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► To cite this version:

Valérie Canals, Claude Diebolt, Magali Jaoul-Grammare, Charlotte Le Chapelain. Education, Defense Spending and Economic Growth in Japan: 1868-1940. Understanding the Time Series Dynamics.. Economies et Sociétés. Série AF, Histoire Economique Quantitative, 2015, 50, pp.951-970. hal-01738207

HAL Id: hal-01738207

<https://hal.univ-lorraine.fr/hal-01738207>

Submitted on 22 Oct 2021

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EDUCATION, DEFENSE SPENDING AND ECONOMIC GROWTH IN JAPAN: 1868-1940 UNDERSTANDING THE TIME SERIES DYNAMICS

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Abstract: Following previous causality analysis (Diebolt & Jaoul, 2004), this paper aims to study the role and the importance of military expenditures in the economic history of Japan before World War 2. We use a triple database drawn from the works of Ohkawa *et al.* (1957, 1974), Taeuber (1958) and Diebolt (2003). Our paper shows that military expenditures played a central role at both the economic and social levels and can be considered as one of the driving forces of the economic growth process of the country. Historical events affect first the military sector and then influence the rest of the economy and especially the education sector.

JEL Classification: C32, H50, N15, O53.

Keywords: Cliometrics, Time Series Analysis, Economic Growth, Education, Military Expenditures, Japan, Outliers.

Éducation, dépenses militaires et croissance économique au japon : 1868-1940. Comprendre la dynamique des séries temporelles

Résumé

Suite à notre précédente analyse en termes de causalité (Diebolt et Jaoul, 2004), cet article vise à étudier le rôle et l'importance des dépenses militaires dans l'histoire économique du Japon avant la seconde guerre mondiale. Nous utilisons une triple base de données issue des travaux d'Ohkawa *et al.* (1957, 1974), Taeuber (1958) et Diebolt (2003). Nous montrons que les dépenses militaires ont joué un rôle central au niveau économique et social et peuvent être considérées comme un moteur de la croissance économique du pays. Les événements historiques affectent d'abord le secteur militaire et influencent ensuite le reste de l'économie et plus particulièrement le secteur de l'éducation.

Mots-clés : Cliométrie, Croissance économique, Dépenses militaires, éducation, Japon, Outliers, Séries temporelles.

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"The fascinating growth of certain Asian economies in the past 30 years has been the subject of many analyses in which the influence of expenditure on defense has never been mentioned. However defense economics has studied in great depth the relations between expenditure on defense and economic development. [...] This link suggests that there is here an interesting field for reflection for an economic history of these countries." (Caro, 1998, p. 141).

1. Introduction

No economic research can present a monistic explanation of growth. Indeed, the effects of many variables overlap to create a favourable texture for economic expansion. Military investment is perhaps an important factor but it can only have an effect if it is supported by a combination of political, economic and social circumstances. Analysis of socio-economic activity in Japan from the viewpoint of military investment does not therefore give any prior decisive importance to this factor at the expense of the other structural variables. However, given the fundamental role played by military expenditure in the country's economic growth, we consider that it is important to stress this impact. But is there a connection between the level of development in Japan and the level of military expenditure? The reply seems obvious. Nevertheless, the question of knowing whether military expenditure is the cause or in contrast the result of economic development is far from having been settled by the specialists and the two hypotheses are still opposed!

The pattern of development of Japan's military expenditure clearly shows growth over a long period and threshold effects. This would seem to strengthen Wagner's law of growth of public expenditure (1904, 1913) in which public expenditure increases with economic growth. Furthermore, relatively high growth rates are observed periodically, followed by a period of low growth rates. This definition corresponds to growth in stages consisting of alternate highs and lows. In their study of federal expenditures in the United States, Kendrick and Wehle (1953) outline this phenomenon without providing theoretical explanation for it. In a study published in 1961, Peacock and Wiseman refer to the same type of development in stages in the United Kingdom as the 'displacement effect'. The amount of resources likely to be produced by the fiscal system (but without causing discontent) determines the amount of public expenditure. They considered that the displacement effect was a direct result of the war.

As was put forward by Von Ciriacy-Wantrup (1936), the greatest changes seem to be those caused by wars and revolutions through the economic, institutional and population changes that they necessarily cause. According to this analysis, the long periods of good times are basically caused by the vast governmental expenditures relating to preparation for war and the war itself, while the periods of chronic hard times, on the other hand, are caused by the difficult readjustments incident to the sharp decrease of war expenditures. The best case for this thesis can probably be made with respect to the first long wave (1793/1797-1847/1850). During the long period of the Napoleonic wars, vast government's expenditures gave a stimulus to economic expansion and hastened the changes in the economic system ushered in by the Industrial Revolution. There is little doubt that the impact of these wars played a very considerable role. Similarly, the sharp decrease of expenditures, together with the necessary readjustments to a peacetime basis after the whole of western Europe had for a quarter of a century adjusted itself to war conditions, goes far toward explaining the difficulties of the long period of chronic hard times from 1817 to the end of the 1840s. More recently, Goldstein

(1988) established a link between the turning points in long cycles of the economy and the periodic outbreak of wars.

Starting from this point, the aim here is to study the nature and importance of the links that may exist between the structural dynamics of military expenditure and that of the socio-economic system (economics, demography, etc.). Does the dynamic of the socio-economic system impulse military development or might it rather be the evolution and change in military financing that changed the economic and social system in Japan before World War 2? Following previous causality analysis (Diebolt & Jaoul, 2004), we investigate here a dynamic analysis (outliers methodology) in order to determine if the socio economic context and especially the conflict context influences the Japanese economy.

The article is in three parts. A succinct description of the state of the art is followed by a description of our database. We then discuss the results of our cliometric tests.

2. STATE OF THE ART

The economic role of military expenditures can't be limited to their volume. Defence economic is related to many economic sectors and the analysis of the impact of military expenditures implies to examine the whole economic system. From a macroeconomic point of view, military expenditures appear as a part of public expenditures and consequently as a part of the "autonomous demand". However, other mechanisms have been integrated to this Keynesian explanation. If their results don't converge, all of them underline the dynamics related to military expenditures.

From a theoretical point of view, many models try to explain the causes and consequences of military expenditures. Added to the econometric analysis, there are two main approaches in defence economics: the models of "arms race" (Richardson, 1939, 1960) and the models of public economy. The first ones generally used game theory in order to analyse the behaviour of many countries; the second ones applied mathematical optimization in order to explain coalition between countries (Matelly, 1997).

At the empirical level, if it is impossible to analyse all papers which deal with the influence of military expenditures on economic growth, it appears that the model –keynesian or neo classical– and the length of the time period studied, influence the results. Indeed, a keynesian model generally underlines short term negative effects of the military expenditures on economic growth (Huang & Mintz, 1991; Batchelor, Dunne & Saal, 2000), on employment (Dunne & Watson, 2000). Other studies show a positive effect of military expenditures on economic growth (Atesoglu & Mueller, 1990; Mac Nair & *alii*, 1995; Diebolt & Jaoul, 2004) while Jacques & Picavet (1994) don't find any relationship between economic growth and defence spending. Finally, many studies underline a causal relationship between military expenditures and economic growth without providing insight about the sign of this relationship (Joerding, 1986; Chowdury, 1991; Kollias, Manolas & Paleologou, 2004 ; Yildirim & al., 2005).

In their panel data analysis on European Union, Kollias, Mylonidis and Paleologou (2007) highlighted a positive feedback between growth and military expenditures in the long run and a positive impact of the military expenditures on growth in the short run. Their results are in line with those of Lee & Chen (2007) on 27 OECD countries and 62 non-OECD countries. They underlined different effects according to the fact that the country is part of OECD or not: they distinguished a positive causal effect from GDP to military expenditures

for OECD countries whereas for non-OECD ones, there is a negative causal effect from military expenditures to GDP.

The influence of military expenditure has also been examined by numerous papers about the development of the Asian economies. At this stage, no clear-cut role has been brought to light. For example, Benoit was the first in 1973 to test empirically a model aimed *a priori* at demonstrating that the slowing of the growth in developing countries results from the scale of the resources devoted to defense. Nevertheless, the author's results showed the opposite. This work was fairly surprising, revealing a positive correlation. Indeed, the countries that had borne the largest expenditure were those with the fastest growth. According to Benoit, expenditure on defense might therefore have favourable effects on growth that are strong enough to make up for the negative effects. He also considers that military expenditure creates a reassuring context that is favourable for investment and hence for growth.

Other authors such as Dunne (1996), Ram (1995), Deger & Sen (1995) and then Caro (1998) subsequently discussed the question. All these studies tend to show that military expenditures do not have one particular effect on growth but that the effect varies in time and space. According to Deger and Sen, for example, only two of the nine channels by which expenditures on defense can influence growth display a positive impact: Benoit's positive externalities channel and the Keynesian channel of support for overall demand. According to Ram (1995), although empirical studies do not reveal a positive effect of military expenditure on growth, they do not make it possible to conclude that it has a negative impact. He considers that this indecision results, on the one hand, from econometric weaknesses (related to the problem of the measurement and imprecision of the series) and, on the other hand, from the heterogeneity of the countries studied. For Looney (1990), economic production has a significant positive influence on defense spending. Finally, Caro (1998), in his analysis of the ASEAN countries from 1967 to 1993, highlights the importance of the positive externalities of military expenditure for '*the coherence of the growth strategy*' of these countries. Nevertheless, numerous authors continue to attribute the rapid growth of the Japanese economy (during the post-war period) to the low level of military expenditure (1% of GNP). Concerning other countries, Dunne & Nikolaidou (2001) suggest a positive impact of military burden on growth for Greece and, on the contrary, a negative effect for Spain, while for Portugal, there is no evidence of any causal links. They also show (Dunne, Nikolaidou & Smith, 2002) that military spending does not have a positive effect on growth in the long run, but would appear to have a clear negative short run effect.

3. DATABASE AND METHODOLOGY

A triple base of original data drawn from the work of Ohkawa *et al.* (1957, 1974), Taeuber (1958) and Diebolt (2003) is used to analyse the evolution of the Japanese economy before World War 2.

The following indicators are considered between 1881 and 1940:

- total expenditure on education (DEDUC);
- military expenditure (DMILI);
- capital expenditure (DCAP);
- gross national product (GNP);
- total government expenditure;
- national income;
- national debt;
- price index;

As an extension to the causality pattern (Diebolt & Jaoul, 2004), we introduce here an alternative econometric technique for shock analysis: the outliers methodology.⁵ Our basic assumption is to say that the regular shocks we observe for the Japanese socioeconomic development are superposed by irregular shocks, which appear rarely. Through this approach, we ask whether the long-term economic development of Japan is caused by such extraordinary shocks and wars especially. If this was the case, economic growth could probably not be explained as a systematic process but would have to be traced back to specific historical events.

*«Outliers represent sudden temporary or permanent shifts in the level of a time series. There are several methods for the detection of outliers based on intervention analysis as originally proposed by Box and Tiao (1975). An often used procedure is that of Tsay (1988). This method was also used by Balke and Fomby (1994), although with some modifications. Here we will use an improved algorithm by Chen and Liu (1993), which is readily available, with slight modifications, in the computer program TRAMO developed by Gómez and Maravall (1997, 2001)».*⁶

In this paper, we analyse three main outliers: AO, LS and TC.

Consider a univariate time series y_t^* which can be described by the ARIMA(p, d, q) model:

$$\alpha(B)\phi(B)y_t^* = \theta(B)a_t \quad (7)$$

where B is the lag operator, a_t is a white noise process, $\alpha(B)$, $\phi(B)$, $\theta(B)$ are the lagged polynomials with orders d , p , q , respectively.

⁵For the reader interested in the complete mathematical and statistical presentation of the outlier methodology, please cf. Darné and Diebolt, 2004, 2006.

⁶Darné and Diebolt, 2004, p. 1452.

The outliers can be modelled by regression polynomials as follows:

$$y_t = y_t^* + \sum_i \omega_i \nu_i(B) I_t(\tau) \quad (8)$$

where y_t^* is an ARIMA process, $\nu_i(B)$ is the polynomial characterizing the outlier occurring at time $t = \tau$, ω_i represents its impact on the series and $I_t(\tau)$ is an indicator function with the value 1 at time $t = \tau$ and 0 otherwise.

In this paper, three⁷ main outliers are classified as:

– Additive Outliers (AO) that affect only a single observation at some points in time series and not its future values. In terms of regression polynomials, this type can be modelled by setting: $\nu_1(B) = 1$.

– Level Shifts (LS) that increase or decrease all the observations from a certain time point onward by some constant amount. In this case, the polynomial: $\nu_i(B) = 1/(1 - B)$.

– Temporary Changes (TC) that allow an abrupt increase or decrease in the level of a series which then returns to its previous level exponentially rapidly. Their speeds of decay depend on the parameter $\nu_i(B) = 1/(1 - \delta B)$, where $0 < \delta < 1$.

It is considered that AOs are outliers, which are related to an exogenous and endogenous change in the series, respectively, and that TCs and LSs are more in the nature of structural changes. TCs represent ephemeral shifts in a series whereas LSs are more the reflection of permanent shocks.

An ARIMA model is fitted to y_t^* in (7) and the residuals are obtained:

$$\hat{a}_t = \pi(B)Y_t, \quad (9)$$

$$\text{where } \pi(B) = \frac{\alpha(B)\phi(B)}{\theta(B)} = 1 - \pi_1 B - \pi_2 B^2 - \dots$$

For the three types of outliers in (8), the equation in (9) becomes:

$$\begin{aligned} \text{AO: } \hat{a}_t &= a_t + \omega_1 \pi(B) I_t(\tau) \\ \text{TC: } \hat{a}_t &= a_t + \omega_2 \left[\frac{\pi(B)}{(1 - \delta B)} \right] I_t(\tau) \\ \text{LS: } \hat{a}_t &= a_t + \omega_3 \left[\frac{\pi(B)}{(1 - B)} \right] I_t(\tau) \end{aligned}$$

⁷There is a fourth main outlier that is not detected in this analysis: the innovative outlier (IO) that affects temporarily the time series with the same dynamics as an innovation. The polynomial is then $\nu_i(B) = \theta(B)/\phi(B)$. IOs will have a relatively persistent effect on the level of the series.

These expressions can then be viewed as a regression model for \hat{a}_t , i.e.,

$$\hat{a}_t = \omega_t x_{i,t} + a_t$$

With:

$$\text{for all } i \text{ and } t < \tau: \quad x_{i,t} = 0$$

$$\text{for all } i \text{ and } t = \tau: \quad x_{i,t} = 1$$

$$x_{1,t+k} = -\pi_k \quad (\text{AO});$$

$$\text{for } t > \tau \text{ and } k \geq 1: \quad x_{2,t+k} = \delta^k - \sum_{j=1}^{k-1} \delta^{k-j} \pi_j - \pi_k \quad (\text{TC});$$

$$x_{3,t+k} = 1 - \sum_{j=1}^k \pi_j \quad (\text{LS}).$$

The test statistics for the types of outliers are given by:

$$\text{AO: } \hat{\tau}_1(\tau) = [\hat{\omega}_1(\tau) / \hat{\sigma}_a] / \left(\sum_{t=\tau}^n x_{1,y}^2 \right)^{1/2}$$

$$\text{TC: } \hat{\tau}_2(\tau) = [\hat{\omega}_2(\tau) / \hat{\sigma}_a] / \left(\sum_{t=\tau}^n x_{2,t}^2 \right)^{1/2}$$

$$\text{LS: } \hat{\tau}_3(\tau) = [\hat{\omega}_3(\tau) / \hat{\sigma}_a] / \left(\sum_{t=\tau}^n x_{3,t}^2 \right)^{1/2}$$

$$\hat{\omega}_i(\tau) = \frac{\sum_{t=\tau}^n \hat{a}_t x_{i,t}}{\sum_{t=\tau}^n x_{i,y}^2} \quad \text{for } i = 1, 2, 3.$$

where $\hat{\omega}_i(\tau) (i = 1 - 3)$ denotes the estimation of the outlier impact at time $t = \tau$, and $\hat{\sigma}_a$ is an estimate of the variance of the residual process.

An outlier is identified at time $t = \tau$ when the test statistics $\hat{\tau}_i(\tau)$ exceeds a critical value. In TRAMO (Time Series Regression with ARIMA Noise, Missing Observations, and Outliers) the critical value is determined by the number of observations in the series based on simulation experiments. The different test statistics at time $t = \tau$ are compared in order to identify the type of outlier. The one chosen has the greatest significance such as $\hat{\tau}_{\max} = \max |\hat{\tau}_i(\tau)|$. When an outlier is detected, we can adjust the observation Y_t at time $t = \tau$ to obtain the corrected Y_t^* via (8) using the $\hat{\omega}_i$, i.e. $Y_t^* = Y_t - \hat{\omega}_i v_i I_t(\tau)$. Finally, the procedure is repeated until no outlier is detected. A multiple regression on Y_t^* is performed on the various outliers detected to identify spurious outliers.

4. Cliometric results

The outliers methodology clearly shows that the dynamic of the process that led to economic growth and development in Japan was dependent of political events, especially the Sino-Japanese and the Russo-Japanese Wars (Annex 1).

Table 1
Outlier detection⁸

Total educational expenditure				
Year	Type	Value	T-stat	Event
1896	LS	0,1546	5,83	Sino Japanese War
1905	AO	-0,069934	-5,01	Russo japanese War
1916	LS	0,24798	9,45	WW1
Military expenditure				
Year	Type	Value	T-stat	Event
1894	TC	1,254	11,13	Sino Japanese War
1896	AO	-0,38199	-5,4	Sino Japanese War
1904	TC	0,83041	11,23	Russo Japanese War
1937	LS	0,60083	5,85	Japan's Invasion of China
National debt				
Year	Type	Value	T-stat	Event
1906	LS	1,0622	4,97	Russo Japanese War
Capital expenditure	No outlier			
Price index	No outlier			
GNP	No outlier			
Total Gov Exp	No outlier			
National income	No outlier			

In order to explain the importance of the influence of various outliers, we consider the two main events which influence both military expenditures and others variables: the Sino Japanese War and the Russo Japanese War.

The Sino-Japanese War broke out in 1894. There may be several explanations for this war. Among these, mutually related factors such as the need to find new markets is probably a crucial one! The war resulted in provoking further nationalism, stimulating national unification, and gradually changing the industrial structure. The victory is also the result by superior spirit and equipment, which may be ascribed to the development of education and the foundation of the industrialisation since the early Meiji period. From a purely economic perspective, the Sino-Japanese War enlarged the domestic financial and capital market through rising military expenditures based on public loans, stimulated military technology and general industry (by the distribution of military expenses). The war also reinforced the foundation for the development of light industry by assuring it connection with the Chinese market, and provided a foundation for the growth of heavy industry. The experience of the

⁸The demographic time series is excluded from our test for the main reason that growth and change in the population dynamics rarely have an instantaneous effect.

war was immediately related to demands for domestic steel production, extending railways, reinforcement of the number of vessels, promotion of shipbuilding etc. Responding to such progress in industrialisation, secondary and higher education began to be consolidated. It is also significant that the Gold Standard was established in 1897 as a result of the reparations paid to Japan after the war. In addition to the influence on military expenditures (1894; 1896), this event also has an impact on educational expenditures (1895). In line with our previous paper (Diebolt & Jaoul, 2004), a causal relationship from the military expenditures to the educational expenditures seems to be verified. So, historical events seem to affect first the military sector and then influence the rest of the economy and especially the educational sector.

Within only ten years after the Sino-Japanese War, the Russo-Japanese War started. The competitive invasion into China stimulated the Boxer Rebellion in 1899. In 1901, the Peking Protocol was concluded, but during the process, opposition arose between Russia and the United States and England. In 1902, the Anglo-Japanese Alliance was formed and the Russo-Japanese War started in 1904. This event was far larger in scale than the Sino-Japanese War in military expenditures, the number of mobilised military forces and the duration of the war. The scale of the war influenced education as well as the whole economy. The Ministry of education summarised the influence of the war upon school children and parents in the following account: the war made them realise the importance of education and academic skills, and stimulating their ambitions for learning; world and nationalistic concepts were clarified, and knowledge of economics, geography, science, military affairs etc. was provided; the war offered an opportunity for cultivation of the virtues of patriotism, public spirit, chivalry, sympathy, obedience, self-respect and progressiveness; the war made them realise the importance of business; the war made the parents and communities accept the necessity of the establishment of schools as basic assets. This war, in contrast to the Sino-Japanese War, was developed in an abnormal situation. Japan was inferior in the number of soldiers and arms, but was superior in the quality of the soldiers. Before country acquired a decisive victory either politically or militarily, the Peace Treaty was conducted through Roosevelt's mediation during the 1905 Revolution in Russia. This victorious war was the turning point for Japanese politics and its economy, initiating its rapid conversion to imperialism!

As for the Sino Japanese War, according to Diebolt & Jaoul (2004), a causal relationship appears for the Russo-Japanese War. This war affected military expenditures (1904), education expenditures (1905) and the national debt (1906).

How can we explain the role of the military expenditures?

There are, at least, three hypotheses to explain state's motives of increasing the defence spending (Castillo and al., 2001):

- Ambition: military expenditures vary with the economic power. This suggests that military spending is a positive function of economic growth. This relation can occur through another variable like capital expenditure (Diebolt & Jaoul, 2004).

- Fear: military expenditures are a function of the state's insecurity. "*The greater the level of threat to a state's security, the higher the level of military spending*" (Castillo & al., 2001, p. 53). This reason has been modeled by Looney (1990) following the work of Richardson (1960) who thought that military expenditures of a country depend on military expenditures of another one. Castillo and al. (2001) also analyzed this possibility: they include US military expenditures in order to explain Japanese military expenditures and showed that there is a significant effect.
- Legitimacy: States use aggressive foreign policies and high levels of military expenditures to deflect domestic troubles.

Contrary to the two first hypotheses which refer to an international system, the latter one refers to a domestic determination of the level of the military expenditures. Concerning Japan, we suggest three main hypotheses in order to explain the increase of the military expenditures (Table 2).

Table 2.
The possible explanations of the increase of the military expenditures

Period	Hypotheses	Events
1870-1890	Fear	Meiji Restoration and Satsuma Rebellion
1891-1913	Ambition and Fear	Sino and Russo Japanese Wars
1919-1939	Ambition, Fear and Legitimacy	Japan's Invasion of China

During the period 1870-1890 Japan begins its period of modernisation with the Meiji Restoration. The country knew an economic takeoff and military expenditures increased rapidly but economic growth didn't imply an expansionist foreign policy so that the ambition hypothesis cannot explain this period. However, fear appears to be the principal motivation of the period of Meiji Restoration.

During the period 1891-1913, military expenditures were driven by territorial expansion. The increase in economic growth pushed up military spending as well as more ambitious foreign policy. However the willingness to extend territory can also explain a feel of fear. So the two hypotheses can explain this period.

The last period is characterised by the three hypotheses: fear (growth of the Russian military capabilities and a possible conflict with the Soviet union over a territory in China), legitimacy (willingness to build a Japanese empire despite scarcity resources) and ambition (between 1934 and 1938, Japanese GDP grew from 30\$ billion to 55\$ billion and spurred military spending in an ambitious way to expend territory). Whatever the reason of the increase on the military expenditures, their role seems to have a lagged effect on the economy. Indeed, the influence on the education sector is lagged of one year and the effect on national debt (for the Russo Japanese war) is lagged of two years. In order to verify this lagged influence, we calculate on the one hand, correlation coefficients and on the other hand, we estimate with ordinary least squared, a single equation explaining (1) the education expenditures in function of lagged (-1) military expenditures and (2) the national debt in function of lagged (-2) military expenditures. The correlation coefficient between education expenditures and lagged (-1) military expenditures equals 0,69 and the single equation shows a significant influence of the lagged military expenditures on educational expenditures (t-stat = 7, 33; $R^2=0,48$). Between national debt and lagged (-2) military expenditures, the correlation coefficient equals 0,71 and the single equation also shows a significant influence (t-stat=7,57; $R^2=0,61$).

5. Conclusion

This paper has investigated the impact of defense spending on Japanese long-term development. Military expenditures can therefore be considered as driving forces behind the economic growth process of the country. Our analysis also shows that the amount of military expenditures governs those of education and capital expenditures. This being so, even if the level of the former is a direct cause of the level of economic growth, it is clear that although the level of capital expenditures encourages economic growth it is initially governed by the initial growth level. Chronologically, Japan therefore seems to have developed its military and education sectors, enabling a certain degree of growth, and this favoured capital expenditures. The latter then played the determinant role of driving force behind growth.

This conclusion has important lessons for current topics in policy, especially for the question of the sources of growth. The subject is of renewed interest since the early 1980s. The so-called ‘endogenous’ growth theories have been used to extend and go beyond the traditional ‘exogenous’ growth model (Aghion and Howitt, 1998). The main factors of endogenous growth, that may or may not generate externalities, are the accumulation of knowledge, public infrastructure and human capital. In addition, there is inquiry into how the economic effects of education may derive directly from individuals and indirectly, through their descendants (the legacy effect) and via other individuals, as well as into how economic activity affects education systems and the types and levels of education offered. After the initial contributions, the themes investigated were different: models based on human capital accumulation insist more on social inequalities or on the relationship between inequalities and growth; models based on R&D insist more on the Schumpeterian issue of destructive creation and its impact on the labour market as well as nations’ specialisation or persistent development gaps. Taken as a whole we feel rather confident that there are historically important effects of education and knowledge on growth. We are less confident that the effects of education on growth are as large as is claimed by the growth theories (Diebolt, Guiraud and Monteils, 2003).

Future studies may investigate more systematically the role of military policy, wartime periods and defense expenditures as a main engine for growth. Wars are special moments in the metamorphosis of economic structures. They take the form of stages during which the economic sphere has to change under the weight of political issues. They deform probably part of reality, but are not just milestones marking the turning points of history. They exist as facts of considerable importance for past, present and future economic growth of many countries.

Future works must also take into account the phenomenon of terrorism in the models of defense economics (Fontanel, 2007) and especially the rationality of the actors and the asymmetrical information. Indeed, with terrorism, the amount of defense expenditures will not be directly linked to the quantity of the military expenditures of an unfriendly state but it will more depend on the detection of a threat.

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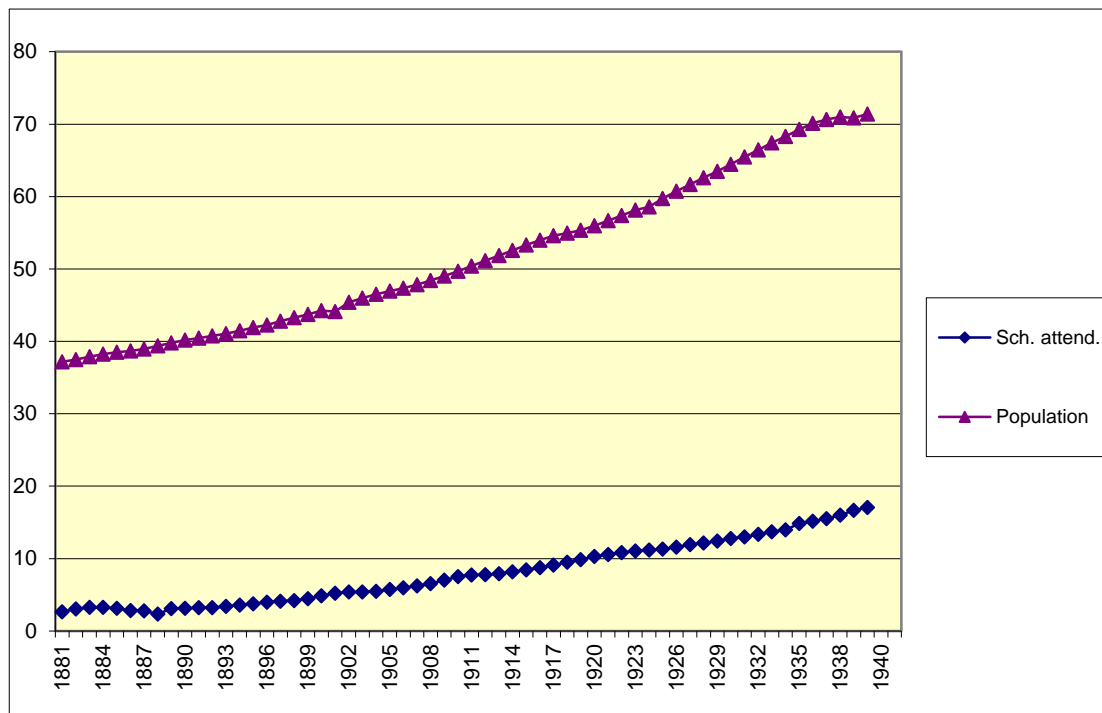
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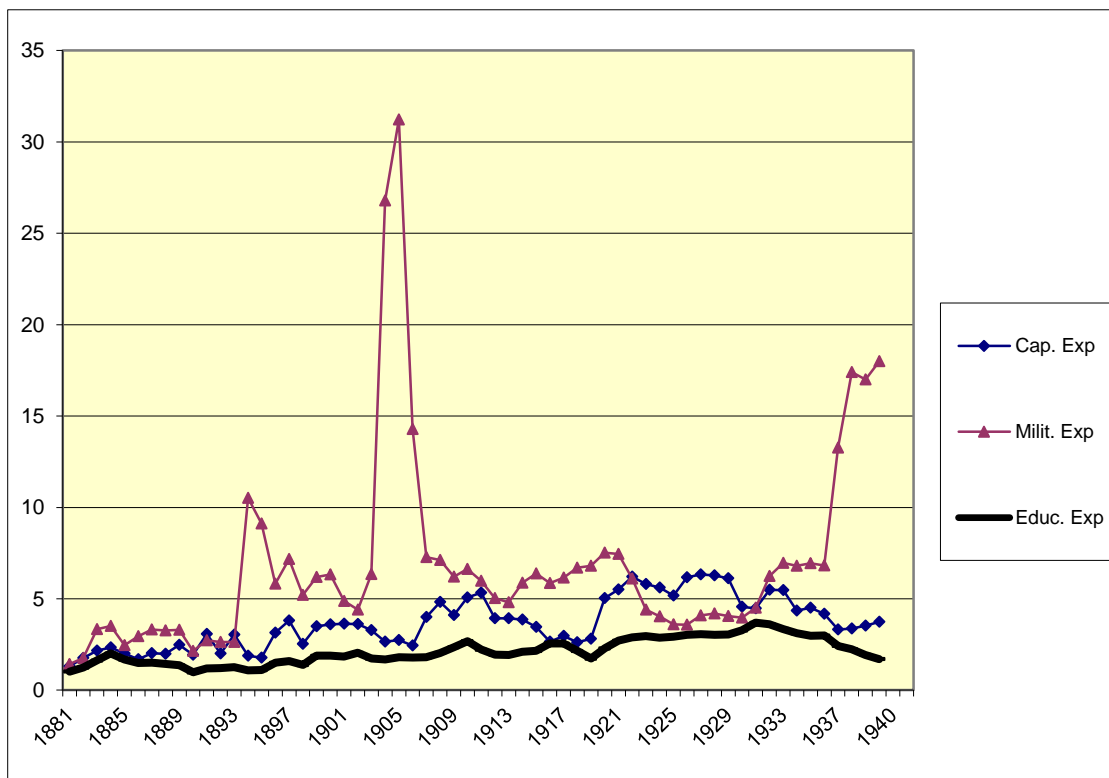
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ANNEX 1

Evolution of the population and school attendance (in millions): 1881-1940



Share of state expenditure in relation to the GNP (percentages): 1881-1940⁹



⁹The 1904 peak was caused by the Japanese attack of the Russian installations at Port Arthur. The Russian-Japanese war (won by Japan) was the first conflict between major powers since 1870. The phase of strong increase in defense expenditure that began in 1937 corresponds to Japan's invasion of China.