect on growth in k the VECM is given by,

$$\Delta \ln k_t = a_0 + \sum_{j=1}^{m1} a_{1j}\Delta \ln k_{t-j} + \sum_{j=1}^{m2} a_{2j}\Delta \ln voc(m) + \sum_{j=1}^{m3} a_{3j}\Delta \ln voc(f) + \sum_{j=1}^{m4} a_{4j}\Delta \ln mainstream(m)_{t-j} + \sum_{j=1}^{m5} a_{5j}\Delta \ln mainstream(f)_{t-j} + \sum_{j=1}^{m6} a_{6j}\Delta \ln c_{t-j} + \sum_{j=1}^{m7} a_{7j}\Delta \ln y_{t-j} + \delta EC_{t-1} + e^{k}_{t} \quad (2).$$

Including male and female education variables as separate explanatory variables is not new to the literature. Knowles and Lorgelly (2002) estimate the neoclassical growth model and they enter male and female education as separate explanatory variables. In addition, the growth in the capital to labor ratio is also included as a control variable to reflect the typical neoclassical growth specification.

The Error-correction-term ECT captures the level of disequilibrium in the co-integrating relationship between the variables. For the lagged variables appearing on the right-hand-side, the number of lags is determined using the Akaike Information Criterion (AIC) and Schwartz Criterion (SC) and the lag that gives the lowest AIC and SC and best fit is chosen.[2] Introducing the variables in their differenced form serves a dual purpose. First, it allows for an analysis of the growth rates of variables and second, it eliminates problems associated with unit roots. This also

takes care of any the problems associated with spurious regressions from using non-stationary data series.

The VECM to be estimated for testing the causal impact of economic growth on male and vocational education is given by,

$$\begin{aligned}\Delta\ln voc(m)_t = \; & a_0 + \sum_{j=1}^{m1} a_{1j}\Delta\ln voc(m)_{t-j} + \sum_{j=1}^{m2} a_{2j}\Delta\ln y_{t-j} + \sum_{j=1}^{m3} a_{3j}\Delta\ln mainstream(m)_{t-j} \\ & + \sum_{j=1}^{m4} a_{4j}\Delta ln voc(f)_{t-j} + \sum_{j=1}^{m5} a_{5j}\Delta\ln mainstream(f)_{t-j} + \sum_{j=1}^{m6} a_{6j}\Delta\ln c_{t-j} + \sum_{j=1}^{m7} a_{7j}\Delta\ln k_{t-j} \\ & + \delta EC_{t-1} + e_t^{voc(m)} \qquad (3),\end{aligned}$$

where all the variables in the equation have the same meaning as discussed above. Specifically, the variable *c* is a control variable given by agricultural productivity in the prewar equation and openness in the postwar equation. The above equation tests for a causal impact of economic growth as well as capital on vocational education of males, along with mainstream education of males and an additional variable as control variables. The VECM for females is given by,

$$\begin{aligned}\Delta\ln voc(f)_t = \; & a_0 + \sum_{j=1}^{m1} a_{1j}\Delta\ln voc(f)_{t-j} + \sum_{j=1}^{m2} a_{2j}\Delta\ln y_{t-j} + \sum_{j=1}^{m3} a_{3j}\Delta\ln mainstream(f)_{t-j} \\ & + \sum_{j=1}^{m4} a_{4j}\Delta\ln voc(m)_{t-j} + \sum_{j=1}^{m5} a_{5j}\Delta\ln mainstream(m)_{t-j} + \sum_{j=1}^{m6} a_{6j}\Delta\ln c_{t-j} \\ & + \sum_{j=1}^{m7} a_{7j}\Delta\ln k_{t-j} + \delta EC_{t-1} + e_t^{voc(f)} \qquad (4).\end{aligned}$$

III. Empirical Results

Tables 3, 4, 5 and 6 present the results concerning whether male and female vocational education had a causal impact on the growth of GDP and the growth of the capital to labor ratio in the pre and postwar periods. Tables 3 and 4 present the results for the impact of vocational

education on per capita GDP growth and the growth of the capital to labor ratio in the prewar period.

According to the results, the vocational education of the male labor force did not have a causal impact on per capita GDP growth, but it did have a causal impact on growth in the capital to labor ratio in the prewar period. However, female vocational education did have a causal impact on both the growth of GDP and the growth in the capital to labor ratio. Economic growth in the prewar period was also causally affected by the growth in mainstream education of both males and females. Moreover, agricultural productivity also had a causal impact on economic growth in prewar Japan. The results reflect the early industrialization pattern of Japan where it was seen that manufacturing activities were dominated by small manufacturing units, predominantly hiring female labor who needed certain technical skills and training for carrying out their work. Tables 5 and 6 examine the results for the postwar period.

[Table 3 Here]

[Table 4 Here]

[Table 5 Here]

[Table 6 Here]

The results show that growth in *both* male and female vocational education, along with growth of female mainstream education, had a causal impact on growth in this period. Moreover, male vocational education had an indirect impact via its causal impact on the capital to labor ratio. Also, there is bi-directional causality between the growth in the capital to labor ratio and the growth of GDP. These results bring out the importance of capital in Japan's economic growth, following the war, and are consistent with the work of Alwyn Young (1995). In summary the results for the postwar period highlight the overall strong causal influence of capital

growth on postwar growth in Japan enhanced further by human capital growth in both the mainstream as well as vocational education.

Before proceeding several issues concerning the above results need to be discussed. The correlation tables seem to indicate that female vocational education is only weakly correlated with the growth of per capita GDP in both pre and postwar periods, yet causality is found to run from female vocational education to per capita GDP growth. These results seem contradictory. However, one must remember that the correlations relate one variable to another, excluding the effects of possible control variables. The causality results include the effects of a number of control variables and this is what allows for the causal relationship to be revealed. A second issue arises from the fact that in the postwar period male vocational education declined and that for females increased slightly, but both are still found to be causal in spite of these trends. Moreover, economic growth in this period did not decline or falter. While this seems contradictory, one must remember that the capital to labor ratio and mainstream education grew rapidly in the postwar period. Thus, any slowdown in per capita GDP growth resulting from the decline in male vocational education was more than offset by the growth in the capital to labor ratio and in mainstream education.

Tables 7 and 8 present results of testing the causal impact of economic growth on the vocational education of Japanese males and females respectively.

[Table 7 Here]

[Table 8 Here]

The results show that the causal influence of the Japanese economic growth in the prewar period was quite different for males compared to females. Even though the data show that the average years of vocational education and its growth was higher for males compared to females, Table 7

shows that neither of the variables of interest, the growth of physical capital per person and the growth of per capita GDP, had any causal impact on the growth of male vocational education. However, the growth of mainstream male education and agricultural productivity growth seem to have had a causal effect on the growth of male vocational education. The error correction term is significant showing a joint and long-run causal impact of all variables. Table 8 shows, in contrast to Table 7, that the economic growth of the prewar period indeed had a causal influence on the growth of the vocational education of females. The growth of mainstream education of females also caused more females to go into vocational education according to the above results. Growth of physical capital per unit of labor did not have a causal influence on the growth of either male or female vocational education. Tables 9 and 10 present results for the postwar period.

[Table 9 Here]

[Table 10 Here]

The results from Tables 9 and 10 indicate that none of the variables of interest have any causal impact on the growth of male vocational education. Most importantly, economic growth seems to have had no causal impact on vocational education for males or females. However, for females both mainstream education and growth in the capital to labor ratio have a causal impact on the growth of female vocational education.

IV. Summary and Conclusion

In this paper it was argued that early Japanese growth was characterized by the expansion of simple, labor intensive manufactured goods, such as textiles. Much of the labor force for this type of manufacturing activity was made up of young females. In this situation, it was hypothesized that female vocational education probably played a causal role in this early growth

process. Attention was focused on vocational education because this was the only form of education widely available to females, beyond primary education, in the period prior to World War II.

Many developing countries, especially in Asia, are following similar paths towards industrialization, emphasizing the production of relatively simple, labor intensive manufacturing such as textiles. Thus the experience of Japan, in terms of which factors were causal for growth, would seem to be relevant for these developing countries. However, one must keep in mind the structural characteristics of the Japanese economy. By the Meiji restoration (1868) Japan was already highly commercialized with a highly productive agriculture sector. Also, small scale manufacturing activities were rapidly developing (Mundle, 1986). Thus when seeking to apply the causality results of the paper, this context must be kept in mind.

The results indicate that there was a bi-directional causal relationship between the growth of female vocational education and economic growth in the prewar period. That is, female vocational education caused and was caused by economic growth. Male vocational education also had a causal impact on economic growth, but there was no reverse causality involved. Further, female vocational education had a causal impact on the growth of the capital to labor ratio while male vocational education did not.

In the postwar period the growth of the vocational education of males and females had a causal impact on the growth of GDP. However, there was no reverse causality for either variable. Male vocational education had a causal input on the growth of the capital to labor ratio, but female vocational education had no causal impact.

The results seem to indicate an important role for vocational education in the process of economic development. The Japanese case indicates an especially important role for female

vocational education in the early process of economic development, fostering both GDP growth and growth in the capital to labor ratio. Thus a policy lesson for less developed nations would seem to be as follows. In countries which have highly commercialized agricultural sectors and manufacturing sectors that are beginning to rapidly expand, vocational education, especially of females, may play an important causal role in the development process.

Footnotes

[1]Results of the parsimonious model, not presented here, are very similar to the complete model. These are available upon request.

[2]Before presenting any of the results or conducting any of the tests, the data streams are subjected to the standard Augmented Dickey-Fuller (ADF) and the Philips and Perron (PP) Unit Root tests and all are found to possess unit roots. Results relating to Unit Root tests and Co-integration tests are available upon request.

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Table 1: Prewar correlations

	Δy	Δk	Δmainstream(m)	Δmainstream(f)	Δvoc(m)	Δvoc(f)
Δy	1.00					
Δk	-0.10	1.00				
Δmainstream(m)	0.18	0.34	1.00			
Δmainstream(f)	0.09	0.30	0.87	1.00		
Δvoc(m)	0.24	0.21	0.36	0.60	1.00	
Δvoc(f)	0.01	0.28	0.47	0.77	0.84	1.00

Note: Δy is the growth rate of per capita GDP; Δk is growth of the capital to labor ratio; Δmainstream(m) is the growth of mainstream education for males; Δmainstream(f) is the growth of mainstream education for females; Δvoc(m) is the growth rate of vocational education of males; Δvoc(f) is the growth rate of vocational education of females.

Table 2: Postwar correlations

	Δy	Δk	Δmainstream(m)	Δmainstream(f)	Δvoc(m)	Δvoc(f)
Δy	1.00					
Δk	0.04	1.00				
Δmainstream(m)	0.50	-0.46	1.00			
Δmainstream(f)	0.32	-0.11	0.75	1.00		
Δvoc(m)	0.51	0.18	0.51	0.33	1.00	
Δvoc(f)	0.10	0.84	-0.24	0.20	0.39	1

Note: Δy is the growth rate of per capita GDP; Δk is growth of the capital to labor ratio; Δmainstream(m) is the growth of mainstream education for males; Δmainstream(f) is the growth of mainstream education for females; Δvoc(m) is the growth rate of vocational education of males; Δvoc(f) is the growth rate of vocational education of females.

Table 3: Causal impact of Vocational Education on Economic Growth (Prewar)

Dependent variable: Δy	Causal impact
Δ *mainstream(m)* $\rightarrow \Delta y$	yes
F-stat (lag length)	10.15**(1)
Δ *mainstream(f)* $\rightarrow \Delta y$	yes
F-stat (lag length)	7.55**(1)
Δ *voc(m)* $\rightarrow \Delta y$	no
F-stat (lag length)	0.28(2)
Δ *voc(f)* $\rightarrow \Delta y$	yes
F-stat (lag length)	37.37**(2)
$\Delta k \rightarrow \Delta y$	no
F-stat (lag length)	0.03(1)
Δ *agricultural prod* $\rightarrow \Delta y$	yes
F-stat (lag length)	4.37**(1)
ECT (t-stat)	4.81**

Note: $\rightarrow$ direction of causality; * signifies statistical significance at 90% and ** signifies statistical significance at 95%; an intercept term and lagged values of the dependent variable are included in each equation but not reported.

Table 4: Causal impact of Vocational Education on Capital Growth (Prewar)

Dependent variable: Δk	Causal impact
Δ *mainstream(m)* $\rightarrow \Delta k$	no
F-stat (lag length)	0.51
Δ *mainstream(f)* $\rightarrow \Delta k$	no
F-stat (lag length)	0.35
Δ *voc(m)* $\rightarrow \Delta k$	yes
F-stat (lag length)	9.75**
Δ *voc(f)* $\rightarrow \Delta k$	yes
F-stat (lag length)	3.53*
$\Delta y \rightarrow \Delta k$	no
F-stat (lag length)	1.86
Δ *agricultural prod* $\rightarrow \Delta k$	no
F-stat (lag length)	0.18
ECT (t-stat)	-7.88**

Note: $\rightarrow$ direction of causality; * signifies statistical significance at 90% and ** signifies statistical significance at 95%; an intercept term and lagged values of the dependent variable are included in each equation but not reported.

Table 5: Causal impact of Vocational Education on Economic Growth (Postwar)

Dependent variable: Δy	Causal impact
Δ *mainstream(m)* $\rightarrow \Delta y$	no
F-stat (lag length)	0.28 (1)
Δ *mainstream(f)* $\rightarrow \Delta y$	yes
F-stat (lag length)	12.43**(1)
Δ *voc(m)* $\rightarrow \Delta y$	yes
F-stat (lag length)	5.6**(2)
Δ *voc(f)* $\rightarrow \Delta y$	yes
F-stat (lag length)	6.21**(2)
$\Delta k \rightarrow \Delta y$	yes
F-stat (lag length)	18.82** (2)
Δ *openness* $\rightarrow \Delta y$	no
F-stat (lag length)	0.11
ECT (t-stat)	-4.53**

Note: $\rightarrow$ direction of causality; * signifies statistical significance at 90% and ** signifies statistical significance at 95%; an intercept term and lagged values of the dependent variable are included in each equation but not reported.

Table 6: Causal impact of Vocational Education on Capital Growth (Postwar)

Dependent variable: Δk	Causal impact
Δ *mainstream(m)* $\rightarrow \Delta k$	no
F-stat (lag length)	0.005(1)
Δ *mainstream(f)* $\rightarrow \Delta k$	no
F-stat (lag length)	0.007(1)
Δ *voc(m)* $\rightarrow \Delta k$	yes
F-stat (lag length)	5.58**(2)
Δ *voc(f)* $\rightarrow \Delta k$	no
F-stat (lag length)	0.88(2)
$\Delta y \rightarrow \Delta k$	yes
F-stat (lag length)	96.71**(1)
Δ *openness* $\rightarrow \Delta k$	no
F-stat (lag length)	0.16(1)
ECT (t-stat)	-5.94**

Note: $\rightarrow$ direction of causality; * signifies statistical significance at 90% and ** signifies statistical significance at 95%; an intercept term and lagged values of the dependent variable are included in each equation but not reported.

Table 7: Causal impact of Economic Growth on Male Vocational Education (Prewar)

Dependent variable: Δ *voc(m)*	Causal impact
Δ *y* → Δ *voc(m)*	no
F-stat (lag length)	0.003(1)
Δ *mainstream(m)* → Δ *voc(m)*	yes
F-stat (lag length)	9.11**(2)
Δ *mainstream(f)* → Δ *voc(m)*	no
F-stat (lag length)	1.4(2)
Δ *voc(f)* → Δ *voc(m)*	yes
F-stat (lag length)	5.54**(1)
Δ *agricultural prod* → Δ *voc(m)*	yes
F-stat (lag length)	5.05**(1)
Δ *k* → Δ *voc(m)*	no
F-stat (lag length)	0.29(1)
ECT (t-stat)	-4.11**

Note: → direction of causality; * signifies statistical significance at 90% and ** signifies statistical significance at 95%; an intercept term and lagged values of the dependent variable are included in each equation but not reported.

Table 8: Causal impact of Economic Growth on Female Vocational Education (Prewar)

Dependent variable: Δ *voc(f)*	Causal impact
Δ *y* → Δ *voc(f)*	yes
F-stat (lag length)	13.02**(1)
Δ *mainstream(f)* → Δ *voc(f)*	no
F-stat (lag length)	0.05(1)
Δ *mainstream(f)* → Δ *voc(f)*	yes
F-stat (lag length)	6.33**(2)
Δ *voc(m)* → Δ *voc(m)*	yes
F-stat (lag length)	7.65**(1)
Δ *agricultural prod* →Δ *voc(f)*	no
F-stat (lag length)	1.12(1)
Δ *k* → Δ *voc(f)*	no
F-stat (lag length)	1.53(1)
ECT (t-stat)	-3.9**

Note: → direction of causality; * signifies statistical significance at 90% and ** signifies statistical significance at 95%; an intercept term and lagged values of the dependent variable are included in each equation but not reported.

Table 9: Causal impact of Economic Growth on Male Vocational Education (Postwar)

Dependent variable: Δ *voc(m)*	Causal impact
Δ *y* → Δ *voc(m)*	no
F-stat (lag length)	0.06(1)
Δ *mainstream(m)* → Δ *voc(m)*	no
F-stat (lag length)	0.07(1)
Δ *mainstream(f)* → Δ *voc(m)*	no
F-stat (lag length)	1.44(1)
Δ *voc(f)* → Δ *voc(m)*	no
F-stat (lag length)	0.001(1)
Δ *openness* → Δ *voc(m)*	no
F-stat (lag length)	0.14
Δ *k* → Δ *voc(m)*	no
F-stat (lag length)	2.33(1)
ECT (t-stat)	-2.48**

Note: → direction of causality; * signifies statistical significance at 90% and ** signifies statistical significance at 95%; an intercept term and lagged values of the dependent variable are included in each equation but not reported.

Table 10: Causal impact of Economic Growth on Female Vocational Education (Postwar)

Dependent variable: Δ *voc(f)*	Causal impact
Δ *y* → Δ *voc(f)*	no
F-stat (lag length)	1.97(2)
Δ *mainstream(f)* → Δ *voc(f)*	no
F-stat (lag length)	0.02(1)
Δ *mainstream(f)* → Δ *voc(f)*	yes
F-stat (lag length)	8.85**(3)
Δ *voc(m)* → Δ *voc(m)*	no
F-stat (lag length)	0.06(1)
Δ *openness* →Δ *voc(f)*	no
F-stat (lag length)	0.53(1)
Δ *k* → Δ *voc(f)*	yes
F-stat (lag length)	8.53**(1)
ECT (t-stat)	-1.91**

Note: → direction of causality; * signifies statistical significance at 90% and ** signifies statistical significance at 95%; an intercept term and lagged values of the dependent variable are included in each equation but not reported.

Figure 1

Prewar Japan: Average Years of Vocational Education

Figure 1

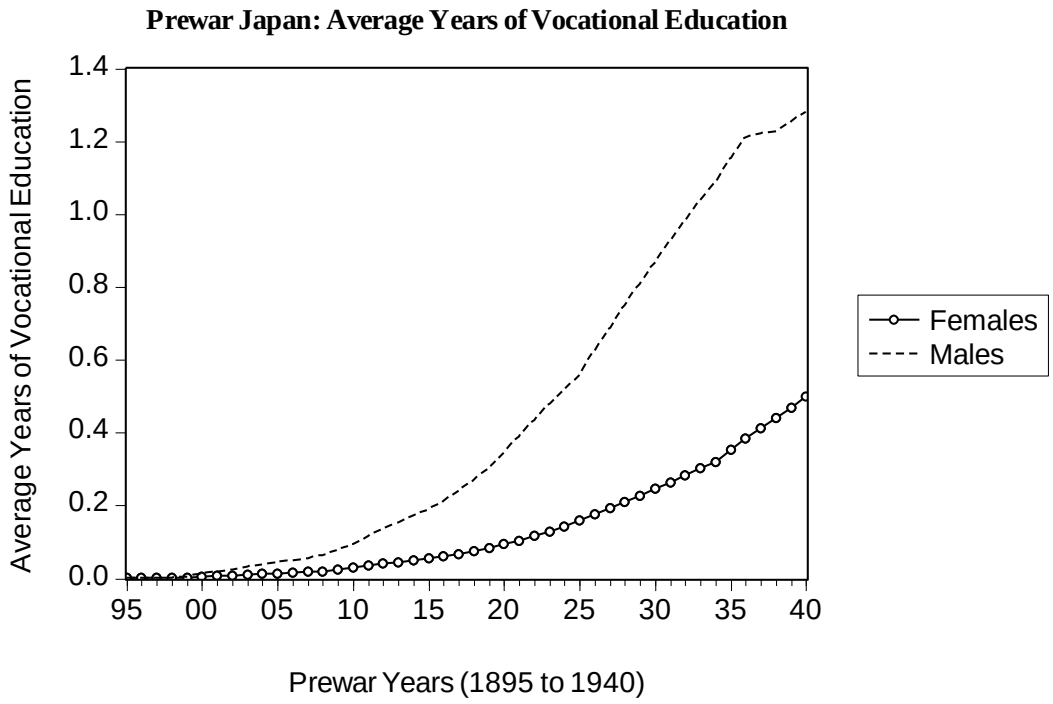

Prewar Japan: Average Years of Vocational Education
Average Years of Vocational Education
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
95
00
05
10
15
20
25
30
35
40
Prewar Years (1895 to 1940)
Females
Males

Figure 2

Postwar Japan: Average Years of Vocational Education

Figure 2

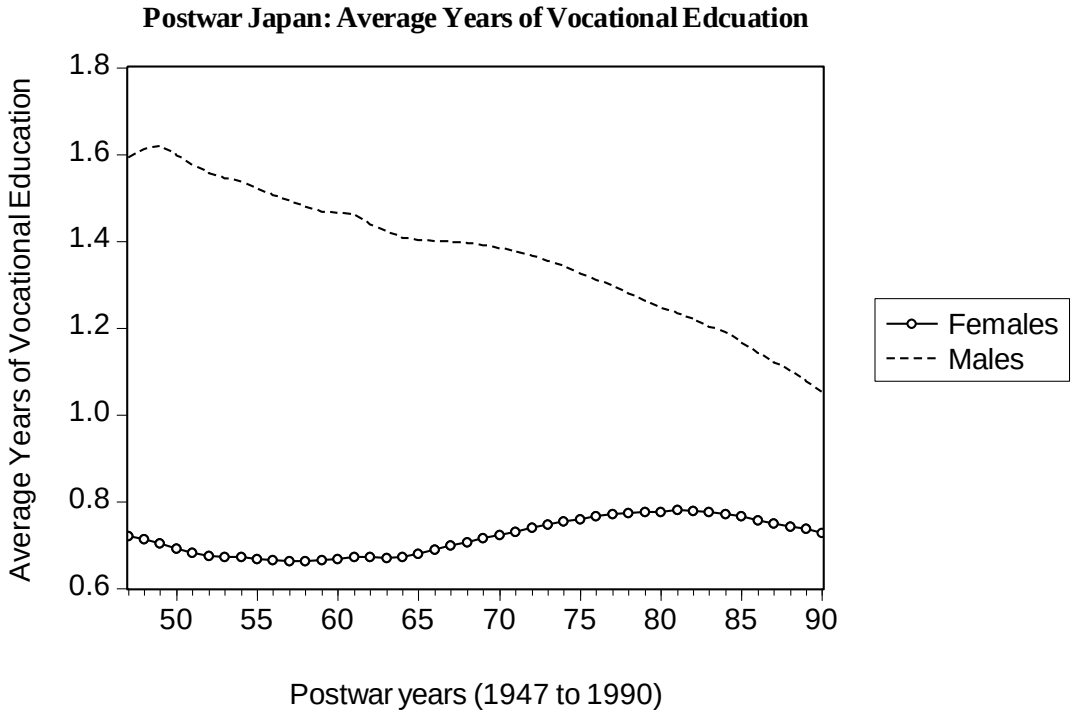

Postwar Japan: Average Years of Vocational Edcuation
Average Years of Vocational Education
1.8
1.6
1.4
1.2
1.0
0.8
0.6
50
55
60
65
70
75
80
85
90
Postwar years (1947 to 1990)
Females
Males

Figure 3

Japan: Average Years of Mainstream and Vocational Education by Gender

Figure 3

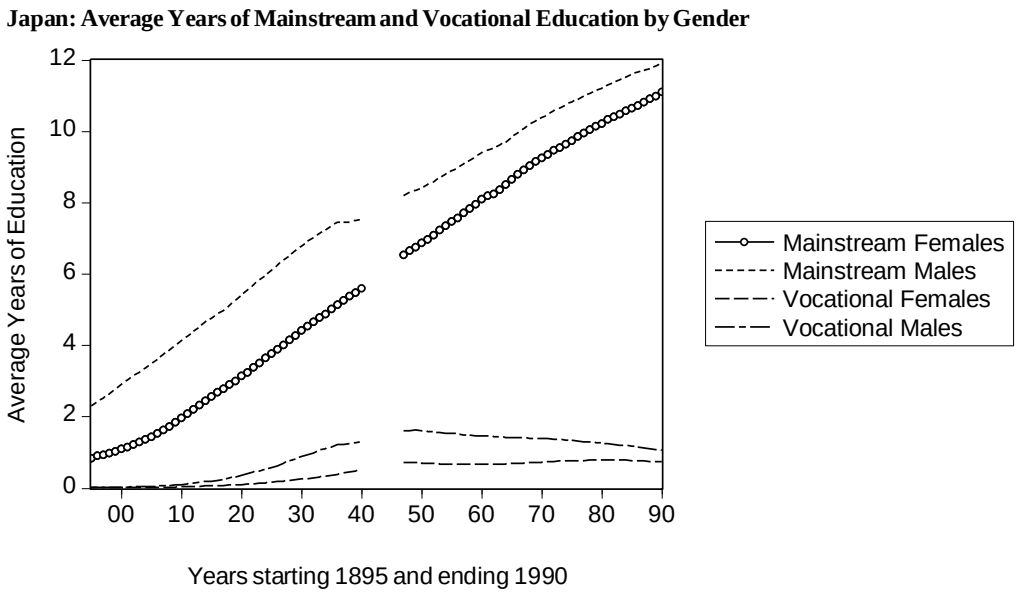
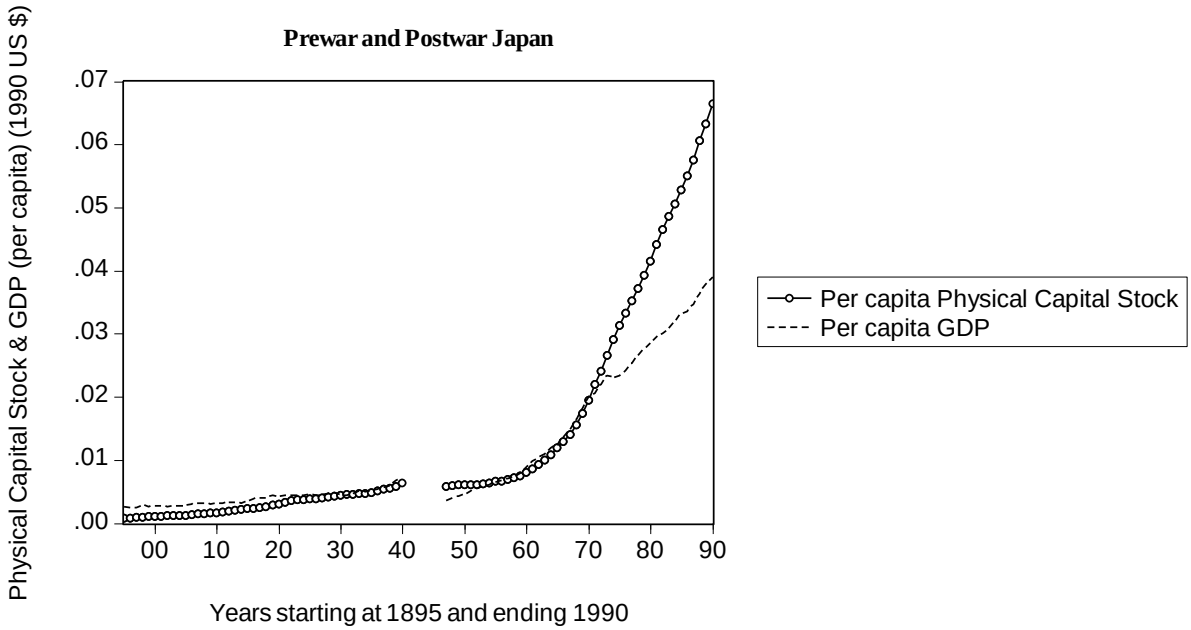

Japan: Average Years of Mainstream and Vocational Education by Gender
Average Years of Education
0
2
4
6
8
10
12
00
10
20
30
40
50
60
70
80
90
Years starting 1895 and ending 1990
Mainstream Females
Mainstream Males
Vocational Females
Vocational Males

Figure 4

Prewar and Postwar Japan

Figure 4


Prewar and Postwar Japan
Physical Capital Stock & GDP (per capita) (1990 US $)
.07
.06
.05
.04
.03
.02
.01
.00
00
10
20
30
40
50
60
70
80
90
Years starting at 1895 and ending 1990
Per capita Physical Capital Stock
Per capita GDP